Editors C. Mileto, F. Vegas, A. Hueto-Escobar, S. Manzano-Fernández

VERNACULAR HERITAGE

DOCUMENTATION, CONSERVATION AND ADAPTIVE REUSE

edUPV
Universitat Politècnica de València

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Preface

C. Mileto, F. Vegas, A. Hueto-Escobar, S. Manzano-Fernández
Research Centre for Architecture, Heritage and Management for Sustainable Development (PEGASO), Universitat Politècnica de València, Valencia, Spain

The "HERITAGE2025 International Conference on Earthen and Vernacular Heritage: Conservation, Adaptive Reuse and Urban Regeneration" has been organized within the framework of three research projects. The first of these, the research project "**Earth4Future -** Sustainable Reuse of Earthen Architecture and its Lessons for Contemporary Architecture", is funded by the Spanish Ministry for Science and Innovation (PID2022-139154OB-I00) and directed by the Universitat Politècnica de València. The second research project, "**Re-Habitat**– Restoration and sustainable rehabilitation of traditional dwellings in historic contexts", is funded by the Department of Innovation, Universities, Science and Digital Society of the Generalitat Valenciana (CIAICO/2022/035) and directed by the Universitat Politècnica de Valencia. Finally, the research project "**ENACT 15mc** Envisioning Neighbourhoods and Co-Creating Thriving Communities in the 15-Minute City" is cofunded by the European Union (through Driving Urban Transitions Partnership, DUT, AEI, PCI2023-145946-2) and directed by the Norwegian University of Science and Technology, in collaboration with other associations, bodies, and universities including the Universitat Politècnica de València.

The project "**Earth4Future** Sustainable Reuse of Earthen Architecture and its Lessons for Contemporary Architecture", with a research team directed by the Universitat Politècnica de València, together with other universities both within and outside Spain, primarily aims to research the energy behaviour and viability of compatible interventions in earthen constructions within Spain. This seeks to identify solutions which increase energy efficiency and reduce emissions without jeopardising cultural, heritage, and social values. This project analyses issues such as respect for heritage values, real economic cost, environmental impact, and energy efficiency based on studies carried out on historic earthen constructions together with contemporary applications of earthen techniques in new constructions.

Furthermore, the project "**Re-Habitat**– Restoration and sustainable rehabilitation of traditional dwellings in historic contexts", with a research team led by the Universitat Politècnica de València and made up of researchers from universities both within and outside Spain, focuses on the analysis of historic buildings in urban and rural settings. By analysing similar parameters within the Comunidad Valenciana, it seeks to propose guidelines and intervention criteria that are compatible with heritage and are economically viable, environmentally sustainable, and energy efficient.

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Analysis on a larger scale features the project "**ENACT 15mc** Envisioning Neighbourhoods and Co-Creating Thriving Communities in the 15-Minute City" directed by the Norwegian University of Science and Technology and different collaborators. This project examines the potential of redesigning historic urban spaces and improving quality of life, active mobility, accessibility and social relations, in order to achieve the concept of "15-minute cities", through case studies such as Trondheim, Gdańsk, Valencia and Oxford.

The three projects are considered complementary, as they all seek to promote sustainable architecture and urbanism linked to heritage, energy efficiency, and community development, always aiming to strike a balance between tradition and innovation. This is a response to critical challenges such as climate change, population loss, the disappearance of traditional crafts, and the need for vibrant, inclusive, and resilient cities. This further highlights the pressing need to promote research, increasing awareness and action in multiple sectors, actively aiding the transition to more sustainable societies in terms of heritage and urbanism.

Given that these research projects display certain commonalities, particularly in relation to the challenges and perspectives for the future detailed above, and offer the potential for joint discussion, the main themes have been combined in the HERITAGE2025 International Conference. The themes established for the conference are: **1. Vernacular architecture** (study and cataloguing of vernacular architecture; study of traditional materials, techniques and construction crafts; mechanisms of sustainability of vernacular architecture; restoration and conservation of vernacular architecture; energy efficiency and sustainable design projects; management and maintenance); **2. Earthen architecture** (study and cataloguing of earthen architecture; study of traditional materials, techniques and construction crafts; mechanisms of sustainability in earthen architecture; restoration and conservation of earthen architecture; energy efficiency and sustainable design projects; management and maintenance), **3. Urban and rural historical sites** (studies of historic urban and rural areas; intervention and regeneration projects; management and maintenance, threats and opportunities in historic areas: tourism, infrastructure and identity; proximity economy and traditional commerce in historic contexts); **4. From tradition to contemporaneity** (contemporary projects inspired by tradition; traditional sustainability mechanisms applied to contemporary architecture; integration of contemporary projects in historical contexts; reinterpretation of traditional techniques for their application in contemporary architecture).

The Scientific Committee is made up of 89 renowned researchers and specialists in the themes analysed, hailing from 25 different countries from five continents. All the contributions to the conference – abstracts as well as final texts – have been subject to a strict peer review evaluation system by the members of the Scientific Committee. Of the 244 proposals submitted, a total of 150 papers written by 328 authors from 30 countries of five continents has been selected for final publication.

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The papers selected have been published in three volumes appearing in print and online format and titled *Vernacular Heritage: Documentation, Conservation and Adaptive Reuse*, *Earthen Heritage: Conservation, Adaptive Reuse and Sustainable Design,* and *Historic Settlements: Conservation, Regeneration and Management*.

The "HERITAGE2025 International Conference on Earthen and Vernacular Heritage: Conservation, Adaptive Reuse and Urban Regeneration" was held on 10-12 September 2025 at the Universitat Politècnica de València, Spain. The conference was carried out with the sponsorship of: WHITRAP – World Heritage Institute of Training and Research for the Asia and Pacific Region under the auspices of UNESCO; ISCARSAH – International Scientific Committee on the Analysis and Restoration of Structures of Architectural Heritage, technical committee of ICOMOS; ICOMOS CIAV – International Council on Monuments and Sites: International Committee of Vernacular Architecture; ICOMOS ISCEAH – International Scientific Committee in Earthen Architectural Heritage; and PROTERRA – Ibero-American Network of Architecture and Earthen Construction. The organization, publication and development of the conference was made possible by funding from the Spanish Ministry for Science and Innovation for the research project "Earth4Future - Sustainable Reuse of Earthen Architecture and its Lessons for Contemporary Architecture" (PID2022-139154OB-I00) and the Department of Innovation, Universities, Science and Digital Society of the Generalitat Valenciana for the project "RE-HABITAT – Restoration and sustainable rehabilitation of traditional dwellings in historic contexts" (CIAICO/2022/035). The Higher Technical School of Architecture, PEGASO - Research Centre for Architecture, Heritage and Management for Sustainable Development, and the Department of Architectural Composition of the Universitat Politècnica de Valencia have also contributed to the development of this conference.

Finally, we wish to thank the authors who have contributed to the quality, range, diversity, and richness of the publication with their papers and studies. We are indebted to all the members of the advisory and scientific committees for their work throughout the entire review process for abstracts and papers. And above all, we would like to thank the organizing committee for their invaluable help in setting up the conference, the style and language reviewers for their corrections, and all collaborators for their inestimable work in the management and organization of each and every phase of the process.

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Architectural Memory: Créole Houses as Living Monuments in Port Louis, Mauritius

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Abstract
This study examines the vernacular architecture of Port Louis in Mauritius island through Créole houses. These houses development because the early architecture of the French colony on the island was not adequately adapted to tropical climate and material resources. Over centuries, the Créole houses have adjusted to the local materials, economy, climate, and culture of the island. The enslaved who were the primary builders of these houses, contributed immensely to the vernacular adaptations. Yet, Créole houses remain understudied despite representing an architectural heritage which links Mauritius to the global network of the French empire and to Africa and Asia. The study seeks to catalogue Créole houses through an examination of their architectural elements, typologies, and craftsmanship. Using archival research, field surveys, and oral histories, this research sheds light on how the enslaved adapted colonial design principles, through their Indigenous Knowledge Systems, to create structures suited to the tropics. One of the research outputs for this study is the first definition of Créole houses in Kreol Morisien. This study will not only provide a visual but also a local architectural vocabulary in Kreol Morisien and contribute to the broader discourse on the preservation of vernacular heritage in postcolonial contexts of the Global South. In doing so, it will advocate for a reimagination of heritage practices to integrate local expertise to ensure the survival of Créole houses as vital components of the cultural landscape of Mauritius.

Keywords: *Creole architecture; Port Louis; Mauritius; vernacular heritage; Kreol Morisien*

1. Introduction

In the 1700s, Port Louis became a prominent French harbour in the Indian Ocean, engaging in commerce with Africa, Asia, and global empires (Toussaint, 1966). However, early French colonial architecture was unsuited for tropical conditions, and this led to vernacular adaptations, which Creole architecture emerged from (Edwards, 1994). The influences for these adaptations were also the contributions of the enslaved, which have been overlooked in Western-centric narratives (Carey, 2018; Edwards, 1994; Green, 2022; Jeewa & Minguzzi, 2024). In Mauritius, enslaved individuals were brought from Africa, Asia, and Madagascar, which are climatically similar (Carey, 2016), and they contributed expert knowledge of the climate and materials in the forms of Créole houses. This article stems from an ongoing doctoral study at Nelson Mandela University, investigating 25 Créole houses of Port Louis—wooden structures dating back to the French colonial era, some over 300 years old.

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Despite their historical significance, Créole houses remain understudied (Carey, 2018) and face threats such as climate change, historical neglect, and lack of funding for maintenance. Currently, only one Créole house is listed as a National Heritage site (Ministry of Arts and Culture of Mauritius, 2003). However, this study has identified 25 Créole houses still standing in Port Louis. The preservation of Créole houses largely depends on homeowners, as financial aid from the National Heritage Fund (NHF) is lacking. Additionally, traditional construction techniques used in these houses remain undocumented, though craftspeople continue to preserve them through Intangible Cultural Heritage (ICH).

Existing research on Créole houses is often framed through a colonial lens, whitewashing their history (Jeewa & Minguzzi, 2024; Seetah, 2018). This article aims to document and catalogue Créole houses in Port Louis in ways that are accessible and relevant to the Mauritian population. A key outcome is to canvass the first definition of Créole houses in Mauritian Kreol, followed by the introduction of a specialised vocabulary for Creole architectural elements which is vernacular to Mauritius.

Given the under-documentation of Créole houses in Mauritius, developing contextualised architectural terms for spatial layout to understand the different existing typologies which exist in Mauritius is a novel contribution. Additionally, the establishment of an architectural vocabulary supports the cataloguing process to create a textual and visual documentation.

To achieve this, the article will outline research methodologies, a literature review, a proposed definition of Creole houses in Mauritius, and finally, a textual and visual catalogue.

This work asserts the agency of Global South researchers in defining their own architectural heritage.

2. Methodologies

The methodologies embody a decolonial approach that reclaims the narratives of Créole houses as lived, evolving spaces rather than static historical artifacts. By integrating desktop research, architectural site surveys, and oral surveys, following the methodology developed by one of the authors over her years of research (Minguzzi, 2021), the study offers a participatory and multidisciplinary framework that not only documents but also reinterprets vernacular heritage through memory, oral traditions, and lived experiences.

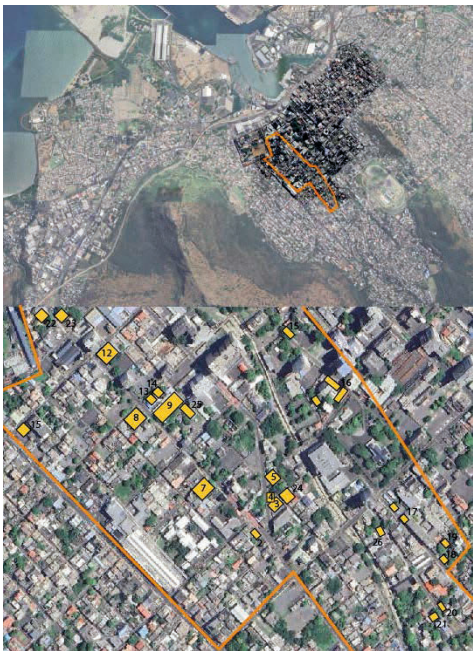

Fig. 1 – *Case studies mapped in Port Louis* (Google Earth, 2025).

The study takes place in St George Street neighbourhood, Port Louis and employs mixed methods as follows:

- **Desktop research:** In post-colonial Mauritius, revisiting history is crucial to representing marginalised communities erased from colonial archives. The study reviews literature on Créole houses and

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Mauritius' history as a site of cultural exchange, to address gaps in existing literature by proposing a novel definition of Créole houses in Mauritius.

- **Architectural site surveys:** The second method involves onsite data collection through architectural surveys, photographs, videos, and sketches. The surveys document dimensions, construction techniques, and materiality, considering both the house and its urban context.
- **Oral surveys:** Oral surveys engage with the community who have been identified for their knowledge of Creole houses and applied construction techniques. These surveys carried out in Kreol Morisien (KM) (local vernacular language) collect first-hand information through a multi-sited ethnographic approach which involves the residents, homeowners, heritage activists, craftspeople, and architects, whose insights—gathered through interviews, house visits, and informal conversations—shed light on oral traditions that have "challenged and resisted the mission of colonisation" (Smith, 2012, p. 30).

These interdisciplinary methodologies challenge conventional architectural historiography by centering non-European contributions and highlighting community agency in shaping the built environment. Research in the Global South and marginalised communities often replicates colonial data collection frameworks, prioritising efficiency and a distant approach. However, studying vernacular architecture and heritage preservation within a community that I am part of requires a socio-cultural approach. Créole houses are more than architectural products; they serve as evolving laboratories, shaped by time, climate, sustainability, and culture.

3. Towards a definition of the Creole houses of Mauritius

Existing scholarship on Creole architecture often borrows terminologies and definitions from broader colonial frameworks, overlooking the localised adaptations and lived experiences that have shaped the Créole houses. This section presents a review of both global and local literature on Créole houses while identifying the gap in the Mauritian Kreol vocabulary.

The global scholarship which studied the evolution of Créole architecture has defined it as a Western phenomenon (Carey, 2016; Edwards, 1994; Fricker, 1984; Pickens, 1948) and limited the presence of Créole houses to the Americas. These scholarships based on American history,

Fig. 2 – *Créole house in Port Louis* (Jeewa, 2025).

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claimed that the Créole houses were primarily established by French settlers in response to the Arcadian region climate, resulting in a uniquely contextual typology that evolves from European customs (Fricker, 1984; Pickens, 1948; Robison, 1975). Architectural historians found this claim to be reductive, prioritising colonial continuity over contextual factors, and they created links between continental Africa and the rest of the Créole world, by highlighting the role of the slave trade as cultural exchange (Carey, 2018; Chapman, 1995; Edwards, 1994).

While it is the case that Créole houses evolved within the French colonial expansion both as a design and an urban scale development, Creole architecture incorporated many vernacular adaptations to become feasible and effective modes of building settlements worldwide (Carey, 2016).

These vernacular adaptations were influenced by contextual factors other than climate, such as:

- The island's natural resources were exploited at an unsustainable rate, necessitating an adaptation in materiality.
- The geographic location of the colony determined the different population dynamics of the enslaved (Carey, 2016; Teelock, 2005).
- Enslaved people were present on construction sites as more than labour, asconsequent architectural responses suited to the local environment, showed their expertise. (Carey, 2018; Jeewa & Minguzzi, 2024).
- Material sourcing, harvesting, and assembling processes were responsibilities left to the enslaved.
- The socio-economic status of the house owners influenced the scale of the building and its material expression.
- The growing economy of the colony determined the permanence of the Creole architecture (Edwards, 2006).
- The policies imposed by the colonial authorities to maintain visual aesthetic and uniformity within the global French Empire.

These contextual factors were compiled by the authors. To consolidate a global understanding of Creole architecture, a definition was proposed by architectural historian Edwards (1994, p. 157), as any “architectural tradition genetically descended from a synthesised tropical colonial form”. An interesting trend in existing literature demonstrates that while Creole architecture is a phenomenon affecting colonies worldwide, the architectural adaptations of Créole houses are regarded as vernacular in most colonies (Fricker, 1984), moving from the cosmopolitan scale to the vernacular.

Despite the historical and cultural significance of Créole houses in Mauritius, a precise definition that encapsulates their architectural, social, and environmental attributes remains absent in both Mauritian academic discourse and the Kreol Morisien (KM) vocabulary.

The Créole house is called *lakaz kreol* in KM but no official definition or description is recorded yet. Using the KM Dictionary (Carpooran, 2011), the following definition for the word *lakaz* (house) and *kreol* (creole) were found. *Lakaz* is as a place where a person resides.[1] and a place where someone feels at home.[2]

The word *kreol* is polysemous, and this article mentions the definitions most relevant to its objectives. *Kreol* described the people who were

[1] Original KM definition: *Lozman kot enn dimounn reste.*

[2] Original KM definition: *Plas kot en dimounn senti li kot li.*

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born in Mauritius and the name of the ethnic group of people who descended from the enslaved population and mixed-race population. *Kreol* is also defined as culture which was born during the time of enslavement in Mauritius, this includes the *Kreol* language, *Kreol* music, and *Kreol* cuisine; it is part of the cultural heritage that the enslaved has passed over to the Mauritian population.[3]

Interestingly, *arsitektir Kreol* (Creole architecture) and *Lakaz Kreol* (Créole houses) was not mentioned in the dictionary definition as being part of Kreol culture. Similarly, in the definition of *lakaz* there is no mention of *Lakaz Kreol* (Créole house). As a result, the term *Lakaz Kreol* has been loosely applied, without a rigorous framework that reflects the unique evolution of these structures within the Mauritian context. A definition of *Lakaz Kreol* in KM is proposed to fill in the research gap regarding a definition of the Créole houses. The following text will be in KM and is part of the research output:

> *Dan konteks Morisien, mo propoze ki Lakaz Kreol kapav definir kouma: enn lakaz dibwa souleve lor en baz ros dan stil arsitektir Kreol ki fin bati par ban artizan ek zouvrier ki servi bann metod tradisyonel typik de lil moris. Sa ban metod la finn transmet depi nu ban zanset de lepok colonial ek esklavaz, sa reflet en melanz de lafrik, lerop, ek sidasiatik. Enn Lakaz Kreol li ena ban trai arsitektiral ki inik ek adapter ek konteks Morisien ek klima tropical..*[4]

This proposed definition has been created to fill the currently existing gap in the Mauritian scholarship on Créole houses. As Fricker (1984) explained, Créole houses should be studied as a collection of unique architectural features which proposes a combination of spatial layout which use geometric design and local material and is not confined to a specific typology.

4. The vernacular expression of the Mauritian Creole houses.

The typologies mapped from the surveyed Créole houses in St. George Street, Port Louis reveals the extent of the variation that were commonly used in Mauritius. As defined before, the Créole houses selected for the research are wooden structures raised onto a masonry rock base.

While other colonies such as French Louisiana, New Orleans, St. Louis used the *poteaux-en-terre* (pillars in earth) methods (Petersen, 1966, p. 29) or limestone blocks (Edwards, 2011), the Mauritian Créole houses used vernacular volcanic basalt rock. On the island, the *poteaux-en-terre* method is prone to water rot and termite damage. However, the volcanic stone is a vernacular element, it is less expensive than wood, requires no after treatment, it remains unchanged by humidity, moisture ingress, and weather conditions.

From fieldwork, it was observed that the rock can be hand sawn when soaked in water. It is then chiselled into smooth rectangular blocks, placed onto one another in a running pattern until the foundation walls were raised from the natural ground line at around 3 blocks high.

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[3] Translated from KM: Ki finn ne dan Moris dan lepok lesklavaz. *Lang kreol, lamizik kreol, lakwizinn kreol, se ban kiksoz ki bann esklav finn donn popilasion Moris an eritaz.*

[4] The text can be translated to “In the Mauritian context, I propose that a *Lakaz Kreol Morisien* can be defined as: a wooden raised house built in the Creole architectural style by artisans and laborers using traditional construction methods specific to the island of Mauritius. These traditions were passed down from our ancestors during the colonial times of enslaved labour, reflect a fusion of African, European, and South Asia. has unique architectural features adapted to the tropical climate”.

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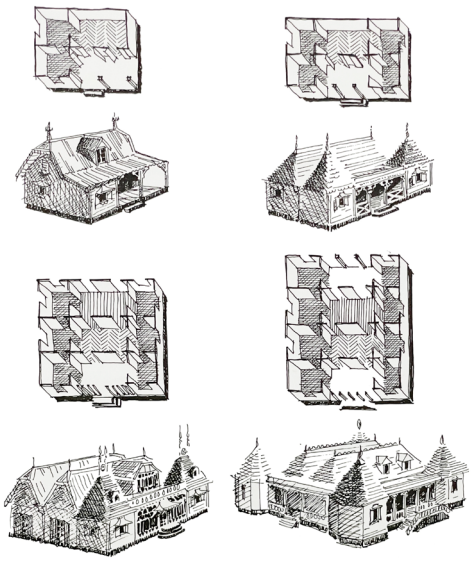

Fig. 3 – *Creole house on research site, Port Louis* (Pages, 1976).

This vernacular adaptation was common in the Indian Ocean colonies as they were linked to the arrival of the enslaved from Pondicherry, India, who were known for their stone carving skills (Seetah et al., 2014). The raised foundation allows for an air gap between the wooden structure and the ground which becomes waterlogged during rainy season. The masonry rock base limits the risk of termite infestations and creates a crawl space for cross ventilation and extra storage. The base punctured with an access hatch and at time slathered with armagasse or a limewash to draw the moisture out from the rock (Fig. 4).

Aside from rock, wood was used as the structural pillars of the building, then as bracing, and internal wooden panels. On the facades, local takamaka and tamarin wood were cut into thin panels and overlaid as shingles on the roof and walls. These woods have water-resistant, antifungal, antibacterial properties, which created an optimum living condition for the household.

Fig. 4 – *Creole house on research site, Port Louis* (Jeewa, 2024).

4.1. The typologies of the Mauritian Créole houses.

The living space of the Créole houses were arranged in ways that follow the strict geometry and building ratio (generally 4 metre x 4 metre) of wooden structures. Pillars are spaced across each other and a diagonal bracing is inserted to apply wooden panels to create wall partitions. The use of corridors was avoided to maximise the internal layout.

To accommodate the privacy, the front of the house was used as living areas for the *salon* (living room) - later *biro* (offices) and *lasam prinsipal* (master's bedroom) was added as the household grew. The *salon* was at times attached to a raised *lavarang* (verandas) or spilled out onto the pavement, making them the most public spaces. The size and ratio differed according to the socio-economic status of the household and the urban density of the neighbourhood.

In the back of the Créole house, *lakwizinn* (the kitchen) and *lasam bin* (the bathrooms) were built as outhouses to reduce risks of fires and moisture ingress into the main house. Therefore, *lacour* (the backyard) was a communal space, often built with a freshwater fountain, fruit trees for shade, a vegetable garden and a room which

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acted as servant quarters and storage. Although communal, these backyard spaces were private and reserved for the women and servants of the house.

Inside the Créole houses, *lasam manzer* (dining room) and *lasam dormi* (bedrooms) were added according to the growing needs of the household. These middle rooms maintain their internal temperatures and act as a privacy buffer for the gendered spaces of the house. In post-colonial and post-enslavement times, these dynamics have changed, yet the evolution of the typology of the Créole houses still follow these unspoken rules (Fig. 5).

5. Conclusions

This article documents the vernacular Créole houses of Port Louis, through a lens which combines scientific, architectural, and ethnographic analysis. The article focuses on a decolonial approach of representing the Créole houses through a proposal of a definition in Kreol Mauritian. This novel contribution is supported through an examination of the typologies of the Créole houses and using KM vocabulary to name the spaces.

Vernacular architecture and vernacular language, here work together to create a cultural reappropriation of Créole houses which are still viewed from a colonial lens. This lens creates historical bias and ignores the context of the enslaved and the cultural needs for adaptation. This research contributes towards the subsequent active protection of these heritage homes and knowledge dissemination to Mauritians. This article raises awareness of the value of the Créole house through the study of historical, material and cultural aspects. Furthermore, this article also addresses how Créole houses have become vernacular through rootedness of the identity within the landscape. The intricate relationship between people, language, climate, and building, becomes a tool to promote the preservation of the Créole houses.

As people face the loss and damage due to climate changes effects, the Créole houses become more vulnerable due to their organic wooden materiality, the tropical climate of the island, the significant vulnerability of Port Louis and financial impact. Since the beginning of the doctoral research in 2022, around 8 Créole houses have been lost yearly due to. Multiple

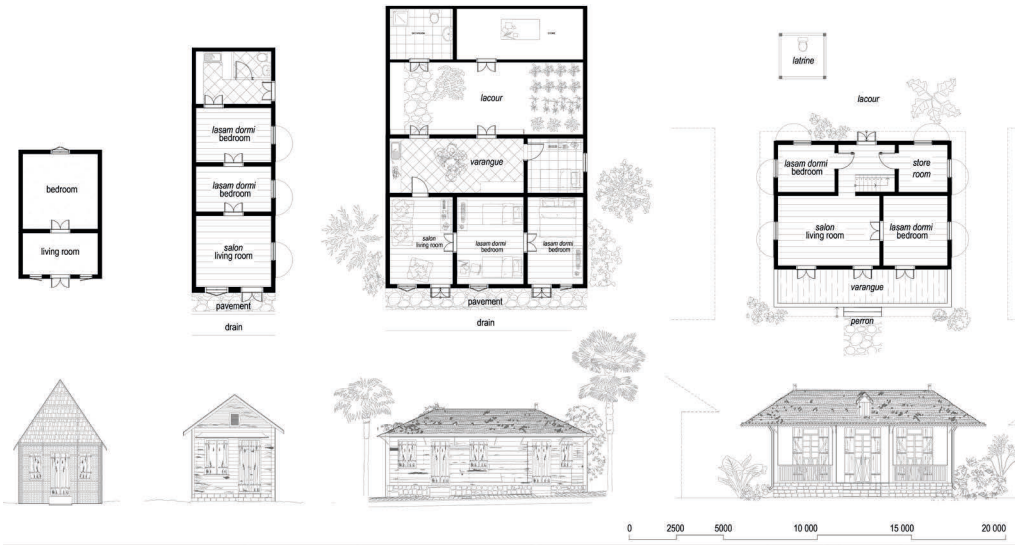

Fig. 7 – *The typologies of the Creole house in Port Louis, Mauritius* (Jeewa, 2024).

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causes including fires, damage due to gradual water penetration and flash floods, and additionally due to the financial burden associated with them.

These circumstances lead to an observation on the protection of this type of heritage. Under such conditions it is, in most cases, not possible to protect the buildings themselves. The intangible cultural heritage practices that generate them must be protected. In the age where modernity has threatened traditional knowledge and crafts, the art of Creole construction must be preserved, transmitted, and translated. The preservation of Creole construction techniques should focus on local materiality and vernacular architectural responses. It should also focus on respecting traditional typologies, even though Creole architecture and Créole houses are a departure from French colonial architecture, their visual and formal aesthetic was regulated by urban policies which promoted regularity and replicability. The owners, residents, and craftspeople are concerned with the conservation and transmission of the knowledge of Creole construction. They fear that the knowledge itself is being lost, therefore, the Créole houses will follow suit. However, research such as this one, supports the valorisation of the Créole houses by recognising its vernacular identity in Mauritius as embedded in nature, oral history, and the memory of the Mauritian people who view the houses as emotionally charged spaces.

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Between Oblivion and Regeneration. A Map of Abandoned Spontaneous Architecture in the Abruzzo Inner Areas (Italy)

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Topic: T1.1. Study and cataloguing of vernacular architecture

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Abstract
Vernacular architecture reflects the relationship between a community and its territory, embodying local traditions and knowledge. It has developed through empirical knowledge, adapting to morphology, resources, climate and socio-economic needs. In many areas, the prevailing rural economy favoured the spread of buildings functional to the management of the territory. This type of architecture is widespread in inner areas of Italy, which face significant challenges related to the marginalisation and demographic decline phenomena. Starting from this premise, the contribution presents a preliminary analysis for mapping the spontaneous architecture in the Abruzzo inner areas, by identifying and cataloguing artefacts that define the built landscape of this territory. This architectural heritage represents evidence of the local building traditions that have developed over the centuries in relation to available resources, climatic conditions and the social needs of the communities. To systematize and make accessible the collected information, a central role has been assigned to digitisation processes through the definition of a digital catalogue integrated with consolidated GIS methodologies for data management and results analysis. The study aims to build a scientific knowledge base of vernacular architectural typologies, which may represent the basis for new insights for developing future hypotheses for the reuse and regeneration of rural architecture in an innovative and sustainable key.

Keywords: *Inner Areas; rural architecture; mapping of spontaneous architecture; regeneration of abandoned heritage; ruin*

1. Introduction

The Italy's inner areas are characterised by the presence of a differentiated architectural heritage that is distinguished by its peculiarities and features. Particularly relevant is the vernacular architecture of rural areas, i.e. those utilitarian artefacts of a spontaneous nature that represent evidence of the relationship between local communities and their territory (Rudofsky, 1966)

Due to the issues affecting inner areas, such as the marginalisation that, since the middle of the last century, has favoured demographic decline and depopulation of territories , abandonment phenomena have emerged, causing the

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deterioration of much of the vernacular architecture. In line with the National Strategy for Inner Areas (Formez PA, 2022), which identifies cultural heritage as a driving force for the economic and social recovery of marginal territories, and the Charter on the Built Vernacular Heritage (ICOMOS, 1999), it is important to implement actions aimed at the knowledge and documentation of the spontaneous architectural heritage to ensure its preservation over time and its enhancement.

Previous studies, at a national (Pagano & Daniel, 1936; Gambi & Barbieri, 1970; Castellano, 1986; Alessandrini & De Concini, 1995) and international level (Blaser, 1976; AA.VV., 1961; Oliver, 2007; Mileto et al., 2015), have contributed to expanding knowledge through typological analyses, laying the foundations for the systematic cataloguing of rural and spontaneous architecture.

The importance of documenting vernacular and rural architectural heritage, as a preliminary action for identifying appropriate conservation and valorisation protocols, is recognized, at the national level, by the activities of the Institute for Catalogue and Documentation (ICCD). The Institute has implemented cataloguing forms to document single objects of movable heritage, archaeological contexts, urban and territorial assets, as well as architectural and demo-anthropological heritage. Recently, within the framework of the National Recovery and Resilience Plan - PNRR, the Rural Architecture - AR form (ICCD, 2025) was developed to describe and document the different types of artefacts found in rural contexts. This form provides for the compilation of different fields, ranging from data concerning the landscape to that of the area's hazard, from architectural analysis to historical data.

This contribution fits into this context and presents the results of a preliminary analysis aimed at mapping the vernacular architecture of Abruzzo's inner areas, combining traditional approaches for thematic analysis with digital technologies for data documentation and management. These knowledge actions support the development of innovative and sustainable strategies for the conservation of abandoned spontaneous architecture.

2. Vernacular architecture in Abruzzo

Vernacular architecture in Abruzzo emerged to meet specific social needs mainly related to daily life, synthesising cultural values and local traditions. This architecture is influenced not only by the orographic characteristics of the Abruzzi territory, which is reflected in the choice of materials and construction techniques, but also by the different economic and labour vocations of territories.

Therefore, vernacular artefacts, which differ according to the region's diverse landscape characterised by sea, hills and mountain peaks, can be ascribed to different functions, such as fishing, sheep farming and agricultural production. This has led to the development on the Abruzzo coast, particularly between Ortona and Vasto, of special fishing architecture called *Trabocchi*, real wooden stilts immersed in the Adriatic Sea (Serafini & Di Toro, 2021) (Fig. 1a). To meet the needs of pastoralism in the Apennine mountains, several dry-stone huts were built and used as shelters by shepherds (Redi & Di Blasio, 2010; Micati, 2016) (Fig. 1b).

The most emblematic expression of vernacular architecture is the residential building, which differs in typological schemes and construction materials according to the geological and orographical characteristics of the territory (Varagnoli, 2003). Mario Ortolani, in his work on the rural house (1961), distinguishes two main models: the slope house (casa di pendio), which develops vertically and is more common in mountainous areas, and the valley house (casa di fondovalle), which develops horizontally and is more widespread in valley areas, extending to the Adriatic coast.

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Fig. 1 – *(a) Photos of: Trabocco "Punta delle Morge", Chieti* (Pixabay, Bueno del tesoro, 13 June 2020)*; (b) Dry-stone huts in Val Maone, Teramo* (courtesy by Giuseppe di Bonaventura).

In addition, the study proposes the distinction into several regional and local types: external staircase type, slope type with a superimposed dwelling, slope type with juxtaposed elements, tower type, Marsica earthquake-resistant type, and coastal gardens type (Fig. 2).

A further classification of vernacular architecture in Abruzzo can be made based on materials and construction techniques. A macroscopic classification distinguishes limestone artefacts in the inner Abruzzo region of L'Aquila, sandstone in the Teramo side of the Gran Sasso (Zordan et al., 2002), and brick houses, also employing the use of rammed earth, mainly in the coastal area (Serafini, 2003). The classification of vernacular architecture derived from existing studies can also be interpreted in relation to the geographical distribution with architectural typologies occurring in inner areas. Based on this assumption, the study proposes to analyse vernacular architecture in a rural context within one of Abruzzo's inner areas (Formez PA, 2022), the Gran Sasso-Valle Subequana located in the province of L'Aquila (Fig. 3).

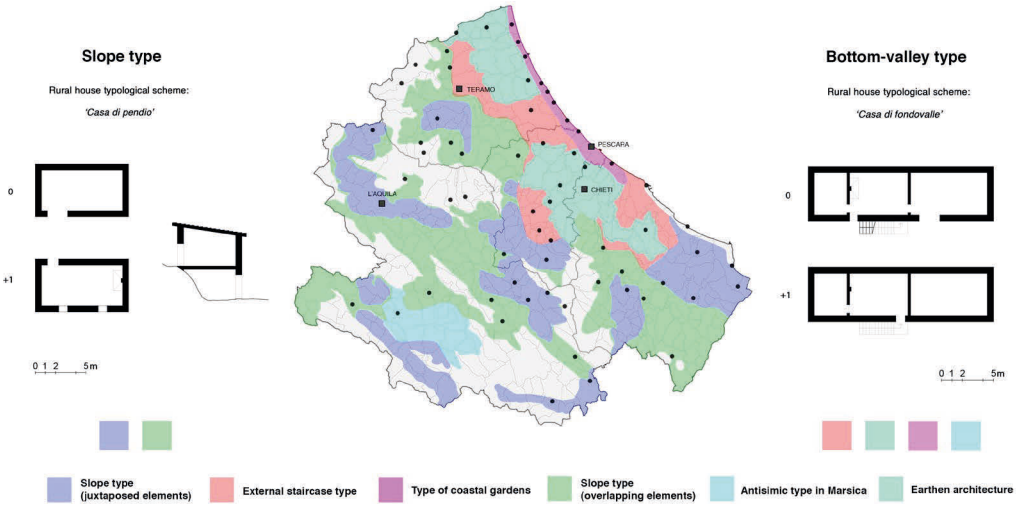

Fig. 2 – *Map of rural house types in Abruzzo* (re-elaborated by authors from Ortolani, 1961).

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Fig. 3 – The map of Abruzzo inner areas with the selected pilot area highlighted in black (Authors, 2025).

3. Materials and methods

The inner area identified as the pilot area (Fig. 3) extends between two imposing mountain massifs, the Gran Sasso to the south-east and the Sirente-Velino to the north-east and is characterised by highland centres and valley-floor settlements that represent the identity of the regional built landscape. The architecture of this area can be analysed in relation to both geomorphological aspects, which have influenced the settlement typologies and the material choices, and to the specific issues faced by inner areas, which have conditioned its use and conservation strategies with the consequent abandonment of many artefacts.

To achieve the research objectives, namely mapping vernacular architecture in the pilot area to increase its knowledge, established methods of analysis and cataloguing have been used for the single artefacts that define the built landscape of this territory. Cataloguing plays a crucial role in documenting the historical built heritage as it enables in-depth knowledge of the typological and formal aspects of heterogeneous assets to be protected and enhanced. In this context, aimed at increasing knowledge through the compilation of specific forms (D'Amore, 2020; Lidón de Miguel et al., 2020) and the development of shared and closed vocabularies that facilitate compilation and ensure standardisation of data (ICCD, 2025), are also significant.

Based on this standard, an expeditious census form for vernacular architecture has been developed, retrieving the main fields of the AR form and integrating them with those derived from the immovable assets forms.

To facilitate the acquisition phase, systematise information and ensure its accessibility, a central role was assigned to digitisation processes. In this regard, the expedition form has been digitised and integrated into a digital catalogue. This catalogue is distinguished by its ability to integrate data, thanks to unique identification code, with specific information from different subject areas, drawing on additional forms developed by the research group (Marra & Fabbrocino, 2020; 2021; Savini et al., 2021).

The catalogue has been integrated into a GIS environment (Accardo, Cacace & Rinaldi, 2005; Acierno & Fiorani, 2019) for a cross-referencing of the data to facilitate the analysis of the results by correlating the artefacts with the territory.

4. Results

The cataloguing of vernacular architecture in the rural context of the Gran Sasso-Valle Subequana inner area helped to validate the potential of the digital catalogue defined.

The first section of the catalogue contains, in addition to the unique identification code (*ID*), general information on the geographical and territorial location of the artefact. The second part of the catalogue contains data that allow for a detailed analysis of the artefact and its specific components, also supported by visual elements such as images and preparatory sketches. Particular attention has been given to the *Category* field, which, thanks to predefined values, classifies the architecture into three systems, as defined in the AR form.

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Specifically, the entries in this field distinguish between: *Single building*, for isolated structures; *Building with outbuildings*, for those consisting of a residential unit and one or more architecturally separate service elements; *Complex*, for groups of multiple elements considered as an organic unit. In the same section is the *Specification* field that allows for recording information on the typological characteristics of the census asset (e.g. *dwelling*, *stable*, *storage*, *warehouse*, *workshop*). The *Typology* field allows for a more detailed classification of the identified typology based on the intended use, specifying the type of dwelling and the characteristics of the outbuildings (e.g. house with overlapping elements, temporary shelter, mill, etc.). Finally, since the typological definition of the property may differ according to the dialectal term used at the regional and local level, the field *Local Denomination* has been included to report the specific name adopted in the reference area.

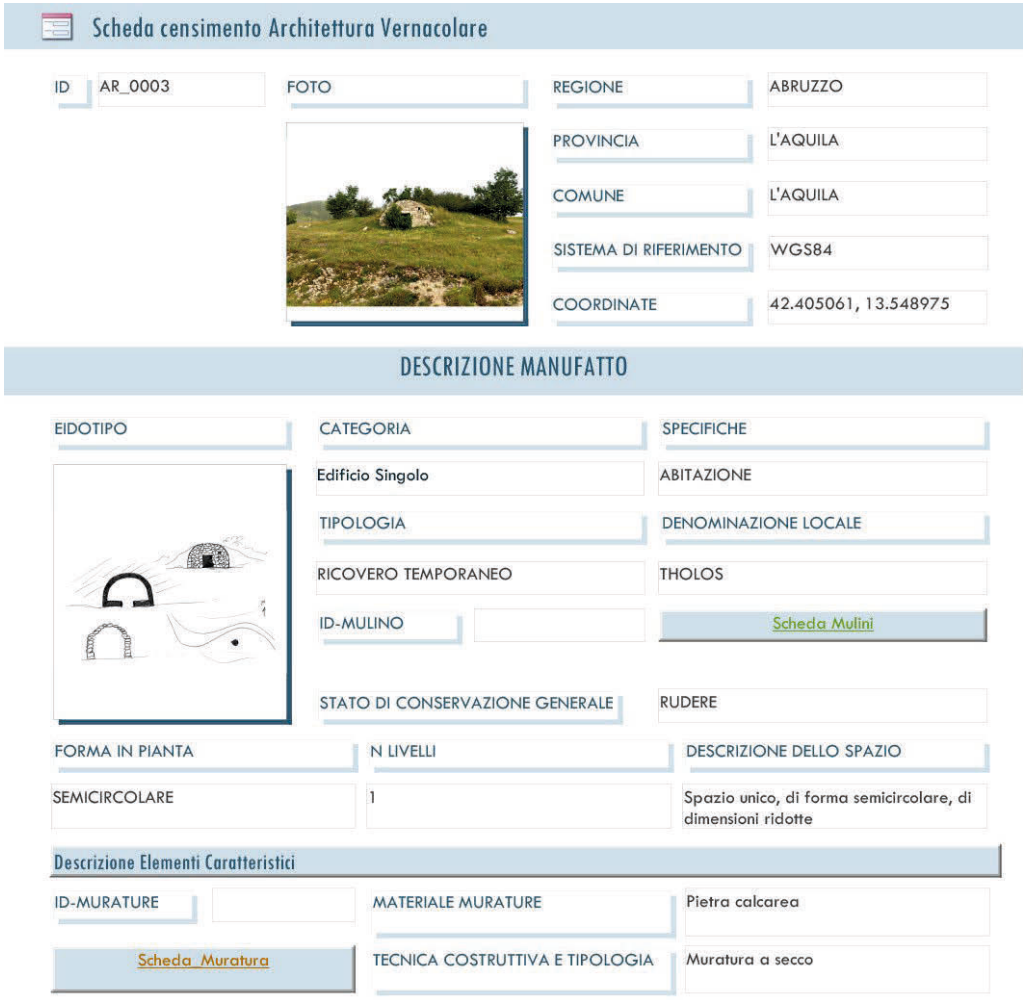

Fig. 4 – *Example of a census sheet of vernacular architecture compiled for a temporary shelter (Tholos) on the Gran Sasso* (Authors, 2025).

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Most of the vernacular architecture in the investigated area refers to the dwellings, which, however, differ significantly according to their location. A notable example is the case of temporary shelters found on the heights of the L'Aquila territory. Among these, the huts used as shelters for shepherds (Fig. 4) are particularly characteristic and are known by different local names, such as *Tholos*, *Locce*, and *Condole*. Some structures with workshop functions have also been surveyed, and their specific function has been recorded in the typology field. Very representative in the Aterno River valley are the mills for which it is possible to implement additional information in a special Mill Form. This form interfaces with the catalogue through the unique identification code *ID-Mill*.

The following fields allow for defining the state of conservation of the artefact and describing it from a spatial and volumetric point of view, thus providing information on the geometric characteristics of the analysed asset that can support future survey campaigns. Some sections of the catalogue concern the characteristics of the masonry for which the materials used, and the construction techniques found can be specified.

The description of the masonry is further detailed in the Masonry Form, which interfaces with the catalogue through the unique identification code *ID-Masonry*. A further field allows the census of architectural elements by defining the type and describing the element. Also in this case, through the *ID-Architectural Element*, it is possible to link the data to those contained in a further form, providing detailed information on each single element.

Finally, the last section of the form includes fields that can only be completed after an in-depth analysis of the structure and its surrounding context. This section gathers information on the history, chronology and evolution of the asset's use, both in the past and present, which may not always be available at the moment of compilation.

The first phase of the census was conducted remotely using the cartographic material available on the Geoportal of the Abruzzo Region. Thanks to the raster layers representing the territory in the form of high-resolution orthomosaics and the digital terrain model obtained through LiDAR, the territorial features in the rural context were analysed. Furthermore, the overlapping with the Regional Technical Map and the one produced by the Military Geographical Institute (IGM) enabled the identification of some isolated artefacts that could fall within the typologies of vernacular architecture. This prompted field analyses for the census of these artefacts through the compilation of the implemented form.

Subsequently, the data collected in the field were linked to the geometric entities created in GIS for each artefact using the Join command, which allows the data collected in the digital catalogue to be related by ID (Fig. 5).

The data analysis in the GIS environment favours a diversified reading according to the information contained in the catalogue. Particularly interesting is the visualisation of vernacular architecture in a state of abandonment. This tool, in addition to increasing knowledge of the architectural heritage, can facilitate the definition of operational strategies by citizens and administrators.

5. Conclusions

The study, which represents an in-depth analysis within a broader research project conducted by the research team on the built heritage of the inner areas of the central Apennines, has allowed for initiating the process of documenting architectural typologies, which, although still at a preliminary phase, represents a crucial step toward understanding vernacular architecture in the Gran Sasso-Valle Subequana inner area.

The results highlight the widespread presence of artefacts belonging to utilitarian vernacular architecture, an expression of the practical needs of communities in the past in relation to both

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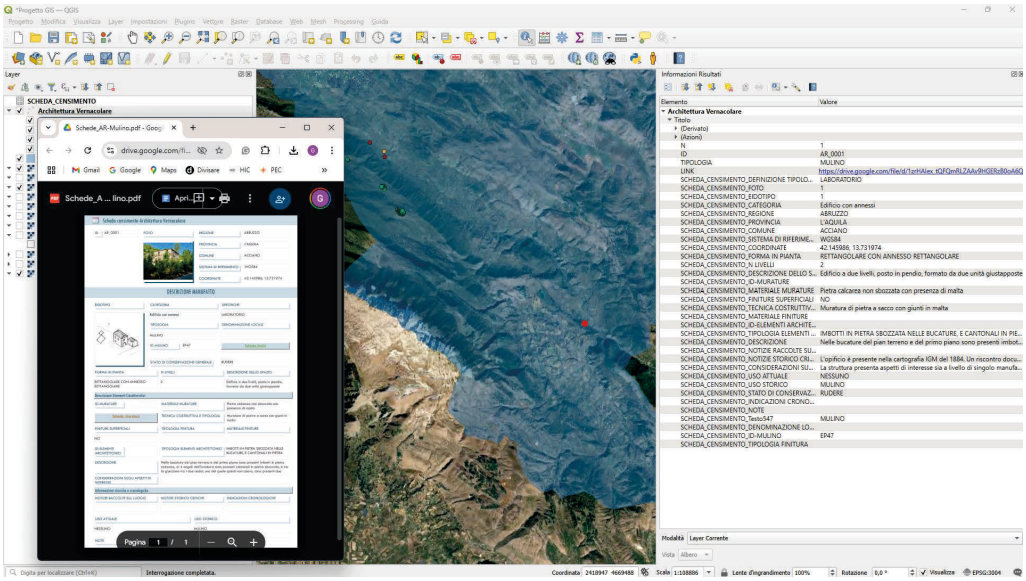

Fig. 5 – *Data integration and visualization in GIS project* (Authors, 2025).

living and working activities. Many structures are closely connected to the agro-pastoral context, serving as refuge for people and animals, thus contributing to the economic and social development of the territory.

The diversified interpretation of the data also allowed the mapping of abandoned vernacular architecture. The map is a potentially useful tool for the conservation of artefacts and historical memory.

Indeed, the digital analysis of the data would improve the management of abandoned vernacular architectural heritage, also in relation to the instability and multi-hazard phenomena that affect inner areas.

The promising results demonstrate how this work can provide the basis for the development of future recovery, reuse and regeneration hypotheses for vernacular architecture in an innovative and sustainable manner.

Acknowledgements

Although the contribution was conceived jointly by the authors, under the supervision of Ilaria Trizio, paragraph 2 is attributed to Gianluca Ciuca, paragraph 3 to Adriana Marra, and paragraph 4 to Francesca Savini, while paragraphs 1 and 5 are attributed to all the authors.

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Characterisation of Vernacular Built Heritage in Corvo Island, Azores: Architecture, Construction and Alterations

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Abstract

To undertake effective and informed rehabilitation and conservation actions, one must rely on the thorough characterisation and diagnosis of buildings. This process is particularly critical in areas where knowledge and practice are limited and where general awareness of the importance of certain constructions, such as vernacular buildings, remains low. Rural, isolated communities are especially vulnerable to this phenomenon, given prevailing lack of social, political, and economic resources necessary to foster progress and development. Corvo island, part of Portugal's Azores archipelago, Portugal, remains a relatively unexplored territory with a single village. Despite maintaining a stable population, its severe isolation has led to a significant lack of information about this territory, including its built environment. The investigation reported in this paper aimed at addressing this research gap by carrying out a comprehensive characterisation of the historical area of Corvo village, focusing on its architectural and construction features through an in-depth in-situ survey conducted in early 2024. The data-gathering methodology included photographic documentation and structured data collection to capture a detailed understanding of the buildings' features and the transformations they have undergone over time. Key characteristics, such as volcanic stone masonry and wooden structural element, were identified, reflecting both the island's material resources and its heritage identity. Furthermore, alterations in volume, usage, and structure are highlighted as examples of common transformations observed in these constructions, which collectively result in diverse variations within the historical area of Corvo village. This study contributes to the preservation of vernacular architectural heritage by documenting and analysing Corvo's unique building practices. The findings lay the groundwork for future conservation interventions and comparative research, offering insights that may inform conservation strategies in similar rural and isolated communities.

Keywords: *vernacular; construction characterisation; rural settlements; heritage values, transformations*

1. Introduction and methodology

Investing in qualified characterisation actions of built environments before any interventions is well-known to be of critical importance. Tasks such as documenting, observing and recording construction and architectural characteristics, as well as state of conservation, are crucial to carry out before undertaking informed action. Despite their importance, these tasks remain scarce in areas where both research and practice are limited, such as rural territories (Ruggiero et al.,

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2019). These territories are characterised by depopulation and abandonment, making them more vulnerable to these circumstances and leading to global lack of awareness regarding the safeguarding of heritage values in existing buildings, such as vernacular constructions (Montalvá et al., 2024).

This paper presents a construction and architectural characterisation of the Historical Centre of Vila do Corvo on Corvo Island, in the Azores archipelago. Besides an initial characterisation of its geography and history based on literature review, research was based on fieldwork including *in-situ* surveys to around 250 buildings, which were observed and photographed, and off-site work for data collection, processing, and analysis. GIS-based software (QGIS) was used to map some characterisation data, providing insights into spatial distribution of buildings with similar features.

2. Geography, history and human context

Corvo Island has an area of 17.12 km^2 and belongs to the Western Group of the Azores archipelago. Formed by volcanic activity (Melo et al., 2018), it presents a central caldera and a coastal lava delta on its southern side, where the only village—Vila do Corvo—is located (Salvador et al., 2021); (Fig. 1). This delta is formed by pyroclastic material, with cinder, ash and tuff (Dias, 2001). The island has been a UNESCO Biosphere Reserve since 2007, and the village itself, established in the 16th century, has been listed as a protected urban site since 1997.

Climate in Corvo is maritime-tempered, with low thermal amplitude, high humidity and precipitation, and persistent winds. The village's location in a sheltered area reflects an adaptation to these conditions, providing proximity to the port and fertile lands. Nonetheless, human settlement in Corvo was an arduous process, marked by poor living conditions, isolation, and pirate attacks until the early 17th century (Salvador, 2020). Despite these challenges, inhabitants remained self-sufficient and maintained a strong sense of community (Salvador et al., 2021).

Corvo's population declined until the 1980s due to a steady demographic exodus to Brazil and United States of America in search of a better life, as extreme poverty persisted until the 20th century (Cordeiro, 1899). Since then, a general improvement in living conditions has allowed the population to stabilise at around 400 inhabitants (Salvador *et al.*, 2021), a figure that has remained relatively stable since the 1980s (Serviço Regional de Estatística dos Açores, 2021). Corvo's development process included a project for the conservation of its built heritage, initiated in 2018 (Governo Regional dos Açores, 2024), which promoted the dissemination of pioneer research on the historical centre of the village (Salvador, 2020; Silva et al., 2018).

3. Urban organisation and architecture

Historical centre of Vila do Corvo (HCVC) has an irregular yet dense urban structure, punctuated by public spaces such as small squares and threshing floors (Salvador et al., 2021). Buildings are urbanely grouped along slopes, following local topography, with main facades usually facing South to maximise solar gains.

Fig. 1 – *Vila do Corvo.*

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Fig. 2 – *Occupancies of buildings in HCVC.*

Historically, building in Corvo were used for housing, animal shelter, or storage of agricultural products. Currently, 79% of buildings are used for housing, opposing to other uses such as storage, garages, services, or public equipment. 33% of buildings in HCVC are vacant (Fig. 2).

Most buildings have two floors and a rectangular shape floor plan. Moreover, 42% of buildings consist of more than one volume, often featuring additional constructions for storage or bathrooms. Previous research indicates that, in most cases, kitchen and storage spaces are located on the ground floor of main volumes, while living rooms and bedrooms occupy the upper floor (Salvador, 2020). Additionally, 60% of buildings have a private patio providing access to the interior of the building. In the remaining cases, the main entrance, accessible from the street, is either on the ground or upper floors.

Regarding the state of conservation, 8% of the buildings are in a very good or new condition, indicating recent interventions, followed by 27% in good condition. 35% of buildings appear to be degraded yet habitable, followed by 23% in a degraded non-habitable state, and 7% are in ruins. 1% are currently under construction.

4. Building techniques and materials

85% of buildings predominantly feature local volcanic stones (basalt, trachyte, and tuff) and wood as primary structural materials. The wood originates from the now-extinct Azorean Forest *laurisilva* (Triantis et al., 2010) and, in some cases, from past shipwrecks. The remaining buildings are primarily relatively recent reinforced concrete structures.

Stone masonry buildings have walls with an average thickness of around 65 cm, which is consistent with dimensions found in other Azorean constructions (Neves et al, 2012; Salvador et al., 2021; Ferreira et al., 2016). Quoins (corner stones) are significant elements in masonry walls, typically made from large, carefully quarried volcanic stones, offering higher quality than the surrounding wall stones. Lower-quality constructions, where quoins consist of irregular stones, are rare.

Uncoated stone masonry is visible in 25% of buildings, while 11% of the inspected buildings feature both coated and uncoated walls. In these cases, the main façade facing the street is coated, whereas the lateral and rear façades remain uncoated. Uncoated masonry buildings typically present façade walls composed of rubble stones arranged in an uncoursed pattern (Fig. 3). Joint alignment is absent, and walls either contain clay mortar or soil-filled joints, or dry joints. Some buildings feature a layer of cement mortar covering the outer surface of joints. Cement render, typically painted white, is the most common wall coating, found in 86% of cases.

Roofs are typically two-sloped gable structures composed of a set of rafters connected to a ridge beam at the top and supported by a ring beam attached to the inner leaf of the masonry wall, running throughout its perimeter (Silva et al., 2018).

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Fig. 3 – *Example of uncoated stone masonry wall with regular quoins, rubble stones, and dry joints.*

Also, horizontal wooden beams placed on this element every 2 meters prevent horizontal movements of the wall and stabilise the rafters. A wide variety of roof coatings placed on tile battens over rafters were found, with barrel-type clay tiles being the most common. Nonetheless, more contemporary materials, such as corrugated roof panels, fibre cement sheets, and Lusa-type clay tiles, are also present.

Aluminium and PVC are currently the most common materials used for window and door framings (44%), following interventions that replaced the original wooden framings, which are still present in 42% of cases. Buildings with mixed framing materials account for 9% of cases. Even though single-hung frames remain the most common window typology (64%), contemporary solutions, such as tilt-and-turn, stand out in 15% of cases, highlighting a trend of replacing traditional framing systems. Double casement (15%), slide (9%), fixed (6%), or casement (4%) windows were also identified, with a significant number of buildings (20%) featuring mixed window typologies. Windowsills are usually absent, instead materialised by horizontal stones supporting window frames.

Exterior stairs, found in 58% of buildings, are made of either large volcanic masonry blocks or concrete. They typically have a straight configuration and are usually parallel to the main façade. When present, the space beneath the stairs is often used for storage, as a bathroom space, or housing animals (Salvador, 2020). Figure 4 shows examples of the previously described construction and architectural characteristics.

5. Alterations

Finally, alterations buildings have undergone were identified. Cement mortars of some kind are present in 95% of buildings, indicating a widespread use of this material regardless of buildings' nature, use, or degree of alteration. Additionally, there is a high prevalence of new construction elements, such as frames, coatings, and chimneys, which have been introduced and are visible in 76% of cases. Structural alterations appear in 51% of buildings, while 40% show changes in volume, such as extensions and additional constructions attached to the main buildings. Finally, 8% of buildings appear to have undergone changes in original use.

Considering how most buildings exhibit more than one type of alteration, total number of alterations per building was calculated, and their spatial distribution was analysed. As can be observed in Figure 5, only 4% of buildings show no alterations of any kind. 33% of buildings exhibit four alterations, highlighting the extent to which most buildings in HCVC have undergone a wide variety of significant changes over time. Buildings with two (25%) and three (23%) alterations together account for 48% of the total sample, which aligns with the previous observation that a significant portion of buildings has undergone substantial changes. Finally, 1% of buildings exhibit all five alterations, having undergone extensive interventions.

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Examples of building with stone and wood as main structural materials (1) and building with one façade covered in painted render (2).

Examples of wooden roof structure (1) and barrel-type clay tile as roof coating (2)

Example of single-hung window framing in wood (1) and PVC (2)

Additional volume for storage (1) and exterior stairs in stone (2)

Fig. 4 – *Examples of contruction and architectural characteristics found in buildings in the HCVC.*

Regarding the spatial distribution of buildings based on the total number of alterations, Figure 5 shows a cluster of less altered buildings in the northeastern end of HCVC. These buildings are

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farther and more isolated from the rest of the study area and from Vila do Corvo, which extends east of the HCVC. Conversely, more altered buildings are concentrated on the western side of HVCV, closer to the main squares and to the remaining area of the village, indicating how more isolated and less busy areas present a higher number of unaltered buildings.

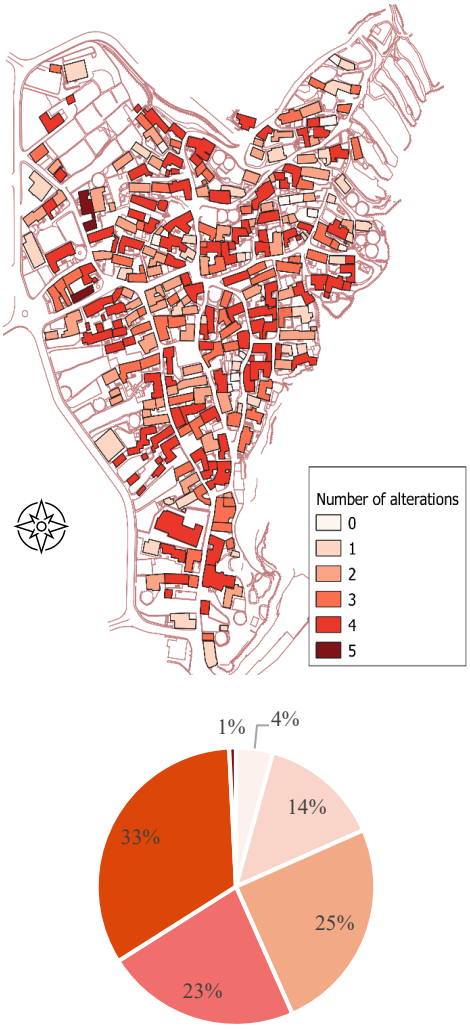

Fig. 5 – *Alterations in buildings in HCVC: spatial distribution (1) and percentage of buildings per total number of alterations (2).*

6. Conclusions

This paper aimed to present a comprehensive characterisation of the historical part of Vila do Corvo–the only village on the smallest and northernmost island of the Azores Archipelago, Portugal. Life on the island, formed by volcanic activity and historically marked by extreme poverty and isolation, improved over the last century, leading to a stable population of 400 people. Its historical centre comprises approximately 250 buildings, which were the focus of this research.

The methodology involved an extensive *in-situ* survey and data processing of the collected information, allowing for the identification of key construction and architectural features characterising these buildings. The predominance of wood and volcanic stone as primary construction materials highlights the preservation and safeguarding of vernacular heritage elements that remain visible in HCVC.

On the other hand, a high prevalence of alterations of distinct natures was identified, including structural, volumetric, and functional changes. Widespread presence of cement mortars in 95% of the sample also indicates the extensive use of this construction material, raising the need for a critical discussion regarding its application in future interventions. The fact that four out of five alterations were found to be the most common result in HCVC buildings underscores the profound level of alteration these buildings have undergone over time. These alterations, however, must be carefully considered in future interventions, as they reflect the demands, requirements, and needs of current populations and, thus, must be carefully balanced with the necessary safeguarding and conservation of heritage values.

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Above all, findings presented in this study aim at acknowledging the current state of a rural settlement with the presence of vernacular heritage, bringing attention to a yet unknown territory. The compiled information is intended to act as a tool for future interventions, which, if well-informed, can be key to improving living conditions for both current and future inhabitants. Future research will focus on a deeper analysis of these changes, as well as on their impact, contributing this way to more qualified and sustainable rehabilitation actions.

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Conflict and Transformation: Historic Perspectives of Architectural Heritage in Achuar Communities (Ecuador)

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Abstract

This article analyses the architectural elements and constructive techniques of the vernacular architecture of the Achuar people, focusing on the physical components of dwellings in response to social and cultural dynamics. A methodological approach based on source triangulation has enabled the comparison of 16th-century cartographic representations, 20th-century ethnographic records, and modern-day observations to evaluate the evolution and survival of tangible spatial and morphological representations characteristic of the Amazonia. The study covers topics ranging from the way in which these structures were documented and represented in early encounters with the Europeans and the Tupinambás, who created new forms of spatial negotiation, to the identification of the main architectural components which have survived, considering both their material dimension and cultural value. This article has contributed to a deeper understanding of architecture as an expression of different ways of life in constant transformation, highlighting the ontological differences between European territorial design and the original peoples.

Keywords: *historic cartography; Amazonia; Achuar; wénuk; transformation; vernacular architecture*

1. Introduction

The Amazon has always been a relatively inaccessible territory which was hard to conquer. The Incas for example, with a vast empire stretching from the heights of the Andes to the Pacific coast, directed their gaze to the East, known to them as the land of the *antis*. However, the jungle, with its dense vegetation and hostile fauna and flora, constituted an almost impenetrable border. Attempts to penetrate this territory can be divided into three major categories: conquest expeditions with limited success; failed incursions into the heart of the jungle; and migrations of dissident leaders or tribes seeking refuge outside the empire. In the transition zones between the Andes and the Amazon, the Incas achieved some success. These less dense and more accessible regions became part of the empire through conquest and assimilation strategies. However, when venturing into the depths of the rainforest, the situation changed, as expeditions launched to subject these territories met with insurmountable natural barriers as well as resistance from the Amazonian peoples, with their expert knowledge of the territory. Furthermore, the Amazon rainforest was not only an indomitable territory, but also, symbolically, a refuge for those of the Tawantinsuyu who had been defeated (Porras Barrenechea, 1942, pp. 112–120).

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The Amazon basin also played a vital role in the final days of the Inca empire, following the arrival of the Spanish and the fall of Cuzco. The defeated Incas retreated to Vilcabamba, a refuge which became the final bastion of Inca resistance. This choice mirrors the dual vision of the Amazon, a space that was both threatening and hopeful for those fleeing the empire (A.-C. Taylor, 2016, pp. 112–114).

The relationship of the Incas with the Amazonia reflects the limits of an empire which was unable to completely subject this enigmatic territory. In the memory of the Tawantinsuyu, the amazon rainforest remained a place of mystery, resistance, and exile, reaffirming its unique role in pre-Columbian history. For Viveiros de Castro (1992), war was not reduced to a territorial or social conflict, but rather to its essential ontological relationship with the other. In this setting, the enemy is not only an adversary to beat, but a figure in the construction of social relationships. A significant example of this interpretation is found in the Amazonian rituals, such as the practice of *tsantsa* among the Shuar people, where capturing and shrinking the heads of the enemy provides vital power, reinforcing the status of the victor (A. C. Taylor, 1993).

2. Methodology

This article aims to identify the architectural elements and constructive techniques associated with the vernacular architecture of the Achuar people. This analysis seeks to highlight the ontological differences between the European interpretations and those of the original peoples. However, the study focuses on understanding the physical components of Achuar architecture as a response to their social interactions. To do so, a methodological approach based on source triangulation is used to contrast information and validate finds (Flick, 2023; Tuhiwai Smith, 2016). Firstly, an analysis was carried out on 16th-century cartographic documents such as the Cantino planisphere and Gonneville's map, in order to examine how the first explorers represented and conceptualized indigenous settlements. Subsequently, studies by 20th-century religious missionaries documenting Achuar architecture in the Ecuadorian Amazon region were also examined. Based on these, the continuity and transformation of architectural components up until the present day can be assessed. In addition, this research is part of a broader field-based investigation on vernacular architecture in Shuar and Achuar cases, conducted within the framework of academic research developed at the Universitat Politècnica de València (Morocho Jaramillo, 2025), as shown in the documentary film "*Ánent: Cantos mágicos que conectan mundos"* (Morocho Jaramillo, 2024).

In 2023, a case study was carried out in the community of Kuseruantz, where demonstrative examples of transformations in vernacular architecture were identified (Morocho Jaramillo et al., 2024). Finally, the relational theory of Viveiros de Castro (1992) and fieldwork observations have enabled the identification and validation of the main material components of Achuar vernacular dwellings, as part of their cultural heritage, from numerous perspectives.

3. Imagined territories and the first representations of the Amazonia

Following the arrival of Columbus in America, the Treaty of Tordesillas was signed in 1494 in order to establish the agreements to delimit and regulate maritime explorations between Portugal and Spain. This allowed Spain to explore and conquer new territories in the West, while Portugal focused on Africa and Asia. This line not only divided the "New World" between the two overseas powers, but also set out the first imaginary borders in a still unknown continent. The accidental discovery of "*Terra dos Papagaios*" by Pedro Álvares Cabral in 1500 reinforced the position of Portugal in South America, since the territory lay to the east of the Tordesillas line (Fig. 1).

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Tierra de Castilla
Tierra de Castilla
Tierra de Castilla

Several timber storage warehouses were built along the Atlantic coast for subsequent dispatch to the European markets. This encouraged the conquest and colonization of the coast with the arrival of new immigrants, forming population nuclei which contributed to the possession and defence of territories. Interestingly enough, the first rivals of the Portuguese were not the Spanish, but the French, who had reached the coast of Brazil in 1504, four years after Cabral's journey. The frequency of these French trips rivalled that of the Portuguese, threatening their control. Therefore, the *Tupinambás* formed alliances on numerous occasions with the French against the Portuguese.

Fig. 2 – *Paulmier de Gonneville 1503-1505. Taken from Amerigo Vespucci, Pero Vaz de Caminha, Paulmier de Gonneville* (Vergara, 1983).

Although houses in the Amazon were not always limited by fences, in situations of conflict they were seen as defensive barriers, establishing limits in the event of constant wars. The arrival of the Europeans brought about a new dynamic for commercial relationships where raw material was exchanged for goods and artefacts. Despite these exchanges, relations were not always peaceful, and on several occasions the Portuguese tried to impose their control, prompting confrontation and resistance. However, these encounters were not exactly invasions, but rather a new configuration of alliances and conflicts (Viveiros de Castro, 1992) (Fig. 2).

4. Achuar defensive architecture

In Achuar territory, according to the information compiled by religious missionaries and travellers, due to the numerous conflicts faced it was common to find houses protected by *wénuk* palisades. This perimeter barrier reproduced the elliptical shape of the house and was built several metres from the main structure. In some case, two or even three concentric rings of palisades were built to reinforce protection from possible enemy attack (Fig. 3) (Bolla & Róvere, 1977, p. 33).

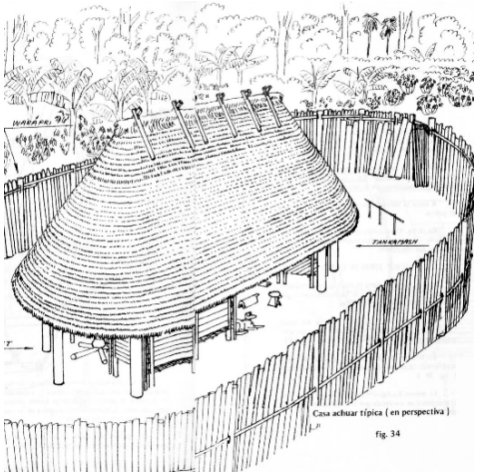

Fig. 3 – *Dwelling with wénuk* (Bolla & Róvere, 1977, pp. 42–43).

Nevertheless, nowadays dwelling rarely incorporate a complete enclosure of *wénuk*, with defined accesses at both ends, as the arrival of the missionaries led to notable changes, and war encounters were replaced by alliances.

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According to fieldwork documented in the Achuar communities of the province of Morona Santiago and Pastaza (Ecuador), these barriers integrated into the dwelling can still be found in the form of enclosures and spatial partitions, especially when the head of the family displays good hunting skills. In some cases similarities have been found with the end finishes of the *wénuk* (Fig. 4).

Fig. 4 – *Wénuk as spatial separation of the house, leaving out the social space* (Morocho, 2023).

Fig. 5 – *Dwelling with palm enclosure, representing a wénuk incorporated into the Achuar dwelling. In the Community of Kuseruantz, Pastaza* (Morocho, 2023).

In situations of conflict, incorporating a perimeter wall may well answer to defensive strategies reinforcing the inhabitants' security, although they are also used as spatial separation within the dwelling or to create more intimate rooms, which in the case of the Achuar are well defined (Fig. 5).

4.1. The constructive process of the Achuar dwelling as an alliance system

The constructive process of the dwelling, documented by the religious missionary Bolla & Róvere (1977), is an important reference to understand the forms of construction and parts of the traditional dwelling. The process begins with the preparation of the terrain, establishing a suitable delimitation for the surface that is to be occupied by the dwelling, usually located in the centre of the orchards or *ajas*. Subsequently, materials, in the form of sticks and leaves, are collected.

The main structure begins with the installation of four timber pillars called *mákui,* using species such as *chikainia, paeni, tuntuam, ampaki* or *kuunt.* These pillars, between 2.30 and 2.50 m high, are planted approximately 80 cm deep. Distinctive shapes, such as arrowheads or representations of caiman or turtle heads, are carved on the upper part supporting the beams, which forms a rectangular structure measuring approximately 4 x 6 m. The log used as the ridge, 15-20 cm in diameter, is then placed, projecting a further 60 cm beyond the side beams. Initially, this ridge was placed provisionally on joints and secured with *bejuco* vines, thus allowing it to be adjusted as necessary before it was definitively installed.

The next step is the construction of the x-shaped ridge finishes. With the aid of a machete, two perforations are added to each beam at a 45 degree angle, 30 cm from the side pillars. For this structure *chiwia* or *kintianyais* sticks approximately 10 cm in diameter are used. Two of these elements are taken and joined at the ends, crossed 20 cm from the end and secured firmly with *bejuco* vines. The size of the x-shaped ridge finish determines the final height of the dwelling, which can be as high as 6 m. During the constructive process, the position of the x-shaped ridge finishes can be adjusted as needed. However, every x-shaped ridge finish is installed in its definitive location, temporarily fixed to the

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scaffolding and secured with provisional logs providing rigidity to the main structure. Subsequently, the two semi-circular sections enclosing the ends of the dwelling and supporting the roof tie beams are built. In order to define the curvature, from the end to the ridge a pole descends vertically to the ground. Then, with the help of a fine cord, the distance from this point to the posts already in place is measured, allowing the radius of the structure to be drawn on the ground (Fig. 6).

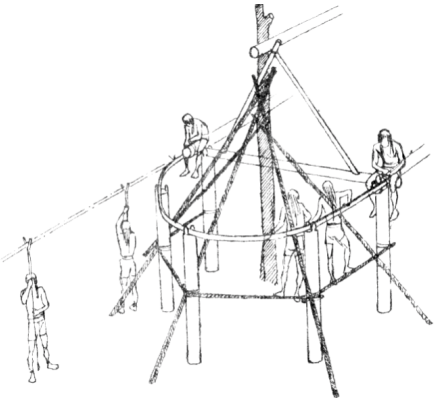

Fig. 6 – *Placement of the semi-circular palm strip.* (Bolla & Róvere, 1977, p. 17).

The semi circumference is usually composed of three equidistant pillars. These are the same length as the central pillars, although they are not set as deeply into the ground, in order to provide structural flexibility. Rigidity is then increased in the structure using sloping poles to reinforce pillars and act as support for the beams at both ends. Palm leaves, preferably from the *kupat* species, are placed on this base, forming the dwelling's characteristic curvature. To do this, auxiliary poles are gradually adjusted in a circular position. During this operation, builders climb onto the scaffolding and use a traction system to adjust the structure until it fits correctly on the top end of the main columns. Once the main structure has been installed the roof tie beams are placed on the ridge. First the tie beams of the straight eave are installed, before installing those of the semi-circular section. Each tie beam is fixed to the side beams and firmly secured with *bejuco* vines to ensure a stable roof (Fig. 7).

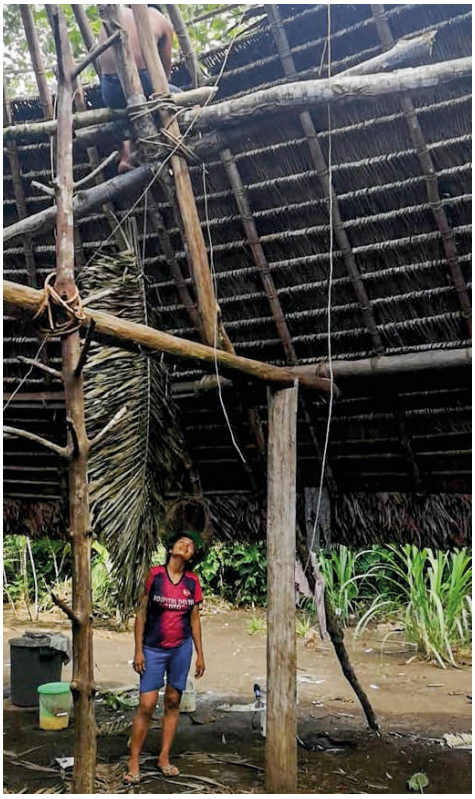

Fig. 7 – *Scaffolding and provisional placement of side sticks to provide rigidity to the main mákui pillar. In the Community of Kuseruantz, Pastaza* (Morocho, 2023).

Work is subsequently carried out on the semi-circular parts of the ends of the house, placing two palms of a similar diameter to the other tie beams, which extend from the end of the ridge to the central post of the semi circumference. If the tie beams are made of bamboo, they are tied to the roof using *chiwia* branches. However, if hard timber is used, it is secured with a hook system (Fig. 8a). Finally, the remaining tie beams, referred to as "projecting" are also secured as they are supported by a rigid stake placed between the x-shaped ridge finishes and the longitudinal tie beams resting directly on the ridge (Fig. 8b). These projecting tie beams are

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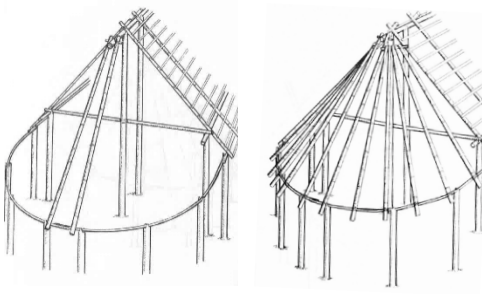
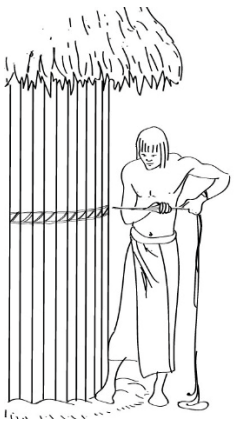
assembled using a fixing system with hook shapes, carved to resemble a boa's head (Fig. 8c, 8d). These are also slightly shorter than the central tie beams, contributing to the general stability of the roof.

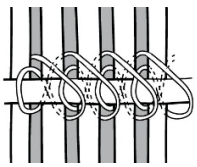


a. *Support for longitudinal tie beams*

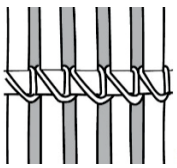
b. *Installation of projecting tie beams*



c. *Wénuk*



d. *Exterior view of ties' wénuk*



d. *Shape of ties' wénuk*

Fig. 8 –*Constructive details of the Achuar dwelling* (Morocho edited from Bianchi, 1978; Bolla & Róvere, 1977).

Once the structure is completed, the roof is added by placing a fabric made with a selection of palm leaves, including *chapi* – which are the most frequently used –, together with *kuunt*, *katira* and *turuji*. The walls are built with palm strips about 3 cm thick, placed horizontally halfway up across the *mákui* or side posts, through an orifice perforated in each of them. A series of 8 m-wide chonta strips is then placed vertically outside and fixed to the structure tied up with *bejuco* vines. In order to optimize the resistance and comfort of the space, the rougher side of the wood faces outward to minimize the risk of brushing against it inside the dwelling (Bianchi, 1978).

5. Conclusion

The vernacular architecture of the Achuar people not only answers to functional needs, but it also reflects a dynamic system of social relationships in which conflict, negotiation, and alliance configure the built space. From an anthropological perspective, the dwelling is understood as both a material and symbolic construct that expresses a community's worldview and interactional logic. Following Viveiros de Castro's theory of war as a relational system, elements such as defensive palisades (*wénuk*) and internal enclosures reveal historical and ongoing tensions between openness and protection in response to external forces.

The analysis of historic cartographic sources and missionary documentation, contrasted with fieldwork conducted in the community of Kuseruantz (2023), has enabled the identification of transformations in vernacular architecture. While defensive strategies have evolved over time, certain symbolic and structural components persist, adapted to contemporary social conditions.

This study contributes to the field of vernacular architecture by showing how traditional construction practices operate within a relational system that reflects both collective memory and current sociopolitical challenges, such as extractive pressures on Amazonian territories. Treating architecture as a culturally embedded and evolving practice highlights the value of anthropological methodologies for interpreting vernacular heritage from a situated perspective. Furthermore, the triangulation of historical sources, ethnographic theory, and direct observation has proven to be a solid methodological approach for analyzing processes

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of dwellings transformation. This interdisciplinary framework opens pathways for further research integrating architecture, anthropology, and territorial studies, allowing for a deeper understanding of inhabited spaces as living systems of resistance, continuity, and identity.

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Conservation of Rural Religious Heritage in the Western Mediterranean Region of Türkiye: Yukarı Kırlı Village

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Abstract

Rural religious heritage is an important value for the future of historic villages and for their conservation. The religious heritage in rural areas of Burdur province, located in the Western Mediterranean Region of Türkiye, deserves special attention in this field both for its monuments and for the settlements and landscapes surrounding them. Documentation studies carried out in the rural area of Burdur show that the religious heritage assets and the historic villages in which they are located have mostly conserved their authentic values and identities. However, structural problems, interventions of poor quality, loss of traditional construction knowledge, inability to provide original material, abandonment, neglect, disuse due to the socio-cultural, economic, political and climatic transformations and depopulation are some of the risks faced by this heritage. Within the scope of the study, Yukarı Kırlı Village and its mosque will be discussed. It is a historic Turkmen village on the Taurus Mountains, which has lost its population over the years due to socio-economic changes. In the village, traditional buildings and areas have become out of use due to depopulation. Yukarı Kırlı Village Mosque, which was closed to worship after being damaged in the 1971 earthquake, is, despite its modest dimensions, one of the rare examples with its well conserved earthen masonry system supported by wooden beams and posts, original roof covering and local ornament details. Architectural surveys were carried out with both traditional and advanced methods at the scales of site, building and architectural element and in addition to archival research, an oral history work was conducted with local people. It is aimed to identify and document the rural religious heritage and the historic villages in which they are located, in the selected region with an analytical study and to reveal the conservation issues.

Keywords: *rural religious heritage, mediterranean vernacular architecture, earthen architecture, wooden architecture, Burdur*

1. Introduction

Rural architectural heritage shows not only the high-quality art works of a certain group but also the socio-cultural, economic, historic characteristics and architecture of large masses of people. To understand a society and its architectural culture, it is indispensable to document, analyze and conserve the heritage of ordinary farmers. Despite the increasing awareness and studies on rural architectural heritage, it has been largely lost or is about to be

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lost in many regions of Türkiye as well as all over the world. The religious heritage shows the characteristics related to the physical environment and construction processes. Also, it carries valuable signs about the culture and people it belongs to with historical, geographical, socio-economic characteristics, beliefs and rituals. It is a subject that can be studied as a multi-layered vernacular structure, as an important part of the rural settlement in which it is situated, as a serial heritage, or with the network of socio-cultural and political relations in which it is involved, and needs to handle upon all the contemporary issues discussed in conservation theory and practice. However, structural, socio-cultural, economic, political and climatic issues cause this heritage to change, transform and disappear like many other assets in the historical settlements where they are located.

The religious heritage in rural areas of Burdur province, located in the Western Mediterranean Region of Türkiye, deserves special attention in this field both for its monuments and for the settlements and landscapes surrounding them. Documentation studies carried out in the rural area of Burdur show that the religious heritage assets and the historic villages in which they are located have mostly conserved their authentic values and identities. It is also understood that wooden pillared mosques have a significant place in the region and shows indigenous typologies which can be classified under different headings. In 2023, five mosques built in different provinces of Türkiye between the end of the 13th century and the middle of the 14th century were registered as serial property on the UNESCO World Heritage List under the name of "Wooden Hypostyle Mosques of Medieval Anatolia" (UNESCO World Heritage Convention, 2023). These mosques have masonry exterior walls and wooden structural systems with numerous wooden posts supporting flat wooden ceilings and roofs (Fig. 1). It is understood that a significant number of the mosques examined within the scope of the study have very similar characteristics to these mosques known as world heritage, but they are much more modest in scale and they are in need of maintenance and attention.

This study covers Yukarı Kırlı Village and its mosque located in Burdur Province. The village is valuable in terms of its Turkmen culture and its built environment and landscape. The old mosque located right in the center is an original example of the vernacular architectural and belief culture of the region. The main purpose of the study is to identify this religious heritage and its historical settlement then evaluate and position it within the whole. For this purpose, documentation studies were conducted with both traditional and 3-dimensional methods. These were converted into various tables, graphics and drawings. Archival research and literature review were conducted, but it was seen that there were very few studies on the region and none of them were related to conservation of the rural heritage. For this reason, an extensive oral history work was conducted with local people and data on tangible and intangible heritage of this rural area were recorded.

This paper is based on the studies carried out within the scope of the PhD thesis currently prepared under the supervision of Prof. Dr. Deniz Mazlum in the Restoration Program of the ITU Graduate School.

Fig. 1 - Ahi Şerafettin (Aslanhane) Mosque in Ankara (Akman, 2024).

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2. Burdur Historic Landscape and its Religious Heritage

2.1. Characteristics of Burdur Rural Area

Burdur situated in the *Göller Yöresi*[1] of southwestern Anatolia is a transition area between the Mediterranean, Aegean, and Central Anatolia (Fig. 2). A rural lifestyle with various production activities can be seen, shaped by the changing vegetation and climate characteristics due to the region's distinct geographical features (Burdur 1967 İl Yıllığı, n.d). In the rural areas of Burdur, where most of the population identifies as Turkmen or Yörük, the nomadic tradition no longer exists. While the majority of Burdur's population used to live in rural areas, this rate has gradually decreased over the past fifty years and currently, the urban population exceeds that of the rural areas (Türkiye İstatistik Kurumu, 2024). This migration from rural areas over the years caused the villages to become depopulated, the rural production to decrease and the built environment to become out of use. In addition, many intangible cultural assets, from special day celebrations to daily practices, cannot be passed on to new generations and are disappearing day by day.

The region has a rich historical background. The archaeological discoveries made in Burdur reveal human existence dating back to 40,000 BC. Numerous ancient cities and settlement traces from various civilizations such as the Luwians, Hittites, Phrygians, Lydians, Persians, Macedonians, Romans, and Byzantines can be found (Burdur 1973 İl Yıllığı, 1974). The Oghuzes, referred to as Turkmen since the 16th century, are believed to have inhabited the region since ancient times (Sümer, 1967). Over the years, the area was controlled by the Seljuks and Ottomans. Some monumental buildings from these periods are still visible today.

Fig. 2 - *Location of Burdur* (Authors).

While the monumental buildings in historic villages date back much further, the majority of other structures such as houses, barns, haylofts, guesthouses, etc. date back to the 19th century. Depending on the geography and vegetation, the main construction materials are adobe, stone, and wood.

The construction technique is mainly stone or mudbrick masonry, supported by wooden posts and beams. Flat earthen roof is also supported by a wooden construction. The houses have mostly two storeys and have a plan layout with semi-open sofa. The barn and hayloft are on the ground floor of the house or can be found as separate structures in the courtyard. On the upper floor, *tahtalık* (sofa) where the daily life passes and rooms each called "*ev*"[2] show perfectly the Turkish lifestyle and building tradition (Akman, 2019). Other structures with different functions like mills, guesthouses and schools can be also found in traditional neighborhood.

Among many earthquakes which occurred in the region, the most devastating ones in recent times are the 1914 and 1971 earthquakes. Especially data on 1971 earthquakes and its aftershocks lasting for two months shows that this disaster had a profound impact, both in the rural areas and

[1] The Turkish Lakes Region is an area with a series of lakes in Southwestern Anatolia.

[2] *Ev* means home in Turkish. Each room has traditional elements such as *ocak* (fireplace), *delik* (niche), *ıraf* (shelf) and *yüklük* (a type of closet), enough for a family to live in.

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in the city center (Yurt Ansiklopedisi, 1984). Five villages were entirely destroyed and relocated to new settlements following this earthquake (Burdur 1973 İl Yıllığı, 1974). Monumental buildings were also affected. It is known that mosques, especially in the city center, were damaged and repaired or rebuilt, while mosques in rural areas were damaged and repaired, and some were closed to worship.

2.2. Rural religious heritage of Burdur Province

The religious heritage of Burdur rural area can be classified under different headings. These are mainly: Mosques/*masjids*/*masjid*-houses; Churches/chapels; Takyas/*cemevis*[3]; Tombs/cemeteries; Madrasahs/religious education institutions. The broadest of these headings is "mosques/masjids/masjid-houses" with both qualitative and quantitative values. After the population exchange following World War I and the Turkish War of Independence, non-Muslim population in Burdur decreased and non-Islamic religious structures became inactive and couldn't be conserved. Kavaklı Greek Orthodox Church located in the city center, has managed to survive to the present day due to being used for different purposes such as warehouse and cinema over the years (Karagöz, 2018). It is a unique example among the non-Muslim structures which have disappeared. It was restored between 2012-2014 and is used as a museum today.

Although the values of the Sunni faith are much more widespread today in Burdur, there are villages and neighborhoods where Alevi-Bektashi thought-faith systems[4] continue (Çakır, 1997). Although rituals and traditions, which are intangible cultural heritage values, are tried to be kept alive in these villages, it has been understood in the field research that the tangible assets of the religious heritage have changed and transformed. Mosques/masjids/masjid-houses, an example of which will be discussed in this study, are widely found in both urban and rural areas of Burdur and are a wide-ranging study subject with their features that can be classified under different typologies.

2.3. Characteristics of mosques in Burdur Province

Mosques which are registered-protected and which are worth preserving were identified on-site and classified according to their different characteristics such as their location, year of construction, materials and construction methods used, architectural type, number of posts (if any), size and state of preservation. In the study, 34 mosques were examined, the oldest of which dates back to the 15th-17th centuries. 22 of them are located in rural settlements (in the villages and towns) while 12 are located in the city.

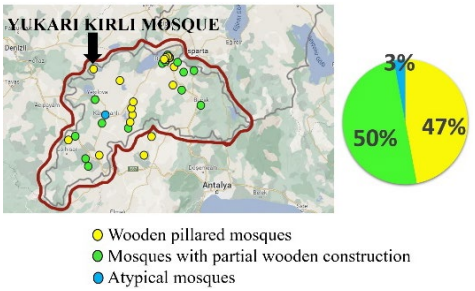

Fig. 3 – *Mosques in Burdur according to their architectural type and the location of Yukarı Kırlı Mosque* (Authors).

It was understood that 16 of these structures have the traditional wooden pillared mosque typology, 17 structures have partially wooden construction with wooden posts and beams, and 1 structure is atypical (Fig. 3). In addition to wooden construction used as a whole or in part, adobe and stone masonry can be seen on external walls of

[3]Worship places for Türkiye's Alevi-Bektashi populations

[4] It is one of the Islamic belief systems widely practiced in Anatolia.

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the buildings. Also, despite their modest size, many of them represent beautiful examples of master carpentry, woodcarving and painted wood ornamentation (Fig. 4).

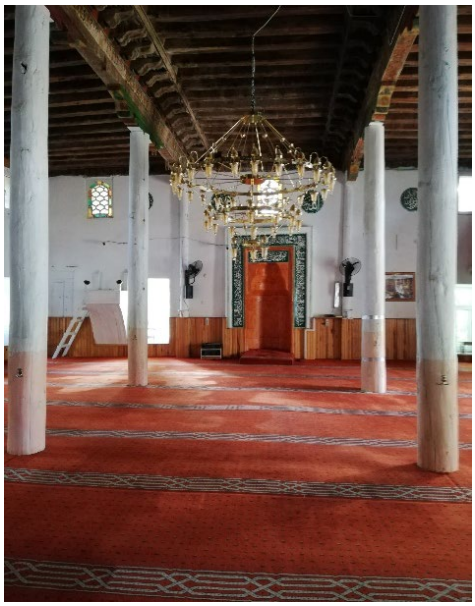

Fig. 4 - *Main Prayer Hall of Harmanlı Mosque, Burdur* (Akman, 2024).

When the buildings were classified according to their sizes, considering their rural characteristics, those wider than 150 m² were classified as large-sized, those between 80-150 m² as medium-sized, and those smaller than 80 m² as small-sized. Accordingly, 12 mosques are large-sized, 18 are medium-sized, and 4 are small-sized. It is remarkable that the sizes of the mosques and the sizes of the settlements where they are located in are not always compatible. 4 of the 12 mosques considered large are located in small settlements (villages).

While evaluating the state of conservation, repairs of poor quality and additions, changes-losses of elements, changes in the façade and plan typology and the extent to which all these changes and losses hinder the understanding of the original character of the buildings were taken into account. Accordingly, the state of conservation was evaluated as good for 12 mosques, medium for 20 mosques, and bad for 2 mosques.

Almost all of the mosques in the city were demolished and rebuilt after being damaged in earthquakes, while the damaged mosques in the rural settlements were repaired by local people or were closed for worship. Unlike the mosques in the city, the ownership of the mosques in the villages belongs to the villagers and their maintenance is carried out by them. The decrease in the population and economic power of the villages caused these structures to remain neglected and abandoned.

3. Yukarı Kırlı Village and its Mosque

3.1. Yukarı Kırlı Village

Yukarı Kırlı Village is a historic Turkmen village on the Taurus Mountains (Fig. 5). The village is located in *Göller Yöresi* which had many lakes and marshes in the past, but the wetlands have decreased over time. It has many plateaus that were used until the 90s. In the past, the villagers used to make their living from agriculture; the number of farmers who cultivate products such as barley, wheat, and poppy as their main source of income and raised goats and cows has decreased significantly.

As a result of the policies implemented in the world, in the country and locally, the people of Yukarı Kırlı Village migrated from the village to the city in the 70s and 80s, as in all rural areas in Türkiye. First of all, social needs and demands, lack of education and job opportunities forced the villagers to migrate to the urban areas of Burdur and to the neighboring cities, Denizli and Antalya. Although the population increases temporarily during summer, the number of permanent residents is still very low. In the records, the population of the village is seen as 59 people in 2024, but it is stated by the villagers that approximately 10 people permanently reside in the village (Türkiye İstatistik Kurumu, 2024).

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Fig. 5 - *View from Yukarı Kırlı Village* (Akman, 2024).

The transformation in the socio-economic structure of the village, the intense migration and the dynamics of the changing world have also led to changes in daily routines and special day traditions. Routines and rituals are an integral part of both the physical environment and the culture of life. Despite this, they cannot be protected; some of them are maintained by only a few people and the rest is disappearing (Fig. 6).

Fig. 6 - *An example of intangible cultural asset: Usage of a traditional tool "dibek" for grinding grains* (Akman, 2024).

In addition, the vernacular construction knowledge and the craftsmanship which are unwritten and passed down from generation to generation are also in danger.

Fig. 7 – *Aerial photographs of Yukarı Kırlı Village, dated 1971 and 2023* (Ministry of National Defence Directorate General for Mapping, 2024).

Characteristics of the settlement and architectural features were examined. The traditional settlement is located near the mountain, on a sloping land, in an area of 700 meters in diameter (Fig. 5). The flat areas around the village are used as agricultural land. In many villages of Burdur, traditional settlements have expanded towards agricultural lands. When aerial photographs dated 1971 and 2023 are examined in Yukarı Kırlı Village, it is understood that the settlement did not expand unlike other villages of Burdur (Fig. 7). This situation is also confirmed by the statements of the villagers. The decrease in population after the 70s caused no significant new construction in the village. Some of the traditional houses remained abandoned, and the ones that were still in use continued to be used in the appearance of a "new house" by changing elements such as roofs and window-door joinery and applying cement-based plaster on the facades.

3.2. Yukarı Kırlı Village Mosque

Yukarı Kırlı Village Mosque is located in the center of the village (Fig. 8). It is thought to have been built in the 19th century. It was closed to worship after being damaged in the 1971 earthquake. After being closed to worship, it was used for different purposes such as depot or meeting place for villagers.

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Fig. 8 – *Yukarı Kırlı Village Mosque* (Akman, 2024).

It is well preserved, medium-sized and belonging to the first type in the classification according to its architectural type, the "traditional wooden pillared mosque typology". For this reason, it is thought to be a good representative of Burdur rural religious heritage.

The construction technique is stone and mudbrick masonry, supported by wooden posts and beams. Numerous pillars are part of the wooden construction. There are 7 pillars in the main prayer hall (1 pillar has disappeared), 9 pillars in the last prayer hall and 10 pillars adjacent to the facade. The external pillars are interesting because they remind us of the residential architecture of the region (Fig. 9). The wall thickness is approximately 90 cm. The dimensions of the interior are 9 meters by 10.55 meters.

Fig. 9 – *Facades of Yukarı Kırlı Village Mosque* (Akman, 2024).

It is understood that the roof of the building, which originally was a flat earthen roof, has changed over the years. However, the eaves in front of the last prayer hall are similar to the "*tura*" roof, which is the traditional roof of the region (Fig. 8). Despite its modest dimensions, there are special paintings and local ornamental details on both interior and exterior walls (Fig. 10). In addition, there is special woodcarving and painting used in wooden elements and furnishings such as door joinery and minbar (pulpit) (Fig 11).

Fig. 10 – *Main prayer hall of Yukarı Kırlı Village Mosque* (Akman, 2024).

Although it is registered as a cultural property, it is still at risk due to neglect. As a result of abandonment, element losses and material deterioration are the most common problems. However, despite its current problems, the presence of the original typology, materials, techniques, details and traces of lost details improves the state of conservation of the structure.

Fig. 11 – *Women's lodge of Yukarı Kırlı Village Mosque* (Akman, 2024).

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The rural religious heritage and historic villages of the region are in danger and need to be seen. Considering how fragile they are, a detailed documentation of the registered and unregistered assets should be carried out urgently and steps should be taken to ensure cooperation between local governments, villagers and professionals.

4. Conclusion

Rural architectural heritage is still a heritage that is extremely vulnerable to change and gradually disappears despite the increasing awareness and studies. The religious heritage holds an important place in this field. It is mostly located in the heart of the rural settlement not only in a tangible way but also in an intangible way as being an important part of the social, cultural and economic relations network of the region.

The findings obtained in the study show that culture has continued for centuries both in the physical environment and in many scenes of traditional life, and that "cultural heritage" does not form a linear line or a single dimension; it has taken root in different dimensions over a long time, and provided exchange between these dimensions.

Documenting this heritage and analyzing it from different perspectives, especially in neglected regions such as Burdur, is seen as completing the missing piece in understanding and protecting the cultural heritage in all its aspects.

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Contribution to the Knowledge of *Apennine* Rural Architecture. Technical Culture in the Abandoned Historical Villages of the Upper Santerno Valley (Italy)

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Topic: T1.1. Study and cataloguing of vernacular architecture

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Abstract

The regeneration of rural architectural heritage, at the centre of the debate on the depopulation of internal areas, often falls into simplistic interpretations, leading to interventions that alter cultural values and contents. In Italy, this phenomenon also affects the Santerno valley, in the Tuscan-Romagnolo Apennines. Dotted with abandoned rural settlements and traces of old castles, this valley preserves evidence of a rural settlement system consolidated since the Middle Ages, during which the Florentine Republic and the Ubaldini family clashed between the 13th-15th centuries. The abandon conditions of buildings and slope agriculture threaten the survival of this widespread heritage. An ongoing research conducted by the University of Architecture and the Superintendence of Florence has the objective of understanding the cultural and technological contents of the Piagnole village, a high-altitude settlement made up of a few buildings and a chapel made of wood and stone, whose origins are connected to one of the Ubaldini castles. Starting from architectural surveys, typological methods were used to read the building, analysing techniques and characteristics of structures and architectural elements, observing any systematic distribution in plan and elevation. Furthermore, in-depth investigations on the 50 openings and squared blocks, clear evidence of the technological culture that created them, recorded their characteristics (position, materials, dimensions, geometries, etc.). Some recurring types of these architectural elements emerged whose distribution focused the evolutionary framework of the settlement. Furthermore, the rich presence of ancient units of measurement (in the individual elements and in the buildings) in use in Florence, Imola and Bologna, highlighted their articulated and combined use over time, connected to the culture of the authors who took turns. The chrono-typological investigation therefore proved to be crucial in understanding the architectural remains, demonstrating how this study can also support the expansion of knowledge of other numerous villages of the Santerno valley.

Keywords: *rural-villages; Santerno; Piagnole; typological-methods; openings; units-of-measurement*

1. Introduction

The depopulation of inland areas and the consequent abandonment of smaller settlements are increasingly pressing issues within contemporary architectural preservation efforts. These areas should be addressed to safeguard the identities that constitute our rural tangible and

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intangible heritage. Research in this field not only provides the foundation for the conservation of these architectural remains, enabling more informed actions, but also fosters the reconnecting of heritage with the community. The Upper Mugello region in the Tuscan Apennines is characterized by numerous small hilltop villages that were once inhabited by communities engaged in agriculture and livestock farming. These villages exemplify a vernacular balance between humans and nature.

The economic and social changes of the post-war period (for example the preference for factory or farm labour, rather than small-scale family-run agricultural activities) led to a reorganisation of the settlement system in the valley and to the gradual demographic decline of these villages (Coppola & Di Pasquale, 2022).

Furthermore, the Santerno Valley in the municipality of Firenzuola serves as a clear example of medieval fortification processes that define the history of this area. In many cases, the founding of mountain villages is closely linked to pre-existing castles, which were sites of frequent conflicts between the Republic of Florence and the feudal Ubaldini family during the 13th and 14th centuries (Pirillo, 2005).

Among the settlements in the region, this research focused on the village of Piagnole, a small cluster of five buildings and a chapel built in chestnut wood and local sandstone. This case study was selected for its unique conditions and the richness of its historical layers, such as the remains of the old Castrum Piagnole, one of the above mentioned Ubaldini fortresses.

2. Objectives and methodologies

This research aims to demonstrate how the study of these artefacts can lead to the rediscovery of values (anthropological, architectural, historical, environmental, etc.) that are essential for the preservation of our rural architectural heritage.

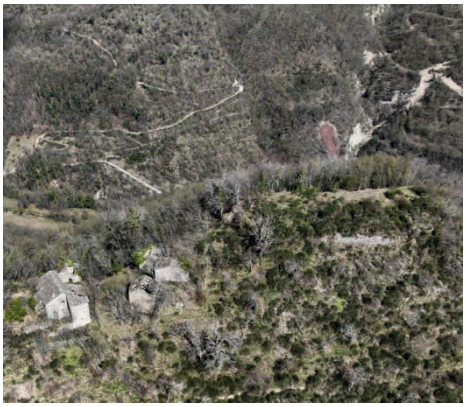

Fig. 1 – *The Piagnole village and the old castle's walls from a drone flight* (Authors).

Direct investigation of the buildings is an indispensable strong tool to increase the understanding of the architectural development of the villages in the Upper Mugello area. This approach can create the board of knowledge necessary to plan appropriate intervention strategies that respect their history and identity, while ensuring thoughtful restoration efforts. (Coppola et al., 2022). The investigation of bibliographic and archival sources was complemented by extensive data collection in situ. This was achieved through a series of multi-scale analyses designed to interpret the reasoning and actions behind the settlement's construction. Following the surveying and digital representation of the studied artefacts, an important step to document their actual state of preservation, a typological reading campaign was conducted. This campaign involved an in-depth, albeit non-instrumental and non-invasive, study of the built environment (Coppola, 2018). The analyses identified the technical and structural characteristics of the vertical and horizontal partitions and other architectural elements, revealing different approaches and building cultures. The ultimate goal is to establish a comprehensive knowledge database on the rural architecture of the Santerno Valley. This database could be the basis for new sustainable protection and revitalization programs.

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3. Typological investigations

The typological approach (Gabbrielli, 1999) to studying rural architecture provides an alternative method to instrumental surveys, focusing on the cultural contents behind the construction techniques employed in these structures (Cabona et al., 1989). After examining all the technological features of the buildings, the gathered information was recorded and compared to identify similarities and differences. The goal was to classify the buildings into homogeneous groups based on dominant parameters. These groups, called "types", serve as the basis for a typological analysis of the village's architectural artefacts. This approach allowed researchers to deduce aspects that are not immediately perceptible and to propose multiple interpretations. (Mannoni, 1976) For each construction type, distribution patterns (both in plan and elevation) were examined, highlighting stratifications that acquired chronological significance during the mapping phase.

3.1. Masonry features

The masonry structures, encompassing walls and cornerstones, exhibited a wide range of characteristics to observe and parameterize. To systematize the cataloguing process, a classification table was created based on criteria established by Tiziano Mannoni (1997):

1. Materials of rigid elements (stone and/or brick) and mortars;
2. Techniques for producing and transforming materials;
3. Dimensional data of rigid elements and mortar components;
4. Forms and techniques of the facades (assembly methods).

These parameters were assessed for each masonry structure in the village, including the chapel and the old castle walls, and then grouped into macro categories. Four types of masonry and three types of cornerstones were identified.

3.1.1. Masonry types

The various types of masonry were presented through four reference masonry samples, as they fully represent the characteristics of each type (Fig. 2).

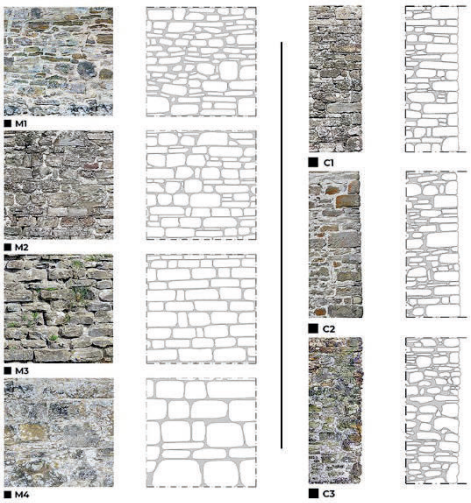

Fig. 2 – *Different types of masonry and cornerstones* (Authors).

Type M1 masonry consists of elements of varying shapes and sizes arranged chaotically and shows the systematic use of lime mortar in excellent conservation conditions. There are no entire buildings made of this type of masonry; rather, it is used only in portions of walls or as a filling of openings. This type also constitutes the walls of annexes to main buildings, such as ovens or loggias, which were added later to the original structures.

Type M2, on the other hand, is the most widespread. It is made of blocks with more regular shapes and placed more carefully. Here, the blocks are divided into two classes: the larger ones range between 0.20 and 0.25 meters in height, while the smaller ones range between 0.05 and 0.15 meters. This type is generally used with earthen mortar, which is worn and powdery; only in the main house and chapel does it appear combined with lime mortar.

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Type M3 differs from the previous ones because it features regular and squared blocks, with heights ranging from 0.15 to 0.25 meters, laid with great technical precision and using exclusively lime mortar. This type is found in all the remnants of the old castle's masonry, where the blocks, mortar, and conglomerate are visibly worn and eroded by time.

Finally, Type M4 is the least common. It is made of blocks and laid with precision similar to Type M3 but features larger block dimensions, ranging from 0.30 to 0.40 meters, with some blocks as tall as 0.50 meters and as long as 0.80 meters. This type has been identified only in the lower portion of the chapel, overlapped by Types M1 and M2, demonstrating a stratification of different masonry techniques.

3.1.2. Cornerstone types

As with the masonry, the cornerstones of the Piagnole village have also been categorized into reference types, divided into three groups associated with the various masonry types.

The first type (C1) consists of rough-hewn, regular blocks, correctly staggered for each course with alternating lengths of 0.40 and 0.20 meters.

Type C2 is similar to the previous one but includes some smaller, irregular blocks used as levelling elements, which disrupt the precision of the layout. These two types are the most common in the village, as they are used consistently in most buildings, combined with both earthen mortar and lime mortar.

Finally, there is C3, the most irregular type of cornerstone. It is made of blocks of varying shapes and sizes, arranged chaotically together with stone chips and wedges, and used exclusively with lime mortar. This type is mainly found in agricultural annexes, such as ovens, stables, and drying rooms, representing a less refined building tradition.

3.1.3. Distribution relationships

Observing the distribution of different types revealed their stratification and the relationships between masonry and cornerstones. Types M1 and C3 are often paired in agricultural annexes or wall closures, indicating a later construction phase. The systematic and abundant use of well preserved lime mortar supports this hypothesis. In contrast, types C1 and C2 are associated with M2 and represent the most widespread combination in the settlement, generally using earth mortar. Types M3 and M4 are less comparable, appearing only in specific parts of the chapel and the old castle perimeter walls, which exhibit consistency in dimensions, shapes, and assembly techniques. The lime mortar in these structures shows significant degradation, and differences in preservation between M1 and M2 are evident in the chapel's exterior walls, where the types overlap (Fig. 3).

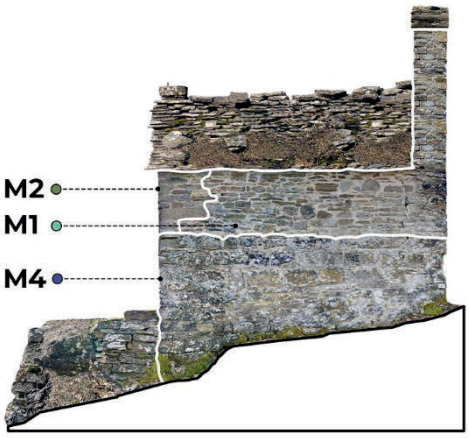

Fig. 3 – *Stratifications in the chapel's exterior walls* (Authors).

3.2. Openings

Among the architectural elements analysed, openings reflect the close relationship between the construction phase's operational intentions and the builders' cultural practices. (Gabbrielli, 1996) A total of 31 windows and 17 doors in the settlement were surveyed to document their

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characteristics using the same typological approach as for the masonry (Fig. 4). The analysis considered materials, shapes, tool marks on individual elements, as well as the sections, orientations, and dimensions of frames. These parameters enabled the classification of all openings in the village into five primary macro-types. Due to the high number of variables and examples, these macro-types were further subdivided based on internal differences, resulting in 26 sub-types from the initial five.

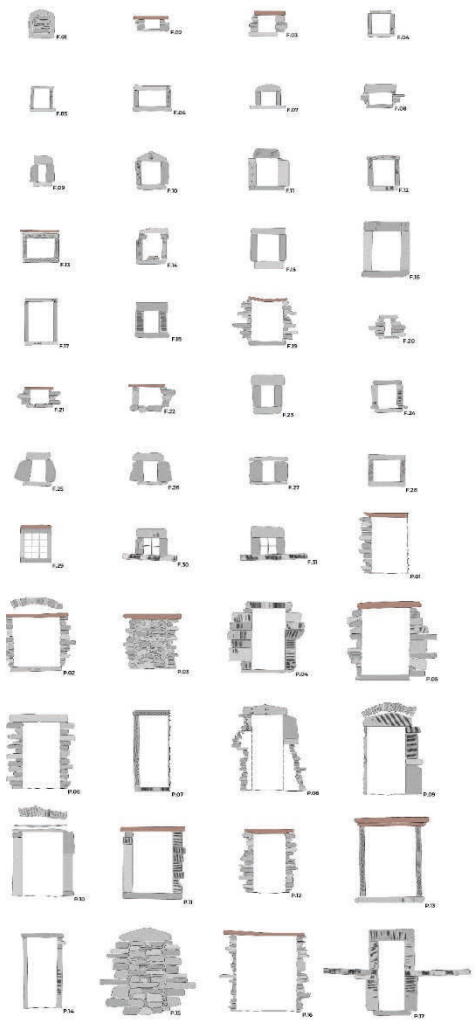

Fig. 4 – *The 48 openings analysed in the village* (Authors).

This genealogical process, supported by mapping the results in plan and elevation, was instrumental in visualizing the relationships between the identified types and the village's buildings. Some types of openings were exclusive to individual buildings, while others were present across multiple structures. This section was particularly valuable in showcasing how specific opening types were closely tied to the functions of the spaces they served, with typological variations depending on building use and vertical positioning.

3.2.1. Distribution relationships

Throughout the settlement, three types of openings are the most common, deeply tied to the functions of the buildings in which they are found. The smallest openings, made of single rough-hewn elements, are positioned high up to ventilate attics, stables, and drying rooms during the chestnut drying process. These windows are often made of irregular blocks (often not perfectly orthogonal to each other), similar to those used in the masonry, prioritizing functionality over aesthetics. This characteristic demonstrates the immediacy of their construction, emphasizing the rural nature of these elements. The taller openings, on the other hand, are intended as main entrances to dwellings, often adorned with worked surfaces featuring grooves and anathyrosis. These doors frequently display symbols with an apotropaic function, engraved on the lintel or threshold, to protect the home and ward off misfortune.

The third most common type consists of wider openings, associated with agricultural buildings or stables. These large openings are designed to allow livestock and agricultural tools to pass through. Similar to the first case, this type fully reflects the rural nature of the village, featuring wooden beam lintels and jambs that align seamlessly with the masonry pattern. Thanks to the recorded data, it has been possible to hypothesize the construction intentions of the creators of these structures, highlighting the

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existence of specific types of openings for each function and the corresponding selection, processing, and assembly of the blocks used to create them.

4. Historical linear units of measurement as a research tool

An additional step in this research involved extensive measurements taken in plan and elevation for every building in the village. During the typological investigations, recurring measurements were identified among blocks exhibiting similar characteristics. The individuals who prepared these blocks relied on specific dimensional references, passed down through construction traditions tied to their historical context (Lugli, 2014).

Throughout the Middle Ages and up to the mid-19th century, Italy employed a variety of local units of measurement used for trade and construction practices. Considering the site's medieval past and its intermediate location between Bologna, Imola, and Florence, (Ministero di Agricoltura, 1877) several widely used historical linear units from these regions were selected to investigate potential correspondences within the Piagnole buildings:

- Bolognese Foot (0.380 m)
- Liutprand Foot (0.436 m)
- Imolese Foot (0.439 m)
- Florentine “Braccio” (0.583 m)
- Bolognese “Braccio” (0.639 m)
- Metre (1.000 m)

Using these units, measurement grids were created to record the dimensions of building base sides and wall thicknesses. For the openings, specific parameters were chosen to develop a dimensional catalogue that revealed correspondences and combined uses of these units. This inventory allowed researchers to determine the dimensional references for each opening's individual blocks and their assembly. Multiple combinations of different units were identified, suggesting how varying construction cultures influenced specific shapes, techniques, and dimensional standards across different areas of influence.

4.1. Measurements of individual blocks

By observing all the correspondences with historical linear measurement units recorded during the investigations, the Florentine “Braccio” emerges as the most commonly used dimensional reference throughout the built structures of the Piagnole. In particular, many openings made of squared and regular blocks show a correspondence with the Florentine unit. For this reason, all the blocks of this type were measured for each opening, resulting in a total of 120 blocks, in order to gather a dataset and compare the characteristics of blocks with similar size correspondences. Undoubtedly, these types of blocks most clearly reflect the deliberate intention of the individual who created them, thereby reinforcing the connection between the measurement unit and the block's characteristics. Following this analysis, it was observed that regular blocks primarily feature two types of finishes: surfaces with parallel grooves (pointed chisel) and anathyrosis (flat chisel), which may be inclined or orthogonal to the longer side of blocks.

The first category shows grooves inclined at 60° relative to the longer side of the block, well defined anathyrosis, and block thicknesses between 0.10 and 0.15 meters. These elements frequently correspond to the Meter unit and are the best-preserved blocks, often associated with modifications to the masonry around the opening itself (Fig. 5).

The other type of finish features grooves orthogonal to the longer side of the blocks, which have thicknesses between 0.25 and 0.30 meters. Anathyrosis is not always found, due to conservation conditions that make it difficult to

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discern. Nevertheless, this type of block is closely linked to the Florentine "Braccio" and is found in the primary structures of buildings, often characterized by earthen mortar.

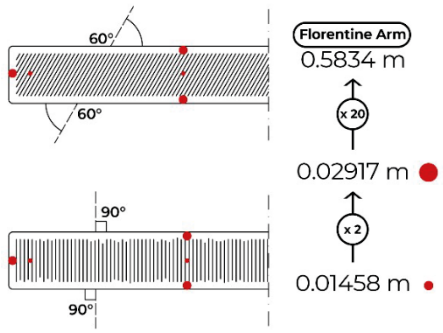

Fig. 5 – *Different types of surface finishing* (Authors).

5. Evolutionary framework of the village

The observations made during the analyses enriched the understanding of the built environment and enabled the formulation of chronological hypotheses. In addition to the collected information, additional analytical parameters were employed to organize the collected data. These parameters include:

- The period of influence of specific units of measurement;
- Evidence of transformation, such as contact lines between different masonry types or buildings;
- Modifications to masonry, including the insertion of new openings;
- Reuse of elements, sometimes with differing dimensional references.

These parameters helped establish relationships between the buildings based on their units of measurement, masonry types, and openings, allowing researchers to hypothesize the chronological evolution of the village. Studies have shown that examples from the same era and with similar functional and social purposes tend to exhibit comparable characteristics in shape, materials, decorations, etc. (Boato & Pagella, 2015). In the case of the Piagnole village, the castle's perimeter walls and the chapel's foundation represent the earliest construction phase due to similarities in their masonry fabrics. Following this, the five buildings in the village core were organized based on their opening types and dimensional combinations. The final phase is represented by the annexes to the main structures, such as ovens and loggias, which are characterized by less precise masonry and frequent references to the Meter.

5.1. Chrono-typology of openings

In the evolutionary study of the village, openings deserve special attention as they reflect the diverse cultural influences over time. By connecting the chronological development of the buildings with their respective openings, a chrono-typology was established (Fig. 6). This system illustrates how the opening types in the village evolved over time in terms of shape, size, workmanship, and other characteristics.

6. Conclusions

This research seeks to demonstrate that the apparent simplicity and uniformity of vernacular architecture conceal a wealth of cultural elements.

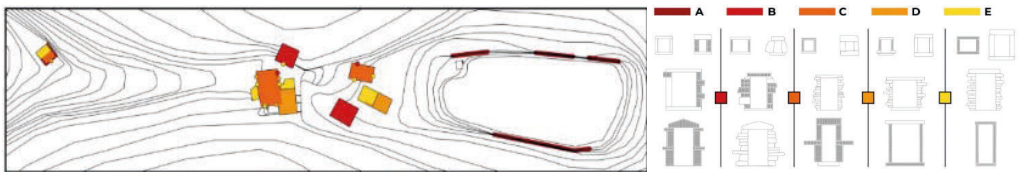

Fig. 6 – *The five temporal phases of village and the openings chrono-types* (Authors).

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These insights can deepen our understanding of the built heritage and inform contemporary architectural design. The goal of this type of investigation is to expand knowledge about the analysed artifacts by offering alternative, non-instrumental, and non-invasive interpretations. It also aims to foster sensitivity among professionals, encouraging further study and recognition of other villages in the Santerno Valley.

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Documenting and Studying the First Indigenous Peoples of South Africa's Villages and Dwellings in Baviaanskloof, Applying an Indigenous Methodology

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Abstract

This contribution will speak about a research project developed at the Nelson Mandela University, School of Architecture, with the aim to document, study, and raise awareness of Indigenous villages and their wattle and daub dwellings. These dwellings, which had never been studied before, are examples of vernacular architecture and are located in a remote area of the Eastern Cape province of South Africa. The Indigenous knowledge system applied to building these structures has been passed down from generation to generation from pre-colonial times up to the present. This being the case despite the long history of the First Indigenous Peoples' – the San and Khoikhoi – displacement from their territory and forced removal from their homes, which started with the arrival of the settler colonisers. The project, which started in 2021 and is currently in progress, is conducted in collaboration with a team of Chiefs and community members of the San and Khoikhoi peoples. The research methodology in use has its foundations in the holistic Indigenous worldview. This ethically sound process is rooted in principles of mutual trust and accountability, respect for each other's views and cooperation in the research decision process, reciprocal knowledge product appropriation, and use of Indigenous protocols toward the right of Indigenous Peoples to retain full control of their knowledge. The core phases of the research project and the methods applied will be discussed with a specific focus on the relationship and involvement with the First Indigenous Leaders and community members in the process of investigation.

Keywords: *San and Khoikhoi architecture; indigenous knowledge system; indigenous methodology; Baviaanskloof Valley*

1. Introduction

The research project, entitled "The First Indigenous Peoples of South Africa's Built Environment and Dwellings in Baviaanskloof", developed at the Nelson Mandela University by a working group composed of academics and Indigenous Leaders (PI Minguzzi), is particularly relevant because of its groundbreaking nature. In fact, thanks to this project, the three hamlets – Zaaimanshoek, Sewefontein, and Joachimskraal – and dwellings documented by the working group in collaboration with the inhabitants, were recognised and acknowledged as unique examples of Khoikhoi vernacular architecture which still exist and are in use. Therefore, this research is a unique opportunity to build up new

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knowledge and a better understanding of the Indigenous Peoples' building traditions and living heritage. A know-how which has been passed down orally, in these communities, from previous generations up to the present time. Considering the history of repression, segregation, and the genocide suffered by the First Indigenous Peoples in South Africa, along with the prevalent colonial narrative that portrays the San and Khoikhoi as extinct peoples, the topic under study and the process of cultural reappropriation involved are of crucial importance. Furthermore, this project has been an opportunity for the research group to apply and further refine the indigenous methodology they have developed over years of collaboration.

2. The hamlets under study: overview

The three hamlets –Sewefontein, Zaaimanshoek, and Joachimskraal– are located in the Baviaanskloof, a long and narrow valley, defined by two parallel mountain ranges. A river runs all along the valley, and it's probably one of the main reasons why the valley has been occupied since pre-colonial times, as testified by the conspicuous and well-spread pictograms present in caves and shelters. Despite the valley being difficult to reach even today, it was not immune to colonial invasion, which led to the fragmentation of private property. In addition, since 1923, a large part of the valley has been subject to conservation management, with significant areas restricting access to Indigenous inhabitants. Although here, the majority of Indigenous peoples were not forcibly removed as was the case in the rest of the country, they were dispossessed of their territory and became mainly *bywoners*, which in Afrikaans means "landless tenants", giving their labour in exchange for the right to occupy the land. When the productive life period of the individual ended, or if the landowner changed, the Indigenous families were at risk of being evicted from their farmland dwellings.

Sewefontein and Zaaimanshoek were established by local Indigenous families as a way to break the oppressive cycle they faced. They purchased land from farmers willing to sell it to them as the original custodians. Zaaimanshoek's land was acquired in 1916 and placed under the custody of the Union Congregational Church, because of the fear of losing the land. Sewefontein has been

Fig. 1 – *Aerial view of Zaaimanshoek positioned in between the two ranges of mountains defining the Baviaanskloof Valley* (Author).

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owned by 75 families since 2002 who constituted the Sewefontein Community Farming Trust. Joachimskraal, though, is located on farmland and hosts the first Dutch Reformed Church Mission School established for Indigenous children.

The three hamlets have similar wattle and daub dwellings, but their urban morphology or their disposition in the landscape is different. Sewefontein is a very open and flat landscape and the dwellings are widely spread across the semi-circle defined by the hills that embrace the open land. Zaaimanshoek is semi-structured in plots distributed organically around a small hill present in the village and defined on the sides by high hills which seem to protect – even visually – the village (Fig. 1). Joachimskraal, which hosts the lowest number of dwellings, shows an orthogonal disposition of these fabrics, recalling its Western influence (Fig. 2). Despite this, the natural elements of the surroundings are very prominent, and the inhabitants said that the orientations of the dwellings are decided upon according to the direction of the winds.

Fig. 2 – *Aerial view of Joachimskraal. The hamlet is divided by the main road that runs all along the narrow valley* (Author).

3. The wattle and daub dwellings

3.1. The plot organisation

The wattle and daub dwellings surveyed by the working group, in collaboration with their inhabitants and, on some occasions, with the local Master Builders, present similar characteristics in their distribution, the building techniques, and local materials used. The "plots" where the dwellings are located are defined by fences consisting of dry, thorny branches of a local bush – Sweet Thorn[1] – or steel wire mesh. Usually, these plots have a garden and sometimes a vegetable garden.[2] The freshwater point and the toilet are situated outside the dwellings as part of the elements present in the plot.

3.2. Spatial distribution of dwellings

There are three types of dwelling plans or layouts, determined by the position of the cooking room. This room, usually small and mainly containing only the traditional wooden stove, is not part of the kitchen-dining room. This last room, the kitchen-dining room, is in fact a combination of the kitchen – with fridge, cabinets to store pots, plates, and cutlery – and the dining room, and is not used for cooking, but only for eating and as a main meeting place.

The first dwelling's type is rectangular, with the cooking room integrated within the plan. In many dwellings, the cooking room is separate, which seems to be preferred, and in these cases, the layout has an L shape. This constitutes the second type. The third one involves the cooking room being completely detached and positioned parallel to the house. In both the second and third type, the position of the cooking room creates the opportunity for a defined, open communal space, usually paved and furnished with small benches,

[1] This recalls the pre-colonial way of defining the round Indigenous settlement as described through drawings by early travellers.

[2] The conspicuous presence of baboons in the area poses a challenge for growing fruits and vegetables.

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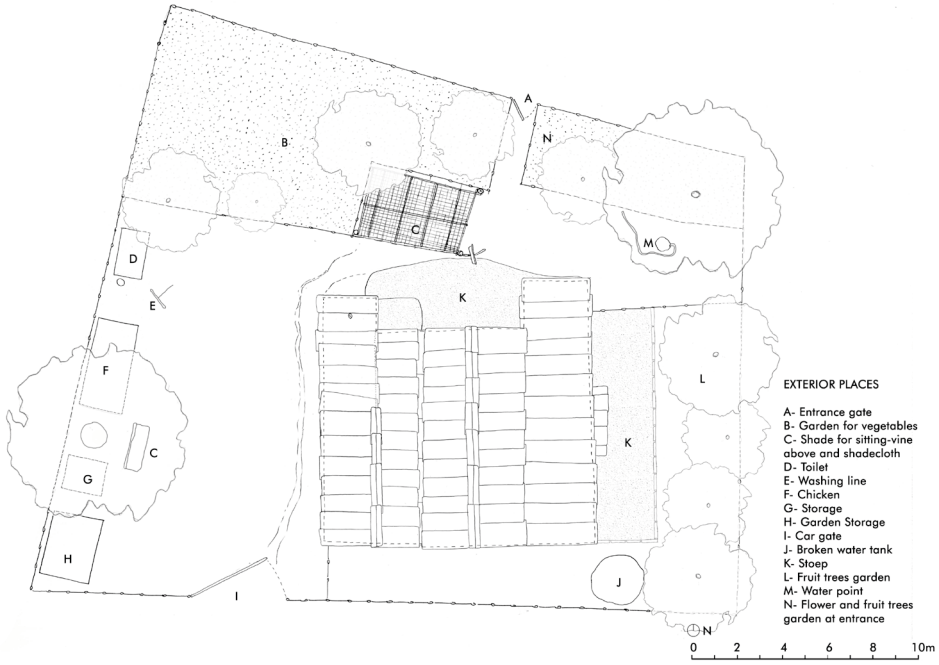

Fig. 3 – *Example of plot distribution. Here is a dwelling in Zaaimanshoek* (Author).

where the family members or visitors meet (Fig. 4). This gathering space can also be found in rectangular houses, although it is less "anchored" to the house and is often positioned under a nearby tree. The cooking room is always the first room facing the entrance to the site.

The inhabitants describe the position of the cooking room as separate as a necessary safety precaution because of the presence of the stove (fire) and the smoke. Still, this also serves as a reminder of the pre-colonial cooking space (fire) positioned at the entrance of the shelters as protection from wild animals.

On entering the dwellings, the first room encountered is the kitchen-dining room, which forms the core of the house. The main entrance is typically located in this room, although some dwellings feature a second, more formal entrance facing the living room. The bedrooms are situated around the kitchen (Fig. 5).

Fig. 4 – *Examples of outside gathering spaces* (Author).

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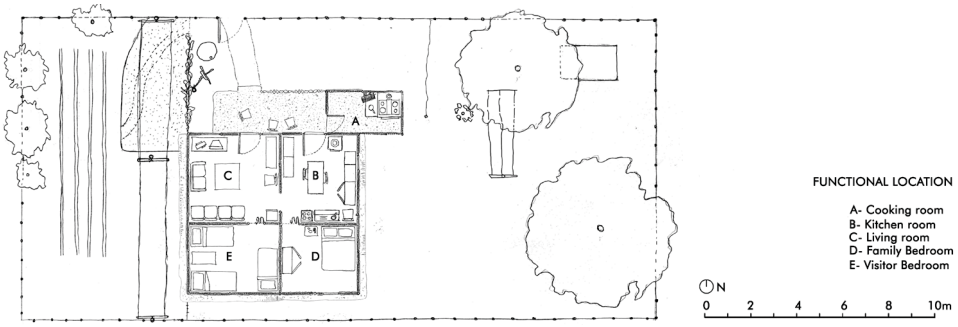

Fig. 5 – *Example of plan distribution. Dwelling in* Zaaimanshoek (Author).

3.3. Materials and dimensions

The materials used for construction are primarily sourced locally (though not indigenous) and obtained directly from the field or recycled from nearby dilapidated structures. This process is carried out by the Master Builder or family members who have prior experience with building activities, giving them a good understanding of the construction process.

The main structure is usually built using Blue Gum tree[3] poles, or the Agave plant tall stem. The secondary wall's structure (horizontal), as well as the infill walls, are constructed using reeds.

Fig. 6 – *Dwelling under construction in Sewefontein* (Author).

The dimensions of the house are determined by the human body proportions. Room sizes and the distance of the poles are determined using footsteps, with 1 step being equivalent to one meter in distance. Vertical measurements, such as those for windows, doors, and the roof structure, are obtained by measuring a length of thread held in the hand, rolled up to the armpit, which equals approximately 50 centimeters. Each room is approximately 3 by 4 meters.

4. The Indigenous methodology and methods applied

4.1. Introduction

The Indigenous methodology and methods applied by Minguzzi's research group have been developed and refined during the years of collaboration, starting from 2015. Working with an Indigenous methodology meant establishing a framework, methods, and tools driven by the Indigenous holistic worldview and protocols. An approach rooted in constant development and constant consultation, together with mutual trust and accountability, respect for each other's views, and cooperation in the decision-making process towards the right of Indigenous Peoples to retain full control of their knowledge.

[3] Eucalyptus Globulus. Blue Gum trees are not indigenous to South Africa but were introduced by farmers and used for fencing farmlands.

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Community participation is applied in each phase of the project: from the ideation of the project of research, the application for funds, the recruitment of the participants and data collection. It also includes evaluating the process and outcomes, as well as creating outputs and sharing the findings. These are steps that allowed the group to own the project in full. Throughout this process of research and engagement, it was essential to continuously evaluate and self-reflect on the process and our experiences while being attuned to each other's needs and changes in the contingency of each other's reality.

The use of a multidisciplinary approach was seen as fundamental to be able to broadly embrace the complexity of the topics under study. The research project did not depend on written text or archival materials. Not only because there is no such record to be consulted, but because the group approach depended on the knowledge held by the Indigenous Peoples involved in the study. An approach that helps to avoid further misinterpretation, misrepresentation, fragmentation, mystification, commodification, and simplification of Indigenous Peoples' knowledge (Louis, 2007; Smith, 1999, 2000). In general, the methods applied by Minguzzi's group are focused on the three major sets of data that they usually envision to collect and analyse: desk research for the historical records, field trips and site surveys for the tangible heritage, and semi-structured interviews for oral traditions and intangible heritage.

4.2. Typical field trip and data collection in Baviaanskloof

The field trip started off with Lucy Vosloo and Magda Minguzzi picking up Chief Margaret Coetzee and her Headman, Mr Flip Pieterse. The trip to reach Baviaanskloof took approximately 4 hours and was used as an opportunity to discuss and refine a proposed working plan before reaching the sites. In the valley, the fieldwork started with a prayer of thanks by Chief Coetzee to God, *Tsũi-||goab*, for allowing the group to be together, and to ask for protection and guidance to achieve the planned goals (Fig. 7). Chief Coetzee and Headman Pieterse pre-selected the dwellings to survey on the hamlets under study, and the families to interview. Subsequently, the researchers were introduced to the selected family. This was an important moment: for the researchers, it posed a precious opportunity to get to know and connect with the members of the community, and for the Chief, it was an important occasion to reconnect with her people.

Fig. 7 – *Prayer at the start of the working day* (Author).

Usually, the data collection started with the interview, organised with an informal setup to avoid creating unnecessary pressure on the part of the interviewee. Before starting the recording, the Chief introduced the general scope of the research project to the family and the aspects related to the working group's ethical conduct, together with the university's clearance forms to fill in and sign. After the interview, the group asked permission to survey the dwelling. This was done in collaboration with the Headmen and community members (Fig. 8).

Fig. 8 – *Site survey with community members* (Author).

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The Chief assisted with obtaining ethical clearance at the end of the data collection process. This timing was intentional, as it allowed the family to fully understand the nature of the work conducted and provided them with the opportunity to ask for clarifications if needed. By securing clearance at the end, the family could see the group's activities firsthand and make an informed decision about whether or not to participate in the project.

The last phase of the data collection involved reporting back to the main working group composed of ten Indigenous Chiefs.

Elaboration of data and output production was done in cooperation with the Chiefs, who evaluated the final work. The researcher needed to wait for final approval and a blessing from the group before making the output public. This is part of the Indigenous protocol and ensures that the outputs truly represent the Indigenous Peoples.

5. Conclusion

Through the undertakings by the research project, the San and Khoikhoi communities of the Eastern Cape were given the opportunity to build a written and digital repository of their knowledge, with a specific focus on the Indigenous knowledge system of the built environment and heritage. Since 2024 the Baviaanskloof research project is among those funded by the Endangered Wooden Architecture of Oxford Brookes University and the hamlets and dwellings documented will be included in an open source archive. For the working group, this was a crucial international recognition of the value of the San and Khoikhoi heritage, and the acknowledgement that a First Indigenous heritage still exists and is a living heritage. Furthermore, it will help the community to preserve the record of the technology applied and to pass this knowledge on to future generations.

The research itself activated processes of validation of the importance of these hamlets, their wattle and daub dwellings, and the Indigenous knowledge applied by the local community. The field trips and the engagement activities on site had a positive impact, especially on the young generations living there. At the beginning of the research project, the working group identified a sense of discomfort and unhappiness stemming from the negative perceptions associated with living in homes constructed from wood and mud. However, through lengthy interactions with the community—including the involvement of university students from the School of Architecture at Nelson Mandela University—the group was able to emphasize the regenerative and sustainable qualities of these dwellings. This engagement contributed to a shift in mindset that fostered social cohesion.

Ultimately, the project helps the Indigenous Peoples in the process of writing their narrative and their story, advancing the process of restoration of the Indigenous culture and identity.

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(Camdeboo); Gaob Brato Malgas, Inqua People (Jansenville); Chief Xam ≠ Gaob Maleiba, Damasonqua People; Paramount Chief Gert Cornelius Steenkamp, Oeswana People; Chief Wallace Williams, Oeswana Camdeboo; Gaos Anne Williams, Gamtouers/Gamktwa People (Thornhill/Loerie area).

The academic team members of this research project are: Assoc. Prof. Magda Minguzzi (Nelson Mandela University) (PI); Arch. Lucy Vosloo (Nelson Mandela University) (CO); Dr Yolanda Hernández Navarro (Universitat Politècnica de València) (CO); Arch. Kim Harmse (Nelson Mandela University) (CO).

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Exploring Rural Heritage in Central Sicily (Italy). Proposals for Cataloguing, Protection and Valorisation: the case study of Fondaco Cuba

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Abstract
Rural architecture in Italy has a significant impact on the landscape, revealing itself through a vast and varied array of structures and building typologies that demonstrate a fundamental link between culture and natural context. Man and nature's interactions are manifested through a series of spaces designed for living and farming, along with other material elements that create recognizable historical and anthropological units. Besides being tangible signs on the territory, these structures also convey many intangible values associated with cultivation practices, traditional economies, ways of living, and crossing places. The rural landscape of Sicily maintains its essential character and specific identity. Recognizing important qualities from a constructive and formal point of view allows us to distinguish this landscape from others and identify a heritage that deserves to be preserved. This work summarizes the first results of wider research aimed at carrying out a cognitive investigation on rural constructions in Central Sicily to deepen the understanding of the settlement dynamics and transformations of this area. Following a census activity, carried out on recent guidelines established by the Italian Central Institute for Cataloguing and Documentation, the essay focuses on an emblematic case study where innovative knowledge activities were carried out to support conservative rehabilitation strategies and local development processes.

Keywords: *rural architecture; landscape; cataloguing; conservation; valorisation; Sicily*

1. Introduction

In Sicily, rural architecture is a mosaic of local and sectoral situations that are highly distinct from each other. The region's insularity may seem uniform, but it is not. Numerous and varied sub-regional territorial realities exist: many islands within islands can be counted, as Leonardo Sciascia pointed out while describing Racalmuto, his hometown (Sciascia, 1990). A Sicily composed of 'one hundred Sicilies', territories that are only apparently the same, but in reality, always different, each characterized by customs, variations and typicality, which are the consequence of its historical condition as an 'island-crossroads': "a theatre of memory in which ethnic groups, codes and languages have alternated and overlapped" (Di Grado 2021, 24). Destination of countless invasions, dominations, and consequently of settlement and integration of different peoples, Sicily has, in fact, been shaped by different experiences and knowledge that have produced equally vast cultural stratifications: an

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"immense archive of the peoples of the Mediterranean, in an articulation of spaces, in a peculiarity of landscapes, in portions of 'togetherness' that end up breaking up the regional individuality" (Campione, 1992, p. 16). A palimpsest, not always easy to decipher, that, especially in internal Sicily, has been marked by the long persistence of the feudal-type landowner system. An organisation that has significantly influenced the way of understanding nature and using it: "that infamous Sicilian latifundium that, in truth, was able in other eras to reward, with copious and sought-after fruits, the assiduous care of the owners and the loving work of so many good farmers" (Pontieri, 1943, p. 50) but which still in the 19th century was a source of wealth only for the baronial class. Although the Sicilian Constitution of 1812 abolished feudal rights, this did not lead to a redistribution of the lands, but rather to their transformation into private property. The Sicily of the feudal system changed into the Sicily of the latifundium, and the old and confident feudal lords became the new and equally confident landowners. The agricultural landscape continued to be marked by the irredeemable character of what Giuseppe Tomasi di Lampedusa spoke of in *The Leopard*.

Following the establishment of the Kingdom of the Two Sicilies and the incorporation of the *Regnum Siciliae* into it, a series of administrative and bureaucratic reforms was initiated to improve the State's efficiency. Road infrastructure investment was made, and trade and agriculture reforms were introduced. This quickly led to the birth of numerous scattered *masserie*, farmhouses and rustic agglomerations, characterized by a different typological conformation depending on the orography of the territory and the type of productive activity for which they were intended. However, for a long time and well beyond the unification of Italy, due to the powers acquired over time and in the absence of a strong State, the Sicilian barons, supported by the nascent mafia phenomenon and banditry, continued to exercise power over the rural populations, preventing farmers from working the land, causing them enormous suffering and worsening their living conditions.

Unlike the coastal areas, where the development of citrus production strongly oriented towards export had transformed agriculture, inland Sicily, still dominated by cereal production, was affected by an increasingly important exodus from the countryside at the end of the 19th century. The price of wheat decreased because of the large amounts of stocks arriving from Russia and America. This situation, accentuated by important demonstrations of peasant struggle, particularly affected the internal territories of Sicily, where the exodus of people employed in agricultural and pastoral activities had greater relevance than in other areas of the island. Emigration, which mainly involved agricultural labourers and small tenant farmers, the progressive sterility of the lands irrationally deforested during agricultural colonization, and subsequently the disastrous decline in agricultural incomes accelerated the functional decline of farms and cottages. It caused, in the countryside, abandonment, solitude and desolation, as demonstrated by the numerous investigations conducted at the time, including the very famous one by two young Tuscan scholars and politicians, Leopoldo Franchetti and Sidney Sonnino (Franchetti & Sonnino, 1877). At the end of the First World War, a new subdivision of rural areas became necessary, driven by the urgency of making the land productive and ensuring the collective well-being of the population in economic, productive and social terms, recalling a nationalist patriotism. Fascist ideologies focused on the idea of returning to the land as a chance to restore social balance and traditional values of peasant society. Ruralisation took on a central role among the government lines of the fascist regime, positioning itself as a tool that was supposed to change the face of Italy and its territory and modify the mentality of Italians. The land reclamation laws of 1923, the colonization of the

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Sicilian latifundium in 1940 and the Agrarian Reform started in 1950 continued an activity of fragmentation of the latifundium, contributing to the construction of villages and, at the same time, of numerous farmhouses, set on a scattered settlement system characterized by small plots of land to be cultivated (Guarrera, 2022).

The study of agricultural settlements was aimed at tackling the practical issue of the new rural constructions promoted by the fascist government in a more conscious manner. Giuseppe Pagano and Guarniero Daniel's 1936 exhibition on *Rural Architecture* resulted in a genuine discussion about how to make people understand the aesthetic value of rural houses and to promote the respect for this little-known heritage: a significant expression of Italian tradition in architecture, “clear, logical, linear, morally and also formally very close to contemporary taste” (Pagano & Daniel 1936). Thus an interest was reawakened in the study of a particularly varied and fragile heritage of our country which in Sicily would find expression in the research of numerous scholars, who would concentrate on the architecture and rural landscape of the hinterland, on the elements which had mostly disappeared from major architecture, but were precious for those who wished to follow their entire evolution: [the] most modest part of that building activity which commonly goes under the name of “minor architecture [...], the spontaneous fruit of the popular soul, permeated with naivety, often expressed with poverty of means by the small workforce or by the peasant himself who improvises as the architect of his own home” (Epifanio, 1939, pp. 7-8). Despite the tentative results of the post-war Agrarian Reform, this architecture became disused due to the economic boom and the subsequent de-ruralization of Sicily. In the period 1951-1970, over 400,000 jobs were lost in agriculture, and the internal areas of the region became empty and deteriorated (Amata, 2017).

Today, the rural landscape is still suffering the consequences of a period of great hardship in the sector that the rural development programs promoted by the European Union in the last thirty years have tried to fill through the implementation of a series of financing and new recovery plans, not always effective. Rural architecture is increasingly at risk due to the often-radical transformations carried out on the territory, as well as the numerous political and socio-economic changes. A heritage made up of a multitude of structures and building typologies that reflect centuries of history, culture and interaction with the natural environment and that express, at the same time, a mass of intangible values linked to cultivation practices, traditional economies, ways of living and crossing space. Following the impetus given by the census work promoted by the Italian Ministry of Culture, in implementation of the provisions of the National Recovery and Resilience Plan, a (parallel) activity of cataloguing of historical rural buildings was therefore conducted in Central Sicily. Focus was given to an area of great interest located in the province of Enna, emphasizing the municipalities of Centuripe and Catenanuova. An area dotted with a large nucleus of rural dwellings that are witnesses to the Sicilian peasant civilization, which the survey aimed to identify. The paper will describe an emblematic case study, the Fondaco Cuba, where innovative forms of study and analysis were experimented with to safeguard and recover it.

2. Rural heritage cataloguing for assessment and recovery

The study area is a rare example of an uncontaminated and intact environment in Sicily. The phenomenon of depopulation of the countryside that occurred after the war has effectively frozen the landscape as it evolved over centuries until the 1950s. New construction has been hindered by the failure to return to the countryside and poor humanization and almost only are remnants of vernacular tradition. In

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addition to some mills and small homes, there are more complex settlements such as the *Masserie*, which includes the houses of the *Massari*, the internal *Bagli*, and the houses of the labourers. These places, often designated as farms, are linked to an extensive cultivation system associated with livestock breeding. The *masserie* "small fortresses in the middle of bare countryside: pivots or fulcrums of a medieval type and flavour of landed estates, in the process of disintegration" (Pecora, 1968, p. 340) are mostly located in low and medium hill areas, while their diffusion decreases considerably with the rise of the relief, until in the high Erei and in the culminating areas of the Nebrodi, as well as in the high Iblei, where they disappear.

In general, in the Enna area, the *masserie* present an architecture like that widespread in other internal areas of Sicily, characterised by a large courtyard that connects the various parts of the building, composed of a massive and compact central body in the shape of a quadrilateral. The unique access to the courtyard seems to limit contacts with the outside and underlines the defensive nature of the structure, highlighted by the bare wall surfaces with rare openings. The sole entrance is made up of a double door, which is topped by a round arch and has the initials of the owner engraved on it. The courtyard, which is quadrangular in shape and never less than 500 square meters, has a paving made of stone slabs or cobblestones. In some of them there are also real religious chapels, in a harmonious synthesis between uncontaminated nature and human presence (Alleruzzo di Maggio et al., 1973). An important heritage of rural architecture that, only in part, appears to be in use because it has been transformed into agritourism or it is still dedicated to a residential function maintaining the relationship with the landscape cultivated with cereals, fruit trees and olive trees, but which for the most part lies in a state of abandonment. About twenty *masseries* with particular significance from historical, anthropological, and architectural perspectives have been listed in the census. Among them are the Schembari farm in the Catenanuova area and Cuba, Diodato, Muglia, Burgì, Spitaleri, Sternazza, Grande, Cocuzza, Pernice, Mammana and Cantarella in the Centuripe area. In accordance with the provisions of the Central Institute for Cataloguing and. Documentation of the Italian Ministry of Culture, the new Rural Architecture catalogue card has been compiled for each of these assets. The AR – Rural Architecture catalogue model, specifically developed for the project, can describe the different types of rural houses, return their specific characteristics, and allow the development of documentation that collects a lot of information. The peculiarity of the new AR card lies in the variety of data that can be inserted, ranging from those relating to the landscape to those of hydrogeological instability detection, from those relating to the analysis of the architecture to those of a historical-bibliographic nature.

The recognition has enabled the emphasis on a particularly significant typology of *masserie*: the so-called *fondaci*. In Sicily, these rural warehouses were located along the main connecting roads of the island with functions not exclusively linked to agricultural production and breeding activities but also intended for the storage of goods and the reception of merchants. Introduced during the Saracen domination, the warehouses represent an architectural typology of extraordinary importance, derived from the Arab model of the *funduq*, architectural complexes divided into a series of smaller buildings around a large courtyard. They arose at regular intervals, along the ancient *trazzere*, the public roads that served as strategic axes for transhumance, trade and transport between the different areas of the island (Tesoriere, 1993). Their development took place between the 12th and 18th centuries during the reign of Frederick II of Swabia, when, for the purpose of royal control of trade and for fiscal reasons, these structures were subject to concessions and precise regulations for their management. In fact, they

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allowed the control of agricultural products from the places of production to the city markets and ports for export. The warehouses therefore became strategic for the government of the territories and responded to logistical and social needs: they were structures designed to offer refreshment to travellers, shelter for goods and animals, stables, carriage sheds, in addition to performing the functions of inn and post station. They were not configured only as simple places of rest, but as true centres of economic and social exchange: spaces in which commercial activities, essential for the community life, took place.

3. The Fondaco Cuba case study

The Fondaco Cuba fits into this context, located in the district of the same name that arose along the dirt road that connected Palermo to Catania, along the stretch passing through Catenanuova, a city founded by Prince Andrea Giuseppe, firstborn and heir of the Riggio-Saladino and Statella-Paternò families. The name of the village *Terra della Nuova Catena* (later Catenanuova), built in execution of the imperial diploma issued in 1726 by the Viceroy Count de Palma is a clear reference to Aci Catena, of which he was prince. Its existence is documented in a notarial deed dated February 9, 1733, relating to a sale of land, which confirms the existence of the new settlement that had a community of about 500 inhabitants, mostly from Centuripe (Fig. 1).

The center required the reclamation of the Dittaino marshes and the creation of a new section of the royal *trazzera* towards Catania and Syracuse, creating a new route downstream from San Filippo d'Agira and Centuripe - in the direction of Paternò (Virzì, 1989). The Fondaco Cuba has a more ancient history, and the complex architectural stratification suggests construction phases prior to the current phase; it is mentioned for the first time in a deed of sale of 1408 as the property of Giovanni Esquifanio, it later passed to the family of the Biscari princes, who owned it from 1633 to 1919.

Fig. 1 – *The Fondaco Cuba and its territory, rich in masserias* (Fiorenza).

Originally it was only a farmhouse that was transformed into a warehouse in the 18th century following the new route of the *trazzera* and strongly transformed by interventions carried out perhaps also because of the damage caused by the earthquake of 1693 (Virzì, 1989). From the 18th century onwards, the warehouse was often described and cited in the travel reports of visitors on the Grand Tour. The chronicles tell that Victor Amadeus II of Savoy, King of Sicily, and his wife Anna Maria of Orleans stayed there for an entire night in the spring of 1714, accompanied by their royal entourage (Ansaldi 1981). Johann Wolfgang Goethe also stopped there on 30 April 1787, mentioning it in his Italian Journey. He described it as a solitary farmhouse where he stopped to refresh himself with his travel companions and where he was struck by seeing the farmers intent on extracting, with the tip of small pocket knives, the pulp from the upper end of wild cardoon plants (Mistretta, 2023). The Fondaco di Cuba is recognizable in the famous Historical Atlas of Sicily by Liliane Dufour and in subsequent maps, a sign of its importance in the island's connection system until the 20th century. In 1935, a transfer of ownership of some portions of the warehouse was recorded, sold by Nicolò La Noia to

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Commendator Prospero Mammano, through a deed of sale drawn up by the notary Rosario Sciuto (one of the founders of the Pia Opera di Centuripe). In 1936, finding the building in a state of decay he began its restoration. Today, despite the recognition of its historical value by the Superintendency of Enna in 1985, and its classification among the assets of historical-artistic and ethno-anthropological interest in 2005, the complex is today in a state of abandonment, with serious risks of collapse. This state of degradation, repetitively denounced by scholars and local officials, makes it urgent to intervene, not only to safeguard the building, but also to reconstruct the historical and infrastructural memory of an area often marginalized in historiographical narrative.

3.1. The survey for knowledge

The knowledge project is the basis of any intervention that involves cultural heritage. The collection, analysis, and interpretation of historical, architectural, and technical-constructive data on the built asset is the basis of a methodological approach, which aims to ensure its conscious conservation and effective enhancement. To protect and return Fondaco Cuba to the community with renewed awareness of its value, it has been necessary to first recognize its material and immaterial components. This is why, through a rigorous documentary analysis and a 3D survey of the existing building, the adopted methodological approach was aimed at understanding both its typological and technological characteristics (Fig. 2).

Fig. 2 – *The 3D model created with UAV systems.*

Modern digital surveys and diagnosis technologies have made it possible to acquire data with great accuracy and high precision. The creation of 3D models has allowed not only to analyze in greater detail the state of conservation of the structures, but also to advance reconstructive hypotheses about the different constructive phases that have characterized it. Documenting the status of Fondaco Cuba through digital survey methods will be useful not only to preserve and promote its memory, but also to acquire useful data for its conservative rehabilitation and functional recovery. Through aerial photogrammetry and laser scanning high-resolution models were obtained. They have constituted the scientific basis for the study of the geometries, of the wall textures, of the materials used and the degradation and alterations phenomena that have compromised the building and its relationship with the surrounding spaces. In particular, the UAV (Unmanned Aerial Vehicle) survey using Remotely Piloted Aircraft Systems (SAPR) was essential to overcome the limitations of accessibility of abandoned rural area such this one, which are in general hard to measure with other systems due to the high vegetation and the risk of collapse of the roofs and vaulted parts. The 3D survey, therefore, has represented then an essential tool for the work of the restorer in an era in which the conservation of the architectural heritage requires increasingly complete methodologies obtained through integrated analysis with different sensors. One of the most relevant aspects of the study was the possibility of combining the acquired data with archival sources, thus creating a dialogue between the digital dimension and the historical documentation; the digital survey was not only a technical-analytical support but a real key to understanding the past and guiding future choices. The digital analysis, combined with an interdisciplinary approach, has given the opportunity to tackle with a scientific method the problems related to the protection and enhancement of the rural complex, thus ensuring

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a significant contribution to its understanding and transmission to future generations. The first step was, however, the direct survey, intended as a moment of inspection and 'unfiltered' contact with the warehouse, aimed at knowing the space within which to design, as well as to acquire a first overall picture, not only of the dimensions of the various compositional elements, but also of their material consistencies. All of this, as mentioned, was integrated with the historical-documentary study, made possible thanks to the consultation of the documents preserved in the Archives of the Superintendence of Enna, of the Municipality of Centuripe of the Opera Pia Pietrangelo D'Amico of Centuripe. The graphic restitution was declined both in geometric form (with the aim of obtaining Mongian projections useful for understanding the relationships between the parts, the metric links of proportionality and reciprocity, as well as analyzing the sequence between full and empty spaces), and in architectural form (to investigate orders, styles and decorative elements of the different ornamental components), to understand the quality and specificities of the place.

The survey provided the required information for material mapping, structural failures and degradation analysis; the analysis of the latter was conducted through an experimental technique, processing the datasets of images with Deep Learning approaches for inspection and recognition, to characterize the surfaces and identify surface alteration phenomena. For the automatic identification and classification of objects, the YOLO (You Only Look Once) technology was adopted, a retrained neural network, known for its ability to detect and categorize elements in real time. The experiment was conducted using the Roboflow platform, specifically used for training images to identify the elements to be classified. Automatic recognition of some construction elements was then performed, such as sandstone ashlars, plaster, roof and openings (Fig. 3).

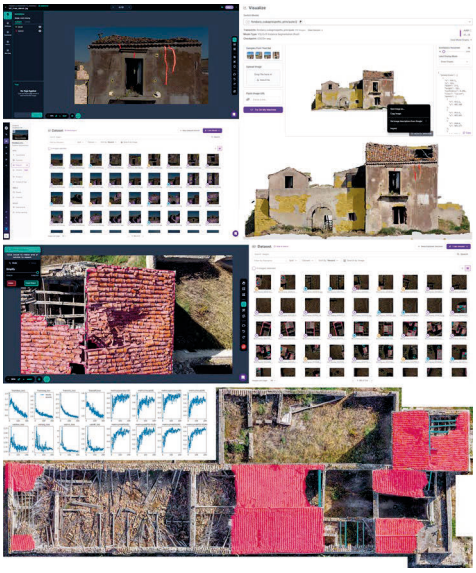

Fig. 3 – *Manual annotation steps for dataset creation, results and final test on orthophotos.*

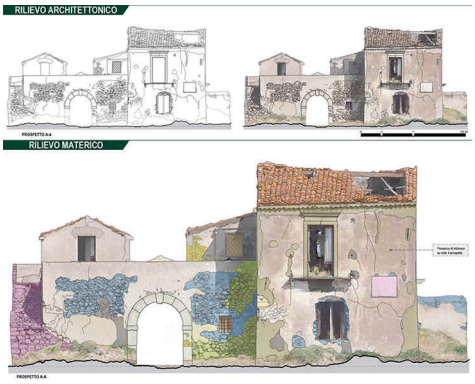

Fig. 4 – *Ortophotos and 2D drawings for materials'mapping.*

The experiment allowed for an initial automatic mapping of the images but highlighted some limitations, in the system's ability to accurately distinguish materials in variable lighting and texture conditions. This made it necessary for the operator to intervene, using traditional techniques, to correct and finalize the final mapping (Fig. 4). Enhancing the use of rapid survey techniques, which are based on innovative digital acquisition systems like drones and LiDAR technology, seems fundamental from this

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perspective. Already widely tested in the infrastructural and industrial fields, these solutions prove to be extremely effective also for the reconnaissance of rural architectural heritage, often consisting of isolated and difficult to access artifacts, offering new opportunities for systematic mapping and more extensive protection of the territory.

4. Conclusions

The research carried out on the Fondaco Cuba and, more broadly, the rural architecture of central Sicily emphasizes the importance of rethinking the strategies for documenting, protecting, and enhancing this cultural heritage. It is not just a matter of preserving material structures, but of rediscovering and reactivating a stratified cultural heritage that reveals the deep bond between community and landscape. Physical isolation and structural degradation aggravate the risk of oblivion, which makes knowledge a tool for resistance and regeneration.

The adoption of integrated methodologies – including historical research, digital survey and data analysis– represents not only a technical opportunity, but a cultural and political choice to restore centrality to marginal territories, promoting a new form of rural habitability. In this perspective, the reuse project of the Fondaco Cuba, which relaunches its function as a place of rest and reception through respectful and compatible interventions, demonstrates how this heritage can return to being an active resource and not remain a victim of abandonment. The aim is to use these experiences to develop new operational scenarios for the protection of the agricultural landscape and to raise awareness of the widespread value of our built heritage.

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José Luis Romany and the Vernacular Architecture of the Former Marquisate of Dénia (Spain)

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Abstract
For five years in the 1970s, José Luis Romany photographed, drew and measured dozens of vernacular homes around Dénia. The main objective was to identify construction systems and architectural types typical of the local popular house. His drawings and notes were taken freehand in pencil during the visits in small school drawing notebooks. He reviewed some of these ink drawings during his long absences in Madrid. He had in mind to carry out an in-depth study, but this project was cut short. His recent death compels us to recover not only his work. It forces us to rethink our place with respect to that heritage to which so much attention he devoted, and of which so little remains. Understanding the relationship of these anonymous houses with the territory, their typological evolution and the way in which they were constructed is a prior step to being able to address the urgent challenge of updating them. And, in all of this, the material provided by Romany is undoubtedly relevant.

Keywords: *vernacular architecture; José Luis Romany; Dénia; construction systems; architectural types*

1. Introduction

Born in 1921 in Dénia, José Luis Romany Aranda later moved to Madrid to pursue a career in architecture. Though he built his professional life there, he maintained a strong connection to his hometown, returning regularly for summers and, in his later years, spending extended periods in a house near Dénia.

Romany was part of a group of architects known for their contributions during Spain's post-war autarky period, alongside figures such as Sáenz de Oíza, Luis Cubillo de Arteaga, Adam Milczynski, and Manuel Sierra. He played a key role in several major urban projects, including the Unidad Vecinal Erillas, the Batán neighborhood near its namesake station, and Puerta del Ángel in Madrid. His work also included a development of 600 homes along the Manzanares River in 1952. Among his most notable projects was the Fuencarral Housing Development, a complex of over 2,000 residences featuring diverse architectural styles.

Additionally, he collaborated on housing developments in the Juan XXIII and Loyola neighborhoods with Carlos Ferrán and Eduardo Mangada, contributed to the construction of 760 homes in Orcasitas with Alfonso Valdés Ruiz de Assin and others, and worked on large-scale housing initiatives in Palomeras Sureste. In the 1990s, he also designed the cultural center in Tres Cantos.

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Romany's architectural achievements earned him significant recognition, including the 1954 National Architecture Award for the Chapel on the Camino de Santiago, a project undertaken with Sáenz de Oíza and sculptor Jorge Oteiza. This work was judged by a panel including Luis Moya Blanco, Modesto López Otero, and José Luis Fernández del Amo. In 1956, he secured first place in a competition for experimental housing, contributing to what is now the Colonia Puerta Bonita in Carabanchel. His generation of architects worked within the framework of large-scale public housing initiatives, balancing technical expertise with limited resources.

In another context, during the 1970s over a five-year period, Romany dedicated himself to documenting the vernacular architecture of the Dénia region. Using a Hasselblad camera, he captured images that he considered secondary to his primary objective: studying the structural techniques and distinctive styles of traditional local dwellings (V. X. C., 2007). His research was carefully recorded through hand-drawn sketches and notes in small drawing notebooks, refined with ink during his time away in Madrid. Though he had envisioned producing a comprehensive study, the project remained unfinished (Soriano, 2007, p. 21).

A portion of this work was later exhibited at the Palau Joan de Valeriola between February 2 and March 30, 2007. The exhibition, focused mainly on his photographs, was made possible through the efforts of Josep Ivars, a local architect who played a central role in bringing Romany's work to public attention. The event was co-organized by the Chirivella Soriano Foundation, the Instituto Valenciano de la Edificación, and the Official College of Architects of the Valencian Community. Romany himself was actively involved, personally selecting the ten houses featured in the exhibition, curating excerpts for the catalogue, and even participating in an interview.

The exhibition included 96 photographs taken by Romany and architectural drawings of ten houses, prepared by Romany and Vicente Puig Casas. All materials were presented in a 70x70 format. Several of Romany's original sketchbooks were also displayed, with at least 16 pages reproduced in sets of four, matching the scale of the photographs and drawings. The accompanying catalogue, entitles *Raíz, construcción y vida, José Luis Romany* [*Root, Construction, and Life, José Luis Romany*], remains accessible online. Years later, a second exhibition, *Una mirada a la arquitectura popular de la Marina Alta* [*A Look at the Vernacular Architecture of the Marina Alta*], was held at the Centre d'Art l'Estació in Dénia from March 11 to April 17, 2016. This exhibition featured only a selection of the photographs from the 2007 event.

Since the production of first exhibition, the Valencian Institute of Building has been safeguarding 5 digitalized sketchbooks with a total of 148 drawings, 78 framed photographs in 70x70 format and 96 high-quality digitalized photographs. In all this material three themes that interested Romany emerge: the territory, the architectural type and the construction.

2. Architecture and Territory

Construction is just one of the many instruments that humans use for the productive transformation of the land. Buildings, layouts, partitions and embankments, plantations, and crops are interventions on nature that interweave to create a unified and coherent environment that defines a place. As Purini writes, "It is the work of man that essentially founds the land" (1984, p. 148). Referring to an idea from Alberti, this architect speaks of the area as "a kind of geometric irradiation of the architectural object into the surrounding space" (1984, p. 67-68). The area is the environment created by the artifice of architecture implanted in a specific setting. Thus, the surroundings and architecture establish a relationship of mutual dependence.

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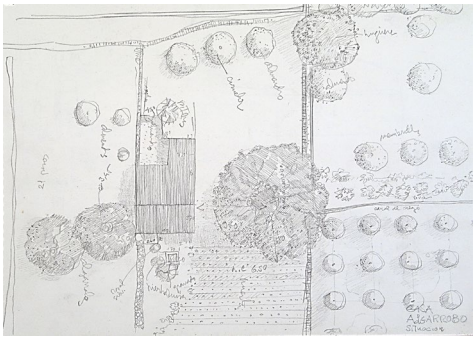

Fig. 1 – *Casa del Algarrobo* (Archivo del Instituto Valenciano de la Edificación, Ref. 152_5201).

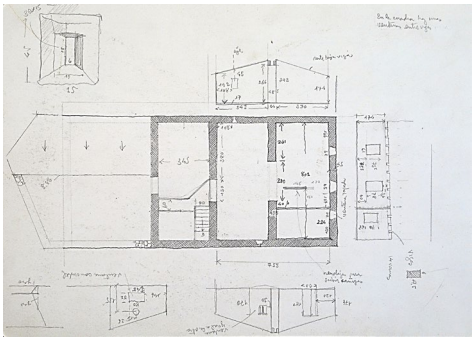

Fig. 2 – *Casa Azul* (Archivo del Instituto Valenciano de la Edificación, Ref. 151_5194).

The construction modifies the nature of its immediate area, but at the same time, it is immersed in the conditions imposed by that area. The agricultural exploitation of the land, along with the associated works and constructions, defines the area of a place at a specific moment in its history (Fig. 1). It is a concept that, as Purini points out, transcends formal aspects: "The counterproof of the substance of architecture consists precisely in understanding that what is not visible, what is not described as 'form' in the relationship between architecture and nature, constitutes the ultimate and definitive necessity of the former". (1984, p. 148-149)

After the Spanish Independence War in the early 19th century, a shift in the productive structure of the Valencian territory was consolidated, a transformation that had been developing throughout the previous century due to demographic growth. In La Marina region, the need to expand farmland to supply a growing population, along with the disappearance of the threat previously posed by pirate raids along the coast, led to the intensification of agricultural exploitation and the clearing of previously uncultivated lands (Banyuls and Pastor, 2004). In 1795, Cavanilles described the consolidated agriculture of the Marquesat de Dénia area: carob trees, vineyards for raisin production, olive trees, fig trees, and orchards with corn, wheat, mulberry trees, and vegetables (1975, p. 209, 211 and 212).

Fifty years later, Madoz almost verbatim repeated what Cavanilles had written but added the cultivation of oranges, whose export through the port of Dénia in 1844-45 was beginning to compete with raisins, the region's traditionally dominant export (Madoz, 1982, p. 322). As a result, during the first half of the 19th century, scattered constructions proliferated across the landscape, where the permanent dwellings of the farming families cultivating the land (*quarto*, *cuina*, *banc*, *llar*, *rebost*, *escala*, *sitara*, *armariet*, *escudeller*, *safareig*…) coexisted with spaces required for agricultural activities (*riurau* and *sequer*, *porxe* and *era* for spreading and protecting *canyissos* for raisins, *cambra* for storing harvests, *garrofera*, *pallissa*, *cup*, *almàssera*, *trull* and *celler*, *forn*, *pouet* and *aljub*, *quadra* for draft animals, *corral* and *ras* for goats, hens, and rabbits, *porquera*, *colomer*…). In these houses, residential and work functions overlapped in the same spaces, shaping daily life.

The photographs taken by Romany capture precisely the architecture of that period. They overflow with objects and tools that speak of that rural life (the *carro*, the *llit*, the *mecedora*, the *márfega*, the *cómoda*, the *forcat*, the *tauleta*, the *cadireta*, the *gerra*, the *cànter* and the *canterer*, the *botija*, the *cabàs*, the *cistella*, the *sac*, the *bicicleta*, the *sária*, the *esbarda*, the *collaró*, the *ferramenta,* etc.). However, his perspective is not ethnographic or anthropological but architectural. The utensils, spaces, and

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furnishings highlight the functional nature of the buildings. Functionality is the central theme of this reflection. A telling example is the long, narrow slit in the floor of the *cambra* in Casa Azul designed to move the *cañizos* (Fig. 2).

This is why the occupants, the users of that world, are absent from the images. Only a few sporadically appear: a caged bird, a cat, the blurred shape of a dog, the open door of a dovecote, an old man sitting on a low chair on the porch of Casa Fornés, next to the well's corner (Fig. 3). By the time Romany drew these spaces, they had already been emptied of the life they once housed, leaving only the props of an abandoned stage.

3. Typological Evolution and Academic Architecture

The houses of this period reveal a combination of two parallel and simultaneous themes. On one hand, a typological rather than chronological evolution (as buildings in different phases of typological change could coexist at the same

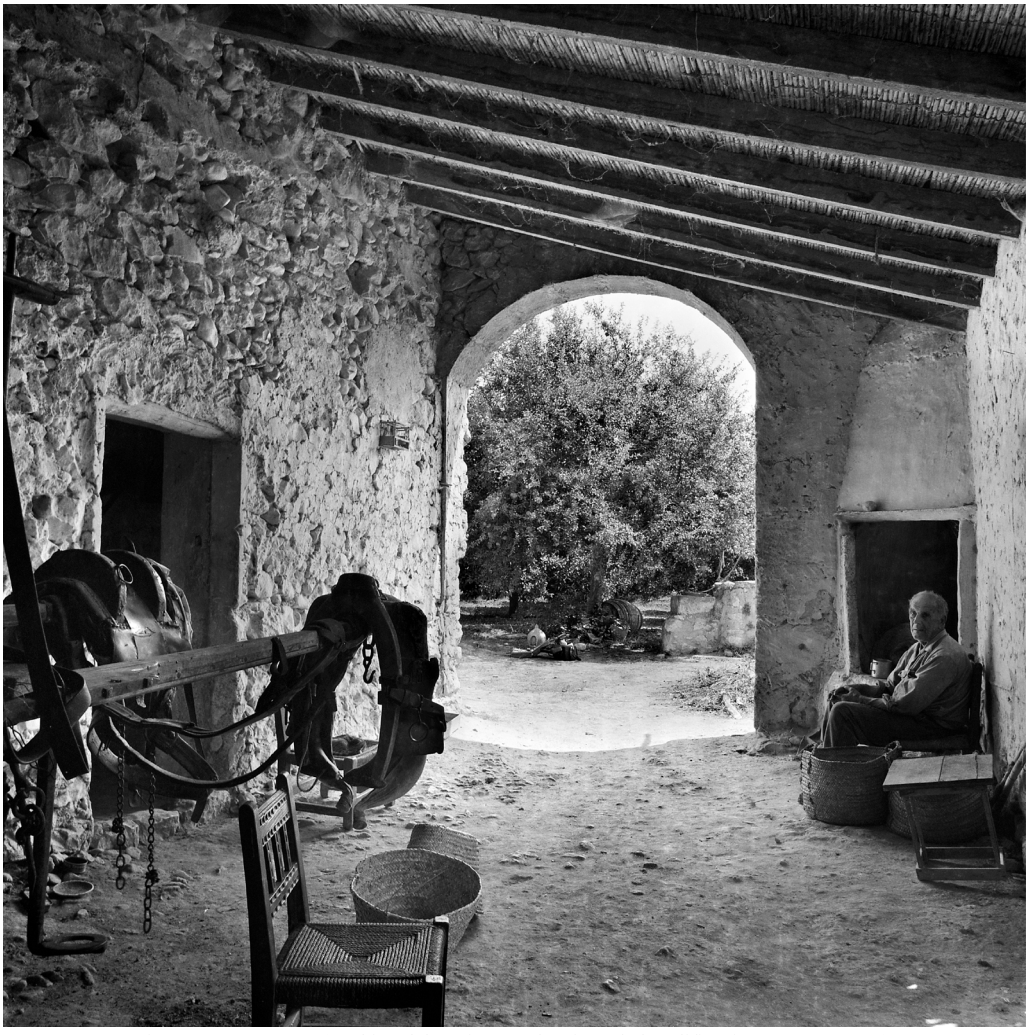

Fig. 3 – *Casa Fornés* (Archivo del Instituto Valenciano de la Edificación, REF. 172_11).

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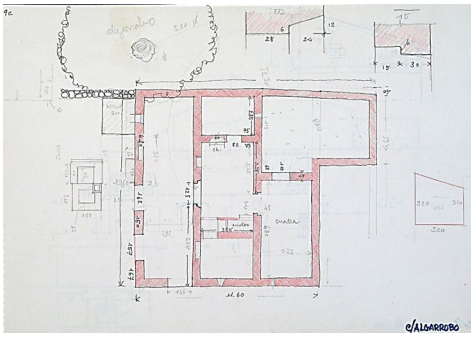

Fig. 4 – *Casa del Algarrobo* (Archivo del Instituto Valenciano de la Edificación, Ref. 152_5250).

time), moving from the most elementary forms derived from the region's traditional rural architecture toward more complex solutions (Banyuls and Pastor, 1982; Del Rey, 1986; Del Rey, 1998). On the other hand, the incorporation of formal and compositional criteria influenced by academic architecture, demonstrating a certain mimicry of urban forms. These possibilities combined in various ways, resulting in a wide variety of different solutions based on a few shared elements. The base type of a single-bay structure (*navada*), following the principle of spatial duplication and functional differentiation (Cannigia and Maffei, 1995), evolved into a double-bay structure, often later supplemented by a third bay (*la falsa*). A *cambra* was added on top, always covered with reed and tile, with one or two slopes, and additional constructions were attached as new needs arose (*porxe*, *quadra*, *forn*, *pouet*, *corral*…). This evolution can be traced.

The Casa del Algarrobo is one of the simplest, consisting of a single bay with a front *riurau* and a *quadra* and corral (*ras*) at the rear (Fig. 4).

The Casa Azul has a single bay with a front *riurau* and *falsa*, along with a *quadra*, *pallissa*, and *ras*, which is connected to an open lateral portico. In this case, the *cambra* sits above the *riurau* and extends over the *quadra*. The most common solution consists of two bays and two floors, to which a front *porxe* or *riurau* is added, as seen in Casa Tent and Casa Pinella.

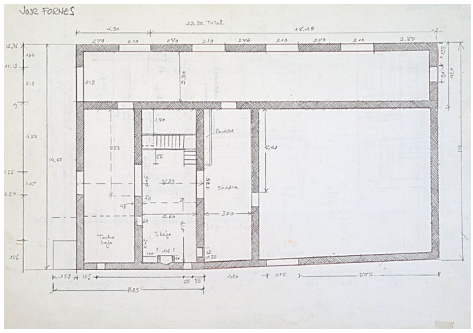

Fig. 5 – *Casa Fornes* (Archivo del Instituto Valenciano de la Edificación, Ref. 152_5236).

Alternatively, the *riurau* is placed laterally, as in Casa del Reloj de Sol and Casa Fornés (Fig. 5), seeking optimal orientation. In all these cases, a *falsa* bay is also present, usually at a single height, housing the *quadra*, storage rooms, and other facilities. Additionally, various annexed elements, such as an oven, a well, or a chicken coop, are frequently found.

A more evolved and complex example is the house next to the landfill (Fig. 6). This structure consists of two bays and two floors, with a *quadra* and a single-story storage room on one side, and a double-height space connected to a smaller structure and a corral on the other. A long *riurau* spans the central core and both lateral sections, along with other smaller attached elements such as a well and an oven.

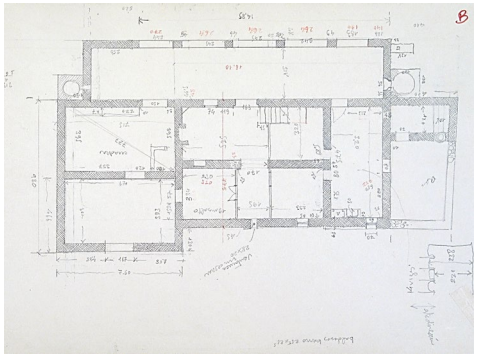

Fig. 6 – *Casa junto al Vertedero* (Archivo del Instituto Valenciano de la Edificación, Ref. 153_5301).

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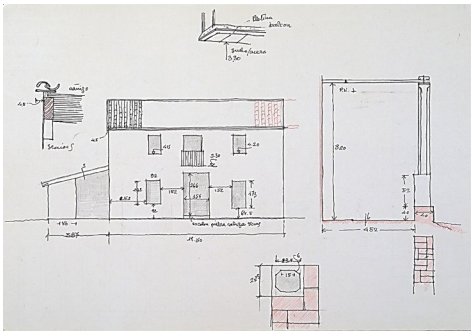

Fig. 7 – *Casa del Reloj de Sol* (Archivo del Instituto Valenciano de la Edificación, Ref. 153_5350).

In some cases, there is a clear osmosis with the academic world, which, since its establishment in the mid-18th century, had standardized formal guidelines such as systematic floor plans, geometric regularization, symmetrical arrangements of elements, and the compositional order of openings and façades. These principles were requirements in the exams that guild master builders had to pass to practice their trade (Esteban, 1983) (Fig. 7).

The growing influence of this academic repertoire ran parallel to the adaptation of these houses as temporary residences for landowners during periods of leisure or rest. This manifested in two ways: first, the *cambras* were repurposed as residences for the owners, while the farmers working the land continued to occupy the ground floors. Second, formal elements characteristic of urban architecture were imported (such as the *a dos mans* layout typical of clustered farmhouses or specific features like balconies, carpentry, ironwork, moldings, etc.). These elements, along with the furnishings, created an atmosphere reminiscent of townhouses, distinguishing them from scattered rural homes.

This new use, which combined agricultural buildings and peasant housing with the landowners' leisure residences, led to the adaptation of gardened areas in the immediate surroundings of the buildings. These included trellises, gazebos, pergolas, fences, walkways, and ornamental flowerbeds.

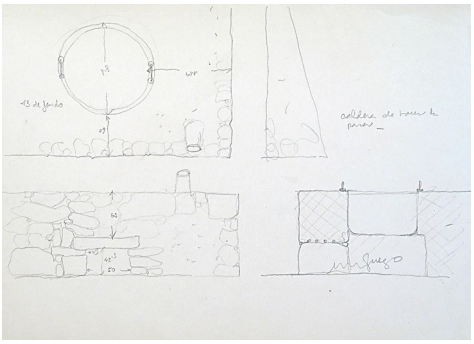

Fig. 8 – *Casa Mateu, kettle for making raisins* (Archivo del Instituto Valenciano de la Edificación, Ref. 152_5286).

In short, the rural house, while still maintaining its agricultural function, began transforming into a temporary residence for the owners, who brought their urban tastes to the countryside (Davillier, 1984, p. 129).

4. The construction

Romany devoted meticulous and extensive effort to another crucial aspect: the material execution of the construction. The teachings of traditional architecture had intrigued modern architects, surfacing in their debates, especially in the mid-20th century when Romany was studying and beginning his professional career (Peñín and Taberner, 2022, p. 249). His research on rural architecture in El Marquesat aligned with the modern architectural movement of his time. Rather than adopting an ornamental and picturesque vision of traditional construction details as mere decorative games (grilles, eaves, moldings, railings, balusters, etc.) (Fig. 8), he focused on faithfully documenting the knowledge of traditional construction techniques, the expertise of skilled trades, and the methods passed down through guilds, which were in danger of disappearing.

When the balance of anthropic transformation is disrupted and the existing system is replaced by a different one, a new architecture emerges, adapted to the new reality, while the previous one gradually disappears.

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Fig. 9 – *Casa Fornés* (2024, Archivo del Instituto Valenciano de la Edificación).

Fig. 10 – *Casa Mateu* (2024, Archivo del Instituto Valenciano de la Edificación).

In El Marquesat, the shift that Madoz had already hinted at in the mid-19th century with the rise of citrus cultivation reached its peak in the final decades of that century. Agricultural use, which had begun to coexist with the landowners' temporary stays, was ultimately displaced throughout La Marina by the vacation leisure of an urban bourgeoisie for whom agricultural production had become largely irrelevant or marginal.

Consequently, the new architecture that emerged from this shift was the *torreta* (villa), where spaces linked to farm work were relegated to a secondary role (Banyuls, 1993; Bonilla, 2007). The remnants of the previous phase (rops, land use, constructions, irrigation systems, road networks) became obsolete and fell into ruin. The decaying architecture of that bygone era is what Romany captured in his photographs and drawings.

5. Conclusions

Romany's work reflected his concern for the preservation of traditional architecture, which, even in the early 1970s, was already vanishing. During the opening press conference in 2007, he reiterated this concern. By then, the deterioration of these historic structures had accelerated, particularly from the early 1990s onward.

Ivars, in curating the exhibition, noted that of the ten houses Romany had documented, only two remained well-preserved: Casa Ventura in Pedreguer and Casa Mateu in Jesús Pobre. Today, Casa Mateu has fallen into ruin (Fig. 10).

Understanding the relationship of these anonymous constructions with the territory, their typological evolution and the way in which they materialized is a prior step to being able to address the urgent challenge of updating them. And, in all of this, the material provided by Romany is undoubtedly relevant.

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Acknowledgements

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Millars Hydraulic Architecture (Almassora, Spain)

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Abstract

The Millars River feeds the fields of the four traditionally agricultural cities near its mouth: Burriana, Vila-real, Almassora and Castellón. To carry out the distribution of the waters corresponding to each population, an extraordinary hydraulic infrastructure was initially developed in Muslim times, formed by unique elements. Starting the route at the Almassora weir, which is different from those of the rest of the towns, the water flows for approximately one kilometre through a buried irrigation ditch. This irrigation channel forms a siphon to pass under the channel of the Rambla de la Viuda. Afterwards, the waterway runs underground for a kilometre until it rises to the surface again next to the old castle of Almassora. Along this route there are different constructions called boqueres that consist of openings from the underground channel. They are made of masonry according to the traditional construction of the area. A hundred metres from where the irrigation channel returns to the surface, the Casa de les Reixes is. The division of the waters that belong to Almassora and Castellón takes place there. Water that belongs to Almassora runs through open ditches, while the water heading for Castellón disappears again under the ground. This new buried irrigation ditch was full of boqueres. They were destroyed by the city's urban planning, leaving as a memory the name of the street through which they ran, Boqueres Avenue. This peculiar hydraulic infrastructure, so linked to the economy and popular culture of the area, has been abandoned over the years, falling into oblivion and subsequent deterioration. Currently, the town council intends to catalogue all the elements that make up that water route to request its inclusion as an Asset of Cultural Interest (BIC).

Keywords: Millars; Almassora; Burriana; hydraulic architecture; irrigation ditch; boqueres; weir

1. Introduction

The last part of the River *Millars* flows through the region called *La Plana*[1]. This area constitutes a coastal plain built by detrital materials resulting from river transport. It is limited by the mountain ranges of Oropesa, *les Santes*, Alcora (N and NW) and *Sierra de Espadán* (S and SW).

The composition of its land has given it great fertility. For this reason, it has traditionally been dedicated to agriculture (Fig. 1). The irrigation

[1] The Valencian Community is divided into regions defined by geographical features. Near the mouth of the Millars River lies the Plana, split into Plana Baixa to the south and Plana Alta to the north.

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Fig. 1 – *Millars River sckech, by Miguel Ruano in 1810* (Centro Geofráfico del Ejército Colección SG).

water for the fields comes from two different sources. In the southern area, it comes from groundwater that arises naturally through wells due to the gypsum and clay composition of the soil (García et al., 2012). In the rest of the territory, irrigation water supply is through the hydrographic network. It is concentrated in the *Millars* River, since the rest of the water courses cannot be considered due to their great irregularity (García et al., 2012; Pérez, 2009).

This river has received different names over the centuries. For the Romans it was the Idubeda River because it was fed by the springs of the ancient name of the Iberian mountains. After the Reconquest it was called Albentosa. Finally, it was called *Millars*. It is assumed that this name comes from the cereal fields that were nourished by its waters, the millet fields, or as it is named in Valencian, *mill* or *millars* in plural (García et al., 2012). Regardless of the origin of the river's name, it is a fact that its waters have always been linked to agriculture. Although the irrigation of *Baix Millars* area originates from the time of the Muslim occupation, there are some vestiges of the presence of Roman irrigation (Antequera Fernández, y otros, 2009). From the Reconquest until the 19th century, the municipal councils controlled these waters. The water was traditionally distributed among the towns of Burriana, Almassora, Castellón and Vila-real. This division was already established in their *Carta Puebla*[2]. In 1229, Jaume I corroborated the traditional sharing. However, the irregularity of the river flow caused numerous conflicts over the centuries. Finally, on March 20, 1347, Pere d'Aragó fixed the amount of water belonging to each town in the arbitration sentence of the Conde de Ribagorza. This distribution has remained unchanged until nowadays. It determined how to distribute water in periods of scarcity. In these occasions, the water must be divided into 60 equal *files*[3], or 120 hours in extreme scarcity, and distributed as established (Table 1) (Antequera et al., 2009; Agut et al., 2003).

Table 1 – *Division of the water of the Millars River* (Burguete, 2025).

Town	Scarcity	Extreme scarcity
Vila-real	14,00 files	28 hours
Almassora	12,50 files	29 hours
Castellón	14,50 files	25 hours
Burriana	19,00 files	38 hours

[2] Diploma that contained the distribution of lands and rights that were granted to the new settlers of the site or place where the town was founded.

[3] *Fila (pl. files)* is a number that indicates the proportion of the total flow that a ditch can take. If there is abundant water, this figure depends on the capacity of the irrigation ditch, if in tames of scarcity according to an equivalent and proportionate number of hours.

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Along the 18th and 19th centuries, a complex hydraulic network was developed to achieve this distribution of water and to complement the network of Muslim irrigation ditches. All these elements constitute an important part of our architectural and cultural heritage. They show how agriculture has been the base of the region's economy. And how important it still is despite the current degradation it is experiencing. Besides these irrigation constructions show how engineering and architectural works have been developed over the centuries to optimize water resources.

2. Objectives

Some of the components of the hydraulic network have been named in different publications about the irrigation of the *Baix Millars*.[4]. However, the main theme of all these publications was agriculture and irrigation, leaving the architectural element as a simple anecdote. On the other hand, the Confereración Hidrográfica del Jucar (CHJ), as the administration responsible for the river, has financed research projects developed by ESTEPA.[5]. These studies had the objective of deepening the knowledge of the hydraulic heritage of territory belonging to the CHJ. They were based on the historical irrigation situation in certain territories and different aspects related to the elements for the collection, distribution, transportation, storage and use of water. The Almassora City Council has conducted a study to locate and catalogue the hydrological network from the Almassora-Castellón weir to the distribution of the water between the two cities. It is going to serve as the basis for initiating the process of declaring these assets as an Asset of Cultural Interest (BIC).

3. Methodology

To allow the location and assessment of the elements that make up the hydraulic network, a study has been carried out based on different texts on irrigation in *La Plana* edited by the CHJ, Almassora council and different agricultural associations such as *Història del nostre poble* (Agut et al., 2003), *Los regadios históricos del Baix Millars - la Plana*.[6] (Antequera et al., 2009), *Artefactos hidráulicos tradicionales en el Baix Millars*.[7] (Antequera et al., 2009), *Los regadios históricos del Baix Millars - la Plana*.[8] (Pérez Cueva, 2009), as well as on old plans related to the river and the castle of Almassora, made by Jaubert de Passa from 1844 and that by Giner Alledelagua from 1790.

This information has been completed through informal interviews with local elders and with representatives of the Almassora irrigation union.

With all the information collected, an on-site exploration was carried out to visually locate the elements described in the consulted sources and proceed to catalogue the elements one by one.

4. Components of the hydraulic network

4.1. Dams and reservoirs

The *Millars* River has different reservoirs and dams that regulate its use, such as the *Arenós* Reservoir, located upstream from the town of Montanejos and the *Sitchar* Reservoir, located in the town of Alcora, and other small dams such as those of Cirat, Ribesalbes, *Les Toranes* and Vallat.

[4] The publications are named in the references section.

[5] It is a research unit of the Department of Geography of the University of Valencia.

[6] The historical irrigation of the Baix Millars – la Plana.

[7] Traditional hydraulic artefacts in Baix Millars.

[8] The historical irrigation lands of the Baix Millars.

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Except for the *Arenós* reservoir dam, which is built with loose materials and a clay core[9], the rest of the dams are built by the gravity system, which usually consists of a vertical section with a triangular or trapezoidal shape and a horizontal section with a straight or curved axis. The stability and resistance of the dam to hydrostatic pressure depend solely on the weight of the construction (EADIC, 2017).

Fig. 2 – *Almassora-Castelló weir* (Comunitat de Regans d'Almassora, 2025).

4.2. *Assut* of Almassora-Castellón

The *Assut* of Almassora-Castellón[10] is placed in the protected area of Santa Quiteria, close to the confluence of the *Millars* and the *Rambla*[11] *de la Viuda*[12] (Fig.5, n. 6). It is believed that there were others before this one, but their locations and building materials were different. This element takes the water from the river that belongs to Almassora and Castellon. The actual one was built from 1886 to 1895 according to a Salvador Flores project. The weir is made of carved ashlar and it is 106 m long. As it is located at the lowest point on a steep slope of the river, access to it is gained, in a descending direction, through a 3-storey building.

4.3. *Sequia of Castelló-Almassora*

Once the waters destined for Almassora and Castellón have been diverted by the Almassora weir, these flow through an irrigation ditch or *sequia* towards these towns[13] (Fig. 5, n. 8). This ditch constitutes one of the most important heritage elements linked to the architecture of water in the orchards of *Baix Millars* (Antequera et al, 2009). The waters flow through an underground irrigation ditch. This ditch is siphoned to cross the depression of the *Rambla de la Viuda*. This passage is 1.82 m in diameter, 30 m deep and dates back to the 17th century (Antequera et al., 2009). The underground ditch was excavated through compacted, but not petrified, sandstone (Torán, 2023).

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[9] Loose material dams: these are dams made up of a core of impermeable, low-resistance clay, and on the sides, shoulders (made of gravel, sand or breakwater) that promote stability.

[10] *Assut*: weir that is made in the river to take advantage of the water through an irrigation ditch or water wheels for this purpose.

[11] *Rambla*: natural channel of rainwater when it falls in abundance.

[12] Rambla which is a tributary of Millars on its left bank, from the union between Monleón River and the rambla Carbonera.

[13] *Sequia of Castelló-Almassora:* irrigation ditch that collects waters belonging to Castellón and Almassora.

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17 *boqueres*.[14] were built along the irrigation channel. They are located at intervals of 25 meters. Their use is to allow aeration of the tunnel and accelerate the speed of the water, as well as allowing access for maintenance and repair. They were built following the traditional construction of plastered masonry walls. Rectangular in plan, their exterior dimensions are similar, ranging between 3 and 4 m on each side and about 10 metres deep. It has been possible to locate 13 *boqueres* despite the fact that most of them are in terrible condition since their interior is clogged with vegetation.

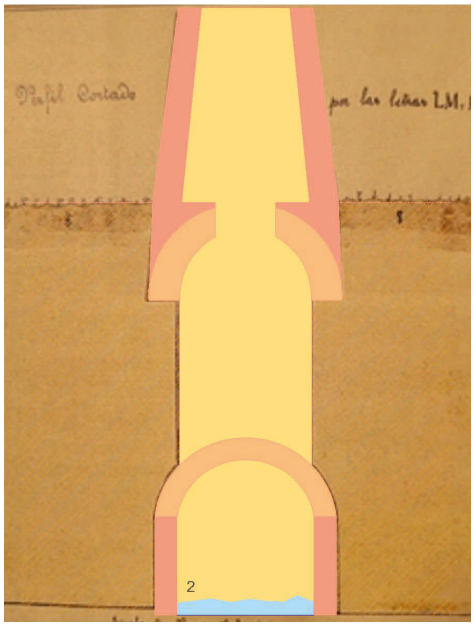

Fig. 3 – *Section of a boquera. A. Giner I Allendelagua, 1790. Museu Arqueològic Comarcal de la Plana Baixa. Borriana* (Garcia, 2003).

The location of the remaining *boqueres* can be guessed by following the layout of the buried ditch; however some of them are impossible to detect because of the vegetation that surrounds them. Once *Rambla de la Viuda* has been surpassed, a small section of the irrigation channel is visible. At this point, it can be accessed through a brick arch to the interior of two large *boqueres* that are joined together (Agut et al., 2003). In the plan of the weirs of the Millars River by Jaubert de Passa of 1844, a washing place is indicated coinciding with the location of these mouths. During their exploration, part of a bricked-up door has been discovered. That would corroborate the existence of a wash house where the two *boqueres* come together. After this point, the irrigation ditch disappears again to continue underground until the point known as *Casa del Millonari*. This is the traditional name for a large abandoned farm that belonged to an Indian man. Along this section, the underground channel passes under the Almassora castle. It is considered that at this point the irrigation channel was connected to the cistern of the castle. At this same point, a spillway of the irrigation channel was located, dug into the rock and closed with a gate that empties into the riverbed.

4.3. The water divider of *La Casa de les Reixes*

Once it emerges, the ditch runs for about 240 m on the surface through a 7x2 m concrete ditch. At the end of it is the C*asa de les Reixes* (Fig. 4). This construction collects the water and diverts in the pre-set proportion towards Castellón and Almassora.[15] (Fig. 5, n. 17).

Fig. 4 – *The entrance of the Casa de les Reixes* (Burguete, 2024).

[14] *Boqueres*: water divider, opening built on an underground channel.

[15] C*asa de les Reixes* could be translated as The bars house, so called because of the trellis located on its façade.

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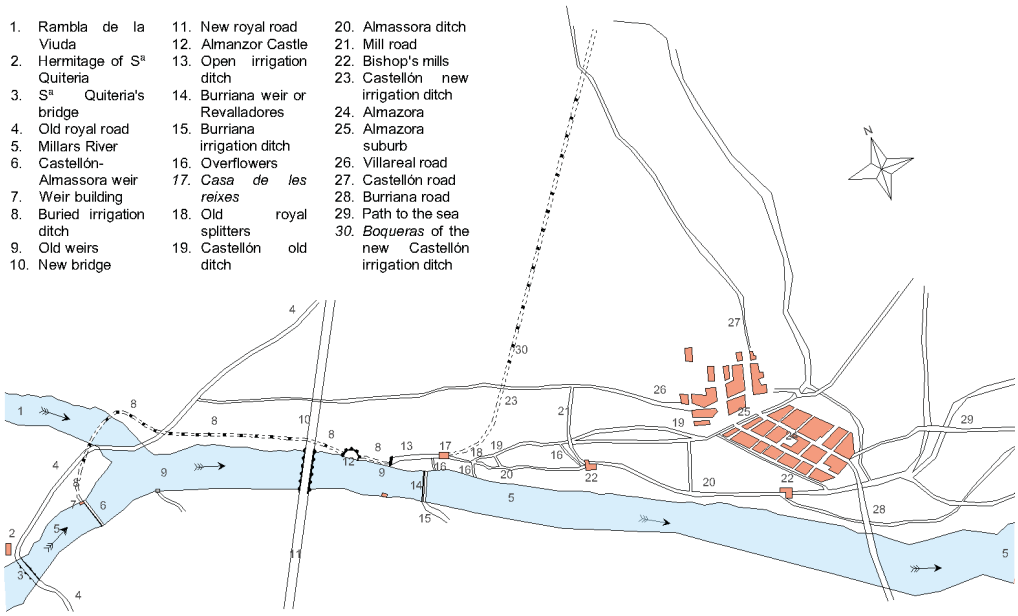

Fig. 5 – *Map of the watershed of the Mijares based on the work of. Antoni Giner I Allendelagua. 1790.*

The construction is built as a traditional farmhouse. It is rectangular in plan with brick wall and a gabled tile roof. Inside, a brick barrel vault frees up the space to allow passage the irrigation ditch, the roughing grates roughing and the water partitions gates. Inside there are gates that direct water to its destination.

4.4. Sequia of Castelló

The layout of the old ditch of Castellón passed next to the old town of Almassora (Fig. 5, n. 23). It was used by the citizens to carry out washing and dumping, thereby polluting the waters. For this reason, in 1789 the new ditch of Castellón began to be built with a new layout. This trench run underground and included a number of new *boqueres*. But the new layout was absorbed by the expansion of Almassora and the *boqueres* destroyed. They remained in memory for the name of the avenue along which the irrigation channel runs, Boqueres Avenue. Only three *boqueres* survived the expansion. Two of them are trapezoidal, 2 m on each side and 3.5 m high. The third one has special characteristics, since it is distributed in two bodies and was covered to avoid accidents.

4.5. *Séquia d'Almassora*

Unlike the irrigation channel of Castellón, the one of Almassora runs through an open concrete channel of 2.30 m wide and 1.30 m deep.[16] (Fig. 5, n. 20). It supplies an entire irrigation network that reaches all the way to the coastal area (Fig. 6).

There is another water splitter similar to the *Casa de les Reixes*, 1.5 km downstream, but smaller. There, the distribution of water to the so-called mother ditches begins and runs throughout the Almassora irrigated area.

[16] *Séquia d'Almassora*: The Almassora irrigation ditch.

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Fig. 6 – *Almassora ditch beginning* (Burguete, 2025).

4.6. *La caseta dels moros*

Some metres before the C*asa de les Reixes*, la *caseta dels moros* [17] is situated in the riverbed (Fig. 5, n. 9). It dates from 1519 and was the first weir, shared between Almassora and Castellón (Fig. 7).

Fig. 7 – *Moorish house* (Carmen Burguete, 2025).

4.7. *Assut de Burriana* or *les Revalladores*

The old Burriana weir is close to the *Casa de les Reixes,* just some metres downstream (Fig. 5, n. 14). It is popularly known as the *Revalladores* for its use by young people as a water slide. This dam is no longer in use due to the construction of a new one close to the current Almassora-Castellón weir.

4.8. Water mills

Along the river, there were different mills to take advantage of the driving force of the water and the ditches. They all are now in disuse, or they have been transformed into country houses. There are 54 mills inventoried by the CHJ linked to the waters of the *Millars*. However, it has to be noted that they were all powered by the waters of the ditches, not by the river. It was due to the irregularity of the river waters, so they were captured upstream by the weirs. Of all these mills, only the one called *Llum de Toll* remains in operation. Located in Vila-real, on the right bank of the river, it has its own weir and ditch. (Antequera et al., 2009)

4.9. Wells

The irrigation of the fields with water from the river is complemented by water from the wells, dug throughout the entire cultivation area. They were used to compensate for times of drought. These wells obtain water directly from the aquifers and pour it into the irrigation network. There are 122 wells inventoried in the *Baix Millars* area.

5. Conclusions

The elements that make up the hydrologic network of the *Baix Millars* are classified as of great interest by the CHJ. They are also of great importance to the irrigation communities. But they are unknown both to the general public and

[17] *La caseta dels moros*: The Moorish house.

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to cultural institutions. This situation, together with the increasingly dwindling resources of the irrigation communities due to the economic regression suffered by orange cultivation, has caused the lack of maintenance and their progressive degradation. However, they must be considered an important part of our heritage because their relationship with the economy and local tradition. They are elements of great architectural quality that make them unique, such as the siphon of the underground irrigation channel under the *Rambla de la Viuda*.

These two reasons are sufficient to promote its value and develop a proposal to be declared as an Asset of Cultural Interest (BIC) that guarantees its conservation and study. In the investigation carried out for the initial phase of this proposal, it has been possible to locate elements that were only reflected in old plans (the washhouse in the plan of Jauber de Passa). In the same way, the elements that are considered missing in the current texts of those responsible for this heritage (4 *boqueres* of the underground irrigation ditch) have been located.

The objective of the proposal is not only to achieve the administrative declaration of this hydraulic heritage, but also to obtain the necessary financial support for its cleaning and recovery and its enhancement through its connection to the route of la *senda verda* (the green path). This runs parallel to the river from the natural area of *Verge de Gràcia* in Vila-real to the estuary of the *Millars* in Almassora and Burriana and shows the fauna that this protected area sustains.

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Research on the Indigenous Architecture and Its Transformation of the Bahnar *Rong* Houses in Kon Tum City, Vietnam

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Abstract

The Bahnar people, one of the 54 officially recognized ethnic groups in Vietnam, residing in the Central Highlands, are characterized by their distinctive culture and customs. A significant architectural symbol for them is the "Rong" house, a traditional community house found in every Bahnar village. This house has unique architectural features, particularly the axe-shaped roof reaching 20 meters in height, which has yet to be thoroughly studied from an architectural perspective. The Bahnar Rong houses encapsulate the architectural essence and indigenous spirit that have been meticulously preserved and handed down through generations. They function as communal spaces for villagers, hosting meetings, ceremonies, and collaborative activities that engage people of all ages. Constructed with traditional techniques and natural materials, the Rong house is characterized by a design that harmonizes with the local climate, terrain, environment, culture, and customs. However, due to urbanization and modernization, these houses have been transformed in terms of materials, construction methods, and morphological design. Many Rong houses have been extensively altered, threatening their intrinsic architectural values. This research examines 44 Rong houses in Bahnar ethnic villages in Kon Tum City through field measurements, interviews, document reviews, and comparative analysis to identify their core architectural features and assess transformations driven by modernization. Furthermore, this research will serve as a valuable resource for the conservation and restoration of Rong houses that have been changed or lost in the future.

Keywords: *Rong house; Bahnar; indigenous architecture; communal house; transformations; Kon Tum City; Central Highlands; Vietnam*

1. Introduction

The Bahnar communal house (Rong house) represents a unique architectural form imbued with aesthetic, cultural, and social significance. Although numerous studies have examined the Bahnar ethnic group in Vietnam, most have focused on aspects of culture and belief systems. Nguyen Van Cu and Luu Hung (2018), in *Rong Houses of the Central Highlands*, offered a general overview primarily focused on visual documentation. More recently, Khuat Tan Hung (2023) analyzed architectural features of Xo Dang Rong houses and investigated their potential for preservation and sustainable development. A review of the existing literature reveals a notable gap: there is currently no in-depth research dedicated specifically to the architecture of the Bahnar Rong house or its alarming transformations under the pressures of modernization.

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2. Methodology

This study aims to assess the current architectural condition of Bahnar Rong houses, identify their architectural features and transformations, and investigate the underlying causes of these changes within today's socio-cultural and environmental context. The research combines field measurements, interviews, comparative analysis, and document review. A total of 44 Rong houses across 43 Bahnar villages in Kon Tum City, Vietnam, were surveyed. On-site documentation included architectural drawings and observations. Semi-structured interviews were conducted with local elders, village leaders, and government officials. Supporting materials included local government reports, historical records, books, newspapers, and online sources (Fig. 1).

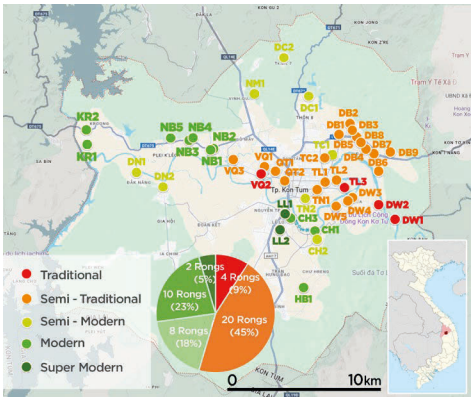

Fig. 1 – *Location of 44 Bahnar Rong houses in Kon Tum City and their current status* (Google Maps and Authors, 2025, edited).

3. The architecture of Bahnar Rong House in Kon Tum City

3.1. The Bahnar Rong House and its function

The Bahnar ethnic group is one of the major ethnic communities within the Austroasiatic language family in Vietnam. Alongside the Xodang, Jeh-Tariang, and Jarai ethnic groups, the Bahnar constitute a significant portion of the local population and were the first ethnic group to settle in Kon Tum City. They live primarily along both banks of the Dak Bla River, which flows through the city center. According to 2020 statistics, the Bahnar population in Kon Tum Province was 68,799 people. Most of them are concentrated in Kon Tum City with two subgroups: Bahnar Kontum and Bahnar Rongao.

Fig. 2 – *Rong House in Konjori village, Kon Tum City had its roof and walls repaired in 2024* (Authors, 2025).

A distinctive feature of Bahnar villages is the traditional communal house, known as the Rong House. Each Bahnar village typically has one Rong House that serves as a focal point for community activities. It functions as a gathering space for village festivals, meetings, and traditional music performances. Previously, the Rong house also served as a communal lodging space for unmarried young men who would spend nights around the fire stoves inside. There is a spacious yard in front of the Rong house, which provides an area for traditional festivals, recreational sports, and children's play. For the Bahnar people, the Rong house is sacred and believed to be the dwelling place of protective deities that safeguard the village. In the Central

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Highlands of Vietnam, several ethnic groups, including the Xodang, Jeh-Tariang, and Jarai, also have Rong houses as part of their cultural heritage. However, the Rong houses of the Bahnar ethnic group in Kon Tum City stand out due to their remarkable size and height, as well as their distinctive architectural design (Fig. 2). In the past, traditional Bahnar villages were relatively small due to the practice of shifting cultivation. Each village consisted of approximately ten dwelling houses, arranged closely together and surrounding the central Rong house. Village layouts, with the Rong house serving as the central focal point, were typically organized in one of two patterns: houses aligned in the same direction or arranged in a bird's nest formation (Fig. 3).

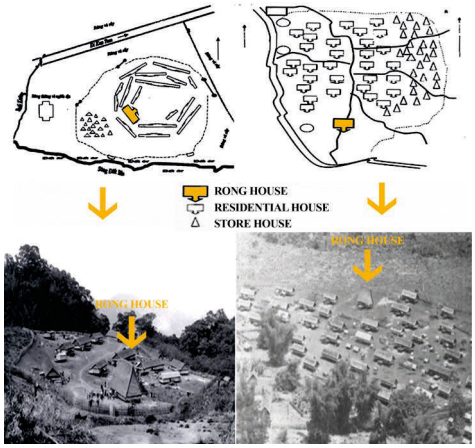

Fig. 3 – *Rong houses in the layout of the traditional Bahnar village* (Bui Minh Dao, 2006 and US Army Special Warfare School, 1964).

3.2. Architectural characteristics of the Bahnar Rong House

An analysis of four representative Bahnar Rong houses (DW1, DW2, TL3, VQ1), selected from 44 surveyed houses as the best-preserved and most intact examples, identifies the fundamental architectural characteristics of traditional Bahnar Rong houses.

Location and overall planning: Rong houses are typically built near rivers or streams at the foot of gentle hills. Their orientation adapts to the terrain to support accessibility and community use. Centrally located within the village, near main roads, they serve as gathering spaces with large front yards for communal activities. Common features include flagpoles, sports courts, and playgrounds. The Rong house site is open and unfenced, often situated near chapels or Catholic churches. This spatial arrangement reflects the enduring presence of Catholicism in Vietnam's Central Highlands since the early 19th century.

Floor plan and space organization: The floor plan of the Bahnar Rong house is rectangular, supported by either 8 or 12 large columns, and divided into 3 or 5 compartments. The central compartment (LT3) has an average width of 3.97 meters, while the two side compartments (LT4) each measure an average 3.87 meters in width. The gable walls are straight, while the front and back walls have a distinctive curved form resembling the hull of a boat. There is a wooden shelf used for displaying sacred items, adorned with traditional motifs. The floor height (C1) from the ground is approximately 2.24 meters.

Porch and Stairs: Access to the Rong house is traditionally provided through three porches: one central main porch (DH1) and two side porches (DH2). Positioned lower than the main floor level, these porches are constructed as independent wooden-frame structures. The main porch typically consists of six columns, while each side porch has four. In front of the house, two carved log stairs are usually installed, each comprising seven to nine steps (Fig. 4).

Elevation: The Rong house features a towering roof, averaging 16 meters in height (C2), with four sloping sides. The front and rear facades form two primary curved surfaces. This subtle curvature allows the roof to effectively adapt to strong winds by partially dissipating and neutralizing wind forces. The elevation follows a symmetrical axis, which is wider at the base and narrows as it ascends, creating a visual effect resembling a flame or an axe blade (Fig. 4).

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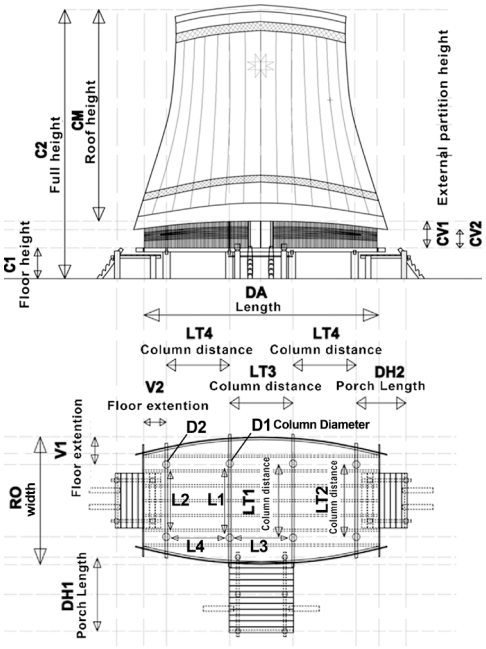
Structural characteristics: The Rong house is structured by a wooden frame of columns and beams. The column system consists of two longitudinal rows along the length of the house and four or six transverse rows across its width. The connections between the vertical columns and horizontal beams use mortise-and-tenon joints, while the roof and wooden frame are secured with a combination of bearing joints and lashings. The roof structure consists of interlocking horizontal, vertical, and diagonal wooden braces, ensuring stability and support.

Interior space organization: The interior space of the Rong house is expansive and high, with no partitions or ceiling. In the central compartment, there is a wooden shelf for exhibiting sacred objects. The outer walls typically include a gap of about 40 cm at the top to allow for natural ventilation and light.

Material characteristics: The main structural framework is constructed from high-quality wood for strength and stability. The roof is made from cogon grass, woven into panels, and tied to the roof truss system with rattan ropes. The walls at the front, back, and sides are woven from bamboo to the sheet and strengthened by a bamboo frame outside. The doors are often crafted from woven bamboo in a sliding style or from wood with a hinged and two-leaf design. The flooring is made of medium-quality wood, joined together and supported by a wooden beam system.

Decorative motifs: Decorative motifs are featured at the roof peak, the four corners of the house, and along the inside beams and columns. These motifs often carry deep symbolic meanings, including representations of the axe blade, fern fronds, lozenges, the sun, or doves. The ends of the porch columns and the top of the stairs are also intricately carved or decorated with jars, gourds, or statues. In some Rong houses, painted decorative patterns are found on the beams and columns, often illustrating the daily life activities.



The average dimensions of the 04 traditional Rong Houses
(Konktu, Konjodri, Konklor, Konrbang)

Unit: meter	D1	D2	L1	L2	LT1	LT2	L3	L4	LT3	LT4
	0.48	0.42	4.08	3.72	4.56	4.14	3.52	3.42	3.97	3.87

V1	V2	DA	RO	C1	C2	CV1	CV2	CM	DH1	DH2
0.92	0.58	14.15	6.90	2.24	16.06	1.55	1.14	10.05	3.70	2.05

Fig. 4 – *Model of a typical Bahnar Rong House in Kon Tum City* (Authors, 2025).

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Fig. 5 – *Table of current status and the transformations of 44 Bahnar Rong Houses in Kon Tum City* (Authors, 2025).

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4. Transformations of Bahnar Rong Houses in Kon Tum City

4.1. Current status of Bahnar Rong House architecture in Kon Tum City

A field survey of 43 Bahnar villages in Kon Tum City, covering 44 existing Rong houses, found that most of these Rong houses have significant changes. Some of the most noticeable changes include the roofing being replaced with metal materials (corrugated steel roofing), the replacement of the wooden structural framework with reinforced concrete, and the removal of the side porches and side entrances. In many Rong houses, the wooden porches have been replaced with reinforced concrete. The traditional fire stoves have disappeared, and many no longer have the shelves for sacred objects as they did before.

The study shows that 20 Rong houses are roofed with corrugated metal, while 22 still maintain traditional thatched roofs. Thirty-one houses have been newly built or renovated using reinforced concrete columns and beams. In ten cases, wooden floors have been replaced with concrete. Seventeen Rong houses have substituted bamboo walls with other materials, and 13 have adopted metal roof truss systems. The stairs have also undergone major changes in 32 Rong houses, with 24 featuring reinforced concrete and 8 using steel. For safety reasons, metal handrails have been added to the porches of 31 Rong houses. The transformations affect not only the construction materials but also the shape, size, and location. Most of the Rong houses have been constructed or renovated with dimensions that differ from the original. Notably, approximately half of these Rong houses have been relocated or rebuilt in new settlements due to the moving or establishment of new villages.

In resettlement areas located far from the city center (KR1, KR2, NB1, NB5, HB1), where communities were relocated due to hydroelectric and urban expansion projects, Rong houses have been completely modernized and standardized. They were designed and constructed under supervision and funding from government projects, intended for immediate use after relocation. Meanwhile, the traditional Rong houses in the original villages were either demolished or left abandoned.

Among the Rong houses that have undergone significant alterations, DW1, DW2, TL3, and VQ2 have preserved their traditional architectural features, largely due to the efforts of local authorities and residents. The promotion of these Rong houses for tourism has been a key factor driving government and community initiatives to restore and renovate them to their original form. Moreover, the Rong house architecture in the two communes of Dak Ro Wa (DR) and Dak Bla (DB) share a common feature: they aim to preserve their original elements by reusing materials from older structures, while sections that have been significantly damaged are replaced with more durable modern materials (Fig. 5).

4.2. Causes of transformations

Through semi-structured interviews with elders, village heads, and local authorities, with the support of documents and local government reports, several important causes have been identified.

4.2.1. Causes of state policies

Before 1975, Bahnar Rong houses in Kon Tum City were mostly built using traditional methods and natural materials. After 1975, the government focused on post-war recovery and economic development. This led to the preservation and maintenance of Rong houses not being prioritized, resulting in a significant decline in their number.

In 1986, Vietnam entered the "Doi Moi" (Renovation) period, which emphasized industrialization and modernization. The policy of migration to work in the new economic zones

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encouraged people to move to the Central Highlands to reclaim land for rubber and coffee cultivation. This influx of people (especially the Kinh people) resulted in significant cultural exchange and assimilation. During this period, both the quantity and quality of Rong houses diminished rapidly.

In 1999, recognizing the significance of the Rong houses, the Kon Tum Provincial People's Committee issued Directive No. 21/1999/CT-UB on November 25, 1999, titled "Maintaining and Restoring Traditional Rong Houses of Ethnic Minorities in the Province." This directive outlined specific instructions for the preservation of the Rong houses. A new concept of the "Cultural Rong House" emerged, accompanied by a set of regulations specifying the essential features such houses should include, such as the national flag, a statue of President Ho Chi Minh, a flagpole, or a sports field. The function of the Rong house was also broadened. They became a venue for meetings and the dissemination of state policies and laws under the guidance of local authorities. During this period, while the number of Rong houses grew significantly, the construction methods were still influenced by modernization and the dominance of new materials.

From 2010, the two major National Programs including the New Rural Program and the National Target Program on Socio-Economic Development of Ethnic Minorities and Mountainous Areas period of 2010-2020 and 2021-2030 allocate substantial government funding to support local efforts in preserving and promoting traditional Rong houses. During this time, the Rong houses in Kon Tum City were repaired, renovated, and rebuilt with both traditional and modern materials.

On August 31, 2021, the Kon Tum Provincial People's Committee issued Plan No. 3113/KH-UBND on the "Preservation, Restoration, and Promotion of the Cultural Values of Traditional Rong Houses of Local Ethnic Minorities in Kon Tum Province for the Period 2021–2025." This plan provides specific guidelines for the preservation, repair, and construction of new Rong houses in accordance with traditional local practices and materials. As a result, newly built or restored Rong houses are now encouraged to incorporate thatched roofs and traditional materials. However, despite the efforts of the government and local communities to preserve the intrinsic values of the Rong houses, many of them are still being modernized. According to the local government, the primary reason for this tendency is the urgent need to complete construction projects in order to utilize the allocated financial resources on time (Fig. 6).

Fig. 6 – *The Rong house in Konhra Ktu village under construction with modern materials, except for the thatched grass roof* (Authors, 2025).

4.2.2. Other causes

The primary traditional materials used for Rong house construction such as wood and cogon grass, have become increasingly scarce. The Vietnamese government's strict policy on banning the exploitation of natural forests since 2014 has further restricted access to forest resources, causing difficulties for local communities to construct Rong houses using natural materials.

Additionally, shifts in community lifestyles have significantly altered the function and usage of Rong houses. Traditional practices such as overnight stays and spiritual rituals have been replaced by new communal activities, including flag-raising ceremonies and meetings of local organizations, such as women's and farmers'

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associations. Due to the availability of alternative social spaces, younger generations now engage with Rong houses far less frequently than before. Surveys from almost all Bahnar villages in Kon Tum City indicate that major traditional ceremonies, such as the new rice celebration, grave-leaving ceremony, and water-drop ceremony, are no longer held in Rong houses. Furthermore, in more than half of the surveyed villages, the frequency of Rong house usage was less than twice per week. Furthermore, concerns about fire hazards and the vulnerability of structures to extreme weather conditions, especially whirlwinds and high temperatures, have significantly influenced construction choices. Reports from the Division of Culture and Information of Kon Tum City show that there is an increasing number of Rong houses being destroyed by fires, prompting both residents and authorities to favor more durable materials.

Another significant challenge in preserving traditional Rong houses is the diminishing number of elderly individuals with the necessary skills and experience for their construction. As a result, the transmission of traditional building techniques to younger generations is limited, leading to the loss of valuable knowledge. Currently, the construction of Bahnar *Rong* houses in Kon Tum City predominantly relies on external contractors—most of whom are either untrained or possess very limited knowledge—further accelerating the shift away from traditional architectural methods.

5. Conclusion

The Bahnar Rong houses in Kon Tum City have unique architectural features that need to be preserved and promoted. Although most of the Rong houses in the city have been partially or fully transformed, many still retain their traditional characteristics. The preservation of the architectural values of the Bahnar Rong house largely depends on the efforts of the community and local authorities in raising awareness, preserving knowledge, and passing it on to younger generations. While the current policies from the government are relatively appropriate, additional support mechanisms are needed—such as sustainable timber exploitation, planning of raw material zones, and organized resource management. Moreover, exploring and implementing effective preservation strategies—such as integrating Rong houses into tourism development, educating younger generations, and fostering community awareness—should be a priority in future plans to ensure sustainable adaptation.

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Rural Architecture in Calabria (Italy): the Example of the *Stabilimento degli Insiti*

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Abstract
This essay aims to investigate the composition and evolution of rural factories in Calabria, specifically in the Sibari Plain in the province of Cosenza. The area in question is a concrete example of a thriving centre for agricultural production, especially for the olive oil production chain, which has shaped the cultural and economic life of the region over time, allowing for the enhancement of the land and encouraging the colonisation of new territories. Starting from an analysis of the production chain, the study focuses on a historical and critical interpretation of the typological and structural conformation of the factories, which is inevitably linked to their functional requirements. The Stabilimento degli Insiti, located in the municipality of Corigliano-Rossano, is taken as an emblematic example of rural heritage. The study of the ancient oil mill has highlighted numerous invariant typological and technological features. The complex, which is part of a wider survey and analysis of structures used for olive oil production, bears witness to the presence in the area of an architectural heritage that has been little studied and appreciated. The essay aims to draw attention to the importance of protecting a historical architectural heritage of great value, which preserves the stratification of signs and languages and is the fruit of local identity.

Keywords: *rural architecture; crusher; Piana di Sibari; knowledge*

1. Introduction

This essay aims to investigate rural factories, focusing on their technological, architectural, and social evolution. In particular, the paper focuses on olive oil production facilities located in the northeastern part of the province of Cosenza, namely in the Sibari Plain, a vast alluvial plain crossed by numerous waterways that run perpendicular to the coastline and flow into the Ionian Sea. Due to its strategic geographical position, natural conformation, and abundant water supply, this area has long based its economy on agricultural production.

These conditions have also strongly influenced the urban development of the anthropized areas, dating back to the Enotri and Bruzi peoples, and have characterized the territory, which is still rich in examples of rural and proto-industrial factories, many of which are unfortunately abandoned and degraded. The first settlements in the Sibaritide area, often walled and equipped with defensive and lookout features, were preferably located on the hillside, further away from enemy incursions from the sea. The flat areas were almost completely abandoned, partly because they were marshy and unhealthy.

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It was only with the end of the barbarian raids and the first land reclamation efforts that the settlements gradually moved towards the coast, often resulting in a division of the urban centers, which, in addition to the traditional hilltop or inland urban structure, also developed a more downstream layout that untangled itself and adapted to the widespread presence of streams and rivers. It was precisely water, with its power to fertilize the soil, that favored the development of agriculture in this area, not as a simple means of subsistence, but as the basis for its economy and trade (Candido, 2002).

In particular, olive cultivation has always characterized the production of the Plain and, in general, the cultural and economic life of Calabria (Fig. 1). Olive trees in Calabria, in fact, have a cultivation tradition dating back to 3 millennia BC and in any case prior to the settlement of the Greek colonies of Sibari and Crotone, as evidenced by the results of systematic studies on various necropolis sites in Calabria, which have revealed that in many of these places, as early as the 7th and 6th millennia BC, there were agricultural villages whose population had reached such a high degree of civilization and evolution that they knew how to cultivate vines, olive trees, and other agricultural species (Gullo, 2002).

It was in the Sibari Plain, during Roman rule, that cultivation began a period of expansion such that the product was even exported outside the region. It is well known that the Romans were true specialists in the oil industry.

However, starting in the 5th century AD, with the fall of the Roman Empire, barbarian raids forced people to retreat inland, and the arrival of the Arabs, who hindered olive cultivation for commercial and competitive reasons, led to a period of agricultural decline (Brasacchio, 1986).

Olive cultivation was revitalized mainly thanks to the influence of Basilian monks who arrived from the Middle East between the eighth and twelfth centuries. Accustomed to living in arid and rocky places, they found familiar climatic and morphological conditions, imported new crops, cultivated mainly olive trees, and contributed to the agricultural and social development of the Sibari Plain.

However, despite the noble commitment of the Church, under Norman and Swabian rule, and until the end of the independence of the Kingdom of Naples in 1503, agriculture in Calabria remained in a disastrous state, with a reduction in olive cultivation.

Fig. 1 – *Planimetry Piana di Sibari: Identifying the main urban centres, cultivated areas and relevant rural architecture* (Tenuta, 2022).

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Until, at the beginning of the 18th century, the Bourbons settled in the region and commissioned the Genoese marquis Grimaldi to improve Calabrian agriculture. He played a key role from both an economic and cultural point of view, promoting the education of farmers, introducing cutting-edge techniques and machinery for olive oil production, and contributing to the reconstruction of the agricultural industry after the earthquake of 1783. With the advent of the industrial revolution, olive oil production was enhanced, as was its export abroad, particularly to England and France (Placanica, 1999).

This marked the beginning of the great revival of olive cultivation in Calabria: the areas of Cassano, Rossano, and Corigliano in Calabria Citeriore were the most affected by the renewal. The government introduced measures to support olive growing by reducing taxes on the manufacture and transport of oil, thus giving new impetus to production and export.

It was during this period that the main rural and proto-industrial factories, still visible today, were built in the Sibari Plain. Rural architecture is one of the most important and characteristic forms of human intervention in the natural landscape. In its traditional forms, it is an expression born of a poor culture, with an agropastoral cultural background, which is why the buildings in this category were often made with simple, locally sourced materials such as wood, stone, and earth, serving multiple functions that included not only rooms for processing and storing products, but also living quarters, stables, barns, enclosures, common areas, and even places of worship.

2. Methodology

The study conducted in this essay is part of a broader research of knowledge analysis and cataloging of the rural factories and farms present in the Sibari Plain. The investigations conducted in the essay focused on the architectures intended for oil production and starting from the production chain and functional needs, variant and invariant characters of the architectures were analyzed. The knowledge of the rural heritage, approached starting from an emblematic case of the area considered, was based on documentary analysis and on-site observation, with the drafting of constructive material survey, which allowed the analysis of permanences and mutations over the centuries. The study, which is still in progress, includes the investigation and comparison with other factories, in order to carry out a broader cognitive analysis that is fundamental for subsequent valorization actions.

3. The oil production factories

In the diversified rural heritage that the Plain has handed down to us, the structures used for olive processing and oil production are rightfully included. Factories, modified or expanded over time to adapt to new work needs, or the result of a broader construction project that determined their typological complexity and articulation, but which always presented effective and functional technical solutions to allow the best possible use of environmental resources. A main distinction between rural architecture for olive production is related to the amount of material to be processed inside and the type of production process adopted. In particular, one can distinguish factories with limited processing capacity, from 600 to 1,000 tomoli of olives, called *trappeti*, which used primitive devices and systems, and establishments, used to process up to 60,000 tomoli per season thanks also to a higher technological level of machines and methods (Battaglia, 1898).

The term *trappeto*, derived from the Sicilian and generally southern tradition to indicate a traditional type of oil mill, involved an almost constant layout whose rooms determined an invariant character of the entire structure. It could have a single room that provided housing the oil mill, the press, the stove for hot water

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production and sometimes served as a storage room for the *sansa*, or two separate rooms, one for the press and stove and the other for the oil press. Rarely was the oil storage room found, while in a non-generalized way trappeti had *olivai*, i.e., special tanks, single or multiple, for storing olives awaiting processing. Finally, the trappeto was completed by the so-called *inferno*, or a covered cistern, made of masonry and connected by pipes to the press area, used for storing the turbid liquid left in the sottini, i.e., specific containers, after the oil was harvested.

Typologically, the trappeto could be hypogean, semi-hypogean or external. In the first variant, they appeared as real caves, dug into the underground rock, attached to farms and farmhouses or near places rich in olive groves, which due to their conformation maintained excellent temperatures for processing and storage (an example can be found in Santa Maria a Cerrate, Lecce). The semi-hypogean conformation, on the other hand, was half below ground level and half above, with rooms that were topped by a vaulted roof resting directly on the rock or masonry (such a type can be seen, for example, in the Muro Leccese in Apulia). While the outer trappeto type had all rooms above ground level and, if necessary, underground rooms for storage and preservation.

Typical and indispensable inside the trappeti were the machinery used, such as millstones and presses. The former, cylindrical and normally made of granite, could appear as single, with a single wheel of the largest diameter, or double, with two wheels of smaller diameter and thickness, placed at unequal distances from the center of the trough. A vertical shaft, with a fifth wheel at the bottom, a beam support and one or more horizontal arms, allowed the machinery to be driven. The presses, on the other hand, could be distinguished into the Genoese type, with a single screw, and the Calabrian type, with a double screw, both of which were used to compress the *fiscoli* castle below. Until the 18th century, the traditional Calabrian trappeto, with a rotating vertical grindstone above a circular bowl, was operated by animals and required the constant presence of an operator who had to direct the olives toward the grindstone to ensure uniform pressing (Grimaldi, 1770).

Only in the second half of the century, thanks to the emergence of factories with higher labor capacity, higher technological level and strong business value, and thanks to the use of newer and more sophisticated machines and methods, the traditional structures of trappeti were modified and hydraulic mills were introduced, which favored working conditions, avoiding the presence of draught animals and the paliero, thus increasing the quality of milling began the emergence of real factories with a strong industrial character, i.e., the transition from trappeto to factory. The latter, often generated by the adaptation of existing buildings, corresponded to a higher level of technology. The functional composition included the presence of the production premises and from the residences of the settlers, who seasonally moved with their entire families to the factories, transforming them into small productive citadels. Often the existence of the lord's residence or the residence of the director of the factory could also be found. The presence of volumes used as residences is configured as an invariant character of architecture for production. As for the workers' lodgings , these were often composed of quadrangular rooms joined in a row, on one or two levels (Masseria Torre della Chiesa in Cassano all'Ionio) or as isolated single-family types (Masseria Olmo Torto in Cassano all'Ionio). Manor residences, on the other hand, were larger in size and often occupied several floors. They could be incorporated into the remaining productive volumes (Masseria Morsidoso and Scorza in Cassano all'Ionio) or be independent, such as that of Masseria Buscata in Sibari, a stylistically simple quadrangular mansion with an upper roof terrace.

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From a careful analysis of the Plain, it was possible to classify from a typological point of view, the establishments that historically connoted the area. The first typology is the isolated networked one where the volumes, residential building and operational buildings, did not present a compact aggregation around an open space, but were distributed around the courtyard with apparent randomness. Aggregation descended from work functions and relational activities (see, for example, Masserie Scorza, Toscano and Dorsa in Cassano territory). The second type is the enclosed courtyard type where volumes were distributed to create a closed and compact space. The one-directionality of the complex was accentuated by the position of the stairs to the habitable floor, placed on an axis with the entrance to the enclosure. This typology has two significant variants: a single enclosed space bordered by the production rooms and the manor house, as seen in the Masseria Malvitano in Rossano Calabro; or a system with doubling of the courts, separated from the manor house, as in the Masseria degli Iti, also in Rossano Calabro. And finally, the open courtyard type, thus with a free side, where more direct contact was created with the land used for cultivation. Again there can be a single court, as in Masseria Mascaro, or a doubling, visible for example in Masseria Toscano Ioele, both in Corigliano Rossano territory.

As already mentioned, production in the factories was inanimate, using hydraulically driven or steam-powered engines. The machinery was the same as in the traps, but inevitably characterized by technological advancements. In hydraulic oil mills, the millstones were mostly driven by vertical box wheels that received the water jet on top. Steam drive, on the other hand, made it possible to overcome the problem of capturing and adduction of water to the oil mill, and spent pomace could be reused as fuel to feed the boiler, realizing significant economy.

The different millstones were then connected to other machinery such as the pulping machine, used to tear the olives and extract the pulp, and the grinder, used to support the milling stage. As for the presses, in the factories they were mainly of the hydraulic type, consisting of a cast iron cylinder into which water was inserted by means of a pump; inside it moved a plunger, which terminated at the top with a horizontal plate. Between the plate and the heating element were then arranged the fiscoli and a metal cage fitted with slots and holes was placed. Knowledge of the machinery and the production process put in place in these factories also allows for a critical reading of their typological and structural conformation, which as workplaces is inevitably linked to the functional needs of the same. What is certain is that the transition from trappeto to factory marked a fundamental point of evolution for these rural architectures, which, numerous throughout the South and Calabria, began to distinguish themselves precisely on the basis of the technological instrumentation used. In the entire province of Cosenza, at the end of the 19th century, there were in fact more than 60 oil mills that processed more than 60 tomoli of olives per day (Battaglia, 1898). Made mostly in the last thirty years of the 19th century, some factories still employed animal power to operate the mills, but slightly less than half still inanimate sources.

4. The *Stabilimento degli Insiti*

In the Rossano district, in the Sibari Plain, there were five oil mills with a mixed hydraulic and steam system, and as many as 13 oil mills with steam engines. Among these, the *Stabilimento degli Insiti*, a factory falling within the municipality of Corigliano-Rossano and among the most relevant for production between the end of the 18th century and the beginning of the following century, was chosen as an emblematic example, showing diachronically the important transition from trappeto to factory. The analysis of unpublished archival documents made it

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possible to proceed to the historical-architectural reconstruction of the property, highlighting variant and invariant characters and typological and technological transformations, demonstrating the structure's affinity and consistency with the general characters previously analyzed.

The factory, dating back to the 18th century, presents itself today as a complex structure in size and stratification, but simple and essential in form, an example of a poor architecture, emblematic of the agricultural and peasant history of the place. The structure shows an imposing closed-courtyard typological conformation, generated by a progressive aggregation of partial structures that differ not only in construction period and architectural morphology, but also in function assumed over time (Fig.2).

Fig. 2 – *First floor plan of the Stabilimento degli Insiti* (Tenuta, 2022).

The Insiti estate, as well as the factory that arose and developed in it, has always been a feudal possession and for that reason inextricably linked to the historical and economic vicissitudes of the lords who succeeded one another in ruling the fiefdom of Corigliano Calabro. The history of the fief began when the Byzantines were succeeded in power by the Normans who, under the able leadership of Robert Guiscard, had already conquered all of Calabria in 1059. From 1114 to 1192 the fief of Corigliano remained the property of the Altavilla family of Sicily, and olive cultivation was improved thanks to the Basilian monks who intensified and improved it by experimenting with new plant qualities. This practice is probably also responsible for the toponym of *Insiti*, which derives precisely from the Latin word "*insitium = graft"*.

In 1192 with the Sanseverino family a long period of subjugation began, which continued with the Dukes Saluzzo and Barons Compagna and lasted well beyond the subversion of feudality in 1806.

Particularly important turn out to be the figures of Agostino II Saluzzo, who reorganized the ducal farm and intensified the cultivation of olives, and Giacomo III, the architect of the very construction of the first oil mill on the Insiti estate (Archives of the Saluzzo Dukes of Corigliano). In 1828 the Compagna family acquired a fief and trappeto, consisting of a single building composed of rooms for processing olives, warehouses and rooms for residential use (Archives of the Saluzzo Dukes of Corigliano) and began the conversion into an innovative Factory.

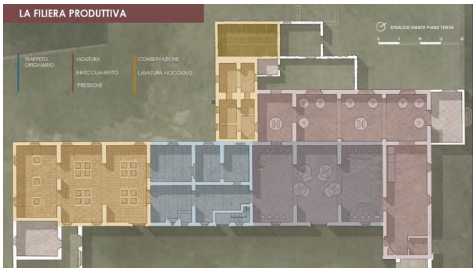

Fig. 3 – *Reconstruction of the production environment of the Insiti* (Tenuta, 2022).

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The first description of the Compagna Factory was finalized in an 1898 text, from which it can be deduced that there was an inanimate, more precisely steam-powered, engine-powered factory occupying an area of around 6,000 square meters, with a large courtyard of 2,300 square meters (Battaglia, 1898) (Fig. 3). A later depiction was instead found in the Compagna Barons' Archives (Fig. 4). Comparison of this with the present state has made it possible to determine more accurately some of the evolutionary stages of the factory.

As early as 1898, the complex consisted of production rooms, olive workshop, or *bottega*, pomace workshop, or *frullino*, and warehouses for storing oils, storage rooms, and administration rooms. The entire east side of the perimeter, and to a depth of 9.40 meters, was occupied by the olive mill, more commonly known as the *spanditoio*, in which the olives were deposited after harvest waiting to be pressed. This room was totally covered by a canopy, supported by a double row of red brick pillars, which divided the olivaio longitudinally into two sections. Only later was part of the *spanditoio* enclosed and used for settlers' residences.

Halfway along the east side was a church, probably an evolution of an earlier minute place of worship for the settlers, built in its present conformation in the mid-1900s (Compagna Barons' Archives). The religious building is a symbol of protection of peasant labor, with a strong apotropaic value and is an invariant character in the rural factories of the Plain. The location is different for each farm and can be part of the building (like at Masseria Perciaccanti and Scarpa, both in Cassano all'Ionio, with the first one accessible from outside and the second one with a gate in the courtyard) or present an isolated volume within the courtyard (as in the Buscata farm in Sibari and the Chidichimo farm in the hamlet of Doria di Cassano all'Ionio).

In the case study, compared to the current layout, the only other differences are the addition of a few buildings, probably used as storage, which are real additions of little architectural and historical value. Overall, the rooms that currently make up the factory can be divided into: residential structures for the farmers, a group of single-room dwellings on one level, arranged adjacent to each other to form a compact curtain, and for the manager; two rectangular buildings on two levels, containing accommodation and rooms for sheltering animals; and production facilities, the most important rooms for production and storage, integrated with characteristic underground cisterns; service and communal areas.

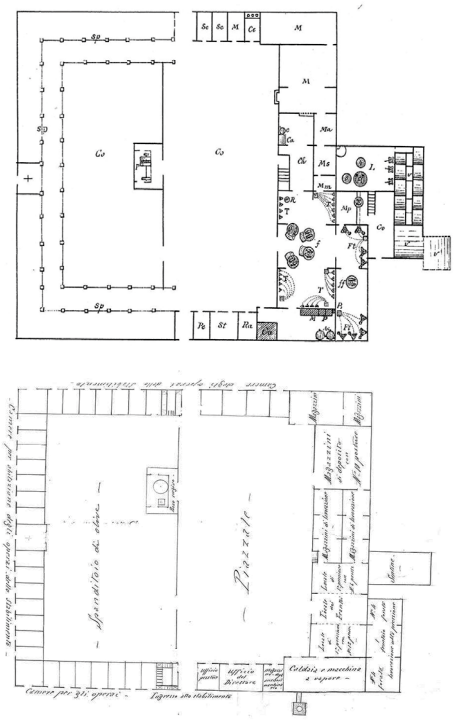

Fig. 4 – *First plan of the the Compagna Factory* (Tavola IX, Battaglia, 1898); *Later representation in the Compagna Barons' Archives* (B. 17, fasc. 297, A.S.Cs., Archivio dei Baroni Compagna).

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The changes undergone by the factory over time, as evidenced by the documents analyzed, can also be deduced from an analysis of the material and construction composition. This demonstrates the presence of masonry systems dating back to different periods, ranging from masonry with rough-hewn stone blocks and pebbles, to the use of regular brick laying patterns, to the more recent use of regular-shaped fired clay bricks with a masonry pattern consisting of a course of elements laid on edge and a course of elements laid on their sides. Similar evolutionary considerations, and evidence of the evolution of traditional construction techniques in rural areas, can be made with regard to roofing systems. The two specular entrance buildings, for example, have pushing roofs, similar to the Piedmontese system but lacking the spine wall, while the production rooms for processing fine oils use a heavy roof based on the Lombard system. Furthermore, the roofing systems have been replaced with joist and clay tile floors in the complex used for storing paste oil.

The factory continued to operate until the mid-1900s, when it was sold and the land was divided up and partly converted into a citrus grove (Conte, 1971), leaving it in a state of serious disrepair and surrounded by a landscape that was no longer the same as when it was built and expanded (Fig. 5).

5. Conclusions

This first historical-critical reading of the factory and analysis of the evolution of Calabrian olive production can allow us to highlight both characters related to the local economy and to unveil a historical architectural heritage that is too often forgotten. The rural buildings scattered throughout our territory, while not having the same artistic value as monumental constructions, are evidence of a savoir-faire and a productive world that has been instrumental in the development of the region.

Fig. 5 – *Current picture of the Stabilimento degli Insiti* (Tenuta, 2022).

The study addressed therefore, placing itself in a broader research on the productive buildings of Calabria, aims to open reflections about the need to preserve and reuse these architectures. The knowledge and preservation of the industrial heritage is to be understood as a substantial enhancement of the identity features of the places, such as to determine regeneration processes that, respecting the places, the buildings and their history, allow the rediscovery of virtuous relationships between the countryside and the city, between natural and man-made space.

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Rural Architecture in the Pinerolo Area (Piedmont, Italy): The Search for Evidence of Viticulture

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Abstract
The rural landscape, understood as the highest expression of the interaction between natural and human factors, offers the observer glimpses into the history of places, shaped by the events of a community over the centuries. Climatic and environmental conditions, available raw materials, political circumstances, and the needs for sustenance and productivity have always shaped the character of vernacular architecture. This heritage is grounded in shared principles of necessity and possibility, yet it remains diversified depending on the context in which it develops.This essay focuses on the local variations of the rural landscape in the Pinerolo area, a Piedmontese territory southwest of Turin that has been influenced by alternating Savoy and French domination, with particular attention to the historical cultivation of vines, now only partially revived. Documented as early as the 10th century, vine cultivation spread across the plains and hillsides of Pinerolo, flourishing between the 17th and 18th centuries, reaching high levels of production and quality by the 19th century. This prosperity was halted by the arrival of phylloxera and mass industrialization. From the typological variants of the architectures to the terracing and the toponyms: the study aims to highlight the transformations of the local vernacular landscape related to viticulture. Starting from a brief overview of the types of local rural architecture, the article seeks to explore the variations and specific features connected to wine production through the case study analysis of the farmhouse La Bottegaria.

Keywords: *farmhouse; Pinerolo area; viticulture; vineyard*

1. Rural architecture: influences from the land, influences on the landscape

This contribution aims to highlight evidence of how viticulture has shaped the rural landscape of the Pinerolo area, with particular focus on the Pinerolo hill.

The study constitutes a first phase in the investigation of a theme that leaves room for interesting in-depth studies, and is based on the identification and analysis of farmsteads in the territory, carried out as part of the ICCD Istituto Centrale di Catalogo e Documentazione, Ministry of Culture's "Censimento dell'Architettura Rurale nazionale" project, financed by the PNRR[1].

The in-depth study of individual buildings or complexes is inseparable from the study of the territorial and landscape context in which they are set: rural architecture and the landscape are a pair of mutual influences, in which local territorial characteristics have to a large extent

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determined the conformation of extra-urban architectures, which in turn are responsible for the transformations of the landscape generated by anthropization. The study of numerous local rural architectures has made it possible to compare repeated typological characteristics and specific variations, reflecting the multiple causes that determine our vernacular heritage's spatial organisation and identity-related architectural elements.

In this perspective, the interest in analysing the identity-related elements of a landscape and architectural heritage influenced by the widespread wine production that has affected the Pinerolo area for centuries, subsequently abandoned and only recently partially recovered, emerges. This brief discussion, therefore, aims to illustrate, motivate, and relate the traces of the cultural landscape linked to winegrowing, including first and foremost the typological variations of architecture.

2. The case of Pinerolo: transformations of the landscape

For centuries, winegrowing has concerned the Pinerolo area, a piedmont and mountainous territory extending south-west of Turin, in the territories between Barge and Cumiana, and through the Pellice, Chisone, and Germanasca Valleys. In particular, the characteristics of the Pinerolo hill, located to the north of the historical centre and characterised by an extensive sun-drenched slope with soil suitable for vine cultivation, irrigation canals, and mild climatic conditions, meant that the area was permanently inhabited and cultivated from the Middle Ages onwards. Between the 12th and 15th centuries, the area was affected by the emergence of numerous scattered rural architectures, the *cassine* (farmsteads), small or medium-sized rural farms surrounded by vineyards or *alteni*[2]. This is the so-called *quartiere delle vigne*, extended from the Costa Grande area to the Santa Brigida hill and Monte Oliveto.

In the centuries that followed, the settlement pattern of the Pinerolo hillside did not change substantially, nor did the widespread presence of vineyards. Given the slope of the land, the farmsteads mainly consisted of a single body, with linear development oriented parallel to the contour lines, but there are a few cases, on the slopes of the hill, of courtyard farmsteads. The hill appeared intensively cultivated and organised in small plots of land (Fig. 1). From the end of the 18th century, the *alteni* were gradually replaced by vines with supports, i.e., stakes made from the wild chestnut trees cultivated in the Pinerolo hills. During the 19th century, the number of farmsteads increased slightly, and the first villas appeared in the south-eastern area of the hills. In 1881, Pinerolo also hosted the great "Esposizione Ampelografica" (Ampelographic Exhibition), where more than 600 grape varieties were counted, including 333 indigenous vines from the province of Turin, most of which came from this area of ancient winegrowing vocation.

The following centuries witnessed the abandonment of cultivation, particularly of vineyards, due to the industrialisation of the area. The farmsteads lost their rural function and were converted into residences, and in some cases, significantly transformed. The result is a landscape in which the settlement typology is still legible, but where the vineyards have a

[1] For Piedmont, the census, still in progress, is conducted by the "RTP-Panzani", with Arch. Laura Panzani as mandatary and Arch. Valentina Musetti, Ing. Federica Castiglione, Arch. Alice Vergano, Dr. Simona Lunatici, Arch. Ramona Minnucci, Dr. Maria Scalici, Arch. Monica Delle Donne, Arch. Sara Cecchi. Further details can be found on the national project website: https://caserurali.cultura.gov.it/.

[2] Alteno is a form of vine-training on braced trees, such as elms, mulberries, maples. In some cases, the vacant land underneath is cultivated with cereals or vegetables.

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reduced and fragmented extension, replaced by wooded areas, meadows, and arable land, characterised by less difficulty in carrying out normal farming operations on steep lands.The remaining vineyards are characterised by rows arranged following the contour lines and trained with a modified Guyot system, supported by wooden poles with three iron wires.

In this study, the examination of bibliographic sources is flanked by that of historical cartography, starting with the *valbe* (cadastral parcels) of the Catasto Sabaudo (Sabaudian Cadastre), or Old Cadestre. This is a geometric-particle cadastre, which combines cartographic representation, surveyed with criteria of homogeneity and high technical precision, with descriptive lists of properties (land registers). The *valbe*, kept at the Historical Archive of Pinerolo, consist of the representation of adjacent portions of land, delimited by watercourses, roads or ditches, subdivided into parcels, characterised by cover crops that connote the use of the land; the indication of the number of the parcel refers to the list in which the ownership, the use of the land and the quantities are specified.

From the *valbe* it is clear that at the end of the 18th century, the Pinerolo hill was almost completely planted with vines or *alteni*. The farmsteads, mainly consisting of a single building with linear or, in some cases, L-shaped development (see section 3), with any small ancillary buildings, were located within the estates, which constituted the compositional elements of the perceived landscape.

This was followed by the consultation of the *Catasto Rabbini* (Rabbini Cadastre), dating back to the second half of the 19th century, and the original cadastral maps, the first cadastre of the unified Italian state, drawn up between 1874 and 1886. Both have proved to be valuable tools, on the one hand for ascertaining the substantial permanence of the settlement structure legible on the *valbe*, and on the other for reading the toponyms that characterise the territory under examination.

While some historical photographs testify to the hillside being entirely occupied by vineyards, the consultation of aerial photographs from the end of the 20th century makes clear the transformation of land uses and the reduction of vineyards.

Fig. 1 – *Extract from Valba n. 47 of the Sabaudo Cadastre* (Historical Archive of Pinerolo).

3. The Vineyard farmsteads of the Pinerolo hill

The strong winegrowing vocation that characterised the Pinerolo hill in the past is difficult to interpret from a landscape point of view, but has left significant traces in traditional architecture. However, the analysis of the Bottegaria Farmstead case study, and above all the identification of the elements closely linked to winegrowing, requires a preliminary overview of the identity-related characteristics of the rural architecture most widespread in the surrounding area.

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The rural building, which houses both the living functions and the service functions of the farm, represents the archetype of traditional local architecture. It is the result of the sum of the knowledge and traditions of centuries of building and farming experience. The site of installation, the exposure, the distribution and size of the various functional volumes, the materials and construction techniques constitute identity-related aspects, which vary according to the territorial areas and the type of materials available in the territory.

The Pinerolo area is characterised by the presence, on the plains and in the hills, of many farm buildings still legible in their original distribution and functional characteristics. For the most part, these are simple farmsteads, corresponding to the type of linear agricultural building or with opposing bodies. In the first case, the buildings, located in positions well exposed to the sun and developed along contour lines, have a simple wing and generally two floors, and house the main functions of farming activity: the dwelling, the stable, and the barn. They represent the most elementary system of scattered settlement and are generally single-family run. The main front faces south; the northern front, with no or few openings, may be against the ground. The courtyard is small and frontal, used to distribute the minor activities of the outdoor space.

In many of the cases found in the area, the spaces are distributed in two opposing buildings: the main building, with the façade facing mainly south, houses the dwelling and a portion used as a stable with a barn above; the second building, facing the first one, is used for storage (Fig. 2). The residence is on two floors with a plastered façade towards the courtyard, with a wooden gallery on the first floor. To the side is the building dedicated to agricultural activity, used as a stable with a barn above. On the ground floor, enclosed by walls, with a vaulted structure overhead and ventilated through generally square-shaped, small openings on the outside front, is the stable. The barn, located on the first floor, is characterised by large openings on the front towards the threshing floor, bordered by quadrangular brick pillars supporting arches or the roof structure, sometimes closed by brick grid walls, necessary to ensure easy accessibility and the necessary natural ventilation to protect the straw. The roof may be the same for the dwelling and the rustic, otherwise, the two elements may simply be juxtaposed. The vertical partition between the dwelling and the rustic portion is implemented by means of a wall with a firebreak function. In front of the house is the threshing floor. On the opposite side of the threshing floor is the *cas* (a Piedmontese word taken from oral tradition still in use), a building serving the agricultural activity, which has, in the conformation most common in the area, a rectangular floor plan, one floor above ground with double height, and a gable roof. The outer front is generally without openings; the inner front is open and bordered by quadrangular brick pillars supporting the roof, or occasionally by arches.

Fig. 2 – *Typological examples: opposing-wing farmhouse (Pinerolo, Cascina Pescia), L-shaped farmhouse (Pinerolo, Cascina Danesy), courtyard farmhouse (Macello, Cascina Sordello)* (Vergano, 2025).

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We note the presence of some L-shaped farmsteads (Fig. 2), in many cases generated by a development of the basic linear type, which is configured as a terminal enlargement of the main building, covered by the extension of a portion of one of the roof layers. Alternatively, the L-shaped scheme is determined by the aggregation of two wings, where the longer one generally has a service function, with a stable on the ground floor and a barn on the upper floor, while the shorter one houses the farmer's residence, with a kitchen and any appurtenances on the ground floor and bedrooms on the upper floors.

Finally, there is the presence of courtyard farmsteads (Fig. 2): these are buildings located mainly in the plains, which are larger, more complex, and richer. The main buildings, used for residential and service purposes, are arranged in a C-shape around a large central threshing floor (open courtyard farmstead), sometimes protected on the fourth side by an enclosure wall in which the main entrance is located, generally marked by large portals (walled courtyard farmstead); alternatively, the buildings are arranged on the four sides of the ideal perimeter of the farmstead area (closed courtyard farmstead). As indicated above, while on the slopes of the Pinerolo hill it is possible to identify a few isolated cases of courtyard farmsteads, most rural buildings are of the linear type.

Their location, the organisation of the properties and production needs have determined some specific distinctive features: the relatively small overall dimensions, depending on the characteristics of the sloping terrain and the generally small size of the plots; the presence of a covered open space known as a *tinaggio* (wine-making room) preferably located near the cellar, the presence and conformation of which is dictated by the needs of the grape vinification process; modest sized barns and the absence of granaries, as the land owned was almost entirely given over to vineyards, in addition to the presence of modest sized vegetable gardens and occasional lawn areas. It should also be emphasised that, given the position of the farmsteads within the estates, there are no *ciabòt* (small rural shelters) on the Pinerolo hill. These are elementary constructions built as tool sheds, shelters for agricultural products, and for the farmers from the sun and rain, generally built to support work in the larger vineyards, located halfway up the hillside, in the centre of the vineyard or on the edge of the estate at the bottom of the valley.

In view of these indications on local typologies, we intend to analyse a building that preserves the identifying features of the wine-growing farmsteads in the Pinerolo hill: La Bottegaria farmstead. The building is located on the eastern portion of the sunny slope of the Santa Brigida hill, in a landscape context that largely preserves the historical settlement typology of scattered rural settlements, but with substantial modifications in terms of land uses. Originally located in an area almost entirely dedicated to viticulture, it is now surrounded by meadows and wooded areas, as well as some portions, particularly upstream of the building, still characterised by the presence of vines.

The farmstead and adjacent land can be seen on the cadastral parcel number 47, as the property of *Illustrissimo Signor Conte Brunetta* (most illustrious Sir Count Brunetta). The building had an almost rectangular plan and was flanked on the west side by the Chapel. Access to the property was from the west, as it still is. Except for the threshing floor, the vegetable garden in front of it, and a modestly sized area of lawn, the entire land was cultivated with vines.

On the *Catasto Rabbini* (Rabbini Cadastre), the volumes and boundaries of the property are unchanged. The toponym *La Bottegaria Cas.na* (La Bottegaria Farmstead) is legible, while on the *Catasto di Impianto* (plant registry), one can read the name of the road that bounds the farm to the west, *Strada Vicinale di S. Margherita* (local road of S. Margherita).

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The building is of the linear type with orientation parallel to the contour lines along the east-west axis. The main residential portion is located at the eastern end: it has two above-ground storeys, a load-bearing structure in plastered brickwork, and a gable roof with a wooden structure and a mantle covering of tiles. It is characterised by the typical presence of the stone balcony on the first floor and the belvedere at the top aligned with the entrance door, with a pavilion roof. On the eastern side of the building is the *tupiùn* (Piedmontese word taken from oral tradition still in use), the typical vine-covered pergola, with supports arranged to form a short walk that was generally taken after meals.

On the western side is a building of slightly lesser height, which housed the sharecroppers' dwellings, of great compositional simplicity, where there is a bell to call the workers from the vineyards at mealtimes. This is followed by a smaller portion used as a stable with a barn above, recognisable by the presence of large openings bordered by arches on the first floor, where the hay produced on the portion of meadow downhill from the farmstead was stored.

Upstream is a volume covered by the extension of the northern slope of the roof, now closed and used as a warehouse, which historically housed the *tinaggio* at the bottom of which is the cellar originally covered by a barrel vault. A further canopy was built in the late 19th century upstream from the chapel, presumably also used for the *tinaggio*.

Wine production required the grapes to be harvested from the vineyard and placed in the *s'bre* or *brente* (wooden tub), wooden containers made of staves held together by iron hoops, slightly flared from the bottom to the mouth, with two staves protruding from the top, specially perforated to allow the insertion of a pole and facilitate transport. The *brente* were transported by hand to the wagon, onto which was tied the *arbi* (vessel), a wooden container in the shape of a ship, about 3 metres long, intended for transporting the freshly harvested grapes from the vineyard to the farmstead. The wagon reached the *tinaggio*, a covered open space easily accessible from the wagon and located near the cellar, where the grapes were transferred to the vats prepared for the crushing of the grapes and the fermentation of the must, which lasted about 10-15 days. The wine was then tapped and poured into barrels, stored in the cellar, where it aged for about six months. The cellar was generally a semi-basement, to ensure shelter from light, constant humidity, and temperature.

The slope upstream of the building is planted with vines, with linear rows oriented according to contour lines, supported by vibrated concrete poles and iron wires.

4. Other traces of the cultural landscape

The Pinerolo hill preserves, in addition to the identity-related features of the architecture, other traces of a past strongly marked by viticulture, which are briefly treated here.

Fig. 3 – *La Bottegaria* farmstead*: the vineyards; the chapel and the tinaggio; the sharecroppers' dwelling flanked by the stable with barn above, and the main residential portion* (Vergano, 2025).

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These include the Chapel of Santa Lucia, known as the *dei vignaioli* (winemakers') chapel, located on the slopes of the hill at the end of St. Lucia Street, which branches off from the route historically known as the *Strada Vicinale delle Vigne*. Among the frescoes preserved inside, dating back to the late 15th century, is the scene in which St. Lucia gives bread and wine to the poor. In 1813, the building was known as the *Cappella Pubblica delle Vigne* (Public Chapel of the Vineyards), belonging to the owners of the vineyards and used for the celebration of functions linked to the cult of St. Lucia *patrona dei vigneti circostanti* (patron saint of the surrounding vineyards).

Several dry-stone walls have also been preserved on the steepest portions of the slopes, built to shape the steepest areas and make them suitable for the cultivation of vines. The abandonment of cultivation and the lack of maintenance put these artefacts, a precious trace of the cultural landscape and evidence of the activities of local farms, at risk.

Finally, it is worth mentioning the local toponyms linked to the world of viticulture, identifiable on the 19th-century cadastre. Examples include Bottale Farmstead (from *botal*, meaning barrel in Piedmontese), Ciabòt Bas Farmstead (the toponym refers to the *ciabòt* described above), Vignassa Farmstead (the toponym is a derivative of the term vineyard) and Villa Guyot (Guyot is a system of training and pruning vines).

5. Towards the recovery and valorisation of the local wine-growing tradition

Pinerolo is often mentioned for its military history, characterised by a long period in which its fortified citadel, now no longer in existence, was disputed between the House of Savoy and the Kingdom of France.

Its historical events have allowed the preservation of a historic centre rich in medieval architecture and evidence of the famous 19th-century cavalry school.

Fig. 4 – *Frescos in the Chapel of Santa Lucia* (Vergano, 2025).

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The most relevant historical events, however, have been accompanied by a reality of daily life and local economy, based on agriculture and viticulture, which it was deemed important to investigate in its architectural and landscape components, understood here as the driving force behind the transformations of the landscape over the centuries. The cultivation of vines, the necessary interventions on the land to make it possible, the conformation of the spaces dedicated to wine-making, the variations in local architectural typological models linked to production needs, and subsequently the abandonment of viticulture, the expansion of invasion vegetation, and the re-functioning of farmsteads, are all elements that have contributed to the constitution of the local cultural landscape.

The spread of a culture that is more attentive to the recovery and enhancement of local identity, flanked by the approval in 1996 of the denomination of controlled origin of Pinerolo, has contributed to the recent development of new wine production realities. From a landscape point of view, the recovery of uncultivated land, the valorisation of native vines, and the planting of new vineyards are the new signs that the wine vocation has left on the Pinerolo hillside. As far as architecture is concerned, the themes of reuse, adaptation and valorisation of existing buildings are of great interest and topicality: the preservation of traditional characteristics, together with the needs dictated by production innovations, require the identification of design solutions capable of outlining new typological models of local architecture linked to wine production.

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Rural Settlements in the Territory of Alessandria (Italy): Types and Construction Techniques

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Abstract
This paper aims to identify the various architectural types most widespread in the Alexandrian area and, at the same time, to identify the construction techniques that best represent this territory, now lost, namely the use of raw earth. On this vast territory, mostly flat, with extensive areas of agricultural use, with large intensive arable crops, characterised by a dense network of canals for irrigation, farmsteads, in their typological and formal complexity, have played a fundamental role. Such architectures are examples of a close relationship between building typology and productive organisation. A survey of them would allow a clear reading of their evolution over time, from the most elementary form to a more articulated architecture, but always in harmony with the agricultural landscape in which they are included. However, crucial will also be the investigation of construction techniques, which will allow us to understand how the territory has been built up over time, defining its character and identity. Therefore, this study will allow for a clear reading of the evolution of the rural architectural heritage of the Alessandria plain, both under the typological and constructive aspects.

Keywords: *farmsteads; territory of Alessandria; typology; materials*

1. Introduction

The farmsteads (rural houses) have represented and still represent the liveliest expression of Alexandrian's peasant civilisation, which over the years has undergone various transformations both in the distribution of internal spaces, and externally with the addition of new bodies, either joined to the existing ones or autonomous, whose testimonies are still visible today.

On this vast territory, for most flat to the east, with large intensive cultures of arable crops, characterised by a dense network of irrigation canals, and hilly to the west, with vast areas used as vineyards, the farmstead has evolved from the most elementary form to a more articulated architecture, but always in harmony with the farmscape in which it is included.

Today, unfortunately, only some of them have become the seat of agricultural companies or have been reconverted to other uses, the remaining persist as architectures that are signs of an era now lost.

The study aims to conduct a first census of the most widespread typologies in the Alessandria area, underlining their main characteristics and tracing a brief temporal evolution, as well as their localization in the different areas of the province.

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2. Identification of rural types

The different typological distinctions of farmsteads are linked to the geographical, historical, and economic aspects of the territory (Ripartizione urbanistica del Comune di Alessandria, 1989). Specifically, in the Alexandrian area, we can identify four different building types: 1) Linear farmstead; 2) Farmstead with ancillary buildings; 3) Open courtyard farmstead, and 4) Closed courtyard farmstead, which will be investigated by highlighting their distinctive features (Fig. 1).

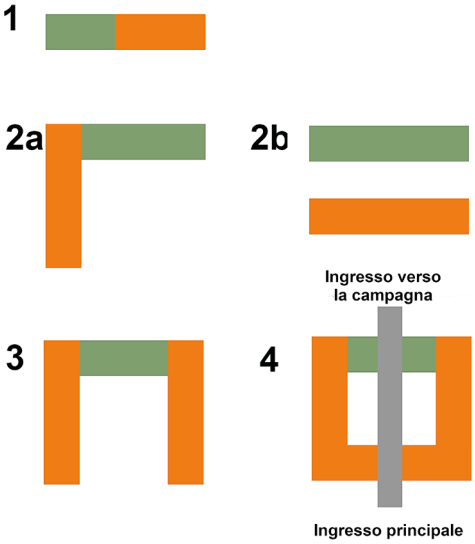

Fig. 1 – *Outline of farmstead typologies* (Minnucci, 2005).

2.1. Linear farmstead

This typology is one of the most widespread across the territory, although it is sparsely distributed, an expression of the essential character of architectural form, also defined by the clean and symmetrical lines of the architecture itself, devoid of valuable architectural elements. The farmstead is identified as a single volume, usually two or three above-ground floors, within which one can find a residential building and a rustic outbuilding (barn).

The building extended in a straight line, with a non-turning façade, and located in a position well exposed to the sunlight, housed the main functions of farming activity, representing the most basic system of scattered settlement.

The residential building is very often smaller in size than the barn, falling within the typology of the elementary settlement unit, where it is simply the place for the day and night activities of the family unit, while greater importance is given to the productive activity.

On the other hand, the barn can be easily identified by two architectural elements: the porch, either aligned or extending the roofline towards the courtyard, and the trellised pattern of the upper openings, which allowed air to circulate to facilitate the hay drying (Figs. 2 & 3).

Fig. 2 – *Farmstead, located in Valmadonna (AL)* (Minnucci, 2004).

Fig. 3 – *Farmstead, located in Sale (AL)* (Minnucci, 2004).

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2.2. Farmhouse with ancillary buildings

The farmstead with ancillary buildings is an evolution of the more elementary system of scattered settlement, connected to the growth of farming activity. The complex is made up of two main volumes that may be placed either perpendicularly or in opposition to one another. However, in both cases, their common overlook, the conformation, and the nearly identical length of the wings, unequivocally define the inner courtyard, identifying the essentiality of the typological and planimetric layout. The farmstead with ancillary buildings is particularly common in the central Alexandrian area, and corresponded to the dwelling of the average farm, where the stable and another rustic building were juxtaposed to the residential one (Fig. 4).

2.3. Open courtyard farmstead

This architectural definition stems from the fact that the buildings are placed along three sides of the perimeter of the courtyard, leaving the fourth free. The three built portions were partly intended for residence, even articulated or hierarchical, and partly for rustic, aggregated by continuity and turning on two sides of the ideal perimeter of their area.

This complex of medium to large-sized was aimed at a rational and entrepreneurial agrarian organisation, and with such an arrangement of the buildings, guaranteed greater security against threats from outside and greater control over access to the courtyard. Generally, the open courtyard farmstead included the manor house, easily distinguishable by the richness of the external and sometimes also internal decorative apparatus (see Opizia Farmstead in S. Michele), very often also a small tower (see Bolla Farmstead in Spinetta Marengo, Ferrero Farmstead in Valmadonna, and Bracchiera Farmstead in Viguzzolo) or recesses with statues inside to protect the family and the property.

In addition to the manor house, then, there was the house of the wage-earners, identifiable by a simple architectural layout with clean lines, linked mostly to functional factors, and by the presence of one or more rustics characterised by one or more porches, trellised closed windows or large full-height arched openings.

The preferred building technologies were exposed bricks and roofs with warping and wooden beams with a roof covering of roof tiles.

Fig. 4 – *Ruffina Farmstead (AL)* (Minnucci, 2004).

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Fig. 5 – *Cravina Farmstead, Tortona (AL)* (Minnucci, 2004).

This typology is widespread in the explored territory, except for the North-West quadrant. In addition to those already cited, we mention Valoria Farmstead located in Cristo, Salvadora in Pontecurone, Torrenuova Farmstead and Melgrone Farmstead in Alessandria, Lombarda Farmstead in Litta Parodi, Cravina Farmstead in Tortona, etc. (Fig. 5).

2.4. Closed courtyard farmstead

The nucleus of the farmstead develops around a closed courtyard (Sereno, 1980), the fulcrum of the spatial organisation (Fig. 6).

The entrance to the courtyard is through a main portal, which architecturally characterises the statement of the façade, and one secondary, aligned with it, which provides access to the owned land (Figs. 7–9).

Fig. 6 – *Valmagra Farmstead, located in S. Giuliano Nuovo (AL)* (Minnucci, 2004).

Fig. 7 – *Examples of portals. Cascinolo Farmstead, located in S. Giuliano Vecchio (AL)* (Minnucci, 2004).

Fig. 8 – *Examples of portals. Scaccavela Farmstead, located in S. Michele (AL)* (Minnucci, 2004).

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Fig. 9 – *Examples of portals. Calcamuggia Farmstead in Spinetta Marengo (AL)* (Minnucci, 2004).

Each volume has its specific destination, but the manor house is always present, distinguished by its appearance as a bourgeois dwelling, the house of the wage-earners or workers, and the rustics.

Their position along the perimeter is also important; in fact, the manor house is strategically placed, close to the entrance door or on the opposite side, to oversee every movement and work in the courtyard and the various rustics.

Another characteristic element of this complex is often the presence of a chapel or church, incorporated within the perimeter or separated from it, to represent the family's importance, with an entrance facing outwards, so that it could also be enjoyed by those who did not reside in the farmstead (Figs. 10–12).

Fig. 10 – *Some of the chapels in the area. Scaccavela Farmstead, located in S. Michele (AL)* (Minnucci, 2004).

Fig. 11 – *Some of the chapels in the area. Grattarola Farmstead (AL) – Ronco Farmstead, Tortona (AL)* (Minnucci, 2004).

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Fig. 12 – *Some of the chapels in the area. Ronco Farmstead, Tortona (AL)* (Minnucci, 2004).

In the Alexandrian area, this typology is widespread especially in the flat area, with several examples such as Pistona Farmstead in Litta Parodi, Zerboni Farmstead and Grossa Farmstead in Cascinagrossa, Vignetta Farmstead in Frugarolo, Posta Farmstead in Bosco Marengo, Presidenta Farmstead in Valle San Bartolomeo, Calcamuggia Farmstead in Spinetta Marengo, etc. In some cases, where the size of the property is greater, the farmstead, while remaining unchanged in the architectural features of its original nucleus, may be defined by one or more courtyards (see Fiscala Farmstead in Spinetta Marengo, Ghilina Farmstead in San Giuliano Nuovo, Motta Farmstead in Lobbi) or by perimeter walls so massive that they define a gated courtyard (see Scaccavela Farmstead in San Michele, Castellana Farmstead in Cristo, Rivellino Farmstead in Alluvioni Cambiò).

3. Identification of the traditional building techniques

From the survey carried out throughout the province, two different building techniques can be identified: raw earth, mainly in the East quadrant, and brickwork in the North-West quadrant (Prati, 2011). The use of these techniques is linked to their evolution: from a very simple material to a more standardised and manageable one, capable of guaranteeing clients greater security in terms of the solidity, healthiness and elegance of their building, as opposed to a material such as raw earth considered poor, no longer suitable to represent the new social status (Quagliarini & Tassi, 2008).

On the Alexandrian plain, there are two types of use of raw earth in the construction of brickworks:

- Pisé (rammed earth), with the wet-laying technique, modelled directly during construction, which consists of compressing, layer by layer, slightly moistened earth inside a wooden formwork (see Farmstead located in Via Piacenza, 38 or Beltan Farmstead, both in San Giuliano Vecchio, etc.) (Figs. 13 & 14).

Fig. 13 – *Beltran Farmstead realised with pisé technique, located in San Giuliano Vecchio* (Minnucci, 2004).

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Fig. 14 – *Beltran Farmstead realised with pisé technique, located in San Giuliano Vecchio* (Minnucci, 2004).

- Adobe (unbaked brick), with dry laying, preferred because it did not require long drying and laying times, allowed construction even in cold seasons, and was easy to assemble. This technique differs from other areas of Italy, where the combination is made from a mixture of earth and straw or other vegetable fibres. In the Alexandrian area, bricks are made exclusively with earth without the addition of other materials except sand, which avoids the excessive shrinkage of some soils (see Ravisson Farmstead in S. Giuliano Nuovo, Baraccone Farmstead in Pontecurone, etc.)

On the other hand, the use of brickwork occurs more frequently in the early years of the 20th century, as an extremely effective material used with the exposed-face technique, is used both as a coating and as a supporting structure. In the Alexandrian countryside, it can easily be found in the construction of rustic buildings where it is left exposed (barns, warehouses), while the dwelling is painted in shades of red, deep yellows, and ochre. It takes on great importance when it is used for certain architectural elements such as arches, round-arched, pointed, and depressed vaults, for the realisation of trellises to limit the openings of rooms while favouring ventilation (Figs. 15 & 16).

Fig. 15 – *Viecha Farmstead, rustic, located in Valmadonna (AL)* (Minnucci, 2004).

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Fig. 16 – *Masone Farmstead (AL)* (Minnucci, 2004).

4. Conclusions

The above study is the result of the extensive survey, still in progress, made by the ICCD's (Istituto Centrale per il Catalogo e la Documentazione- Ministry of Culture) "Census of National Rural Architecture" project, financed by the PNRR[1], which involves the identification, study, and cataloguing of the articulated range of rural buildings throughout the country.

Through this first census and the analysis of the data collected in the different parts of the Alexandrian territory, a synthetic evolution of the architectural type of the farmstead (from the basic linear type to the mature closed courtyard type), as well as of the two most used brickwork techniques, was outlined. Moreover, an initial attempt was made to locate the distribution over the territory, which, through subsequent in-depth studies, may lead to drawing statistics concerning the different geographical areas of the province.

These operations are, therefore, necessary for the knowledge, and subsequent protection and valorisation of a huge heritage that is increasingly being abandoned.

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[1] For Piedmont, the census was conducted by the "RTP-Panzani". More information on: https://caserurali.cu-ltura.gov.it/.

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The Architecture of Rural-urban Complexes through Typologies. The case of Maestrazgo (Teruel, Spain)

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Abstract
The Maestrazgo is a historical region located in the eastern part of the province of Teruel (Spain), made up of fifteen municipal districts and numerous villages sheltered by the mountains of the Sierra de Gúdar. After the Christian Reconquest, military orders played a decisive role in controlling the territory. The region reached its peak at the end of the Middle Ages before the Industrial Revolution, thanks to the exploitation of livestock and the wool trade. The modern era, on the other hand, was marked by a drastic economic and demographic crisis in rural areas, which brought many of these villages to the brink of extinction. This phenomenon - shared by large areas of the interior of the Iberian Peninsula - largely coincided with the global development of urbanization and industrialization. Fortunately, the rural-urban complexes under study have hardly been affected by the transformations brought about by the modern era. This has favoured the preservation of the essence of vernacular architecture with few alterations. The definition of the uses and the typological characteristics of the buildings in these villages reveal the flow of traditional daily life behind their thick stone walls. This study aims to explain and understand the raison d'être of these invariant architectural structures in a decisive period of the region's history, the 16th and 17th centuries.

Keywords: *pre-industrial heritage; architectural types; permanence; cultural heritage; libro blanco*

1. Introduction

1.1. The region of Maestrazgo

The Maestrazgo is a historic Aragonese region located in the east of the province of Teruel (Fig. 1). It consists of fifteen municipal districts nestled in the mountains of the Sierra de Gúdar. The region covers an area of 1,204 km^2 and has a population of 3,177 inhabitants, resulting in a density of 3.1 people/km^2. After the Christian Reconquest in the second half of the 12th century, led by King Alfonso II, military orders played a decisive role in controlling the territory. Initially, the Order of the Templars, followed by the Order of the Knights Hospitaller of Saint John, took on this responsibility due to the frontier nature of these lands, which bordered the Muslim Arab dominions of Valencia.

The region reached its peak of splendour during the 16th and 17th centuries, thanks to the extensive exploitation of livestock and the flourishing wool trade across the Mediterranean.

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The wealth generated left a lasting imprint on the urban landscape, manifested in the construction of mansions for wealthy families and new buildings for town halls, including *lonjas*, butcher shops, and prisons. This prosperity also led to the renovation of churches and the construction of new shrines (MVdM).

The next significant chapter in Maestrazgo's history took place during the Carlist Wars, particularly the first Carlist War (1833-1840), when the region emerged as a key player under General Cabrera. The consequences of this conflict were deeply felt in the urban landscape, marked by the remodelling of military structures and the destruction of several religious and civic buildings. On the other hand, the 20th century was defined by a severe economic and demographic crisis in rural areas, pushing many of these villages to the brink of extinction.

Fig. 1 – *Location of the Maestrazgo region. (*Almagro et al., 2024, p. 18-19).

1.2. Maestrazgo as Architectural Heritage

The Maestrazgo region boasts an exceptional wealth of cultural, natural, and architectural values, which are harmoniously reflected in each of its villages. With their cobbled streets, squares and iconic buildings, alongside their seamless integration into the surrounding natural environment, they stand as a testament to a rich history that has profoundly shaped the region's character.

The demographic decline has largely coincided with the global development of modern architecture, so the urban complexes studied have been scarcely affected by the transformations resulting from the industrial age. This has favoured the preservation of the essence of vernacular architecture with minimal alterations. However, the ongoing threat to its continuity (use of modern materials such as concrete or metal, electrical installations) underscores the fragility of this valuable heritage in the short and medium term (Almagro et al., 2024, p. 15).

This risk can be seen in several aspects, such as the lack of knowledge of traditional building principles, techniques, and materials, aggravated by the loss of traditional trades and the use of modern materials due to new lifestyles and depopulation; the lack of adequate planning figures; the frequent inconsistency of the intervention criteria in the protection rules; or the pressure of regional development, primarily viewed through an economic lens.

1.3. Objectives and methodology

The study of building typologies seeks to enhance the understanding and interpretation of the region's heritage while raising awareness of the need to protect it.

Despite its significant historical and artistic value, pre-industrial architecture remains largely unknown to the general public, who are more interested in the most striking structures like palaces, castles, and cathedrals. For this reason, when exploring the built heritage of the region from a typological perspective and taking into account the limited extension of this paper, the focus is exclusively on the more modest buildings during the heyday of the 16th and 17th centuries.

To carry out this study and achieve the established objectives, a working and monitoring methodology has been developed based on the following key points:

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- Gathering preliminary information.
- Site visits with the collection and compilation of graphic documentation.
- Selection of specific typologies and the models to be analysed.

The purpose of this text is to disseminate a part of the knowledge acquired during the elaboration of the *Libro Blanco de Embellecimiento urbano e Iluminación nocturna de la Comarca del Maestrazgo*, written by the authors of this paper together with Marta Coda Muradás.

2. Study of typologies

Typologies allow us to understand the structure of spatial organization that repeats across different locations with minor variations that do not hinder the recognition of its essence. Thus, they offer a formal approach to historical architecture, focusing on its permanence. This perspective is further complemented by another formal approach on a larger scale: the analysis of urban morphology.

The type is useful insofar as it expresses the formal essence of a set of concrete cases (such as the «ball court») by reducing their complexity into abstract parameters (for the same example, the «number and type of arches», the «section of the intermediate column», etc.) that allow a logical and ordered classification.

2.1. *Cárceles* (prisons)

The existence of prisons to hold criminals was widespread across all the villages of the three bailiwicks (judicial areas of the military orders) of Cantavieja, Castellote, and Aliaga. The commanders and Judges of the Order of the Templars had full civil and criminal jurisdiction over their territories in Aragon. The permanent presence of banditry and frequent escapes prompted the fortification of these buildings (MVdM).

These jails were located on the ground floor of the Council House, next to the *lonjas*, the butchers' shops and the municipal granaries. In fact, many of them were built with the construction of the new Town Halls between the late 16th and early 17th centuries. Their functioning also depended on the Town Halls. They were housed in strong, enclosed spaces to prevent escapes. For greater security, some prisons were built within defense towers, as seen in Molinos, Tronchón, and Castellote (Fig. 2). The windows were small and protected by bars. In some cases, the prison was connected with a dungeon or an excavated cell through a small square hole at the top, with no ventilation or lighting. It was common for prisons to be equipped with instruments of restraint and punishment devices. Cells were furnished with a simple cot, mattress, wooden bench, plate, and basin. Latrines could have been provided (Benavente, 2022).

Fig. 2 – *Interior of the old prison of Tronchón (14th century), consisting of a rectangular vaulted room a door reinforced with iron sheeting* (MVdM).

2.2. *Hospitales* (hospitals)

These small rural charitable institutions addressed the physical and spiritual needs of the most vulnerable: the sick and the so-called "solemnly poor" (orphans, elderly people without families, people with disabilities, widows, etc.). Health care was considered as essential as food, shelter, and spiritual guidance. The regional network of hospitals in Maestrazgo extended even to the most remote villages. Since the Middle Ages, these institutions were very popular and necessary, initially serving as a

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means of Christian charity and later evolving into an indispensable tool for public welfare. Despite the support of the local council and parish, they generally operated with minimal resources to carry out these functions. Care was provided by the village doctor and surgeon, who were compensated through alms from the community (Sánchez, 2021).

In many villages, the houses donated by their owners in their wills or originally intended for other purposes were transformed into hospitals. For this reason, they often do not share a uniform typological structure. An exception is La Cañada de Benatanduz, where a dedicated building was erected for this purpose in the 16th century.

2.3. *Lonjas* (ballcourts)

Their origin is more likely linked to the Italian *loggias* than to the *lonjas* of the great cities of the Crown of Aragon, such as Valencia, Barcelona, Palma de Mallorca, or Zaragoza, whose typology consists of large, enclosed spaces supported with slender columns. In contrast, the *lonjas* of the region were designed as small, open structures with arches facing the public square (Fig. 3). These spaces served as venues for both commercial and social exchange while also fulfilling an important representative role. In some cases, they even served as meeting places for the General Councils of the municipalities. Hence, there is a frequent association of the lonjas with town halls and other related spaces, such as prisons, butchers' shops, or granaries. Chronologically speaking, most of the *lonjas* in the Maestrazgo were built in the 16th century.

They are typically rectangular, open at the front and sometimes on one side. The arches are pointed, semi-circular, or segmental, supported by central columns with cylindrical or polygonal shafts. *Lonjas* are built of ashlar or masonry, featuring well-squared stone arches. They may include low stone walls at the front, probably linked to the later adaptation of these spaces as handball courts.

Fig. 3 – *Lonja / ball court of Mirambel (1583). It opens onto the square through two front-facing segmental arches and a lateral one* (Almagro).

The removal of the historic plaster from the walls, aimed at exposing the stone, has condemned their use for this sport.

2.4. *Fuentes*, *abrevaderos* and *lavaderos* (fountains, troughs, and laundries)

As towns settled closer to the valleys, water could be sourced from springs through wells or water pipes. From the 16th century, public fountains began to be built on the outskirts of urban centres. The water supply was embellished with fountains, often monumental in scale, featuring one or more spouts over a basin attached to an ashlar wall decorated with moldings and small sculptural reliefs. Unconsumed water was drained into another basin, usually an adjoining, which was used as a watering place for animals. Many of these urban fountains were the only water supply for the population until well into the 20th century.

Later, the excess water from the well was channelled into a place for clothes washing. Earlier, the washbasins were placed at ground level and uncovered. It was not until later that the laundries were covered and raised above the ground for greater convenience. After washing, the water was typically used to irrigate the vegetable gardens, either by being stored in a pond or poured directly into a ditch. From the late 19th century onwards, washhouses or laundries

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made life easier for women, as they no longer had to spend hours bending over a ditch, pond, or river to clean clothes. At the same time, the laundries became a popular meeting place for women, where news, anecdotes, and other topics of daily life were exchanged or discussed until well into the 1970s. (Mallén, 2015). The laundries fell into neglect following the invention of electric washing machines. Fortunately, some have been recovered and preserved, although no longer in use (DdT, 10-2-2020).

From an architectural perspective, there are two predominant types of washhouses: one with a simple single-sided roof, walls on three sides and the fourth side open, with water falling on the opposite side, and another with a gabled roof with a central pillar (Fig. 4). Washhouses usually have two interconnected basins, one for washing and the other for rinsing.

Fig. 4 – *Old fountain and washhouse in Castellote. The fountain, dating back to medieval times, has four spouts and supplies water to the washhouse through a narrow excavated canal* (Almagro).

2.5. *Carnicerías* (butchers' shops)

Meat was a staple food, so the town councils regulated and controlled its supply and sale. In fact, the shops were a municipal monopoly, with the councils leasing the premises to the highest bidder and collecting taxes. As a result, the butchers' shops were usually located in the town halls, with access from the *lonja*, or in buildings controlled by them. The service offered meat products from local livestock and wild game. It was necessary to ensure a steady supply of meat to the population while providing the community with a place to slaughter their livestock in the same municipal facilities (Mallén, 2013).

Tiles have been preserved on round arches, indicating their original location. Apart from their association with the *lonjas* and town halls, their typological arrangement from an architectural standpoint remains uncertain.

2.6. *Herrerías* (blacksmiths)

Blacksmithing was another essential activity in the villages for several centuries. The blacksmith was responsible for crafting and repairing tools, agricultural implements, and tools used in other trades and the home. He also produced ironwork for carpentry and performed the basic task of making and fitting horseshoes. His work involved shaping bars of wrought iron, which he heated in the forge until red-hot, then shaped on the anvil with the help of a hammer. Once the iron was formed, it was cooled in a basin of water (MVdM).

No single architectural type accommodates the needs of forges, which could be in their own buildings or on the ground floor of a house. Nevertheless, it was common to find two distinct areas: an enclosed one where the forge was located, complete with its bellows, chimney, anvil, and cooling bucket, and an open veranda-like space used for shoeing horses. Having a space outside for storing the wood fuel is also frequent.

2.7. *Hornos* (bakeries)

Traditionally, the *hornos de pan cocer* were not just a place for baking and selling bread but a popular service with a significant social and participatory role. It was customary for each family to prepare bread dough at home, mixing flour with warm water, yeast, and salt. Once prepared, the dough was carried to the oven in a basket covered with a blanket. Upon arrival, the

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bread was shaped on a long central table and marked with distinctive cuts. At the end of this process, the shaped dough was placed on long slats with handles, ready for baking. The service provided by the oven required payment, either in cash or in kind.

The historic ovens found in Maestrazgo and its surroundings share common characteristics with other rural areas, with slight variations depending on the villages. They are nave-like structures with a single elongated rectangular floor plan, divided by diaphragm arches (pointed or semi-circular, depending on the period), with the oven's opening located at the end of the nave (Fig. 5). In this respect, they resemble the type found in Reconquest churches in the Levant, albeit on a smaller scale. This design simplified the roof construction, as it could be supported by simple timbers placed perpendicular to the arches, with one or two slopes depending on the size and the buildings attached to them. The walls were made of masonry with few openings and reinforced with ashlar at the corners. A characteristic feature is the ashlar arched doorway on one side, positioned away from the oven to minimize heat loss. The long room allowed for long worktables in the centre and long benches between the arches.

Fig. 5 – *Medieval bakery in Cuevas de Cañart. It consists of a single room divided into sections by six pointed diaphragm arches that support a gabled roof. At the back of the room is the kiln* (MVdM).

2.8. *Molinos* (flour mills)

The mill was another fundamental part of the population's livelihood, providing the flour for daily bread. For this reason, mills were present in all of the villages, although not always close to the urban centres. The mills in Maestrazgo were all hydraulic, meaning they had to be situated in low-lying areas near rivers. With the help of a weir, water was diverted through a channel to the mill, where it was collected in a holding tank at a higher level than the mill. At the mill there was an impeller or *rodezno* –a turbine made up of radial blades– onto which a stream of water from the holding tank was directed to make it rotate. The impeller was connected to an upper grinding wheel by an axle, while the lower stone remained fixed. The friction between the two stones ground the grain. A hopper above the grinding wheels supplied the stones with grain.

Architecturally, these buildings have simple volumetric forms. The main functions –mill and dwelling– could be housed within the same building or in different structures. In the first case, the mill was located on the ground floor or semi-underground, with the dwelling above. In other instances, the two functions could be juxtaposed in adjacent or separate buildings, the mill having a single floor and the dwelling spanning two or more floors. The buildings are generally rectangular, with variations depending on the topography, and feature single or gabled roofs. They are usually constructed with masonry and reinforced with ashlars in the corners. In addition, the entrance door to the mill is often defined by an arch with wide ashlar voussoirs.

2.9. *Neveras* (ice wells)

Ice was collected and stored in these structures, and it was then used to preserve food and for therapeutic purposes, such as preserving medicines, or as a local anaesthetic to stop bleeding, or to treat fever, etc. Most of these building installations date back to the period between the 16th and 18th centuries, and sometimes, exceptionally, 19th century.

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However, with the advent of industrial ice-making at the end of the 19th century, the urban icehouses were abandoned.

The *Neveras* were made by digging a pit in the ground and building retaining walls around it (Fig. 6). They were typically circular in shape and located in shaded areas to maintain a cool environment. Snow was brought in and compressed in layers until it turned into ice, optimizing space and ensuring long-term storage without minimal melting. The layers of ice were separated by straw or branches, placed approximately every 50 cm, to facilitate removal. Channels or wooden planks were placed at the bottom of the pit to allow water drainage during the thawing season. While the construction technique was similar across all of them, their capacity varied according to the needs of each village. They were usually built with masonry walls of between 0.60 and 1 metre thick and a false dome made by aligning the rows, leaving an opening at the top closed by a stone slab and a main entrance at half height, flush with the outside (MVdM).

Fig. 6 – *Inside the Cantavieja ice well. It has a circular plan, approximately 6 m in diameter and 7.5 m high, with a corbel vault covered with earth* (MVdM).

2.10. *Palomares* (pigeon houses)

The purpose of these simple constructions, typical of the subsistence economy that defined rural world in pre-industrial society, was to produce complementary resources for both food (such as pigeons) and agricultural use (such as pigeon droppings for fertilizer).

The most common type of dovecote found in Maestrazgo is known as *pied de mulet* («mule's foot»), so called because of the formal analogy with the animal's upturned hoof. This design originated in southwestern France and is particularly common in the Jiloca valley. It is characterised by its prismatic, tower-like shape, with a parallel, stepped gable roof, creating intermediate terraces for birds to enter and exit. The three walls surrounding the roof are usually cantilevered and adorned with stone or ceramic decorations, so that the pigeons can easily identify their loft (Souto, n.d.). Inside, the walls have niches to encourage nesting. The entrance door opened at ground level, and ladders led to the upper platforms where the pigeons were regularly caught and cleaned. These constructions were usually located on the outskirts of the town, as is the case of Molinos. It is also common to find fortified towers repurposed as dovecotes, where the space beneath the roof are used. This transformation involved removing the upper section of the walls and making holes with shelves for the pigeons to access.

2.11. *Tejerías* (tile kilns)

Tile kilns were built to fire ceramic products – mainly tiles but also bricks or flagstones– for local construction projects. The potters collected the clay, kneaded it with their feet, shaped the pieces using moulds, and left them to dry outdoors before firing. As they required external space and were a fire risk, these facilities were usually located on the outskirts of villages or away from urban centres, preferably in places with some slope to facilitate access to each of the internal levels.

The kilns commonly consisted of two chambers, one above the other. The lower served as the furnace or fire chamber and was covered by a kind of perforated floor or platform, through whose holes the heat rose to the upper chamber. The latter functioned as a cooking chamber, where the raw tiles were stacked in three or four

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layers, crossed over one another. There was also an outdoor space for storing firewood.

In the Maestrazgo region, square or circular kilns are found, built with walls lined with bricks on the inside to better concentrate the heat. In the past, they were covered with false domes by gradually bringing together horizontal layers of the same bricks, leaving a central hole for the smoke to escape.

3. Conclusions

Vernacular architecture is shaped by practical yet traditional design principles and materials that evolve gradually in response to local culture, climate, and available resources. However, due to the Industrial Revolution, many of these buildings became obsolete and were abandoned. Nowadays, they can hardly be repurposed with a declining population. If there is an intervention, they could become tourist attractions, but the needs and expectations of the new use must be balanced with preserving their historical and cultural integrity. The study concludes that not all functions within a rural society are responded to in the same way or with the same form or special organizational structure. In the case of bakeries (bread ovens), the configuration of a single elongated nave-like space with diaphragm arches is a constant; the number (2-3-4...) and shape (pointed or semi-circular) of the arches, or the roof arrangement (gabled or sloped), vary. By contrast, a blacksmith's workshop and forge lack a fixed formal structure, although it does follow a defined programmatic layout.

The dissemination of these typologies seeks to enhance the appreciation of their heritage value and raise awareness of the need for their preservation, even in the absence of official protection. Given the limited scope of this paper, a comprehensive study of each of the described programs is not feasible. In this context, creating detailed measured surveys of key elements will clarify both the fixed conditions and the variable parameters defining each typology.

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The Art of Milling in Calabria - Italy: History, Architecture, Construction Systems of Some Hydraulic Factories

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Abstract
The essay proposes knowledge of some examples of milling architecture present in Calabria between the 17th and 20th centuries, highlighting its architectural and construction peculiarities. The mills have represented a central activity in the regional economy and still constitute significant prototypes of industrial archaeology. The study aims to highlight the compositional-constructive panorama of the artefacts, aiming to trace the typological evolution, the phases of formation and transformation, the symbolic-formal, distributional-functional, material-constructive variations. The paper starts from considering the basic type to focus on the growth of this in more complex structures up to the present day with the milling industries. The traced panorama has highlighted a large quantity of mills throughout the entire Calabrian territory which are currently in a state of abandonment and strong degradation but significant in their architectural and construction specificities. The intent was to trace the singularities and stimulate conservation and redevelopment actions of the artefacts to reconvert the disused mills to new activities and/or reinsert them into the entire production cycle to return milling architecture and traditions to contemporary communities.

Keywords: *architecture of work; mills; knowledge; conservation; redevelopment*

1. Introduction

The architecture of work in Calabria boasts a significant heritage of milling artefacts scattered throughout the territory. The mills with their production have long represented a central activity in the regional economy and still constitute significant examples of rural architecture of undisputed value.

This essay introduces the knowledge of Calabrian factories, often modest in their architectural and construction characteristics, but important for the recovery of the material culture of a people.

The study pursues an understanding of milling structures through a series of analytical procedures and the examination of sources, in order to achieve a comprehensive understanding of the architectural, functional, and construction-material characteristics of the type, as well as the variant and invariant features within the regional context. The mills present in the Calabrian territory were an expression of the relationship between land and water and the first prototype of a rural factory, they exploited water energy for grinding and for other uses.

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They were used, in fact, to grind wheat and cereals, to crush olives, to produce cannamele, to pulverize oak bark and extract tannin for tanning hides, to crush silver ore, and to operate other machines[1].

Milling structures were widely located inside valleys, far from the main roads, were influenced by the hydrogeological conditions of the territory and built in places rich in torrential and river watercourses with a modest flow capacity that changed according to the season, which affected their functionality. The structures, with the construction of water intake structures and the diversion of watercourses, brought about a modification of the fluvial dynamics of the place (Pantina, 2013). Vincenzo Padula wrote in 1865:

> "The intake of water is where the most, where least distant, fishing is done [...] with fagots and rods soaked in earth; the diverted water is forced along a canal […]; it finds behind the mill the cataract of wall in a few villages, of wood in all; it falls there noisily, it insinuates itself into the shower […] a span and wide to the comely, it goes into the blades of the wheel, and the mill beautifully puts itself, […] in flour" (Padula, 2006).

In general, the art of milling has represented one of the oldest productive activities of humanity throughout the national territory. The need for food sustenance through cereals, started the process of their milling starting, at the origin, from the use of common tools such as wooden or stone mortars. This work was practiced in the region, since ancient times, at family level[2].

With the introduction of the rotary millstone, human and/or animal labor was employed[3]. Much later, manual labor was replaced by mechanical labor using the kinetic energy of wind and/or water. Thus, the first wind and water-powered types were born. In Calabria, where the cultivation of the agricultural landscape predominated, the first factories that exploited the driving force of water were horizontal wheel mills. The basic type worked through the adoption of a vertical shaft with the hydraulic wheel at the lower end, placed horizontally and consisting of spoon-shaped blades generally made of oak wood, a very hard material, which were activated by the jet of water. The upper end of the shaft was connected to a fixed millstone which was in turn anchored by a bar to the rotating upper one (Petrone, n.d.), the millstones were called soprana and sottana (upper and lower).

Although rudimentary, the factories were examples of that system capable of capturing and transforming hydraulic kinetic energy into mechanical energy for the purpose of milling. The mill, precisely because of the quantity of water available, worked with different rhythms regulated by the different seasonal cycles. The difficulty of not being able to count on a constant hydraulic load influenced the construction of this type of system, capable of functioning even with modest quantities of water, so much so as to require the presence of a storage tank for greater autonomy called in some areas of Calabria *cibbia*. This, into which the water from the supply channel flowed, was made of earth or

[1] The castle of Bivona and the prison of the Impresa in Santa Maria del Cedro, known for the production of cannamela in the 16th century, were equipped with milling facilities (in the first case the lightning bolt is still visible). In the city of Cosenza on the Crati river there is still an abandoned factory for the extraction of tannin, while for crushing the silver ore one must refer to the mill "*du furnu*" in Bivongi.

[2] In the town of Brancaleone (RC) small stone millstones presumably for domestic use have been found.

[3] This refers to the mills in the Crotone area, known as Canusa, characterised by the operation of the millstones, centimuli, by hand or by animals, which ground even though they were far from watercourses.

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Fig. 1 – *Codice Romano Carratelli 16th century: port of Palmi with the indication of two mills, Bagnara with mill and tuna fishery. Cassiano de Silva 1708: view of Strongoli with the windmills in the foreground.*

masonry and was of different sizes and shapes (Medici, 2003). The dimensions of the canal and the tank determined the operational autonomy of the factory, so the construction of the factory adapted to the environmental peculiarities. The widespread adoption of the horizontal wheel technology proved to be more appropriate to adapt the plant to the variability of the water and also represented the most economical system.

2. Mills in historical iconographies

This type of system is found in the surroundings of almost all the cities of the region, in fact since the 16th century numerous milling architectures have been reported and this is evident from the documentary sources from which it is highlighted not only the existence of mills scattered near and/or inside the ancient nuclei, but also of small rooms for grinding in addition to ovens, located on the ground floor of the buildings and/or in the basic housing where the people practiced grinding to satisfy the family's diet. This situation is widespread in Calabria, as seen in the numerous manor houses of Morano Calabro, where the ground floor housed mills, olive presses, and rooms for cheese production. As evidence of this, we recall some historical views between the 16th and 18th centuries, starting with the Angelica map which portrays the city of Cosenza at the end of the 16th century where two mills are noted on the banks of the Crati and Busento, elementary in construction, reproduced with a single room intended for grinding, with a pitched roof and multiple arches on the façade which refer to the arches for the passage of water, just as in the Romano Carratelli code for the city of Palmi two mills and a warehouse are portrayed on a hill behind the port and the watchtower. In the same manuscript, when depicting the city of Scilla, a construction with a large arch is highlighted between the inlet of the two reliefs, downstream, which could refer to the archway of a mill. Similarly, when depicting the centre of Bagnara, a tuna fishery and a mill are reproduced (Fig. 1). Furthermore, in the view of the abbot Pacichelli that illustrates the town of San Marco, the Veltri mill, called di Mezzo in the Fullone valley, is noted, still existing today but surrounded by vegetation in a state of severe degradation (Fig. 2). Worthy of note is the view of Strongoli by Cassiano de Silva from 1708 that testifies to the existence of windmills, of which today there is no trace, while the windmills of Sorianello can still be visited.

Further evidence of the spread of milling structures since ancient times can be found in the reading of the Onciari land registers where the presence of the profession of miller among the population is highlighted in the various towns of the region.

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Most of the mills existing at the time were owned by patrician families, for example Carlo Contestabile Ciaccio owned four mills in the city of Cosenza (A.S.Cs., 1756), while others belonged to ecclesiastical bodies, some of these structures were, in fact, incorporated within the convent complexes or close to these. Just think of the monastery of San Stefano Bosco where near the rivers there were mills but also fulling mills for fulling cloth, sawmills, oil mills, furnaces (Salerno, 2022), and also to the seven mills in the Fullone valley (San Marco Argentano) in close relation with the nearby Cistercian abbey of Santa Maria della Matina, and those which belonged since the Middle Ages to the Cistercian abbey of Santa Maria di Corazzo. It is therefore evident that, since ancient times, a territory rich in milling artefacts has existed, currently not all of which are registered and at high risk of extinction, which in their characteristics convey an erudite productive past.

3. Typological, architectural and construction features of some milling artefacts in Calabria

From the examination of the formal, typological and constructive characteristics of the mills, starting from the basic type in comparison with some more complex structures, the identity characteristics of the artefacts have been highlighted with attention to the permanence and the changes that have occurred over time.

The water mills of the region were built with large perimeter walls using locally sourced materials, pebbles often extracted from the beds of rivers and streams. The wall structure was made of dry stone or stone bound with lime mortar, or mixed interlocking masonry, or even monolithic stone blocks and typical of some areas of the Vibo Valentia area in sun-dried raw earth bricks and straw (Faeta, 1984), called breste. In this same area, we also note the nine mills of the Ruffa river, of ancient origins, active in the area until the 1950s and currently in a state of abandonment.

Fig. 2 – *View of the abbot Pacichelli that illustrates the town of San Marco Argentano.*

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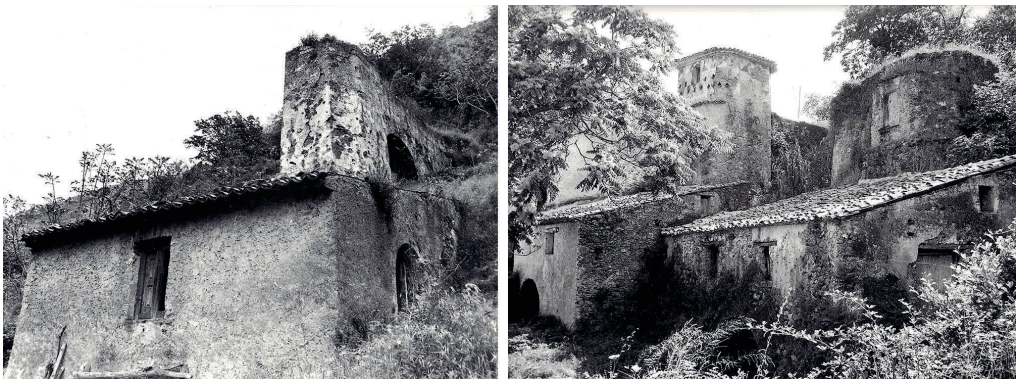

Fig. 3 – *Paola: mill expressing the basic type. San Marco Argentano: doubled mill with a more complex structure and decorated saette*.

The basic type of mills consisted of a single room in which the grinding wheels and various equipment were housed. They had a quadrangular volume with a single or double pitched roof made of exposed chestnut wood beams and purlins and locally produced tiles. On the roof there was the *saetta* connected to the masonry canal supported by arches. The mill was therefore an expression of rural, essential and minimal architecture. The mill artefacts had been built by local craftsmen who used traditional techniques and local materials; this was a widespread construction practice throughout the region and derived from the need to produce an economical architecture, which, in order to contain production costs, neglected the linguistic-architectural styles (Canonaco, 2014). The mills were configured as rigorous constructions in their formal layout, placing attention on the functionality of the factory an delegating adherence to the architectural lexicon of the time to only a few decorative elements.

The internal space had dirt, concrete or stone floors, the walls were without plaster. The mill inside could be equipped with a wooden staircase that led to a small mezzanine or in the more complex types to a second level. On the outside the building showed a simple facade with few holes and underground structures with arches in river stones, barrel vaulted or with a lowered arch, where the hydraulic wheel was housed, called ritrecine, made of wood with spoon-shaped blades or iron.

In the most advanced types, the factory could be made up of two or more rooms and could be developed on two levels, of which the second housed the miller's home and in some cases there could be a house near the factory as in the Mezzo mill in San Marco Argentano. The entire facade was characterized in its architecture by the mill arches. On the essential façade were in some cases impressed decorations of good luck but also votive aedicules placed to protect the factory. In the Perrotta mill in Paola, a aedicule containing the statue of Saint Francis is still visible and on the doubled *saetta* a terracotta cross. There could also be geometric decorations (Mill di Mezzo in San Marco Argentano). The rudimentary architecture of the artifact was enriched by small religious and/or propitiatory details such as the crosses impressed on the walls (Fig. 3).

The most emblematic architectural-constructive element of the factory stood out on the roof: the tower or in the Calabrian dialect the *sajitta*.

The typology of the cascade tower had particular variations throughout the region, they were built in stone masonry and were connected to the water supply channel. The gora or in some areas of Calabria called *mastra*, was set on arches, sometimes so numerous as to create a bridge-channel that crossed inaccessible places (Medici, 2003), and it was also built in stone masonry. Particular types of *saetta* can be found

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Fig. 4 – *Mulino Bruno in Rose and the milling industry currently located in Montalto Uffugo*.

throughout Calabria, such as in the mill in San Benedetto Ullano with a canal on arches surmounting a road and a rectangular *saetta* rounded on the short sides. Also worthy of note is the *saetta* of the mill in Fuscaldo with a rough-hewn base near the factory and a semi-cylindrical upper part supported by several arches of different sizes, and the two circular *saette* of the eighteenth-century Bruno's mill in Luzzi.

From a compositional point of view, the towers could have a hexagonal, quadrangular, cylindrical, semicircular and even stepped section, a characteristic example being the tower of the Rossi mill in Bagaladi along the Melito river. Some factories were equipped with two *saette* and in this case the plant was also larger, such as the Sosti mill in Rossano with a rectangular plan, equipped with a channel on arches. The towers could be decorated, in the two Ruffo mills in the province of Reggio Calabria, the two *saette* with a semicircular section were molded with stone cordons and at the upper end they ended with a cornice also in stone. In one of these, between the molded cord halfway up the tower and the one at the top was placed the coat of arms of the family, while in the other at the base there was the coat of arms and at the top a cross. Of singular beauty is the *saetta* of the eighteenth-century Milana mill in Melia di San Lorenzo (RC) with a quadrangular plan that is wider at the base and slopes towards the top.

The tower is equipped in its middle with a plastic semicircular protrusion which ends above the cornice with an arch with fluid lines. In this case the *saetta* is of architectural value and looms over the elementary structure of the mill. Over time, the basic type expanded, it was equipped with more rooms, the dimensions of the rooms were larger for a more comfortable housing of the machines. In the buildings with a larger size there could be two or more millstones generally of local production, or made with basalt stone from Etna (mill of San Nicola degli Strozzi in Gallico) or in very hard and porous la fertè stone. The factory was now made up of several buildings and its functional structure was more complex, while remaining anchored in its formal composition to rural legacies.

In the region there are factories typologically more complex than those examined, which were born as water-powered types and have over time been transformed into electric factories.

More complex factories, initially close to the planimetric layout of the masseria system but leaning towards a true industrial concept, equipped with several buildings intended for different functions, consisting of the mill equipped with various rooms containing the machines, the warehouses, the large sheds for storing wheat and other cereals, the warehouses for the equipment, the offices for sales. These factory buildings all faced onto a large courtyard.

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The factory, now larger in size, included in its composition the miller's house which in its architectural layout recalled the *palaziata* type. This was composed of large rooms with boardroom and was accessed from an independent entrance through an external staircase with a gallery. This type of system is found in the Bruno mill originally located in Rose, whose history starting from the basic type and passing through the electric type arrives to represent, today, the only industrial reality for milling in Calabria. The first mill was built at the beginning of the twentieth century by a family that had been active in the art of milling since the nineteenth century. It was equipped with a horizontal wheel system and the factory took water from the Lavas stream, through a canal and a large water collection tank. Over time, the factory was transformed with the adoption of a ship's diesel engine and in 1921 it ran on electricity. In the immediate post-war period, the Rose factory was transferred to Cosenza, with cylinder technology. Its composition consisted of a large exposed milling structure divided into several levels in which the machines were housed, there were silos for storing the grain, offices, workshops and a large grain weighbridge, all overlooking a large square. The owners' home was cohesive with the mill.

Today the milling industry located in the municipality of Montalto Uffugo tells a significant story of progress marked by various stages of development starting from the stone mill passing through the electrification process up to the current situation which presents a plant equipped with cutting-edge and sustainable technologies (solar-powered mill) (Fig. 4).

4. Conclusions

The review presented on the mills of Calabria begins with an analysis of the architectural and constructional features of the basic type, moves through an intermediate stage describing a more complex structure that still recalls the rural heritage of the earliest installations, and progresses toward embracing the language of industrial architecture—culminating in the fourth industrial revolution with the milling model of the Bruno heirs. The panorama outlined has highlighted a large quantity of mills throughout the Calabrian territory (about three thousand), almost all of which live in a condition of abandonment and severe degradation, unexplored ruins, widely submerged by vegetation.

The essay aimed to focus attention on this heritage of rural architecture, also expressing the intention to study and catalogue these production sites in order to encourage the reclaiming of these structures and their reuse. This involves actions aimed at preserving their identity features and implementing redevelopment strategies, including the possibility of new cultural and/or touristic uses. Currently, some virtuous actions to reconvert disused mills to new activities and/or reintroduce them into the production cycle are underway in some areas of Calabria with the aim of recovering the historical memory of the entire production process (mill in San Floro) and returning the architecture and traditions to the contemporary age.

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The Calabrian Liquorice in the European Market of the Nineteenth Century: History, Production and Evolution Through the Knowledge of Some Architectures Along the Ionian Sea Coast

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Topic: T1.1. Study and cataloguing of vernacular architecture

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Abstract
*This study examines the historical and architectural evolution of industrial buildings dedicated to the processing of liquorice root, focusing on the international role played by Calabria. We wanted to reconstruct the process that, favoured by a series of favourable conditions, led to identify a type of building dedicated exclusively to this processing, evolved over time in line with the evolution of the market and sales throughout Europe, from wooden huts to masonry structures. Starting from the analysis of agricultural production structures, it was possible to identify typologically new structures as the result of a natural evolutionary process enriched by unique spatial and typological specifications, such as the chimney. The reading of the archival sources was accompanied by the typological reading of some "*concio*" present in the upper Ionian Calabrese, highlighting recurring and other unique elements.*

***Keywords*:** liquorice; concio; Calabria; vernacular architecture

1. Introduction

The essay aims to analyse the factors that led to Calabria's emergence as a significant producer of processed agricultural products, with a particular focus on liquorice. The analysis will be contextualised within the architectural traditions of the upper Ionian belt of Calabria and the Sibari Plain, in Southern Italy.

It is evident that since antiquity and throughout the pre-unification period, there were significant entrepreneurs in Southern Italy, albeit in the form of latifundia rather than modern farms, linked to products derived from agriculture. The dissemination of products was achieved through the utilisation of a, already existing, export network, which facilitated the distribution of goods throughout the Kingdom of the Two Sicilies, and on occasion, beyond its territorial boundaries. It is evident that each territory possesses its own unique characteristics in terms of production, which are closely associated with local geographical features, climatic conditions and the availability of raw materials. Particularly, Calabria was distinguished by atypical crops, including non-native varieties, which enabled the region to diverge from the national market and thus secure a leading position in both domestic and foreign trade. From the late 1700s, a process of modernisation of the production sector commenced with the introduction of new crops such as flax, liquorice, silk and iron. (Di Martino

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& Piccioni, 2005). Before Italy assumed the leading position in liquorice production, France and Spain, in conjunction with a number of other regions bordering the Mediterranean basin, were the dominant producers (Fig. 1).

Fig. 1 – *Major liquorice producer at 18 century: 1) Spain; 2) France; 3) Italy; 4) Greek; 5) Turkey.*

In Italy, the advent of industrialised production was a comparatively recent development. Nevertheless, during the 19th century, the nation assumed the role of a leading nation, thanks to the spontaneous presence of the plant including, precisely, Calabria. It maintained, for two centuries, a leading role in the European market, that substantiated not only by its substantial production output, but also by the fact that prominent Calabrian manufacturing families founded, managed or maintained relations with all the other most important Italian factories. The largest producers, apart from those in Calabria, are to be found in other Italian regions such as: Abruzzo, Basilicata and Sicily (Fig. 2).

Fig. 2 – *Major Italian liquorice producer, 1) Abruzzo; 2) Basilicata; 3) Calabria; 4) Sicilia.*

The preferred route for transporting liquorice has always been by sea, despite the inherent risks. This route was utilised throughout the 18th century and the first half of the 19th century, as evidenced by numerous cargo manifests which document the movement of ships from Calabria to international routes. The employment of small cargo ship permitted navigation in closer proximity to the coast, thereby reducing the inherent risks. This resulted in the reuse of numerous coastal towers, which were numerous in the region but once disused, have become naval mooring points. The phenomenon was also observed in the area under analysis, wherein the primary landing site was situated at the Rossano marina, specifically at the Lido Sant'Angelo, which also functioned as a *fondaco*. Following the construction of the railway line between Metaponto and Reggio Calabria in the mid-19th century, Calabrian producers ceased to rely on maritime transport, relinquishing the risks and challenges associated with seaborne shipping.

2. Methodology

A review of the specialist literature reveals a paucity of research on the structures in question. In contrast, the literary production concerning the properties and uses of liquorice, a plant with a variety of beneficial properties, is more extensive. The subsequent work is, therefore, founded upon a rigorous analysis and technical-critical evaluation of these structures, proceeding by comparison of structures with analogous functions or, in any case, pertaining to the processing of agricultural products, in the examined area. The act of comparison facilitates the identification of all recurring or differing characteristics and elements, thereby enabling the establishment of an original typological interpretation that has not been previously documented in the extant literature.

The origins of liquorice processing structures were traced back to oil mills and mills, the most common structures found in the region, and which used the same production techniques. The

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unique characteristics that define the building typology of the liquorice factory were then identified. The study was conducted through direct geometric and material construction surveys of the case studies analysed, with comparisons made, where possible, with photographs and historical or archival information.

3. A building type called: *concio*

Exponential demand for liquorice precipitated a series of events, including the standardisation of production processes and the development of technologically sophisticated and architecturally complex edifices, specifically designed for the purpose, and designated *concio* or *cuonzo*. The etymology of the word is not entirely clear, but it can be traced back to the verb "*cunzare"*, meaning to sweeten, aromatise or season (Casella, 1908). Alternatively, it can be traced back to a type of wooden press (Marzi et al., 1991) used in olive processing.

The *concio*, dispersed across the upper Ionian Sea of Cosenza, exemplify intricate architectures, meticulously designed and constructed to accommodate the equipment and spaces essential for processing. The architectural evolution of these factories was inextricably linked to the market's progression, resulting in the emergence of increasingly structured industrial buildings. The transition from a rudimentary architectural configuration to a more sophisticated one was driven by the necessity to facilitate the entire production process within the confines of the factory, thereby ensuring the continuity of the liquorice root to the production of the dough. At the dawn of the 20th century, the introduction of steam-powered machinery necessitated spatial specifications that facilitated the transformation of factories into the articulated structures that are characteristic of the modern era.

Initially, both the production process and the type of building used for liquorice processing drew on established practices of processing agricultural products, such as the milling of wheat and the pressing of olives. The simplicity of these two productions is reflected in the architectural aspects of the factories, such as mills and oil mills, which can therefore be considered a matrix of all the other rural architecture dotting the Calabrian territory.

The image below (Fig. 3), summarises the phases that characterised the liquorice factory, from the initial temporary structures to those of a permanent and specialised nature. Indeed, in the early stages, it was customary for *concio* to be installed in the vicinity of old oil mills or mills that had been adapted for the purpose.

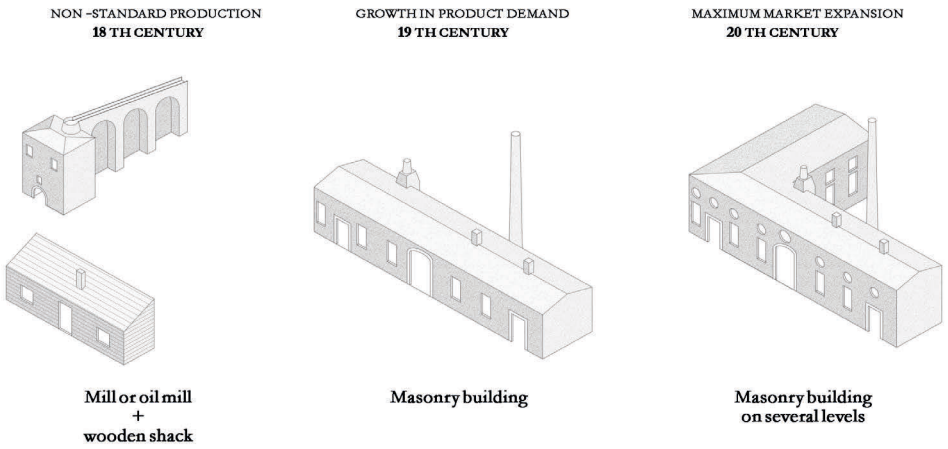

Fig. 3 – *Evolution of concio building.*

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In its primitive form, that of the 18th century, the *concio* was not considered a permanent structure, but rather a nomadic one. It consisted of simple wooden huts (Marzi et al, 1991) built near the field where the root was dug. Nearby mills or oil mills were temporarily adapted to carry out the root grinding stage. The huts, which were temporary and had to be dismantled at the end of the season, were used for the cooking stage, which distinguished the liquorice processing from the grinding and pressing stages.

In the nineteenth century, however, the high demand for the product made it necessary to set up a continuous production cycle, which required many ovens for the parallel cooking and reduction of liquorice juice. This is how the first permanent masonry structures were built. In the area studied, the type of building was simple: rectangular in shape, with only one floor above ground level, built in load-bearing masonry of mixed materials such as pebbles and bricks, with a double-pitched roof of wood and tiles. It contained the mill, the baking ovens, the moulding rooms and the store.

The mature phase of *concio* architecture, that of the 20th century, is common to almost all those visible today in the analysed area. In this century, extensions and structural modifications were made, with buildings being added to the single rectangular room layout for use as warehouses, rooms for packaging and those for shaping. In many cases, the *concio* were elevated by a single storey to accommodate the placement of the substantial wooden table where the women typically shaped the worked dough and subsequently packed it into wooden boxes (Matacena, 1983). A distinctive architectural object of the type was, and still is, the chimney, a masonry element built to evacuate the fumes produced in the manufacturing process. This is characteristic of the last two evolutionary phases described above, albeit with a series of similarities and differences in terms of both construction and function. In the initial masonry phase, the chimneys were utilised solely for the expulsion of fumes emanating from the boilers employed in the processing of liquorice juice. From a constructional perspective, the ovens were located in proximity to the main building, with the structures developed in continuity with the main building, leaning against one or more perimeter walls. The configuration of the structure was regular, with a square or rectangular shape. Its development in height was modest, with the lower part constructed from a mixture of materials, while the terminal part, which was in contact with the hottest fumes, was constructed from brick. In the evolutionary phase defined as "mature", on the other hand, the chimney, in addition to fulfilling its previous function, had to be utilised for the purpose of fume evacuation from machinery driven by a steam engine. Consequently, chimneys from the 20th century deviate from their earlier counterparts in terms of both design and structural height. From a constructional perspective, the circular shape was the most prevalent, exhibiting enhanced efficiency in comparison to the rectangular one. The base component was frequently constructed from a mixture of materials, while the barrel and upper components were typically composed of single or double-lined brickwork.

However, the evolutionary analysis of this type of building cannot be separated from the rural context in which it was built; liquorice processing, although profitable, remained a seasonal activity linked to winter. For this reason, *concio* were often located within large agricultural complexes, so that during the warmer months the more traditional products such as oil, wheat and wine could continue to be produced. The processing of liquorice root had a strong impact on the residential function in terms of noise, the high temperatures generated during cooking, and, above all, the health hazards posed by the fumes. For this reason, it was always housed in a separate building, away from the dwellings.

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Among these, the manor house, distinguished by its care and modest architectural style, stood out from the rooms for the farmer and the workers. The main core of the building was often supplemented with ancillary rooms such as a chapel, a tavern, rooms for children's education and storerooms. Another recurring aspect in the farms of the area under study was the reuse of old watchtowers, part of the defensive system of the Kingdom of the Two Sicilies: if they were small, they could be incorporated into the new buildings or, if they were larger, they could become farms themselves, without the need for other buildings.

The research conducted in the Upper Ionian has made it possible not only to highlight the peculiar typological-evolutionary characteristics of the *concio*, described above, but also to investigate the relationship between this structure and the other buildings of the complex in a broader sense. In the area under analysis, a multitude of production facilities can be identified which, despite exhibiting analogous structural characteristics, exhibit divergent typological-aggregative features. The fundamental element of these agglomerates is the *concio* structure and the external space/pit, which are pivotal in the initial phases of the production process, in allowing the accumulation of raw roots. Two categories of production plant are commonly distinguished. The former, composed of separate individual buildings, present an alignment such as to configure a well-defined, though not fenced, outdoor space. Conversely, in the latter, the *concio* and additional buildings, in conjunction with the presence of low walls in the non-defined regions, contribute to the formation of one or more courtyards.

A recurring feature of these agricultural complexes is the clear separation between the production activity and the residence of the tenants and/or owners. Of all the farms studied, the Amarelli complex is the only one that has retained its original function, although the machinery and production process have been modernised. For the sake of brevity, we will mention the other factories analysed: that of the Longo family in San Lorenzo del Vallo (Fig. 4).

Fig. 4 – *Concio Longo.*

The *concio* is presented as a uniform rectangular body in the elevation and in prospect elevation, while internally, in the head portions, it is developed on two levels. This approach appears to establish an optimal axis of alignment for the remaining edifices. The structure features a single brick chimney of reduced dimensions, to which a brick chimney of considerable size was added. This latter chimney was demolished at the beginning of the last century. The manor building is articulated according to the lexicon of fortified farms. On the Amarelli di Rossano masseria with *concio*, the latter features a distinct structural element, characterised by a longitudinal slatted development to which new small accessory rooms are added, resulting in a plan that exhibits a jagged character. The location of the *concio* is distant from the residence and at right angles to it. In contradistinction to the preceding case, they do not present alignments.

Finally, in the farms Favella della Corte in Corigliano and Pignatelli in Cerchiara, the *concio*, placed behind the other buildings, has no connection with the other buildings, probably the result of a later construction over time. In the case of Corigliano, the disused *concio* has undergone a process of reconversion to another function, yet it still exhibits longitudinal development. In the case of Cerchiara, the structure is located a considerable distance from the manor house and is in a state of ruin, a condition shared by the chimney. One of the characteristic elements of the latter two complexes is the tower: outside the complex and clearly visible in the first, integrated into the main building but visible from the outside in the Pignatelli *masseria*.

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4. An Emblematic Case: The Casello Martucci *Concio*

Finally, an emblematic case in the analysed context, which encompasses all the identity, historical, typological and evolutionary characteristics highlighted so far, is the farmhouse with *concio* at Casello Martucci in Rossano (Fig. 5). The architectural composition of the estate comprises a primary manor structure, accompanied by a series of auxiliary edifices that serve a productive function. These additional structures are organised into a system of external courtyards, which in turn are integrated into the overall layout.

With respect to the reading proposed so far, the entire *masseria* (farm) is in line with the custom of founding agricultural complexes near towers: the 18th-century complex, the one visible today, is the result of an extension of a small 16th-century tower, as evidenced by a 19th-century document. The tower, now incorporated into the building, is no longer distinguishable and, it can be assumed, served as a landing place for small boats that docked near the *masseria* located near the sea. The *concio* proper, then, slavishly follows the reading proposed in the following work: neglecting the wooden phase, the *concio* proper was built at the beginning of the 19th century with a masonry structure with a classic slatted conformation, articulated on one level and with a gabled roof, as can be seen (Fig. 6), the only photo showing the *concio* in its initial phases. This is also confirmed by the cover of the 1904 brochure (Fig. 7), in which the factory is not shown in its current version.

Fig. 5 – *Plan of the Casello Martucci: A) Master House; B) Production Building; C) Workers House; D) Concio.*

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Fig. 6 – *Historical photo of Martucci's concio, last 1800.*

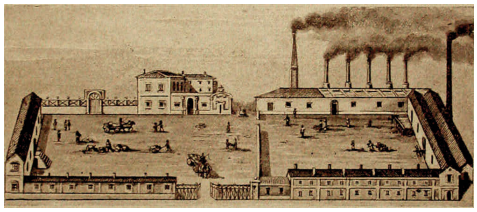

Fig. 7 – *Brochure cover for Naples exhibition l'esposizione di Napoli 1904* (Archivio Abenante-Martucci; sez. VIII, b. 197; f. 29).

Towards the end of the century, thanks to various extension works and the purchase of a steam engine to drive the equipment, it evolved into the mature typological phase.

Indeed, the structural alterations, incorporating a new order of windows, the erection of new buildings and the installation of a new circular brick chimney, which stands in marked contrast to the original building and is added to the older structure with a square plan and octagonal shaft located in adherence to the rear elevation, are still evident today. This typological and evolutionary reading, initially based on architectural and construction evidence, was subsequently corroborated by documentary evidence from archival sources that validated the initial hypotheses. The axonometric scheme presented below. Fig. 8 utilises the colour orange to accentuate the elevation of the concio and the newly constructed chimney, in addition to highlighting a series of modifications apportioned to the surrounding edifices.

In the contemporary moment, both the concio and the entire complex are in a advanced state of decay. This process of deterioration has been greatly increased by the cessation of liquorice processing around the mid-20th century, as demonstrated (Fig. 9). The advanced degradation of the surfaces, which are largely devoid of plaster, has facilitated the evolutionary reading by rendering the different techniques and materials used over time evident to the eye. The factors that contributed to the sudden closure of various production sites, including the introduction of more affordable products from the USA (Matacena, 1983), the infrastructural deficiencies in Southern Italy that remained unresolved following the two wars, and the inability of Calabrian manufacturers to adapt, ultimately resulted in the decline of the Casello Martucci complex and other Ionian Cosentino sites.

Fig. 8 – *In orange the differences compared to the previous phase.*

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Fig. 9 – *Martucci Concio, 2022.*

5. Conclusion

In conclusion, the proposed essay tries to retrace the productive history of Calabria, a region that has become a protagonist in the Italian and European panorama. Building its network of commerce, technology and architecture from scratch. The aim of this study was to provide an overview of a production that has been the flagship of Calabria but today little known. The study has applied architectural, historical, and typological analyses to the area with the most production sites in the region, specifically the Ionian zone of Cosenza. The typological study is a tool for obtaining knowledge and identifying recurring characteristics or variants that are valid for the area under study but can be applied to other areas with appropriate modifications. The other objective of this study is to underline the majestic grandeur that these structures have, as in the case of the Martucci masseria, but too often associated with precarious conditions of conservation. The preservation of these structures, which are almost the last silent witnesses to ancient traditions, which could be lost forever, is a crucial requirement for a region of southern Italy like Calabria, which is experiencing a rapid decline in economic and demographic growth.

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The Census of Rural Architecture in Italy: a Replicable Model for the Cataloguing

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Abstract
The Italian landscape is enriched by rural architecture, which is a fundamental element and a valuable cultural asset. Despite increasing interest, research in this field struggles to establish itself as an autonomous discipline. This paper proposes a methodological model that can be replicated for the census and cataloging of rural architecture, emphasizing its historical, cultural, and environmental significance. The aim is to provide a systematic framework for analyzing and preserving these structures by integrating historical, typological, and territorial data into a coherent system of knowledge and valorization. Since the early 20th century, the study of architecture has expanded to include vernacular buildings alongside monumental ones. Scholars such as Giuseppe Pagano, Bernard Rudofsky, and Amos Rapoport emphasized the significance of spontaneous rural constructions in shaping sustainable and context-driven architectural practices. Today, rural architecture is increasingly recognized for its role in landscape conservation and sustainable development. The Italian Ministry of Culture and PNRR have promoted the National Rural Architecture Census, which aims to identify and document various types of rural buildings across Italy. The goal is to compile around 50,000 cataloging forms, divided into eight regional lots, with the help of the Central Institute for Cataloging and Documentation (ICCD). The AR (Rural Architecture) form provides a systematic classification of buildings constructed up to 1940, gathering essential data on architectural typology, construction techniques, materials, and conservation status. By completing this census, we can safeguard rural architecture and create a model for cataloging vernacular heritage that can be replicated. The project's aim is to combine historical research with innovative tools to foster interdisciplinary approaches that support the conservation and sustainable reuse of rural structures, guaranteeing their transmission to future generations.

Keywords: *rural architecture; vernacular buildings; cataloguing methodology; georeferenced*

1. Introduction

Rural architecture is a distinctive feature of the Italian landscape. Although it represents a distinctive element of the environmental context and has been the subject of numerous specialized studies, research on vernacular architecture remains a topic that struggles to gain broader academic recognition.

2. Initial attention to rural architecture

The study of architectural history began to explore a new perspective, shifting its focus from monumental architecture to the material and

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daily aspects of buildings starting in the early decades of the twentieth century. This paradigm shift, influenced by developments in anthropology and ethnology, led to a greater consideration of rural architecture as a spontaneous and functional expression of the relationship between humans and their territory.

Giuseppe Pagano (1896–1945) was one of the leading Italian scholars who contributed to this transformation. He argued for the recognition of rural architecture as a vital component of Italian architecture. His approach was distinctive for the systematic and photographic examination of rural buildings, which culminated in the Exhibition of Rural Architecture in the Mediterranean Basin at the VI Triennale di Milano in 1936. According to Pagano, the quality of rural architecture lay in its ability to coherently and rationally respond to the needs of daily life. He distinguished between "spontaneous" architecture, driven by practical necessities and closely tied to its context, and "style" architecture, characterized by decorations and symbolic messages.

In contemporary studies of rural architecture, this distinction is still essential, as they see it as a model of design that is connected to the landscape. This interpretation foreshadowed today's interest in vernacular architecture and the sustainability of the built environment. The debate sparked by Pagano continued in the following decades through articles published in Casabella and the reflections of scholars such as Enzo Carli and Giulio Carlo Argan, who respectively emphasized its scientific value and social significance.

His legacy was further reinforced in 1979 with the exhibition Giuseppe Pagano: Photographer, curated by Cesare De Seta, which reaffirmed the anthropological scope of his work. Pagano's analysis marked a turning point in architectural studies, laying the foundation for a broad interpretation of the built environment—no longer limited to grand architectural works but attentive to the widespread and social dimensions of habitation. His work is a precursor to contemporary discussions about the relationship between architecture, the environment, and cultural identity, which represents a significant shift in the field.

3. The value of rural architecture in the present day

In recent years, research on rural architecture has highlighted its fundamental role in Italy's cultural, economic, and environmental context.

Projects such as the National Census of Rural Architecture, promoted by the Ministry of Culture, have made it possible to catalog and study Italy's rural built heritage, recognizing its value not only as a historical testimony but also as a resource for the future (De Seta, 1979).

This project represents an ideal continuation of the pioneering research conducted by Pagano and Daniel over the years. The renewed attention is due to several factors:

- **History and Identity Heritage:** Rural architecture serves as a living archive of Italian history, bearing witness to centuries of human adaptation to the territory and offering an authentic interpretation of local cultures. The memory of the communities that inhabited them is preserved through the restoration and preservation of these buildings (Carli, 1946).
- **Sustainability and Environmental Integration:** Rural constructions, built with local materials and traditional techniques, are now considered a model for sustainable architecture. The efficient use of resources and adaptation to the climate and morphology of the land provide valuable insights into contemporary design, at a time when sustainability is a primary objective (Magnaghi, 2000).

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- **Tourism and Economic Development**: The restoration of rural structures for contemporary uses, such as agritourism, cultural spaces, and residences, contributes to local economic growth. The rediscovery of the aesthetic and functional value of these buildings has led to new restoration strategies that respect their identity, avoiding invasive alterations.
- **Territorial Resilience:** The preservation of rural architecture is closely linked to landscape conservation and the prevention of environmental degradation. In an era marked by extreme climate events and depopulation of inland areas, the enhancement of rural heritage becomes a tool for territorial regeneration and the maintenance of ecological balance (Settis, 2017).

The modern approach to restoring rural architecture emphasizes the importance of maintaining the connection between buildings and their surroundings. While rural buildings may take on evolving meanings, it is essential to preserve their link to the local context, especially in an era where neglect of the territory has shown devastating consequences.

4. Agreement for the cataloging and enumeration of historical Rural Architecture in Italy within the PNRR

The project under consideration is part of the "PNRR, Mission M1, Component C3, Measure 2". Cataloguing and counting the different types of historical rural architecture throughout Italy is the focus.

The primary aim is to create a comprehensive knowledge framework for historic rural heritage by utilizing a standardized data collection and documentation process.

That is done in compliance with the guidelines set by the ICCD of the Ministry of Culture's Central Institute for Cataloguing and Documentation.

4.1. The catalogue contract's structure.

There are eight lots in the contract that cover a specific geographical area that includes various Italian regions. Each lot has an estimated value of approximately €950,000 (excluding VAT), and the duration of each contract is set at 24 months. The selection criteria for the award of the contract were based mainly on a technical evaluation (90%) and an economic evaluation (10%). The lots include the following regions: Lot 1: Piedmont, Aosta Valley, Liguria; Lot 2: Lombardy, Emilia-Romagna; Lot 3: Veneto, Friuli Venezia Giulia, Trentino-Alto Adige; Lot 4: Tuscany, Lazio; Lot 5: Umbria, Marche, Abruzzo, Molise; Lot 6: Campania, Apulia, Basilicata; Lot 7: Calabria, Sicily; Lot 8: Sardinia. Each lot is given under a distinct contract, and bids can be submitted for up to eight lots, depending on each participant's ability to operate at a regional level.

4.2. Award Criteria

The award criteria for each lot were as follows: technical offer: 90 points; organization and methodology: 40 points; experience and competence of personnel: 30 points; innovation and added value: 20 points; economic offer: 10 points. The project value was generated by the sum of the scores. The contract was awarded to the bidder with the highest overall score.

4.3. Methodology

The process was executed in accordance with rigorous technical guidelines that are compatible with the SIGECWEB system, a digital platform for managing cultural heritage. The cataloging was looking at various types of architecture, which included rural buildings, masseries, stables, barns, and other agricultural structures that represent local traditions. The operators involved have collected detailed data on the building characteristics, construction techniques, materials, and state of conservation of each structure to create a database that supports the protection and improvement of these resources. Methodology includes:

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- **Bibliographic analysis:** study of building typologies and morphological context, with particular attention to regional variations and historical developments.
- **Identification of homogeneous areas:** identification of areas with similar architectural and construction characteristics to standardize cataloguing criteria.
- **Field survey:** carrying out photographic documentation, metric measurements, and recording of architectural features.
- **Compilation of the AR form:** Collection of data on typology, materials, state of conservation, and environmental context.
- **Creation of a georeferenced database:** A useful tool for planning conservation and enhancement interventions.

4.4. Implications of European Funding

The financing through Next Generation EU (NGEU) funds is a crucial aspect of the project's success. European funds support the conservation of rural cultural heritage while strengthening the capacity for managing and protecting historical assets. The development of shared knowledge between cultural institutions and local communities is promoted by them at the same time. The investment falls under Measure 2 - Investment 2.2, which is an integral part of policies for the restoration and enhancement of rural heritage. Financial resources are allocated to ensure that cataloging and census projects are carried out with high technical quality and that the results can be integrated into the SIGECWEB system, making the collected data accessible at both national and international levels.

5. Submitted Proposal by Atlante Group, Gap, Archimede, DM Cultura

The Ministry approved a preliminary study for the regions of Emilia-Romagna, Lombardy, Veneto, Trentino-Alto Adige, and Friuli-Venezia Giulia, which was presented, examined, and approved. A preliminary study was carried out to identify morphologically homogeneous areas and recurring building types in each area, reversing the traditional order of research. The survey and cataloguing process was structured based on these initial results.

Bibliographical research has been carried out to identify the references needed to study the areas and the types of rural dwellings that characterize their diverse landscapes. The research considered the essential studies conducted by the C.N.R., which were compiled in the series on rural houses in diverse Italian regions. Revisiting these studies and the most recent bibliography, the first step involved cataloging the predominant rural dwelling types, recording the major differences in their morphology from both synchronic and diachronic perspectives. These types were then compared with the processes derived from analyzing the evolution of rural activities that have partially or entirely contributed to the formation or modification of previously cataloged types and subtypes.

The description of the prevailing typologies was carried out with consideration for the different regional contexts. This choice was made in order to improve clarity in the presentation and ensure the required number of AR modules, it has been linked to different areas for project completion. The purpose of this study was to calculate the figures necessary to define the methodology for conducting the cataloging campaign.

For example, the total number of forms to be produced for the individual regions within Cluster 2 was initially calculated based on their respective surface areas. In contrast to other regions, particularly in Southern Italy, the provinces within these regional compartments tend to exhibit a greater degree of homogeneity in terms of the types they host. Therefore, a preliminary calculation of production numbers based on territory size was feasible.

Analyzing the extensions of the individual regions, the following data were obtained: Lombardy covers approximately 23,380 km², and

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Emilia-Romagna approximately 22,509 km², for a total of about 45,889 km². Given the need to produce 6,000 AR forms in total and the almost identical size of the two regions, the following distribution was determined: 3,000 AR forms for Lombardy and 3,000 AR forms for Emilia-Romagna (Fig.1).

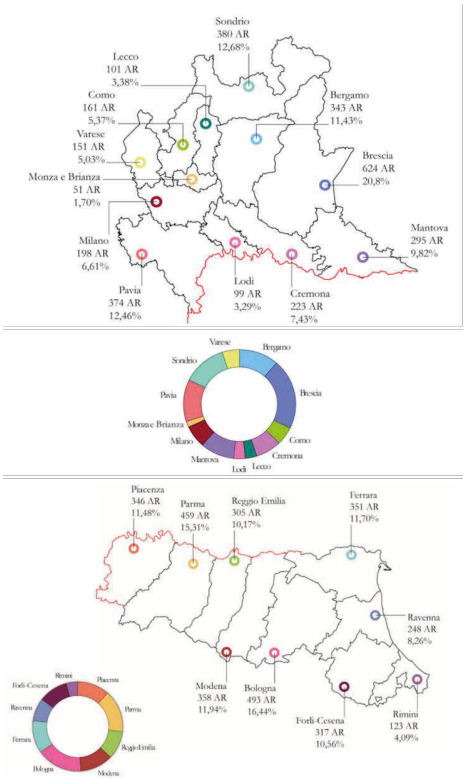

Fig. 1 – *Percentage of listed buildings per homogeneous area Lombardia and Emilia Romagna.*

5.1. Criteria for identifying critical activities and their aspects

The initial list of assets was established by analyzing online catalogs, databases, and reference bibliographies related to rural assets and architecture. This survey revealed several critical issues, particularly in three specific areas.

- Territorial Heterogeneity: the previously conducted surveys did not ensure homogeneous coverage across the territory.
- Typological Definition: a second critical issue that emerged during the study of types, and the consequent execution of the first asset survey, was the challenge of identifying certain specific types of rural dwellings. The classification of dwellings is primarily dependent on the observation of their intrinsic characteristics, such as the distinction between those with corridors serving a distribution function and those with a single room assigned to this function. This distinction consequently results in alterations to the arrangement of other spaces and their entrances.
- Correlation between lists and types is due to the previous critical issues encountered. Therefore, the distribution maps of the identified types can only be developed in a preliminary manner, making them unsuitable for guiding the cataloging campaign. In particular, the inability to directly link the items identified in the initial survey to the typologies defined by the bibliographic analysis would result in misleading typological distribution maps. This, in turn, could create a significant risk of inaccurate preliminary assessments for the planning of the catalogue campaign. Consequently, there is a clear risk of losing data that could otherwise be valuable for redefining the typological framework of rural dwellings within the boundaries of Cluster 2.

5.2. Proposed solutions

To address the identified critical issues, solutions have been devised that consider both the examined territory and the typologies that emerged during the preliminary study. Regarding spatial inconsistencies, particularly the lack of at least partially surveyed assets in the areas under study, the temporary association of companies entrusted the cataloguing campaign to local experts. These experts, through their training and experience, have an in-depth knowledge of these areas. Additionally, a comprehensive list of stakeholders has been assembled, including trade associations and mountain communities, who, thanks to their

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in-depth understanding of the territory in which they operate, can identify various assets they are familiar with. This approach necessitates the rejection of the figures defined in the initial survey as definitive. The case of Lombardy, for example, might appear simple due to the large number of sites already catalogued. However, the nature of the new cataloguing campaign and its objectives require a fresh field analysis that partially disregards previously recorded data. It is therefore proposed to use only a small number of previously catalogued assets as a starting point for operations, both at the regional and provincial levels. These assets will need to be in the field by catalogers and with the contributions of stakeholders. Nonetheless, even with a field-based identification campaign, access remains essential to assets whose typological definition depends on the observation of morphology or the spatial arrangement of environments, both in plan and elevation. The extensive network of identified stakeholders will not only help increase the number of catalogable assets but also refine their typological characteristics by facilitating access to their interiors whenever possible.

Regarding the distribution maps that are useful for mapping typologies, it will be necessary to recalibrate them progressively as the cataloguing advances and the types identified in the field are classified and positioned. A preventative action that still allows for predictive assessments of the number of records to be produced for each type is the recalibration of assigned percentages for widespread but homogeneous types. This approach enables ongoing quality control of the cataloguing process in relation to the project objectives and allows for the implementation of corrective measures if necessary.

The Alto Adige case of the "maso", presented within the PEA for Cluster 3 and awarded to the same RTI, serves as an example. This distinctive rural dwelling's forms are influenced by the legal institution of the same name, which prohibits hereditary property division. Consequently, despite the variations in form, which often present as unique features that cannot be readily grouped, the "maso" in Alto Adige can be categorized into three main types (single courtyard, double courtyard, mixed courtyard). This classification enables the recalibration of the numbers assigned to the province, with the focus of cataloguing efforts directed towards areas where these types are more prevalent (e.g., neighboring Trentino).

5.3. Documentation attached to the records

To give a more precise description of the asset being cataloged, the AR records will come with photographs taken from the ground and, if necessary, drone images. If the assets were selected based on a previous survey that included photographic documentation and/or eidotypes that could help describe the AR record fields more accurately, those materials will be added to the cataloging records.

5.4. Vocabulary of terms and materials

The typological study yielded preliminary vocabularies that introduced novel terms pertaining to diverse dwelling types, their components, materials utilised, and the landscape elements in which they were situated. This annotation underscores the necessity to engage in a dialogue with the contracting authority to delineate their applications and ascertain their suitability for inclusion in the common vocabularies of individual AR sheets.

5.5. Approach to territory and private property

The territories falling under the classification of cluster 2 present certain geomorphological characteristics that exert an influence on the strategy to be pursued in order to undertake the census of rural architecture. Specifically, while a proportion of the area designated for census and photographic documentation is characterized by plains or hilltop locations, such as Lombardy, other dwellings are dispersed across valleys, with mountainous terrain acting as natural barriers. Consequently, the undertaking of an intensive and expeditious census and cataloguing assignment entrusted to individual units becomes unfeasible.

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To address this challenge, it was determined that the operations of analysis and photography of rural dwellings be entrusted to teams capable of independent mobility across both lowland areas and, most notably, the diverse mountain valleys. This approach obviates the necessity to retrace one's steps down slopes or traverse mountain passes to access the subsequent area. Regarding the approach to private property, it is recommended that a variety of approaches be adopted, depending on the areas covered by the survey. The typology of the rural house of plain and that of the middle hill typically provides a closed court, whose access requires authorization from the property owner. By contrast, the situation is less complex in the case of dwellings located in high mountain valleys, where the absence of a court often facilitates access to the subject of study. However, in both scenarios, the issue of accessing interior spaces remains, a concern that is particularly salient given the importance of the internal layout of properties, especially those of the Carnic type, in identifying rural typologies.

In consideration of the aforementioned premises, the following approach to private property is hereby proposed: requests for access permission on site to resident owners of rural assets located in the plains and with the presence of courts or fences limiting the approach to the property; requests for access prior to arrival on site for private rural properties in the lowlands and with time transformed into reception activities; and, in the event that the absence of the owner or the refusal of the latter makes access impossible, and this causes a difficulty for the photographic taking and the description of the mandatory fields of the AR card, we will proceed to the drone shooting of the property. If even this last action is not possible, it is proposed that the property be deleted from the census list and replaced with a property of the same type, identified within the same area of typological development. Regarding the possibility of identifying stakeholders capable of facilitating access to rural housing ownership, it is proposed to act as follows:

- Identification of trade associations related to the world of accommodation activities is the first step in this process. Following contact with the owners of the many ancient rural houses that have been transformed into hotels or B&Bs, access will be requested to ensure the documentation and description of the internal articulation of the premises and understanding of any changes that have occurred.
- Census of mountain communities and their local associations.

In Lombardy and Emilia-Romagna, there are 20 mountain communities, and the associations that reflect them are deeply embeddedded within the social context of reference. Conducting a census of these communities for the purpose of contact will facilitate the dissemination of their work and its associated aims. This initiative will enable the timely notification of rural dwellings and outbuildings regarding the impending presence of cataloguers and the significance of their role in the documentation and reconstruction of the history of their respective territories. This approach is expected to facilitate enhanced access to individual properties, thereby allowing for the acquisition of valuable information pertaining to the history of specific buildings and the diverse rural contexts in which they are situated. An initial list of potential stakeholders has been compiled, and preliminary contacts have been initiated with identified trade associations to ascertain their availability and level of cooperation in facilitating access to the various research sites.

5.6. Working group

In the planning stage of the working group, two catalogers were employed: one for the plane and one for the movement between the Prealpine and Alpine zones. At the commencement of the course on rural cataloging, the individuals responsible for the various groups were identified. Current composition of the group includes one coordinator, one auditor, five area tutors, twenty-three surveyors, and 55 catalogers (Fig. 3).

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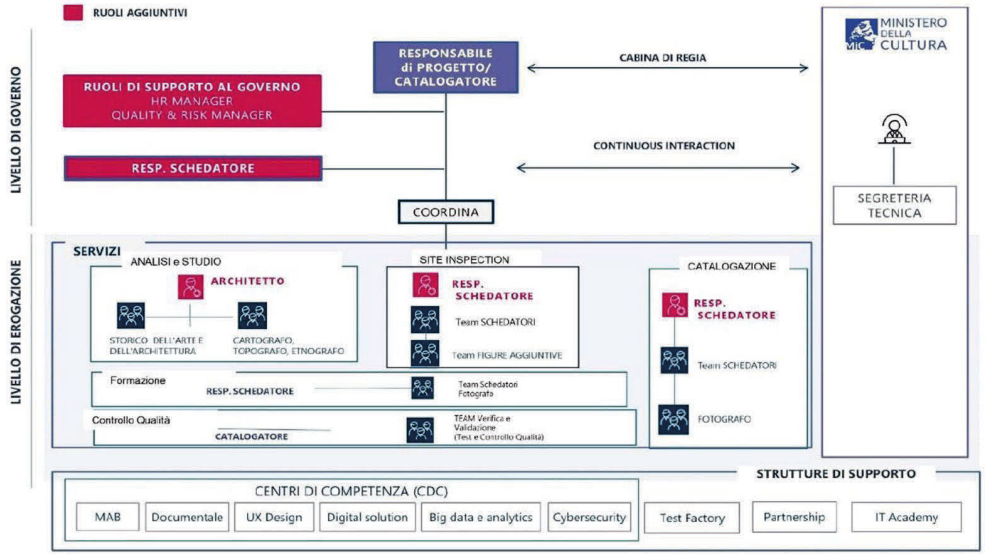

Fig. 3 – *The following text concerns the organization of operators involved in the process of cataloguing.*

6. Conclusions

Rural architecture constitutes a pivotal component of Italy's cultural heritage, yet its significance in shaping the nation's identity remains underappreciated. The Census of National Rural Architecture is a significant endeavor that provides a model for cataloging this heritage that can be replicated. This initiative provides a foundational knowledge base, a crucial element in the protection and sustainable reuse of vernacular buildings. The primary challenge confronting this field is the integration of historical research with innovative methodologies, fostering an interdisciplinary approach that fosters the preservation and enhancement of rural architecture. A further crucial aspect is the implementation of strategies to raise awareness and provide training, thereby enabling local communities to play an active role in the conservation of this significant heritage. Achieving this objective will require coordinated efforts from institutions, research bodies, and the general population, ensuring the transmission of this heritage to future generations and safeguarding the cultural identity and historical value of Italian rural architecture.

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The Census of Rural Buildings in the Italian Region of Friuli-Venezia Giulia

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Topic: T1.1. Study and cataloguing of vernacular architecture

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Abstract
The census of rural buildings in the Friuli-Venezia Giulia Region has highlighted the centuries-old existence of a building repertoire articulated for each of the landscape areas of the Friulian territory. The variety of building types testifies to man's adaptation to the environment, and the careful use of the land has mitigated the anthropogenic impact on natural resources, allowing sustainable forms of housing. The phenomena of abandonment and the slow processes of deruralization of some areas, resulting from the war events and natural disasters that devastated Friuli in the last century, are contributing to widespread renaturalization processes generated by low anthropogenic pressure. The latitudinal succession of woods, meadows intended for high-altitude grazing, terraces where fruit growing and viticulture have specialized over time and, in the flat part, the typical forms of polyculture, have made it possible to decline the settlement dynamics in unique forms of housing connected to agricultural work. However, for several decades these territories have discovered their own tourist vocation, and some of those houses have been converted into accommodation facilities. Therefore, the use of data from this census, integrated with information on the relationship of rural buildings with the landscape context, can support targeted research and cross-sectional analyses aimed at protecting the property from possible exposure to situations of natural or anthropogenic risk.

Keywords: *Friuli-Venezia Giulia; rural architecture; architectural typology; rural landscape*

1. Introduction

Emilio Scarin, one of the CNR researchers who dedicated his studies to the rural house of Friuli, recalls the complex events that, starting from the First World War, have characterized its formation and typological characterization.

When E. Scarin's book, *La casa rurale nel Friuli, (Op.Cit.)* was printed (1943), the Second World War was underway; therefore, at the end of the war it is evident that only some of those documented buildings survived. In addition, the 1976 earthquake made it necessary to exclude the buildings of the villages affected by the earthquake from the census because it would be difficult to recognize their original typological characteristics.

The houses, in fact, have been restored, almost all preserving only the memory of the previous territorial layout. The homogeneity of tradition, praised by decades of research on rural housing, has in some cases been entirely erased.

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While the reconstruction of the oldest rural villages has been philologically rigorous, the rural buildings of the peripheral areas have been rebuilt in a heterogeneous way and there are numerous additions found. In cities such as Gemona, Venzone, Osoppo, the stables and granarys adjacent to the houses have partly disappeared. However, the problem of the permanence of the memory of traditional landscapes has been addressed with great rigor especially by the Superintendencies. In fact, the medieval villages of those villages have been recomposed, respecting the features of tradition, preserving the volumes, size and style of the original artifacts. In fact, a building complex in which its stones have been numbered and placed in the place they originally had cannot be defined as a historical fake.

2. Objectives

The objective of the census is to identify, analyze and finally catalog to protect, enhance and preserve the architecture and the rural landscape by restoring quality to small villages promoting their tourist-cultural attractiveness.

3. Methodological criteria

The identification of the buildings was carried out on a preliminary basis on topographic maps and on the data collected from the censuses carried out by the municipal superintendencies and technical offices. The comparison with the historical studies carried out on the subject has instead made it possible to establish the identification parameters of the rural residential typology variously articulated in the different territorial areas of the Region.

3.1. Bibliographic analysis

The studies on rural architecture, carried out by the geographers of the National Research Council who, between the 30s and 40s of the twentieth century, gave new impetus to the investigations on peasant dwellings, from the low plains to the high mountain valleys of Friuli, started several decades earlier, were examined. It was interesting to observe that already from Scarin's reports emerged an overall picture described as "renewed building criteria or specimens, of the poorest areas, reduced almost to ruins". It is thanks to those geographers that the choice of the nomenclature of the identified types and their variants:

> "Always remains one of the most difficult to resolve. Regional names are naturally indicated where there are well-defined forms with limited diffusion: but even when there are types that are not clearly defined and circumscribed, a regional denomination has the advantage of facilitating identification and subsequent references" (Scarin, 1943).

Other interesting data, pertaining, in this case to ethnography, concern the affinity of Friulian types with certain Bavarian, Carinthian and Slovenian alpine architectures. In this census, an important contribution has come from recent studies that are almost always limited to specific territorial areas and focused on the use of local materials and on the recurring compositional-architectural aspects.

3.2. Other censuses

Other censuses of rural architecture, carried out in recent years by local authorities and regional superintendencies, have returned information only at the inventory level.

Instead, this project, prepared by the Ministry of Culture, explicitly required a level of in-depth study in which the precise analysis of the relationship between architecture and landscape context was evident, in the cataloguing of each individual asset surveyed. The source of reference information was the Regional Landscape Plan of Friuli-Venezia Giulia which emerges a strategic vision referring to the entire territory that considers the landscape as a strong point for the development of the region and the quality of life of citizens.

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Fig. 1 – *UD391 Pozzuolo del Friuli* (Palusa & Rulli, 2024).

3.3. Reconnaissance on the ground

The localities mentioned in the bibliography and in previous censuses, carefully mapped, constituted the starting point for photographic reconnaissance on the ground. The geolocated photos made it possible to verify whether there is a real cause-effect relationship between the settlement choices at different latitudes and the construction of specific architectural types. Observing the recurrence of some rural typologies compared to others, a fact emerged that suggested the correction of the methodological approach of the census, no longer by municipal areas but on an interregional scale. An exemplary case is that of the peasant houses in the municipality of Sappada, administratively Friulian only since 2007, in fact an integral part of the Cadore Belluno area, where the architecture is typologically identical.

4. The outcome of the census

The current census is contributing to the reconstruction of an information framework of Friulian rural architecture, which can be defined by typological clusters, recognizable in territorial areas defined by natural borders.

The identification of a causal link between architecture and landscape is directing the investigation to a deeper level of knowledge of rural settlement phenomena, which demonstrates a knowledge of building, widespread far beyond the artificial administrative boundaries.

The instrumental search for identity values of a people in clear political-administrative boundaries, in the face of the culture of work in the fields and of living, is meaningless.

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5. The rural architectures identified

5.1. The closed courtyard type of the Friulian Upper Plain

The rural house with a closed courtyard dates to the fifth century and is recognizable in the small villages. Maps from the seventeenth and eighteenth centuries indicate that the courtyard type in the Upper Plain has remained largely unchanged to this day. The Friulian courtyard does not have a threshing floor, due to the particularly rainy territory and the function of this is fulfilled by a covered room. In addition, it develops in a relatively compact inhabited center and the property, of the land and of the home, is, in most cases, managed within the family (Fig. 1). Characteristic planimetric elements

- Very uneven closed court
- Access to the courtyard from an entrance marked by an arch on the façade
- Very elongated towards the agricultural land
- Defined on the street front by the other nearby courts
- Rather small size of the street elevation

5.2. The open courtyard type of the Lower Friulian Plain.

The rural house with an open courtyard has numerous variations in the lower Friulian plain, both to the west and east of the Tagliamento, and are juxtaposed or separate. The villages of the lower Friulian plain do not have a rural vocation, as they have developed productive activities other than agriculture. The aggregative form of an open courtyard is defined by buildings with different intended uses, planimetrically arranged in a U-shape, with the house adjacent to the street. The house is narrow, very elongated and its interior spaces are distributed in a simple way. The small size of the cross-section makes it necessary to use an external balcony to access the rooms of the house.

The layout of the rooms is always the same: kitchen and cellar on the ground floor; bedrooms on the first floor; granary in the attic. The stairs are internal, traditionally perpendicular to the façade. The functional specialization of the various buildings of the courtyard includes on the ground floor, around the farmyard, the small outbuildings that house, the pigsty, the chicken coop, the woodshed, and, larger in size, the storage for the shelter of agricultural vehicles and equipment. The hearth is in an external volume and, in this case, arranged on the south-east side, adjacent to the short façade of the building of which traces of the original chimney remain on the façade of the house (Fig. 2).

Fig. 2 – *UD182 Bagnaria Arsa* (Palusa & Rulli, 2024).

5.3. Alpin house of Forni Savorgnani

The house of the Savorgnani Ovens is characterized by balconies and external stairs projecting from the load-bearing structure in squared local stone. This construction feature is also widespread in the nearby valleys of Sauris and Sappada, and in the more distant ones of Alto Cadore (BL). The wooden superstructures of the balconies and external access stairs are very widespread, especially in the oldest settlements, because originally the cattle farms of the Savorgnani Ovens needed large quantities of hay. In that area, late cuts were used to dry on balconies instead of on excessively humid meadows at these altitudes. The balconies, built in such a way as to enjoy the best sun exposure, were also used for the maturation of cereals. These houses are built with gabled roofs and with the ridge line longitudinal to the house, the roof covering is in shingles (Fig. 3).

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Fig. 3 – *UD622 Forni di Sopra* (Palusa & Rulli, 2024).

5.4. Alpine House in Blockbau in the Lumei Valley. The houses of Sauris

In the Lumei valley, the house and the rustic are built in two separate buildings. The residential building is built on two or three floors above ground with a central atrium on the ground floor from which one can it accessed the kitchen with the fireplace, the living room and other service rooms. By means of a wooden staircase, the bedrooms on the first floor and the balconies, where the latrine was often located, were accessed. The attic was used for storing cereals, agricultural equipment and hay. When the house was built on a slope it was possible to obtain a cellar in the basement, obtained in the rocky bank. Below the overhang of the balconies piles of firewood piled up.

Fig. 4 – *UD574 Sauris* (Palusa & Rulli, 2024).

This type of building was built on the ground floor in masonry and with the Blockbau technique for the remaining floors. The vast attic was filled with vertical wooden planks protruding beyond the edge beam of the floor to shelter the gallery below from the weather. In addition to dormers to illuminate the attic, real loggias were built in the tympanum (Fig. 4).

5.5. Alpine House of Degano Valley

The rural houses of Val Degano are characterized by the hip roof with sloping hubs on the short sides. It is a rectangular building, entirely in masonry, without wooden superstructures, with two or three floors, with an internal staircase, preferably in wood. The rustic is generally separated from the house. On the ground floor there is a central corridor in which the access stairs to the upper floors are located. On the first floor, divided by a corridor corresponding to that of the ground floor, there are the bedrooms and, above these, the attic, very large illuminated by one or more dormers, and the roof covering is made of flat tiles with rounded ends (Fig. 5).

Fig. 5 – *UD550 Forni Avoltri* (Palusa & Rulli, 2024).

5.6. Original Carnic House

The original carnic house were generally two-storey houses with very sloping thatched roofs and supported by long wooden beams called *ions*. The plan was rectangular with two avant-corps at the ends, between which there was a space in

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which there were accesses to the rooms on the ground floor: the stable, the hearth (*fogolar in Friulian*) and other rooms used for various minor activities. In one of the two avant-corps there was instead the covered staircase that led to the balcony above used to access the upper rooms that housed the bedrooms and the granary.

5.7. Variant of the Carnic house with open porch and loggia

This variant of the Carnic house derives from the oldest type, of which it preserves the space between two avant-corps, but deep enough to create an open porch. The house is usually divided into a ground floor with the kitchen, the stable and ancillary rooms such as the pantry. As in the oldest type, in one of the two avant-corps there is a staircase that leads to the open loggia *(hall),* whose overhang covers the porch below (*sotpuarti in Friulian),* and to the bedrooms. Finally, the staircase continues to the second floor with the granary (*taulad*) or the granary (*ciast*). The walls of this type of house are made of masonry while the floors are supported by sturdy wooden *beams (ion).* The rural house thus defined is already inserted in a small courtyard closed by a boundary wall (*curtif*) where small buildings are built for the shelter of work tools (*crigne*) and the woodshed (*legnera*).

5.8. The Alpine House of the Canal Valley

The rural house of Val Canale is built in small villages with little agglomeration; only in the Tarvisio area is there a prevalence of rural houses scattered on the cultivated land. The most common type, recognizable today, has two floors above ground and a granary in the attic. The roof is half-pavilion, very inclined, with severed pitches on the short sides of the building, also widespread in Carinthia. The roof covering is made of rectangular wooden shingles, very elongated, fixed in bands parallel to the roof structure by means of riveting. The variant with a single floor above ground and granary in the attic has the rustic separate from the main building. The plan in this case is more articulated and has an entrance from which you can access the kitchen and the living room. On the upper floor, which can be reached thanks to an internal staircase set up in the entrance, there are the bedrooms. The attic is not always used as a granary (Fig. 6).

Fig. 6 – *UD091 Malborghetto Valbruna* (Palusa & Rulli, 2024).

5.9. House of the Julian Prealps

It is a type of house with a rectangular plan with a short side that is not very developed. The cross-section, rather small, lacks the corridor with a distributive function, therefore, access to the rooms on the upper floors is from a gallery accessible, in some variants, by external stairs on the façade. The building is sometimes built on sloping ground and access to the granary is directly from the upstream road (Fig. 7).

Fig. 7 – *UD633 Drenchia* (Palusa & Rulli, 2024).

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5.10. The rural house of Pordenone

The house with deep loggias and open staircase and juxtaposed rustic houses is a type of construction very common in the villages of Frisanco, Barcis and Andreis. Carefully restored, these houses have become an identifying element of the Pordenone foothill and mountain landscape (Fig. 8).

Fig. 8 – PN126 Andreis (Giacomello & Rulli, 2024)

6. Conclusions

The study gives us an overall picture of the rural settlement heritage, which can be summarized in permanences and transformations and, in some cases, involved in obliterations of the significant characteristics of the original typology. Contributions to recent studies on Friulian rural architecture have always focused attention on circumscribed territorial areas, demonstrating the complex variety of buildings recognizable even just a few kilometers away from one settlement from another.

The census detects those buildings in which the material, the construction technique, the distributive solution of the spaces, their relationships with agro-silvo-pastoral activities and the landscape, in the past a resource of raw materials and context of rural life, today a source of income for the conversion of buildings to tourist accommodation activities.

Fundings

The census of rural buildings in the Friuli-Venezia Giulia Region is part of a broader project funded by the National Recovery and Resilience Plan, aimed at identifying, studying and cataloguing the different architectural typologies for residential use of peasant communities present on the Italian territory. The investment is intended for the search for historic rural buildings, still clearly recognizable, to manage their protection and promote sustainable tourism-accommodation activities in respect of traditions, local culture and landscape. In June 2023, an open tender was launched by the Italian Ministry of Culture for the assignment of the project for the census and cataloguing of rural buildings, compliant with the cataloguing standards of the Central Institute for Catalog and Documentation, with a total value of € 7,100,000.00 of which this one on Friuli-Venezia Giulia is an integral part. Currently, the information accompanying the cataloguing for the lagoon areas of the provinces of Gorizia, Udine and Trieste is still being acquired, through photographic reconnaissance and historical-archival insights.

Table 1 – *Summary table of the rural architecture surveyed in the provinces of Friuli-Venezia Giulia.*

Province	Extension in sq km	Surveyed architectures
Udine	4,969	747
Pordenone	2,275	342
Gorizia	467.1	70
Trieste	212.5	37
	7,923.6	**1,196**

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Traditional Moken Ethnic Houses in the Surin Islands, Phang Nga Province, Thailand

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Abstract
Today's vernacular architecture is influenced by urban development and modernity, resulting in the original form and accumulated knowledge gradually fading away and often being neglected. The Moken community in the Surin Islands, Phang Nga Province, is an example of these changes. From the tsunami disaster to the fire incident, the modern influence has replaced the traditional. Even though natural materials are still used, the modern style has affected the living conditions of residents. The fire incident destroyed 60 out of 80 houses, with new houses being provided. As a result, the Moken village has two forms of houses. The newly built houses are constructed differently from the traditional design, changing from a nine-pillar house to a four-pillar house with cantilevered beams, designed to accommodate future expansion. However, the space between the houses is narrow at only 1–1.5 meters, which limits expansion. The field survey conducted in 2019 collected data on the 20 remaining houses that survived the fire to understand the type of housing that supports the lifestyles of Moken. Architectural characteristics, living conditions, and house modification were recorded to provide a database on the design of traditional houses before they disappear or are replaced by new house styles. Such a database would also be useful for house planning in the future. The results of the study revealed that Moken have extensive housing knowledge. The structural systems and construction techniques used support house modifications. The core house with extensions supports long-term living. There are appropriate locations for each activity taking place around the house, as well as room for family expansion and living spaces such as bedrooms, kitchens, storage, and terrace areas. The core house design includes areas that support modern activities, such as shops, and shows the possible width and size suitable to accommodate activities for future expansion.

***Keywords*:** traditional; Moken; ethic house; Sea Gypsy

1. Introduction

In 2004, the Indian Ocean tsunami affected ethnic groups of Sea Gypsies in southern Thailand. The new types of houses subsequently provided have affected living conditions (Attavanich & Kobayashi, 2016). This study examines the Moken village in the Surin Islands, which has retained most of its original form due to the difficulties in transporting materials and the Surin Islands National Park's policies

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supporting the use of natural materials in construction and access to energy from the island's environment (Attavanich et al., 2019). Consequently, the Moken village in the Surin Islands has been slower to change compared to other villages.

The fire incident in 2019 led to the provision of new houses in the Moken village, resulting in the coexistence of two housing forms. The newly constructed houses differ from the traditional designs despite their characteristics being similar to traditional houses but with larger dimensions. The structural design has shifted from the traditional nine-pillar house to a four-pillar house with cantilevered beams. The larger houses are designed to accommodate future expansion, resulting in narrow spaces between the houses of only 1 to 1.5 meters, limiting the potential for further expansion.

Many studies refer to the importance of housing culture, emphasizing the need to consider culture to ensure the sustainability of post-disaster housing (Boen & Jigyusu, 2005). For ethnic communities, housing culture is significant (Oliver, 2006). The understanding of traditional architecture and lifestyles for reconstruction is important to enable the houses to be easily adapted (Jigyusu & Upadhyay, 2015). The one-size-fits-all approach should be avoided. The supply of core housing should have sufficient flexibility to ensure that structures can be adapted to meet a variety of cultural needs (Bakarat, 2003).

2. Methodology

Traditional Moken houses can be found in anthropological and social research (Sajarak, 1997; Na Pombejra, 2003). Since the 2004 tsunami, the rebuilding has resulted in new house designs and village layout patterns (Arunotai, 2006a). These changes have affected living conditions and transformed the village layout (Suzuki, 2010a). The characteristics of Moken houses are derived from temporary Kabang boats to permanent structures in the present time (Amloy, 2019). Their characteristics are based on the human body (Phatthanachaisuksiri, 2022). Previous studies have helped to understand the characteristics of Moken houses.

However, the impact of newly built house construction reveals the problems encountered by the Moken, especially the relationship between the house characteristics and the area used to support their way of life and long-term living arrangements.

This research aims to study the traditional Moken ethnic house. A field survey was conducted in November 2018 and mid-February 2019. However, a fire occurred in early February 2019, destroying 60 of the 80 houses. All 20 remaining houses were measured, with the furniture and living equipment depicted to understand the house characteristics, the use of certain areas, and living conditions. The interviews conducted with villagers focused on improvement and adaptations. The collected data were analyzed to clarify the adaptations made for long-term living.

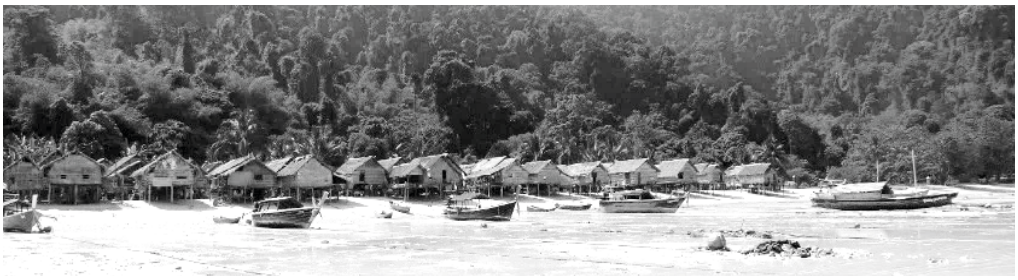

Fig. 1 – *The Moken village in Surin Islands* (Authors, 2018).

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The data on traditional Moken ethnic houses can be used for future house designs based on their culture.

3. Moken Settlement and Livelihoods

The Moken are an ethnic Sea Gypsy subgroup in Thailand. In the past, they were vagabonds of the sea, living on boats in the dry season and building temporary houses in the bay during the monsoon season to avoid the strong winds and waves (Arunotai et al., 2006a). The Moken village in the Surin Islands is known to be the largest in Thailand.

Fig. 2 – *Location of the Moken village in the Surin Islands* (Authors, 2025).

3.1. Settlement

The Surin Islands are located 60 kilometers from the mainland in Koh Pra Thong Subdistrict, Kuraburi District, Phang Nga Province. The Moken built temporary settlements on ten beaches. In 1981, the Surin Islands were declared a National Park; now under the Department of National Parks, Wildlife and Plant Conservation. In 2003, there were two Moken villages in Bon Lek Bay and Sai En Bay, both subsequently destroyed in the 2004 Indian Ocean Tsunami. Both villages moved to Bon Yai Bay in Surin Tai Island where they remain in a permanent settlement.

3.2. Livelihoods

The Surin Islands are a famous tourist attraction, and the Moken village is now included as part of the tourism route (Arunotai et al., 2006b). After the tsunami, the regulations imposed to conserve marine and coastal resources resulted in the Moken subsequently changing their livelihoods from fishing to becoming involved in tourism (Suzuki, 2010b). The reduction in their mobility and access to resources has made them entirely dependent on tourism (Neef et al., 2019).

4. Traditional Moken Ethnic Houses

About 40 Moken houses are located in Bon Lek Bay and Sai En Bay. According to previous research (Sadjarak, 1996; Na Pombejra, 2003), the traditional Moken house plan consisted of a rectangular shape based on a nine-post structure. The central post and steps divided the inside area; the high step area was for sleeping, and the lowest step area was used as a kitchen. The height of the stilt floor was based on the steepness of the beach and seawater level. The house had a high, steep, gable roof with long eaves. The materials from the surrounding area were used to construct the wooden structure, with a bamboo floor and Kor palm leaves for the walls and roof. The wall was open to reveal a small void. In the past, rattan or vine rope was used to join the structural components. The Moken hold certain beliefs in house construction, such as that the front of the house must face to south, etc. The space between the houses is considered especially important since the Moken believe narrow spaces cause sickness. These ideas are related to the living environment. Even though the design of post-tsunami houses may differ in certain details, such as a stilt floor height of 1.50 m., a 4-meter square plan (Suzuki, 2010a) with no steps inside, the donated materials consist of plywood and ready-made Jaak palm leaf panels. As the house structure tended to deteriorate after three or four years, the new designs allowed traditional characteristics to gradually return. The Moken

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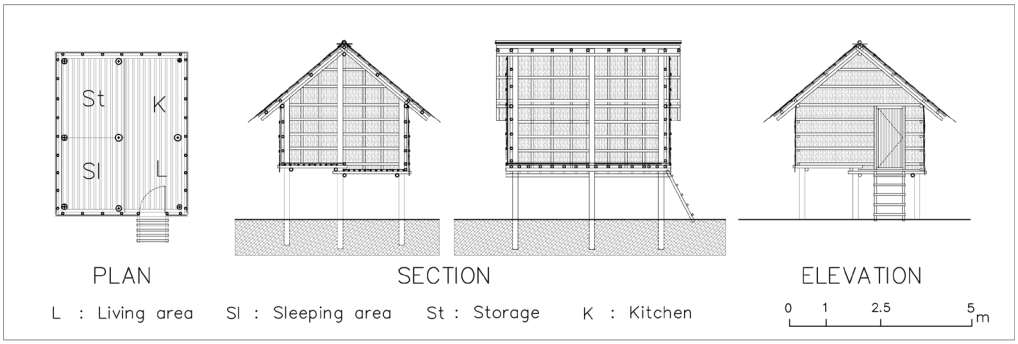

Fig. 3 – *Traditional Moken house* (Authors, 2025).

settlement changed from temporary to permanent, with the houses adapted to support long-term living after the tsunami.

4.1. Moken house floor plans

The house design can be divided into two parts: the main house, based on a nine-post structure to support basic living requirements, and an extension around the house.

All 20 houses are categorized in Fig. 4. The first type consists of a nine-post structure for the main house. The second type is a nine-post structure with an extension spanning the width of the house. The third type is a 12-post structure, and the fourth type is a 15-post structure with a similar-sized extension to the bay width of the house. For house number 15, a nine-post structure is strengthened by the sub-posts in the middle of the house. The fifth type is a complex extension covering two or three areas. House number 21 has been extended using a cantilever structure, while the front part of house number 14 is positioned on the ground. These house types demonstrate that the traditional housing knowledge of the Moken has been used to support the adaptations.

4.2. Moken house sizes

The main house: the width ranges from 2.9 to 5.0 m, with an average width of 4.2 m. The length ranges from 4.0 to 7.5 m, with the average length being 5.3 m. The smallest house measures 12.3 sqm and the largest 36.8 sqm, with the average house area being 22.2 sqm. As with the traditional Moken house, the surveyed houses basically have a living area, sleeping area, kitchen, and storage.

Extensions: the extended area is related to the length and width of the main house. The width of a front extension ranges from 1.1 to 2.4 m, measuring 1.9 m on average.

Front extensions can be used to provide a balcony, kitchen, storage, sleeping, or living area. The width of a rear extension ranges from 1.7 to 3.8 m, with the average size being 2.9 m. It can be used as a kitchen, sleeping area, or for storage, while a side extension ranges in width from 1.9 to 2.4 m, with the average size being 1.9 m. It can be used for storage, as a sleeping area, or shop. The total house area ranges from 12.8 to 53.1 sqm, the average size being 32.4 sqm, the average width measuring 4.8 m, and the length 7.2 m. In addition, each function requires a different-sized extension (Table 2).

Front extension: the average width of a balcony is 1.7 m and a kitchen 2.0 m. The extension can also be used for storage, sleeping or as a living area. Rear extension: the average width of a sleeping extension is 3.4 m, or 2.6 m if used as a kitchen. Side extension: this can be used for a kitchen, storage or as a sleeping area, with the average width being 1.9 m, 1.7 m and 2.3 m, respectively.

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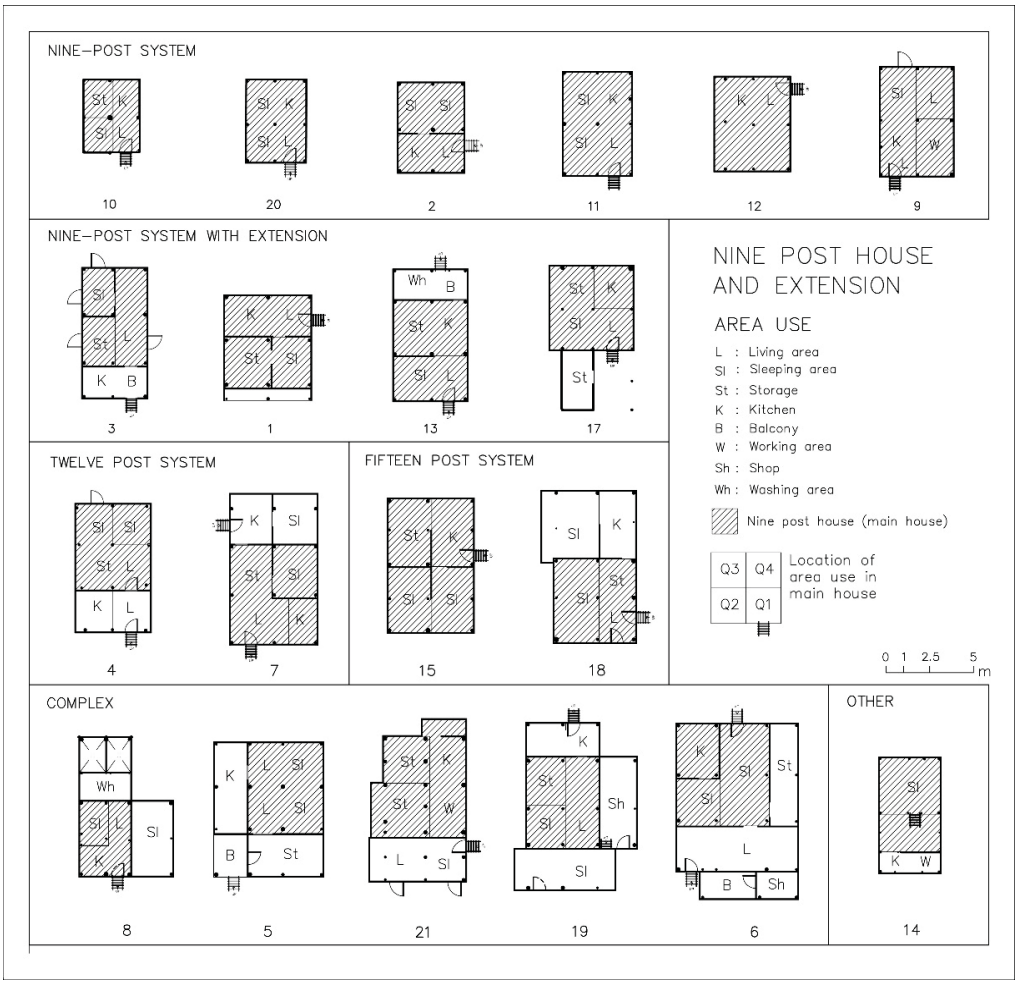

Fig.4 – Moken house type (Authors, 2025).

According to the Moken house size, extension and functions. It can illustrate the possibility of house adaptation based on their extensions and show the relationship between them (Fig. 5).

4.3. Household members

The number of family members can be used to represent the residential capacity of the house. Most houses contained single families, while other households had nephews or grandparents staying with them. The minimum number of residents in a house was one, and the maximum was six. On average, about four residents live in one house, consisting of three adults and one child.

5. Moken House Adaptations

The Moken tend to improve their houses every two years by installing new roof panels. Since the wooden posts are likely to decay every three years, the house needs to be rebuilt. Since the tsunami, most houses have been rebuilt around five times.

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Table 1 – *Moken house size*; *Sl: sleeping area, St: storage, L: living area, B: balcony, Sh: shop, W: working area, Wh: washing area* (Authors, 2025).

House No.	Household member			Main House							Front extension				Back extension				Side extension				Overall house area	Land Area		
	All	Adult (>15)	Child (<15)	Size of area		Area (Sq.m.)	Area use				Size of area		Area (Sq.m.)	Area use	Size of area		Area (Sq.m.)	Area use	Size of area		Area (Sq.m.)	Area use		Size of area		Area (Sq.m.)
				W(m.)	L(m.)		Q1	Q2	Q3	Q4	W(m.)	L(m.)			W(m.)	L(m.)			W(m.)	L(m.)				W(m.)	L(m.)	
10	2	2	0	3.2	4.0	12.8	L	Sl	St	K													**12.8**	3.3	4.1	13.7
20	4	3	1	3.4	4.6	15.8	L	Sl	St	K													**15.8**	3.5	4.7	16.6
2	6	3	3	3.8	5.1	19.0	L	K	Sl	Sl													**19.0**	3.9	5.2	19.9
11	2	2	0	3.9	5.8	22.8	L	Sl	Sl	K													**22.8**	4.0	5.9	23.7
12	5	4	1	4.3	5.3	22.7	L	-	-	K													**22.7**	4.4	4.3	23.7
9	4	3	1	4.2	6.1	25.6	L, K	W	L	Sl													**25.6**	4.3	6.2	26.6
3	5	4	1	3.7	5.5	20.4	L	St	Sl	L	1.7	3.7	6.4	K,B									**26.8**	3.8	7.4	28.1
1	3	3	0	4.9	5.2	25.7	L	Sl	St	K					0.6	5.2	3.3	Shelf					**29.0**	5.0	6.0	29.9
13	4	2	2	4.2	5.7	23.8	L	Sl	St	K					1.7	5.7	9.5	B					**33.3**	4.3	7.5	32.2
17	3	2	1	4.8	4.7	22.5	L	Sl	St	K	1.7	3.3	3.5	St									**28.3**	4.9	8.2	39.8
14	1	1	0	3.5	5.3	18.7	L	St	St	Sl	1.1	3.5	3.9	K,W									**22.7**	3.5	6.6	23.2
4	4	4	0	4.3	4.8	20.6	L	St	Sl	Sl	2.3	4.3	9.9	B,K									**30.5**	4.4	7.3	31.9
7	4	3	1	5.0	5.4	26.5	L	K	Sl	St					3.0	5.0	15.1	K, Sl					**41.6**	5.0	8.5	42.8
15	3	3	0	4.9	7.5	36.8	L, K	Sl	Sl	St													**36.8**	5.0	7.6	38.0
18	3	2	1	4.7	4.7	22.0	L	Sl	Sl	St					3.8	5.4	20.3	K, Sl					**42.4**	5.5	8.6	47.2
8	2	2	0	2.9	4.2	12.3	L	K	Sl	L					2.9	3.6	4.5	Wh	2.4	4.2	9.9	Sl	**26.7**	5.4	8.0	43.1
5	6	3	3	4.3	5.1	21.9	L	Sl	Sl	L	2.4	4.3	10.1	St					1.9	5.1	9.6	K	**46.1**	6.3	7.6	48.0
											1.9	2.4	4.4	B												
21	5	3	2	4.7	5.7	31.3	W	St	St	K	2.4	5.5	13.2	Sl, L									**44.5**	5.4	9.2	50.1
19	4	3	1	4.2	5.1	21.3	L	Sl	St	L	2.3	5.7	17.4	Sl	2.1	5.1	10.7	K	1.9	4.1	7.7	Sh	**53.1**	7.1	9.5	66.9
6	5	2	3	5.3	5.7	30.4	Sl	Sl	K	Sl	2.5	6.9	17.4	L					1.3	5.8	9.6	St	**68.6**	7.0	9.9	69.5
											1.5	5.6	8.3	B, Sh												
	3.8	**2.7**	**1.1**	**4.2**	**5.3**	**22.2**	**L**	**Sl**	**Sl, St**	**K**	**2.0**				**3.0**				**1.9**				**32.4**	**4.8**	**7.2**	**35.7**

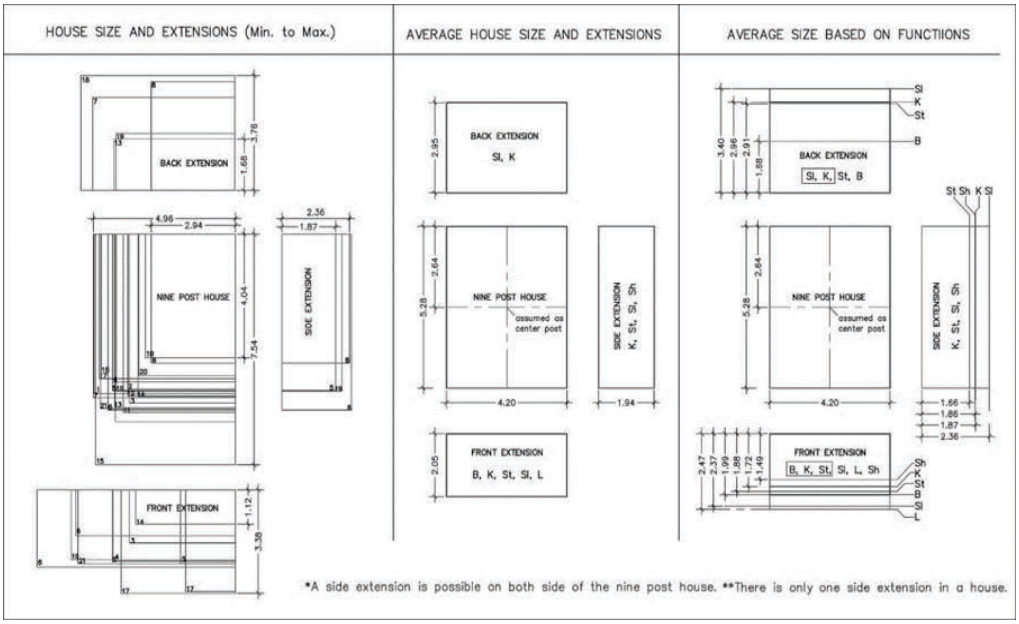

Fig. 5 – Moken house size, extensions and functions (Authors, 2025).

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Table 2 – *Extension size based on area use* (Authors, 2025).

Extension size (width m.)						
	Balcony	Kitchen	Storage	Sleeping area	Living area	Shop
Front	1.5	1.1	1.5	2.3	2.4	1.5
	1.7	1.7	1.7	2.4	2.5	
	2.3	2.3	2.4			
	2.4					
Average	1.2	1.7	1.9	2.4	2.5	
Back	1.7	2.1	2.9	3.0		
		3.0		3.8		
		3.8				
Average	1.7	3.0	2.9	3.4		
Side		1.9	1.7	2.4		1.9
Average		1.9	1.7	2.4		1.9

5.1. Reasons for making extension

Kitchen and storage are common reasons for extending the house to accommodate more dried food, clothes, and other items. An increase in household members is one important reason for extending the house. In single-family households, extensions tend to be built when the children grow up, and when they subsequently marry, a new house is built nearby. However, due to the limited land area, many villagers decide to extend the house instead and stay together when their child grows up. In addition, for long-term living, the villagers often build shops to support their daily lives and the community by selling products to tourists.

5.2. Space limitations in the village

When considering the village layout, after the tsunami, the number of households increased from 60 to 80 or 25% over a 15-year period. The village became densely populated, limiting the space between houses. The extensions constructed in areas. As the Moken extended into empty spaces around the house, village density imposed further limitations on family extensions. The villagers expressed that they intend to build extensions to support their living requirements and make further adaptations to the house such as adding a new kitchen when family members move in or the children grow up. This demonstrates that the limitation of empty space has affected the ability of the Moken to adapt their houses.

6. Conclusion

This study on Moken ethnic houses illustrates the current living conditions. Past knowledge of traditional Moken house construction has been transferred. Natural materials have a short lifespan of around three years, and frequent rebuilding requires construction techniques to be continuously adapted. The house types demonstrate the ability of the Moken to apply traditional construction techniques to strengthen and extend the house.

The traditional construction technique supports house modification. The main house has a nine-post structure at its core with the plans varying because of extensions. The modification possibilities with dimensions demonstrate how the house can be adapted for long-term living, with extensions, sleeping space at the rear, space for a kitchen and storage at the side of the house, and a multi-purpose space at the front. The size of the possible extensions must also take into account the space between houses, and the Moken's belief in maintaining a safe distance for circulation and ventilation shows how traditional knowledge supports long-term living arrangements and the environment. This emphasizes the concept of cultural consideration in post-disaster house design (Boen & Jigyusu, 2005), especially the core house structure (Bakarat, 2003), while preparing for future adaptation also ensures the sustainability of the distinctive lifestyles of ethnic groups (Oliver, 2006; Jigyusu & Upadhyay, 2015). In addition, the community is gradually expanding every year. The limitations of the settlement area mean that preparations will need to be made for future planning, with further research required.

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Vernacular and Fertile. The Pantano Masseria di Puglia, Italy

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Abstract
The Metropolis has attracted the attention of most architects by making them forget about rural spaces. The recent health crisis seems to have restored sensitivity to the rural environment as well as to life in contact with nature, reopening the field of reflection to global challenges such as migrations or climate and demographic changes whose effects are more evident in the countryside than in the cities. In this context, the possibility arises of analysing and interpreting the Masseria del Pantano as a model of popular architecture that could serve as a typological, urban or architectural example for the development of environmentally responsible architecture. The research method chosen for the elaboration of the work has included several phases. Firstly, an approach to the subject with the reading of the main bibliographic texts, a second stage a specific bibliography has been prepared and once this information has been contrasted. We visit the site to collect data that allows us to analyze and interpret the building. The cataloguing of peasant vernacular architecture, almost always anonymous, could perhaps be reused as design material. The beauty that productive landscapes offer us, due to their intelligence, their timelessness, their sensitivity to the land and their link, even today, with mother nature, must be the basis for the future, so that they can nourish us in a respectful way. The conclusions aim to understand the logic used by anonymous peasants in adapting their homes to the landscape. The intention of this work is not only to recognize the value of what exists, but also to find strategies capable of influencing the construction of contemporary housing.

Keywords: *agriculture; heritage; landscape; inhabit*

1. Introduction

Agricultural heritage materializes "the three basic actions of anthropization: traveling, producing, and inhabiting" (Pavón, 1936). This heritage has inscribed on the natural landscape a structure formed by trade routes, productive areas and settlements.

A structure that has become more complex in recent years with the emergence of technological development.

The present work aims to approach this diachronic process of occupation and production of the territory to the role played by architecture in future challenges, such as migration, demographic and climatic changes, which affect rural areas, "as can be deduced from EU policies that also consider the habitability of rural life as a necessary field of action" (Prandi & Brighenti, 2023). With the renewed interest in life in contact with nature that the "Covid-19" era has awakened, a movement has also emerged that has

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revalued small rural settlements, opening the countryside to reflection outside the city as has not happened for a long time. Proof of this is the exhibition Countryside, a report (Koolhaas & Amo, 2020) which reflects on rural territories that are increasingly abandoned by the population, but more decisive in current problems such as the climate, demographic or ecological crisis.

The present study takes the Pantano *masseria* as a paradigmatic case of Puglia's agricultural architecture, concentrating on the way of life, the productive space and its landscape integration. These constructions combine the domestic spaces of the peasants with places dedicated to the cultivation and processing of products. This research aims to revalue local tradition and culture by reactivating a social, cultural, ecological and economic transition that places the vital landscape at the center of each of our operations in contact with the environment. In the face of tourist reuse, reflect on architectural environments in which to promote initiatives and activities linked to its original, sustainable use, giving value to local traditions and culture.

2. Methodology

The research method chosen for the elaboration of the work has included several phases. Firstly, an approach to the subject with the reading of the main bibliographic texts assimilating the basic concepts of Italian popular architecture. In a second stage, a specific bibliography has been prepared on which to work, including books and articles. Once this information has been verified. We visit the site to collect data that allows us to analyze and interpret the building. The text is structured in three main sections; the first focuses on the place and landscape of the Murge, the second on the generic concept of *masseria* and the third deals specifically with the *Masseria* Pantano. Finally, some conclusions are obtained that try to address some of the current problems using the example studied as an example of good practice.

3. The Rural Architecture of Puglia. La Murge Settentrionalli

The Murge constitutes the central section of Puglia, bounded longitudinally by the lower course of the Ofanto, towards the Tavoliere and by the messapian threshold towards the Salentine plain. According to its width, the area of the Murge is delimited between the pre-Morgian trench and the Adriatic Sea. However, the name Murge is commonly known to the hills that rise in the inner strip and extend along the longitudinal axis of the region, from northwest to southeast. The group on which the research focuses occupies an area of La Murge Settentrionali included in the municipality of Gravina di Puglia. The succession of agglomerations responds to orographic shapes, settling on both slopes, one towards the pre-Murgian well and the other towards the Adriatic Sea. Settlements largely influenced by the existence of aquifers that are normally not abundant.

Fig. 1 – *The Murgia landscape,* Territory of Gravina. (Cotallo, 2024).

As in other Italian regions, the landscape of Puglia has been modified over millennia by human labor through the practices of agriculture and livestock that met the food needs of a society. “The most evident signs of this immense work are engraved in the territory through the formulation of a series of anthropized landscapes” (Mongiello, 1983).

Agriculture was essentially aimed at satisfying the food needs of the local population and was extensive, with most of the region devoted to

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cultivating the land, especially cereal crops. The increase in population and the desire to improve social living conditions necessitated increasingly intensive agriculture. The predominance of arid, stony soils and the region's low rainfall forced people to focus on woody crops, the only crops whose deep roots are capable of withstanding persistent droughts. Historically, however, the Murge has always been dominated by spontaneous vegetation, with arid pastures and sparse cereal crops with very low yields over crops and a predominance of woodland. Favourable conditions for livestock grazing. Different characteristics from the southern part of the Murgia, which is very favourable for cultivation. The local farmers have managed, through hard work, to blur the boundaries and unify the territory, transforming it into a more homogeneous area. “The bare rock of vast areas has been converted into dense woody crops of vines, olives, almonds, citrus fruits and other orchards”. (Mongiello, 1983)

The socio-economic structure has undergone remarkable changes over the years, from the general supply trend towards increasing industrial employment. In recent decades, political and state initiatives, in order to improve the economic and social conditions of the populations of southern Italy, have tried to invest in other development models such as industrial and tourism. In an attempt to counteract the strong exodus of the agricultural population from the southern regions to the northern regions and abroad. However, it can be stated that, despite these changes, Apulia continues to give a strong predominance to agricultural activities and is one of the Italian regions with the highest percentage of agricultural workers.

4. The *masseria*

When you look at the Pugliese countryside, you can see a network of masserías that structure its productive landscape. The “artificial” landscape made of stone by anonymous artisans over time is superimposed on the natural environment. (Mongiello, 1983). The *masserias* emerge from the ground in an imposing way, following the translation of the classical Mediterranean world and at the same time dialogue perfectly with their surroundings through their construction and their rotund geometry. These formal aspects inherited from the past led Luigi Monguiello to interpret the *masserias* as a typological evolution of monasteries. (Mongiello, 1983) in his book *Masserias di Puglia* comments that “the monasteries must be understood as appendices to the genesis of the *masserias* of Puglia” (Mongiello, 1983). Alleging that they contain “enzymes” and characteristic elements that are reinterpreted in these agricultural complexes.

These common characteristics are not only formal, but also found in the way in which they are implanted in the territory, conditioned by its autarkic economy. In order to achieve a suitable environment for meditation, monasteries were often implanted in remote places. This isolation forced them to establish a system of self-sufficiency, in which the monks themselves produced through activities such as agriculture, fishing, hunting, textile production and crafts everything necessary to establish a place in which to live in community. The monasteries were gigantic territorial factories (Prieto, 2019) which functioned almost like small cities.

One of the first premises for establishing a monastery was “in the first place, to ensure the possession of the earth, the foundation of all creation” (Duby, 1992), find a natural and fertile landscape to settle in. A landscape with everything necessary, orchard, water and stone, which the monks would soon transform into an agricultural landscape. In this way, monastic groups have a similar structure to the *masserias*, capable of adjusting to the place where they are established, mainly to their nature and topography, without losing their identity. “The success of the monastery over time, as well as its productive culture, was based on the land they owned” (Abalos, 1970).

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The idea of integrating the man-made artifact with nature is not romantically pursued. The association between construction and environment is not made through mimesis strategies, but through the Greco-Latin heritage that structures the rural space. (BONET 1981) The *masseria* settles in the landscape in a specific way, on the one hand it seeks a safe environment by establishing itself in places that dominate the vision of the territory and at the same time it seeks strategic places from which to obtain scarce and necessary resources such as water.

Carlo Colamonico. One of the most profound connoisseurs of the subject of rural housing in Italy, based on his theoretical advances, identified two categories when studying this territory, on the one hand, permanent inhabited housing (Colamonico. 1970) by those farmers whose land demanded greater attention and work. And on the other hand, the temporary housing that occupied the large peripheral strip of the urban centers. La Murge contained the largest grazing area in the region, which was transformed into increasingly numerous patches of woody crops, consequently, rural housing is mostly permanent. Despite the existence of other types of permanent rural housing in Puglia such as: le ipogee, le elementari or le nuove costruzioni (Calamonico. 1970) the rural residence par excellence since ancient times in Puglia has been the *masseria*. This form of rural settlement typical of Puglia is similar to those found in other areas of southern Italy.

Fig. 2 – *Masseria Pantano vista da jazzo. Pantano, Territorio di Gravina* (Cotallo, 2024).

"The phenomenon called *masseria* can be defined as the only testimonial essence of the relationship that has existed for centuries between: man, agricultural work and production" (Mongiello, 1983). The great distance from the urban centers and the characteristics of its terrain make the Murge one of the areas with the highest concentration of *masserias* and *jazzi*.

The *masseria*, in addition to serving as a house for the peasants, was provided with places for the breeding of cattle (sheep, horses, cattle) and the processing of their products. However, in recent years, the Masseria of Murgia has gone through several phases: from meeting the needs almost exclusively of pastoral nature, to responding to the needs of a properly agricultural activity. First with the cultivation of cereals and in recent years with the transformation to woody crops, including their industrial transformation.

The entire construction process of the *masseria* is a simple and logical system that aims to achieve a container space that systematically encompasses the various functions. The most abundant rock in the Pugliese region is the Calcare Compatto from the Cretaceous, its abundance has served man as a building material over the centuries. *Masserias* are basically defined by an organization of spaces or bays built by parallel load-bearing walls that support the 4/6 m grids following the laws of strict constructive economy. In the *masserias* "Construction is interpreted as a work tool and a consequence of man's instinctive and primordial logic" (Pagano & Guarniero, 1936).

The formal language adapts to its constructive period, without altering the essential elements that remain invariant over time from the historical moment in which it crystallized in a defined typology. If we understand typology as a deep structure of form, it is difficult to define a generic typology of masseria, since it is a changing architectural organism adapting to different types, chronologies, places, uses, climates, topographies and users.

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Fig. 3 – *Masseria Pantano, Territorio di Gravina. Le Masserie di Puglia.* (Mongiello, 1983, pp. 143).

5. The *masseria* Pantano

In the linear succession of *masserias* settled on the slope of the Murgia, from Spinazzola to Minervino, is the *Masseria Pellicciari* commonly known as *Masseria Pantano*. In the *Masseria* Pantano (Fig. 3), as in other buildings in the Murge, *masseria* and jazzo are complementary terms. While the *masseria* describes a cattle farm, the jazzo is fundamentally sheep. *Jazzo Pellicari* It articulates a rectangular system of sheepfolds and shelters, approximately one and a half kilometers northeast of the farm.

The *Jazzo* are located at the base of the Rialto, where the limestone rock formation begins with a steep step, where sheep come in search of pasture food. This system of sheepfolds allows the sheep to be organized and classified as well as protecting them from predators. Depending on where they settle, the *jazzo* may contain rooms for shepherds and spaces in which to process milk *in situ* due to the scarcity of means of transport. The topographical detachment between *Masseria* and *Jazzo* is due to the fact that "They take advantage of the slope of the terrain

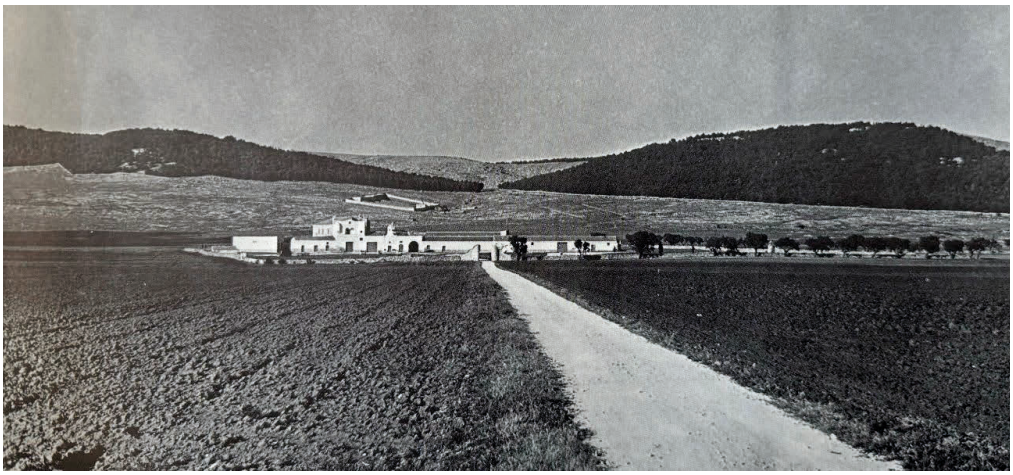

Fig. 5 – *Masseria Pantano*, *Gravina. Le Masserie di Puglia.* (Mongiello, 1983).

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that favors the drainage of urine and prevents the wear and tear of the wool" (Colamonico, 1970) called "accosciamento". The *jazzo* (Fig. 3) in this part of the Murge they are oriented to the south and are related to the morphological conditions and the nature of the terrain. To cope with the significant water shortage at certain periods, it is not only water collected from rooftops. Peasants built canals by moving stones and earth to collect rainwater at the bottom of the promontories and led it to a cistern placed in the highest area to prevent it from mixing with the livestock sewage.

The transhumance routes (Fig. 5) connected the *Jazzo* and the *Masserias* between Abruzzo and Apulia on the King's Sheep Trail, which connects L'Aquila with Foggia with a distance of 244 km.

Peasants ensured pasture and water for herds in the face of territorial and climatic diversity during the winter months and carried out transmigrations annually. In addition, it was believed that these transhumances led to a natural selection of cattle for the benefit of healthier and more resistant specimens, and therefore a better quality in the production of wool, milk and meat. The rectangular stone fence that encloses the *masseria* opens in all four directions to communicate in this way with the dominated agricultural territory and with the trade and communication routes with the nearby villages.

The main body of the *masseria* stands on flat ground, at the foot of the rock formation. It is an elongated volume of 102 m that is inserted into the landscape as a natural episode. The Pantano *Masseria* is articulated around a courtyard or court, the buildings that make up the Masseria form an open quadrangular space (Mongiello, 1983).

Empty spaces play a fundamental role in the articulation and functioning of agricultural organisms. Courtyards allow work and maneuvers linked to buildings, they are easily flexible surfaces and adaptable to any task. The *masseria* closes in on itself to protect itself, which turns the courtyard into a community space for relationship and transit as a "square" for the complex. In many cases, the various agricultural tasks form autonomous formal units, constituting a set by aggregation of elements. To cope with water scarcity, rainwater is collected through canals and stored in wells or cisterns. In the center of the composition we find a smaller courtyard with access for carts that serves as a community space for relationship and work (Fig. 4).

Around it, simple and modulated constructions contain the different uses, protecting themselves from the north winds. In the northeast area there are two attached bodies that contain stables, as well as in the southwest area that in addition to containing blocks has two warehouses and a warehouse. The south-eastern part contains another larger courtyard that is largely cultivated with orchards and irrigated fruit trees, it is a courtyard walled by a masonry wall that on its southwest side is closed with an elongated shed. The elongated northwest room is made up of a succession of rooms mainly on the ground floor, with a vaulted structure that make up one of the sides of the courtyard and resolve the southern elevation by placing the façade of the chapel. These rooms were shared by the settlers and families who worked in the *masseria*. The stables are located between this room and the master's house with direct access to the outside. There is a clear division of the surfaces used with opposing attitudes.

The only volume divided into two levels is the building intended for the owner's residence, which is accessed from an external staircase. Conceptually expressed through a trapezoidal planimetric design (fig. 6) and which is rotated to take the direction of the north-south axis, this volume is made up of four rooms, a saloon and a kitchen, it also has a perimeter corridor with hanging sentry boxes. In the lower part there is the machine room, the rooms for milking, processing and the storage of products. "It was originally the summer residence of the owner and was later divided into rooms for the settler administrators" (Colamonico, 1970).

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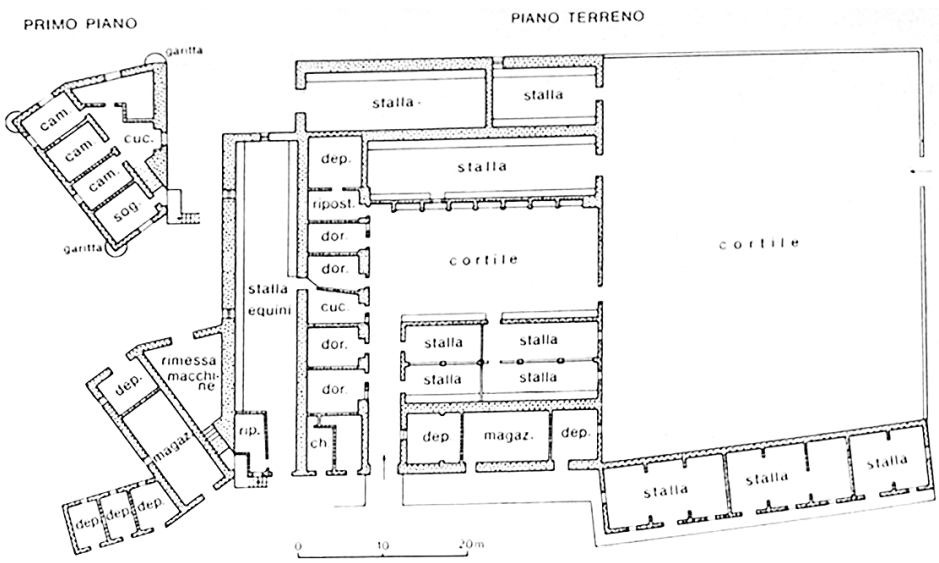

Fig. 6 – *Masseria Pelliccari o Pantano*, *Murgia di Gravina* (Colamonico, 1970, pp. 168).

This agricultural structure of the Gravina territory, both in its planimetric and volumetric articulation, expresses a productive potential. A value that does not come from form but from use: "An agreement between home, field and farmer". (Pagano, 1935), Finally, demonstrating the absolute dependence between the "Aesthetic result and logical functionality" (Pagano & Guarniero, 1936).

Some minor adaptations have altered the old architectural morphology of the Pantano *masseria*. Over the years, new volumes and transformations have been added that adapted the original use to those required by the new exploitation activities. The buildings on the ground floor, old outbuildings or the construction of new ones for wineries, grape processing, wineries, oil, etc. Facilities and environments that with the recent crisis in agriculture and the most rational working methods have largely disappeared. Currently the *Masseria* that housed more than ten families and a thousand animals, is uninhabited and is used as storage. (Colamonico, 1970).

6. Conclusions

The *masserias* of Puglia are an outstanding example of respect for the place and the social, landscape and constructive memory of the place. These residences establish a symbiosis with the natural environment, forming a harmonious system between architecture, landscape and nature. These projects therefore represent "environments and places of life capable of transmitting legacies of past societies, becoming part of collective projections of the future" (Mozas, 2022) which require an architecture that responds to social and economic demands in a sustainable way with the territory in which it is established. The research does not only aim to nostalgically remind the architectural memory of this rural agricultural heritage to new generations, but also to expand the store of resources that can serve as project material. The models of rural settlements of the past have regained meaning for society and architects today, as they are an example of sustainable and environmentally friendly architecture. With a slight lag with respect to urban evolution, the

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rural landscape has been affected by changes that deserve to be considered by architecture. In short, the revision of a type of collective residence linked to production is proposed as an operation of functional updating to offer a renewed projection of the future, while recovering and reinterpreting the memory of pre-existence as an example of respect for the place.

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When the Shapes Unite: Cataloguing and Analysis of Vernacular Architecture in the Valleys of the Provinces of Bergamo and Brescia

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Abstract
This paper takes advantage of the Italian Ministry of Culture's cataloguing of rural architecture currently in progress to suggest reflections on the construction techniques of rural buildings occurring within the valleys of the Provinces of Brescia and Bergamo. It focuses on the analysis of the constructive elements to be found in territories adjacent to one another, yet with a slew of communication issues due to their geographical makeup, and which, by the very same token, also feature some commonalities, to wit, the use of similar local materials, such as stone and wood, which have lent a significant contribution to high-quality engineering construction solutions. These observations have led to the assumption that socially-specific know-how begotten by the same resources has led to equally similar design solutions even in the absence of any direct mutual contamination.

Keywords: *cataloguing of rural architecture; rural buildings; construction techniques*

1. Introduction

The Central Institute for Catalogue and Documentation (ICCD) of the Italian Ministry of Culture outsourced the task of censusing and filing instances of rural architecture raised before 1940, including all residential and work buildings boasting characteristics of rurality. To this effect, a special catalog card going by the name of AR (rural architecture) card has been conceived.

This national census and mapping campaign was developed within the National Recovery and Resilience Plan (*Piano Nazionale di Ripresa e Resilienza – PNRR*), and aims at protecting and valorizing both rural architecture and landscape.

2. Working method

Numerous photographs were taken during an on-field activity and subsequently geo-localized, thus providing an invaluable documentary record allowing for comparisons to be made as to the building features of the different rural architectures at issue. The photographic survey and analysis of the available bibliography allowed to identify some stylisms recurring at a local level and subsequently compare them with those occurring within other areas. The analysis highlighted both traditional practices and anomalies resulting from instances of constructive evolution, rethinking, repair in the wake of calamitous events, adjustments and changes in space use, periods of abandonment and decay, etc.

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3. The areas analyzed

The Provinces of Brescia and Bergamo (Fig. 1), are located on the eastern side of Lombardy and encompass a geographically and geologically diversified landscape, characterized as it is by a transition between the Alps and Pre-Alps on the one hand and the Po Valley on the other (VV.AA., 1982).

Fig. 1 – *The Provinces of Bergamo and Brescia*.

This morphological variety affects not only vegetation and hydrography, but also the availability of raw materials, the use of which has played a fundamental role in the construction of infrastructure and settlements for centuries in a row. The mountainous areas in the north mainly consist of sedimentary rock, such as limestone and dolomite, which are found in the Prealps and have oftentimes undergone karstic changes.

Thanks to their workability and resistance, these materials have been widely used in the local construction business for masonry, flooring, and further architectural works.

The area of Adamello is home to crystalline rocks, especially granite and tonalite, which are extremely resistant and have long been used for engineering works and coatings. The abundance of these materials has affected not only the morphology of the landscape, but also the traditional architectural style, characterized as it is by the use of local stone in rural buildings and, more broadly speaking, historic centers. As the geological substrate descends towards the hilly belt, it becomes more heterogeneous and begins to encompass, among others, marls, sandstones, and morainic deposits. Marl, consisting of alternating layers of limestone and clay, has been used to produce lime, while sandstone has served as a material for walls, stairways, and pavements by virtue of its high degree of workability. This area is characterized by mixed forests with species such as beech (*Fagus sylvatica*), chestnut (*Castanea sativa*), and various oaks, including the oak tree (*Quercus pubescens*) and the hill (*Quercus cerris*), whereas the understory features shrubs like the hazel (*Corylus avellana*) and hawthorn (*Crataegus monogyna*).

In the south, the landscape changes radically and in line with the extension of the Po Valley, characterized as it is by alluvial deposits formed from the sediment transported by many a river. Here, the soil is rich in clay used to produce bricks and tiles, i.e., the mainstays of traditional Lombard construction techniques. In addition, the extraction of sand and gravel from the many quarries along water-streams like the Oglio and Serio provides aggregates ideal for modern concrete and infrastructure (Matteoni, 2022).

Hydrography plays a key role in the structure of the territory. The main rivers of Bergamo are the Serio, which flows along the Seriana Valley before confluting into the Adda, and the Brembo, which crosses the Brembana Valley with a torrential regime characterized by seasonal ups and downs. River Adda, one of Lombardy's largest, marks the western border of the Province. As to the Province of Brescia, River Oglio, its main hydrographic axis, crosses the Val Camonica and Lake Iseo before heading towards the plains (Azzoni, 2015; Belotti, 2005). Other important watercourses include Rivers Mella, which crosses the Val

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Trompia and the city of Brescia, and Chiese, which originates in the Prealps and flows into River Oglio (Paoletti, 2015).

Riparian environments along these rivers are home to willows (*Salix alba, Salix fragilis*), poplars (*Populus nigra*), and black alder (*Alnus glutinosa*), which lend a precious contribution to river bank stability and riverside biodiversity. The original vegetation of the plain, nowadays mainly consisting of agricultural crops, once included lowland forests of farnia (*Quercus robur*), elm (*Ulmus minor*), and greater ash (*Fraxinus excelsior*).

The interaction between geology, hydrography, and vegetation shaped the territory and bore a significant influence on human activity. The abundance of building materials such as limestone, granite, clay, and gravel, lent a significant contribution to the development of local construction, while water courses attracted settlements and allowed for economic development. The close relationship between the environment on the one hand and human activity on the other allowed for sustainable use of natural resources and thus landscape conservation in the Provinces of Brescia and Bergamo (Dematteis, 1996).

4. Typological elements in the rural buildings of the Provinces of Brescia and Bergamo

The following sections will elucidate the construction elements to be found in rural buildings in both provinces.

4.1. The floor plans

In mountainous areas, the planimetric scheme of buildings consists of single, U-shaped blocks together with an independent element added parallel to that "U". Such buildings may occur in the form of single-level or multi-level, as well as single-access or multi-access. Some buildings also feature underground spaces or basements (Fig. 2).

Fig. 2 – *Complex characterized by three different parts* (Vanja Macovaz, 2024).

Figure 2 shows a complex divided into three separate elements: a tower (2b), a residential section including a loggia (2a), and an independent structure (1). The arched loggia highlights the family's wealth. A second gallery was used for storing grain and other crops (Mazza, 1982).

4.2. Walls

Another interesting point of reflection concerns the walls (Fig. 3). They can be classified as: masonry consisting of regular/irregular stones with or without lime-based mortar joints; masonry consisting of regular/irregular stones with cement-based mortar joints; masonry consisting of regular/irregular stones with a rough plaster coating; masonry consisting of stones outcropping from a rough plaster coating; stone corners; curved walls; walls enriched by so called *gelosie*.

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Fig. 3 – *Dry-laid split stone masonry (right and back body) and masonry with lime-based joints (left)* (Vanja Macovaz, 2024).

4.3. Pillars

Pillars are commonly made of stone, brick, wood, or concrete, and generally serve as a support for loggias or arcades (Fig. 4).

Fig. 4 – *Example of a wooden pillar supporting a canopy* (Vanja Macovaz, 2024).

4.4. Partition walls and suspended ceilings

External infill walls, internal partitions, and light ceilings are all typical elements of these architectures. These technological elements can be classified into the following types: stone, solid brick, perforated brick, or wooden closing walls and interior partitions, as well as internal partition walls consisting of wooden frames and lattices occurring in the form of braided branches (Fig. 5), solid bricks laid by knife, lime and straw mortar, *cannicci*, or wooden slats.

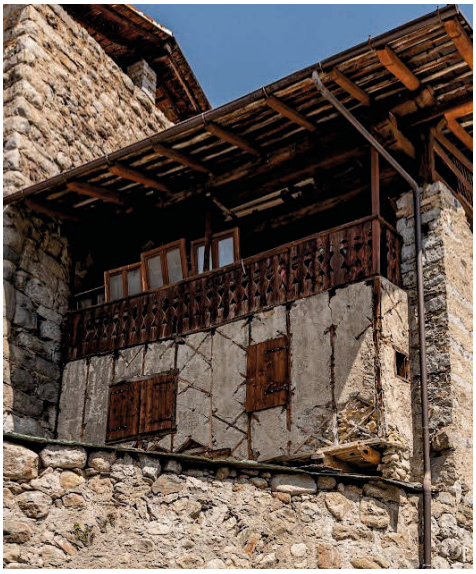

Fig. 5 – *External wall made of vertical wooden elements bound by diagonal strips filled with light stones (limestone tuff)* (Vanja Macovaz, 2024).

4.5. Slabs

The original slabs identified herein consist of wood, in the shape of either wooden beams and slabs or stone and brick slabs (Fig. 6) (Scala, 2016).

Fig. 6 – *This particular wooden ceiling consists of a series of very large joists interspersed with stone scales inserted between each one of them. Above it, a continuous lime cast can be seen* (Vanja Macovaz, 2024).

4.6. Vaults, arches, and portals

Generally speaking, the vaults are round and feature visible stones or stones covered in plaster. The arches consist of stones or bricks, and the entrance sometimes features a stoney trilithon (Figs. 7 & 8).

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Fig. 7 – *The entrance to the property is identified by a single block stone structure resting on stone pillars equipped with a protruding shelf. The inside floor consists of beaten earth, whereas the external surface is covered in pebbles* (Vanja Macovaz, 2024).

Fig. 8 – *Cruising vaults in stone with plaster coating. Please note the volume encasing the stairwell* (Vanja Macovaz, 2024).

4.7. Balconies and horizontal overhangs

In most cases, the balconies were constructed by using wood, with more recent ones being made of concrete. They typically boasted a balustrade of wood or iron (Fig. 9). It should be noted that beyond the height of the balustrades an array of vertical posts can be detected which reach all the way to the upper floor or roof joists and are fixed thereto.

Fig. 9 – *Wooden balconies with parapets and vertical pulls extending towards the roof. The wooden pillars on the first floor widen at the top in order to support the balcony on the second floor* (Vanja Macovaz, 2024).

4.8. Additions

Oftentimes, additional elements can be found which serve as toilets, barns, or useful spaces to keep small animals near home (Fig. 10).

Fig. 10 – *Additional elements usually consisting of toilets* (Vanja Macovaz, 2024).

4.9. Roofs

In general, roofs possess the following features: structures made of wood, reinforced concrete, or metal. All these kinds of roof typologies occur in one, two, or four pitches. The structure consists of so-called Lombard-style trusses, with regular or rough beams and continuous or discontinuous wood planks supported either by pillars or walls (Fig. 11). Oftentimes, the roof structure is two-sided and supported by conical pilasters in the center. Sometimes there are no trusses, but rather wood purlins perpendicular to the façade supporting the layer of discontinuous planks. In the latter case, the wood purlins are supported at

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the corners by bucks placed under a heavy beam for extra support. In the image below, the timbers on the second-floor façade betray the existence of a previous wooden balcony. The first and second floors served as residential spaces for farmers.

Fig. 11 – *Rural building with wooden roof* (Vanja Macovaz, 2024).

4.10. Roof covering

As a consequence of their utmost proneness to degradation, the roof coverings have undergone significant changes. As a consequence of aging-related instances of replacement, the roof coverings now consist of clay or stone tiles, as well as metal or cement/fiber cement slabs (Fig. 12 & Fig. 13).

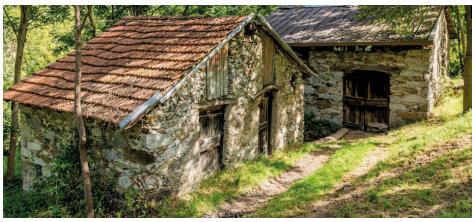

Fig. 12 – *In the background: metal-sheet covering to replace the original clay tiles; in the foreground: newly replaced clay tiles* (Vanja Macovaz, 2024).

Fig. 13 – *Stone-tile covering with snow-stop devices* (Vanja Macovaz, 2024).

4.11. Openings

The openings feature different sizes and shapes depending on their function. For example, Fig. 14 shows a building characterized by ground and first-floor rectangular windows the width of which is greater than their height. Their architraves, doorframes, and windowsills consist of square stones. Iron window grilles also occur in this case. The ground and first floors served as a stable and as a barn, respectively. The first floor can also be accessed from a rear entrance thanks to the street behind the building being at a higher level. The second floor was used for residential purposes and features high and narrow windows with stone windowsills. The architrave is a beam incorporated in the ceiling and supported by the perimeter wall. The shutters are wooden-made and feature vertical, nailed planks.

Fig. 14 – *Example of a house featuring different types of openings* (Vanja Macovaz, 2024).

The valley buildings are equipped with doors and windows sharing some common characteristics. In general terms, all openings feature a stone, wooden, concrete, or metal architrave, and include stone or brick jambs. They can be square or rectangular in shape and generally consist of one or two wooden shutters, with their hardware being made of iron.

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In all spaces intended for residential or work purposes, the windows are rectangular in shape and extend vertically. The doors are either single or double-leaf, with the latter being commonly used for livestock access.

4.12. Plasters

Historical external plasters are typically of lime-mortar based (Fig. 15), while recently applied plasters are made with concrete.

Fig. 15 – *Lime plaster painted with lime milk* (Vanja Macovaz, 2024).

5. Conclusion

The analysis of rural architecture in the Provinces of Brescia and Bergamo, conducted through the cataloguing and surveying of construction characteristics, demonstrates the effectiveness of an approach based on direct documentation for the purpose of protecting these artefacts. The surveys, which are part of a wider project coordinated by the Ministry of Culture, have made possible the identification of both recurring typological elements and traditional construction techniques. This provides a detailed picture of architectural variety development as a function of local material availability and functional needs.

The significance of this study lies in its capacity to provide a systematic analysis of the rural housing stock, thus allowing for exact identification of its structural and material peculiarities. The classification of masonry typologies, roofing systems, ancillary elements, and openings is paramount to identifying the most commonly occurring construction techniques and comprehending the evolution pattern of structures over time.

This analysis allows for understanding their adaptation process to new needs, as well as phenomena of structural and superficial decay. This knowledge is essential for an effective guidance of restoration interventions, which in turn allows for avoidance of incongruous solutions and the preservation of their authenticity.

Fig. 16 – *Example of survey of a rural building* (Vanja Macovaz, 2024).

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The validity of the method at issue also becomes apparent in light of its ability to correlate architectural features with the environmental context and identify the extent to which the interaction between geology, hydrography, and vegetation has borne an influence on the choice of both raw materials and construction techniques. This aspect is pivotal for the conservation of rural heritage, as it underscores the intricate relationship between built structures on the one hand and landscape on the other, thereby leading to the suggestion of conservation strategies that extend beyond the mere preservation of individual artifacts.

A strength of this study lies in its capacity to employ the data being collected for the purpose of formulating operational restoration and maintenance guidelines, promoting the utilization of materials compatible with the original ones, and the preservation of traditional construction techniques.

The photographic documentation and geolocation of this building survey also provide a useful reference for the continued monitoring of both the relevant states of conservation and the decay processes, thus allowing for timely and targeted interventions.

In conclusion, the work lends some significant contribution to the knowledge and protection of rural architecture in that it provides tangible tools for the conservation of instances of built heritage at risk of being either altered or lost altogether.

The study's validity is rooted in its capacity to provide a comprehensive scientific framework, thus adjuvating both the administrative entities in charge of protection and all professionals on the field.

This framework enables the execution of restoration and valorization interventions that are in accordance with the historical and cultural identity of each building at issue (Fig. 16).

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Building Techniques and Environmental Stewardship of the First Indigenous Peoples of South Africa

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Abstract

This paper examines the construction techniques applied to self-built houses in the village of Zaaimanshoek, located in the remote Baviaanskloof, a valley in the Eastern Cape Province of South Africa. The village and dwellings were the main subject of a research project led by Prof. Magda Minguzzi in collaboration with First Nations leaders, staff, and students at Nelson Mandela University. It examines how traditional construction techniques, still practised by the First Nations People, prioritise low embodied energy in construction, material reuse, and a deep respect for environmental balance. These practices not only address environmental challenges but also preserve cultural heritage, laying a sustainable foundation for future generations. There is an inseparable link between construction, culture, and ecology, illustrating how architecture can serve as a living record of cultural heritage. Through community-driven methodologies and knowledge-sharing, the study documents the continued relevance of these practices, fostering a sense of belonging and continuity within the community. This paper further explores the value of Indigenous Knowledge Systems in the built environment and their ongoing role in sustainable construction. By safeguarding these techniques and recognising their contributions, the research supports both cultural preservation and environmental stewardship. The study also presents a detailed technical analysis of these construction methods, emphasising their structural integrity, efficiency, and adaptability for contemporary use. These techniques have been passed down through generations; they minimise waste, maintain environmental balance, and offer valuable insights for sustainable architectural practices. Preserving these skills is essential for protecting cultural heritage and advancing environmentally responsible building solutions that reduce the environmental impact of modern construction.

Keywords: *Indigenous Knowledge Systems (IKS); cultural heritage through building practices; material reuse; self-built houses; environmental stewardship*

1. Introduction

This paper focuses on the construction techniques applied to self-built dwellings in the village of Zaaimanshoek, located in the remote Baviaanskloof Valley in the Eastern Cape Province of South Africa. The village and dwellings were the main subject of a research project led by Prof. Magda Minguzzi in

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collaboration with First Nations leaders, staff, and students at Nelson Mandela University. These houses, dating back over a century, reflect building traditions that maintain deep connections to cultural identity and environmental sustainability (Minguzzi, Navarro & Vosloo, 2022). The above-mentioned research investigates how these construction techniques are not just preserved but actively adapted as they are passed down through generations.

Regarding the First Nations People in South Africa, Zaaimanshoek, their intergenerational knowledge-sharing in the built environment has created a living record of cultural heritage, demonstrating an approach to architecture that has sustained both the community and the environment. In this context, culture, construction and ecology are inseparable.

2. The research objectives

The research project seeks to document, study, and raise awareness of the tangible and intangible heritage of South Africa's First Indigenous Peoples.

This heritage was identified during a site visit to the Baviaanskloof area by Gaob (Chief) Margaret Coetzee of the Inqua tribe, Prof. Magda Minguzzi, and several community members[1]. The study focuses particularly on self-built settlements and houses in this area.

Fig. 1 – *Eastern Cape Province, study area, Baviaanskloof, Zaaimanshoek* (Vosloo & Minguzzi, 2024)

[1] For further details, consult: Minguzzi, Navarro & Vosloo, 2022.

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2.1. Methodology

The research methodology applied in this research, termed "Indigenous methodology," was developed through collaboration between Minguzzi and the community, beginning in 2015. Since then, a dedicated working group of community members and staff from Nelson Mandela University has undertaken community-led projects that integrate teaching, learning, and research. This project is one such initiative (Minguzzi et al., 2021).

Applying an Indigenous methodology required establishing a research framework and data collection process rooted in the worldview and protocols of the First Nations Peoples.

This ethically grounded approach is based on mutual trust, respect for diverse perspectives, collaborative decision-making, and reciprocal knowledge-sharing.

It upholds the right of Indigenous Peoples to maintain full control over their knowledge and ensures adherence to Indigenous protocols (Minguzzi, 2025).

Fig. 2 – *Master builder in the process of construction of house in area under study* (Minguzzi, 2022).

3. Research area

3.1. Environmental stewardship

The thoughtful selection, reuse, and integration of natural and repurposed materials reflect a deep respect for sustainability and resourcefulness.

The plant life in the Zaaimanshoek area plays a crucial role in the construction of houses, with plants being used as natural materials for walls. Alternative plants with similar functional properties are utilised when specific resources are unavailable locally, demonstrating a deep understanding of the local ecosystems (Vosloo et al., 2024).

Locally sourced plants such as agave plants, Spanish reed, and bluebush[2] are harvested using traditional tools, ensuring minimal disruption to the surrounding ecosystem. Blue gum poles, originally used for farm fencing, are repurposed for structural support poles (Vosloo et al., 2024), illuminating waste production. When families expand or adapt their living spaces, the original building materials are reused in extensions or modifications, ensuring that resources remain in circulation. Conversely, when a house is reduced in size or discarded, materials are carefully dismantled and reintegrated into new structures or returned to the earth, leaving no visible debris on-site; this approach underscores the positive environmental impact of this building technique.

The simplicity of the construction process allows buildings to be completed in days, unlike Western applications that often require extensive time and resources. The building process uses only basic tools and traditional hand-measured techniques and is initiated with the excavation of

[2] Spaansriet (Afr.), Spanish Reed (Eng.) (PlantZAfrica, 2005). Used in the construction of wall infill, an Indigenous construction technique; Bloubos (Afr.), Blue Bush (Eng.) A native plant to central and southern Africa, the common name 'Bloubos' refers to the often-bluish colour of the leaves used in the construction of wall infill, an Indigenous construction technique. Bloubos is also harvested for its medicinal properties (Mountain Herb Estate, 2024); Gareboom (Afr.) Agave plant (Eng.) used as structural timber in the beam and post construction.

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the posts, which is carried out manually with the help of the family. These houses follow the post-and-beam method, where timber posts provide structural support, forming a lightweight yet durable framework onto which walls are placed (Ching, 2014). This approach, commonly used in open-plan design in housing, reduces the need for interior walls as the beams bear the roof's load, maintaining openness and flexibility. Further enhancing this adaptability, reed infill is used for both external and internal walls, allowing the structure to expand or reduce when needed.

3.2. Assembly techniques

According to Ferreira (1981), traditional nomadic peoples' houses, such as the Matjieshuis[3], are constructed using natural plant materials. These structures consist of a flexible wooden framework made from local plants, covered with woven reed mats bound together using plant fibres, making them portable and well-suited to the climate. These methods demonstrate how Indigenous communities have long adapted natural materials to create durable, climate-responsive shelters.

While the houses documented here adopt a more contemporary approach, using metal loops and ties for the assemblies of wall panels and roof fixing, the underlying technique remains the same, maintaining the flexibility, adaptability, and efficiency central to Indigenous construction methods. Additionally, the main structural poles use the same method of metal loops and ties, with an added technique of notching beams or posts. This technique allows the main supporting elements to interlock, preventing movement and creating strong anchor points for load-bearing components (Vosloo et al., 2024).

The careful selection and placement of materials is another essential aspect of the technique. Vertical poles are chosen based on their height, with longer poles placed at the roof apex and shorter ones at the structure's front and back (Minguzzi, 2022). The process of measuring pole placement using the human body reflects the intimate relationship between the builder and the materials, ensuring a precise layout. When poles are too short, the method of splitting and reattaching extensions—securely nailed and tied together—ensures a continuous, functional structure, maintaining strength and stability.

Fig. 3 – *Material used in the construction of wall panels for houses* (Minguzzi, 2022).

The technique extends to the roof, where horizontal beams and rafters are secured with wire loops, creating a tight bond that ensures the stability of the framework. The window frames further strengthen the structure by bracing the main posts on which the beams rest. The wall panels are constructed using Spanish reed, placed between the vertical poles and supported by horizontal reeds. These panels are fixed by inserting the reeds into grooves made between the poles, stabilising the wall and ensuring a firm, durable construction.

[3] Matjieshuis (Afr.), Mat-house (Eng.) The traditional reed mat houses of the nomadic peoples (Ferreira, 1981)

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Fig. 4 – *Wall panel connection of post and horizontal supporting reeds to receive reed infill* (Minguzzi, 2022).

3.3. Restoration of houses

The restoration of houses in Zaaimanshoek is not merely a practical necessity but a deeply ingrained cultural practice tied to seasonal changes and important community celebrations. The months of December and January provide ideal conditions for restoration work. This period coincides with the return of family members for the holiday season, leading to a communal effort to repair, maintain, and enhance homes in preparation for gatherings.

Beyond maintenance, restoration is a symbolic act of renewal, reinforcing social bonds and honouring ancestral traditions. The process often involves reapplying natural materials such as clay and reeds or adapting homes to accommodate extended family members. These seasonal restorations serve as both practical interventions and cultural affirmations, ensuring the preservation of Indigenous knowledge across generations.

4. Conclusion

The built environment in Zaaimanshoek is a living expression of cultural continuity, where construction methods reflect both adaptation and heritage preservation. More than just physical structures, these homes serve as living records of oral history, embodying generations of knowledge, tradition, and environmental wisdom. Each building, constructed using traditional techniques, carries layers of storytelling and community memory within it, reinforcing the connection between past and present. Through hands-on learning and intergenerational knowledge-sharing, younger community members inherit not only the technical aspects of building but also the cultural values embedded in these practices.

These techniques provide valuable lessons for contemporary construction, offering an approach that balances environmental stewardship with cultural preservation. While continuously adapting, these building techniques have responded to social and environmental changes. However, it is crucial to explore why, despite these adaptations, traditional natural materials for fixing, once central to the construction process, are no longer in use. By revisiting these methods, we can better understand why they were abandoned and whether their principles can be adapted or enhanced to address today's environmental needs.

Furthermore, the preservation of these techniques should involve collaboration between multidisciplinary specialists (Kovanen, 2002) to ensure the long-term sustainability of materials, particularly in managing plant resources to sustain traditional building practices. Through this approach, we can bridge the gap between cultural preservation and contemporary sustainability, creating a more environmentally responsible and culturally aware future for construction.

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Damage Historical Prevention in Southern Italy's Built Heritage. A Focus on Holed Masonries Through Campania and Molise Regions

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Abstract

The paper pays attention to the historical building preventive technique consisting of the insertion of transversal wooden elements for the reinforcement of the walls. The 'mixed' wood-stone technique, generally interpreted as a variation of the ancient building methods of opus gallicum*, is recognizable with evident differences from this latter in Medieval and Early Modern castles (e.g. Cervinara Castle) and archaeological Medieval urban sites (e.g., the ancient Cerreto Sannita). The recurrence of circular holes placed at fairly regular intervals along wall faces, of wooden fragments and mortars' internal finishing characterizes fabrics of Molise and Sannio contexts, typically affected by seismic events. An exhaustive framework of the technique is not yet available, neither in relation to Italian contexts nor in relation to European building areas. The interpretation of the construction phenomenon through a broad comparative lens is presented as a research perspective to understand the reasons of construction solutions and in the choice of wood species. Through the analysis of a range of case studies, the paper focuses on the above-mentioned construction technique in Italian Central-Southern areas characterized by a historical seismicity interlacing indirect sources analysis and onsite thematic surveys.*

Keywords: *mixed masonries; opus gallicum; wood; seismic prevention; construction history*

1. Introduction

Historic earthquakes have determined responses of progressive improvement in the ability both to predict and react to events optimizing constructive ways and, more widely, to manage the emergency (Arrighetti, 2015; Compatangelo-Soussignan et al., 2022; Petrucci, 2023). This is strongly evident in Central-Southern Italy where the presence of a high seismicity is historically a prominent factor in triggering operations aiming at improving the performance of architectural parts in relation to natural hazards. The historical preventive building technique consisting of the insertion of transversal wooden bars into walls can be considered as paradigm of an empirical pre-reinforcement construction expedient aiming at making wood absorb tensile stresses and connect opposite elevations of masonry walls.

Numerous problems arise when faced with such a construction system in relation to its origin and for the possible relation with other needs such as the accommodation of wooden scaffolding or the insertion of protruding elements –made of wood, too – to support bertesques or for the spacing of attachments.

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Fig. 1 – *Bibracte, murus gallicus* (Wikimedia Commons).

An exhaustive interpretation of the technique is not yet available in relation to Italian contexts: some interesting in-depth studies have been recorded for building areas in Tuscany (Bramanti, 2002) and Molise. It has been studied mainly by Luigi Marino, who also referred, albeit with some variations, to the use of the construction system in the Near East (Marino, 1983, 2007, 2008, 2009; Dinelli et al., 1991).

Literature is wide when dealing with European building areas: detailed researches afford the topic in relation to ancient Celtic *oppida* and Gallic fortified 'mixed' walls – made up the so-called *opus gallicum* (Fig. 1) – with attention to their constructive, symbolic and defencing role (Doperé & Ubregts, 2003; Épaud, 2007; Fichtl, 2010; Moret, 2018).

2. The origins in historical sources

A possible ancient mention of the stone-wood mixed technique could be recognized in the Old Testament referring to King Cirus and the Temple of Jerusalem: *"There should be three layers of great stones and one of timber"* (Ezra 6:4, New International Version).

The so-called *opus gallicum* – a construction technique that has been considered as a reference point for reinforced masonry we are dealing with – was firstly described by Caesar in *De bello gallico*: "Throughout Gaul, walls are more or less built this way. They put beams in the ground at regular intervals, without interruption, along the entire length of the wall, two feet apart. Then they bind them on the inward side and fill the intervals with earth; these intervals are filled in at the front with large boulders. Once all this is in place and cemented in place, another similar row of beams is added on top, to maintain the same interval, making sure that the beams do not touch each other but divided by equal spaces, each one rests exactly on the boulders placed between the first. And in this way the whole wall is built until it reaches the desired height. On the one hand, this work is not unpleasant to look at because of its harmonious variety, with that alternation of beams and stones arranged in straight lines; on the other hand, it offers great advantages for the defence of cities, because the stones defend them from fire and the timber protects them against the battering ram, as the beams are bound on the inside with others of a single piece, usually forty feet long" (Brindesi, 1974, pp. 132–133).

Later, Vitruvius mentioned walls strengthened by "poles of toasted olive wood (...), so that the two faces of the wall, connected with these poles as with harpoons, have eternal durability" (Napolitano Galiani, 1854, p. 132). After centuries and frequent mentions in Renaissance treatises (Bramanti, 2002), the technique was cited by Viollet-le-Duc in relation to its use in Carolingian and Merovingian French architecture recalling its use by the Gauls (Viollet-le-Duc, 1854–1868, Vol. 2, p. 396, s.v. *Chainage*). Auguste Choisy mentioned it in relation to Byzantine masonries with the insertion of small wooden beams in the facings arranged in both directions, with a temporary function and aimed at containing localised subsidence during the settling period (Choisy, 1883, pp. 116–117).

An evident variation in goals and construction modalities emerges over centuries and contexts. If the *murus gallicum*, with its very pronounced thickness, was armed in both directions (longitudinal and transversal), local material cultures expressed different dispositions of the wooden bars over the centuries with a recurring adoption, more generally, in fortified architecture.

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Fig. 2 – *Ancient Cerreto (Cerreto Sannita, Benevento). Aerial view of the medieval site; detail of the position and the six holes for wood bars on the south-west front of the donjon* (Iovine & Giacco, 2021).

No evident relation – despite what is recurring in literature – is possible to define between the ancient solutions (i.e., Celtic and Gaul ones) and the holed masonries recognizable in Central-Southern Italy. As emerges from Medieval case studies, wooden bars are, in the examined fabrics, almost only transversal and little in diameter: possible influences on this autochthon technique from the conquerors Norman yards have still to be clarified, too.

3. The diffusion in Central-Southern Italy

In medieval Italian construction yard, the 'mixed' wood-stone technique – a variation of ancient building methods adapted to the existence of a medium-high seismic risk – finds applications especially in Norman Age fortified buildings in the Sannio and Molise contexts.

Evidence of adoption of this 'improved' masonry performance method was found at the archaeological site of ancient Cerreto, known from sources from at least the 10th century (Fig. 2). The Norman donjon – dating between the 12th and 13th centuries – must have had a considerable height of around 30 metres and a thickness ranging between 3,95 metres at the base and 3,20 metres. In detail, archaeological investigations revealed a system of concentric 'rootings' with respect to the tower plan; together with these, wooden timber traces were found transversally to the masonry at the level of the inner floor and the (collapsed) vault at the top. A recurrence of circular holes, approximately 10-12 cm in diameter and lined internally with mortar, marks the *donjon* (Lonardo, 2022, p. 415; Romano, 2024).

A similar construction expedient characterises the tower at contrada Ferrarisi in Casalduni dating back to 11th century. In the structure in *opus caementicium* with *opus incertum* facing, we can recognise small-diameter (approximately 5-8 cm) transverse circular holes, probably containing wooden bars that radially crossed the thickness of the masonry (approximately 3,80 metres at the base) at the impost of the internal vault (Lonardo, 2022, pp. 417–418).

A widespread presence of circular holes of a similar size in the Sannio region can be found on the walls of the northern tower of the Puglianello castle, characterized by much greater wall thicknesses than the other three cylindrical towers of the same castle.

Confirmation of the recurrent use of the technique in medieval Southern Italy is given by the presence of this structural performance-enhancing technique in the pillars supporting the main arch of the church of San Giovanni a mare in Naples, dating back to the late 12th century (Russo, 2005). These, with an almost quadrangular cross-section and a structure in yellow Neapolitan tuff and a cladding in Piperno (a local volcanic stone), appear to have been pre-consolidated by means of wooden elements arranged transversally with the probable function

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of absorbing tensile stresses and continuously connecting the cladding to the wall core of the pillar.

In the Molise context, it is possible to find relevant solutions aiming at improving the performance of masonry with respect to discordant tensile and bending stresses in several fortified structures dating almost to the Norman domination. In Roccamandolfi fortification, dating back to the 12th century, traces of circular holes with a diameter of approximately 10 cm and a depth equal to the entire wall thickness were recognised on the rectilinear and circular masonry of the towers (Marino et al., 1996). Traces are in the tower of Santa Croce di Magliano (Marino, 1983; Edlmann Abbate, 1983; Ebanista, 2007), in the castles of Pesche (Testa, 2022, p. 307; Testa, Catuogno, & Pane, 2023) (Fig. 3) and Civita di Bojano (Marino et al., 1996), too.

The holes recognized in these structures are circular in shape, approximately 10 cm wide, placed at fairly regular intervals along the wall face. In some cases, wooden fragments still in situ have been recovered (Edlmann Abbate, 1983; Marino, 1983, 2008, 2016; Dinelli & Nenci, 1996).

Fig. 3 – *Pesche (Isernia). Detail of the tower elevation with a regular mesh of holes.*

4. The case study of Cervinara Castle

The Castle, originally of Norman foundation and built on a probable Lombard pre-existence, can be interpreted in relation to the wider defensive chessboard of the Caudina Valley in Campania region, reflecting in its construction the alternating dominations and powers that affected the territory (Russo & Prisco, 2022). The signs, deduced through stratigraphic analysis of the elevations and recognizable in the richness of the wall types, in the joints, in the positive and negative interfaces noticeable on the artefact, today represent a complex map of values that need to be protected.

The fabric rises at the foot of the Partenio mountain at about 460 meters above sea level, from where it visually dominates the entire valley and the surrounding settlement, emphasizing the ancient strategic role. It is surrounded by walls that are punctuated by turrets, includes the donjon, and horizontal structures are completely collapsed. The feudal dwelling – *palatium* – is articulated in two rooms: a smaller one probably intended to be used as a stable, and another, larger room equipped with a large fireplace, conceived as a noble hall. From the feudal residence, it is possible to reach the tower, the access to which is located at a level higher than the ground level, using the remains of an external masonry staircase attached to it.

The first mention of a fortified centre in Cervinara dates to 840 AD when the Chronicon Vulturnense refers to a "castrum (...) quod dicitur Cerbinaria in Caudentanis" (Federici, 1925, Vol. 1, p. 306). With the arrival of the Normans, the policy of development and territorial design changed radically and almost all of what is left of the building today would belong to this Norman phase the stone *donjon* tower is an eloquent expression of (Coppola, 2003, 2005, 2019; Megna, 2008, 2013–2014). The fort of Cervinara, attacked and burnt during the conquest by Frederick II's troops, was probably restored in

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Fig. 4 – *Cervinara Castle. South-West elevation*.

Fig. 5 – *Cervinara Castle. Detail of the transverse holes regularly spaced along the masonry*.

these years, raising the tower – of which the Norman battlements will be incorporated – and replacing the wood in roofs of the *palatium* and *donjon* with vaulted masonry roofs.

The material-constructive consistency of the fortress was investigated through an in-depth direct survey, which revealed information about everyday elements of castle life as well as features typical of military architecture. The masonries showed a great variety of textures characteristic of different historical phases with distinctive and recurring traits. From the information documented during the survey phase, it was possible to identify stratigraphic units in the plan and the elevations from which to define the probable transformations of the building.

The study of the external elevations permitted the recognition of a series of signs that provided interesting insights. The wall panels are characterized by limestone, probably quarried on site, by rough-hewn and widely irregular ashlars. The analysis of the building has highlighted the presence of a conspicuous number of lodgings for wooden chains (‘*radiciamenti*’) with a quadrangular or circular section, arranged longitudinally within the wall sections of the *palatium* approximately in correspondence with a collapsed vault spring; a structural prevention measure, the latter, widely present, as in Abruzzo, also in the Sannio area of Benevento and Molise at least starting from the Norman Age and arranged at the same time as the construction of the structures.

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The elevations of the fortress revealed, more specifically, the presence of a conspicuous number of holes: a complex map of signs to be understood and protected (Fig. 4–5). Visual investigations, aided by the stratigraphic interpretation of the elevations, proved to be of great help in the recognition of holes that can be identified mainly in the *palatium* and the Norman tower. Except for few holes clearly attributable to the wooden floor beams in the tower, the chains at the imposts of the cross vaults of the *palatium* which have now collapsed, and the marks imprinted on the surfaces by the lintels, several through-hole systems in the masonry of different shapes and sizes are clearly recognizable.

In the *palatium* and the room thought to be used as a stable, a conspicuous number of circular holes with a diameter of approximately 10 cm, covered by a thin layer of lime mortar on the inner surface were catalogued. These holes, with an irregular distribution, seem to be concentrated adjacent to the openings and the corners, not affecting the elevations in their entirety. This peculiar irregularity in distribution, together with the presence of the inner layer of mortar, could exclude their use in connection with scaffolding for the construction of the building.

Unlike the Roman *opus gallicum*, which provided for the reinforcement of the walls with wooden elements arranged both longitudinally and transversally, only transversal through-holes can be found in Cervinara castle with respect to the thickness of the vertical partitions, arranged at approximately one metre and with wood fibre imprints (chestnut?) impressed in the mortar lining the hole. In the Norman *donjon*, on the other hand, there are variations in the types of perforations, circular, rough, and quadrangular. This curious arrangement on the various elevations appears to be rather regular and recurring over the entire surface whose placement especially in correspondence to the construction sites suggests a possible use in connection with through-type scaffolding (Coppola, 1996). The scaffold may have been built from rafters embedded in holes running through the entire masonry to support, together with rafters and struts, the work surface consisting of a planking on both sides of the structure.

The presence of wooden traces within some of the holes, however, suggests a dual use of these holes as cavities for housing the rafters during construction and as the location of wooden elements with the function of an internal reinforcing chain. The rafters of the scaffolding may, as in other cases, have been sawn flush with the masonry to meet the need for reinforcement of the face during the settlement phase. Dendrochronological investigations, aimed at dating the wooden elements, will be of great help in understanding the historical period in which the reinforcements were put in place or their possible replacement.

5. Conclusion

The interpretation of the construction phenomenon through a broad comparative lens represents a necessary research perspective to understand the reasons and variations in construction methods (e.g., with respect to the arrangement of the holes and the relationship with the wall thicknesses) and in the choice of wood species.

In particular, the analysis of a wide range of case studies leads to excluding a direct filiation of the Southern Italy 'holed' masonry technique, typical of a historically seismic context, from the far *opus gallicum* construction method, as very frequently literature has more generally marked.

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Insights from Past Technological and Intellectual Adaptations in Japanese Traditional Thatch Architecture

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Abstract

Japan's diverse geography and climate have fostered one of the world's most varied styles of thatched roofs, with each region's vernacular architecture being shaped by unique environmental conditions, cultural traditions, and locally available materials. However, contemporary shifts in these factors have led to the near disappearance of thatched houses in rural landscapes and the decline of maintenance knowledge, necessitating significant adaptations in traditional thatching practices. While modifications in vernacular architecture are often seen as threats to authenticity, this study argues that both past and present technological innovations are crucial for ensuring the longevity and sustainability of thatch structures. This paper examines technical adaptations in Japanese thatch architecture as a response to historical environmental, material, and social challenges that have shaped the distinctive regional styles still present today. Data were collected through 15 site visits to Kita thatch village in Miyama, Kyoto (2021–2024) and three Minka architectural parks in Aichi, Osaka, and Kanagawa. The visits involved detailed interviews with a Japanese master thatcher, photographic documentation, and architectural surveys. By analyzing and categorizing adaptations across Japan, this study demonstrates that evolution preserves and enhances authenticity by addressing regional needs and challenges. Guided by skilled local craftspeople, these adaptations ensure vernacular thatch architecture remains relevant while providing sustainable insights for the future of the craft.

Keywords: *traditional thatch technology; vernacular heritage preservation; intellectual resources; technological adaptation; craft sustainability*

1. Introduction

With growing national and international recognition, traditional thatch technology is one of Japan's most valued forms of rural architectural heritage. However, the transmission of this knowledge to future generations of thatch professionals and the preservation of its intellectual resources remains significant challenges that require immediate attention.

The oldest thatched roofs in Japan date back to the Jomon (10,000–1,000 BC), Yayoi (50–200 AD) (Fig. 1), and Kofun (500–600 AD) (Fig. 2) periods (Ando. 1983; ACBECP. 2017). These early dwellings, simple semi-buried structures,

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have been preserved in historical parks and can be considered as the origins of thatched architecture in Japan, from which all other forms have stemmed. Given the present diversity of regional thatch roof types across Japan, this study examines two interrelated aspects of technological adaptation in contemporary thatch craft. The central investigation explores: (1) How, considering evolving thatched conservation policies, past and present technological innovations are essential for ensuring the longevity and sustainability of thatch architecture. Historically, thatchers worked locally and developed extensive knowledge specific to their region's thatch types (Ando, 1983). Contemporary circumstances, such as the declining number of active thatchers, now approximately 200 (Ando, 2020), have necessitated an expansion of their work to a national scale, reinforcing the importance of these innovations. (2) Therefore, the study also explores how current thatchers acquire techniques from regions outside their traditional areas of expertise. This aspect provides insight into the transmission of knowledge and adaptation of practices beyond local traditions, further supporting the sustainability of the craft. While changes in vernacular architecture are often viewed as compromising the authenticity of traditional buildings, the Nara Document on Authenticity (ICOMOS, 1994) emphasizes that evaluations of cultural value and authenticity must be conducted with respect to the diversity of cultures and heritage, recognizing their unique contexts and significance. In Japan, authenticity is not an objective explicitly referred to in cultural property legislation (Henrichsen, 2017; Weiler, 2016). This paper seeks to expand upon the relatively recent scholarship on the evolution of Japanese thatch roofs, which have primarily developed since the mid-1950s (Nihon Minkaen, 2007). By examining past adaptations to environmental and socio-economic challenges, this study explores how these factors have driven the evolution of various thatch house forms across Japan and contributed to their authentic regional character. It is well established in Japanese literature that Minka designs are closely tied to the climate and characteristics of each region (Japanese Folk House Museum, 2006; Brown, 2022). To further the corpus of research, this study expands on existing research by sharing findings from studies conducted predominantly in Japanese and highlighting these structures' evolution, emphasizing the need for modifications and adaptations in contemporary conservation.

Fig. 1 – *Higashiune Oita park, Yayoi- period dwelling* (Author, 2025).

Fig. 2 – *Higashiune Oita park, Kofun - period dwelling 2022 conservation work* (Author, 2025).

2. Methodology

This research was conducted through site visits guided by a master thatcher with over 30 years of professional experience. He leads one of Japan's largest thatching companies and specializes in the Kyoto Miyama style, while also possessing expertise in thatching techniques across all regions of mainland Japan. His direct involvement in the conservation of several

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houses in these parks provided key insights into regional building techniques and materials. His knowledge of site-specific techniques and materials offered a unique perspective, especially in cases where he had previously worked on the houses. During these visits, expert interviews focused on the architectural characteristics of each house, supplemented by photographic documentation and structural measurements. These analyses, paired with insights into hidden thatch structures not visible post-conservation, provided valuable context. The case studies were selected to reflect the main thatching zones in Japan, ensuring a representative analysis of regional variations. Field expeditions included 15 visits (2021–2024) to Kita thatch village in the Kyoto region, along with surveys at three Minka architectural parks, specifically chosen for their representation of Japan's three primary thatching zones: The Little World Museum of Man

(LWMM) in March 2021 (Reflecting the North and South styles), the Hattori-Ryokuchi Koen Osaka Museum of Japanese Folk Houses in August 2024 (reflecting the Western style), and the Kawasaki Minkaen, Municipal Japanese Folk House Museum in September 2024 (reflecting the Eastern style). All the houses analyzed were authentic, relocated structures. To further validate the findings collected data were cross-referenced through literature reviews and follow-up expert interviews with representatives from the Japanese Thatch Cultural Association (JTCA) in September 2024, alongside participation in their professional workshop in Miyama in November 2024. This process helped to corroborate the findings and to provide deeper insights into regional variations and conservation challenges. A comparative analysis was conducted to identify key drivers of change, focusing on material availability, environmental factors, and socio-economic conditions. Technological adaptations and shifts in intellectual resources were categorized to understand how thatch architecture has evolved over time. This method enabled a comprehensive assessment of technological solutions and their role in sustaining thatch-building techniques.

3. Threats and catalysis of changes

The consensus within thatch roofing literature identifies weather-related damage such as: High winds, heavy rains, and snowfall, as primary threats to thatch roofs. However, these are not the only risks facing thatch roofs across Japan; several other factors, including sometimes non-threatening catalysts for change, also pose significant challenges (Okawa, 1962; Yoshida, 1985; Tsuda, 1995; Nihon Minkaen, 2014). These catalysts have led thatchers and owners to adapt and optimize their roofs through various thatching modifications which have, in turn, become characteristic of regional designs. The various threats are categorized by issue types in Table 1.

4. Case studies

The selected case study examines the house in response to the coded threats that have led to specific technical transformations. The location of the house is particularly significant, as regional thatching zones influence both roofing techniques and maintenance practices. A map (Fig. 3) has been developed based on data

Table 1 – *Categorization of thatch threats in Japan.*

Issue Type	Threat / Catalyst		
A. Weather-related damage	Heavy rain	Heavy snow	High winds
B. Material-related issues	Weathering, Decay	Fire, Desiccation	
C. Maintenance-related issues	Change in usage	Improper Ventilation	Animal and pest control
D. Structural weaknesses	Weak structural points	Lack of skilled maintenance	
E. Human resources	Knowledge or skills loss	Lack of professionals	
F. Cultural aspects	Taboos	Folklore beliefs and religion	

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Table 2 – *Traditional thatch material and Localisation.*

Thatch Kaya 茅	**English terminology *Scientific name***	**Localisation**
Susuki ススキ	Pampas grass *Miscanthus sinensis*	Widespread, especially mountainous areas
Yoshi ヨシ / 葦	Reed *Phragmites australis*	Widespread, especially mountainous areas
Wara 藁	Rice straw *Oryza sativa*	Agricultural zones (rice-producing areas)
Chigaya チガヤ	Cogon grass *Imperata cylindrica*	Widespread across Japan
Mugi-wara 麦藁	Wheat straw *Triticum aestivum*	Grain-farming regions
Ogi 荻	Silvergrass *Miscanthus sacchariflorus*	Riverbanks and moist regions
Kariyasu 刈安	Fine miscanthus *Miscanthus tinctorius*	Chubu region (Shirakawa-gō, Gokayama)
Sasa 笹	Bamboo grass *Sasa veitchii*	Northern, central-west & mountainous regions
Suge 菅	Sedge grass *Cyperaceae*	Wetlands or marshes

collected from the master thatcher, illustrating Japan's thatching practices as divided into ten subzones according to the technical expertise of a leading thatching company. Within the main island, these sub-zones are categorized into three major zones, highlighting a distinct division between the eastern region (case studies 2,3) and the western region (7,8,9). The central zone, or the wider Kanto area, serves as a transitional region, incorporating elements from both eastern and western thatching techniques (4,5,6). This zone can be further divided into two, reflecting a drastic shift in architectural forms (Fig. 3). The Kanto style, characterized by low ridges and gentle slopes, likely evolved as an adaptation to the region's higher population density, whereas the Hokuriku region reflects its historical silk production economy and the need for heavy snow resilience in its roofing forms. This regional classification applies specifically to Japan's main island and excludes Hokkaido (case 1) and Okinawa (case 10), which possess distinct thatching traditions shaped by indigenous Ainu and Ryukyuan cultures, respectively. Therefore, these two regions are automatically regarded as separate zones. The original location of each house is recorded on the map and numbered according to its respective regional classification.

The analysis focuses on specific techniques that thatchers acquire beyond their local expertise, the learning mechanisms they employ, and the challenges associated with adapting to different material and environmental conditions. To avoid redundancy, repeated modifications, such as form evolution, are not duplicated, keeping the focus on original adaptations in the final roofing structure. Case study results are categorized by adaptation issues, highlighting regional differences.

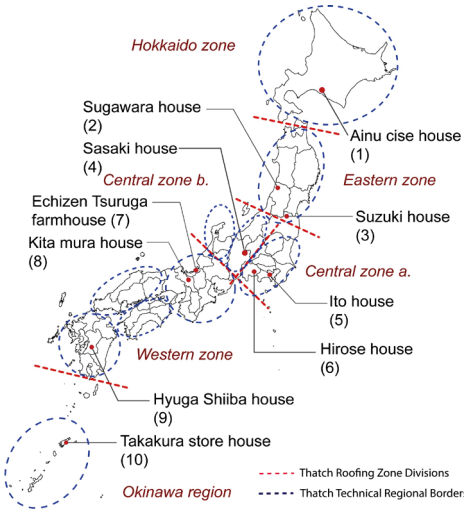

Fig. 3 – *Houses locations within Thatch technical zoning from master thatcher perspective* (Author, 2025).

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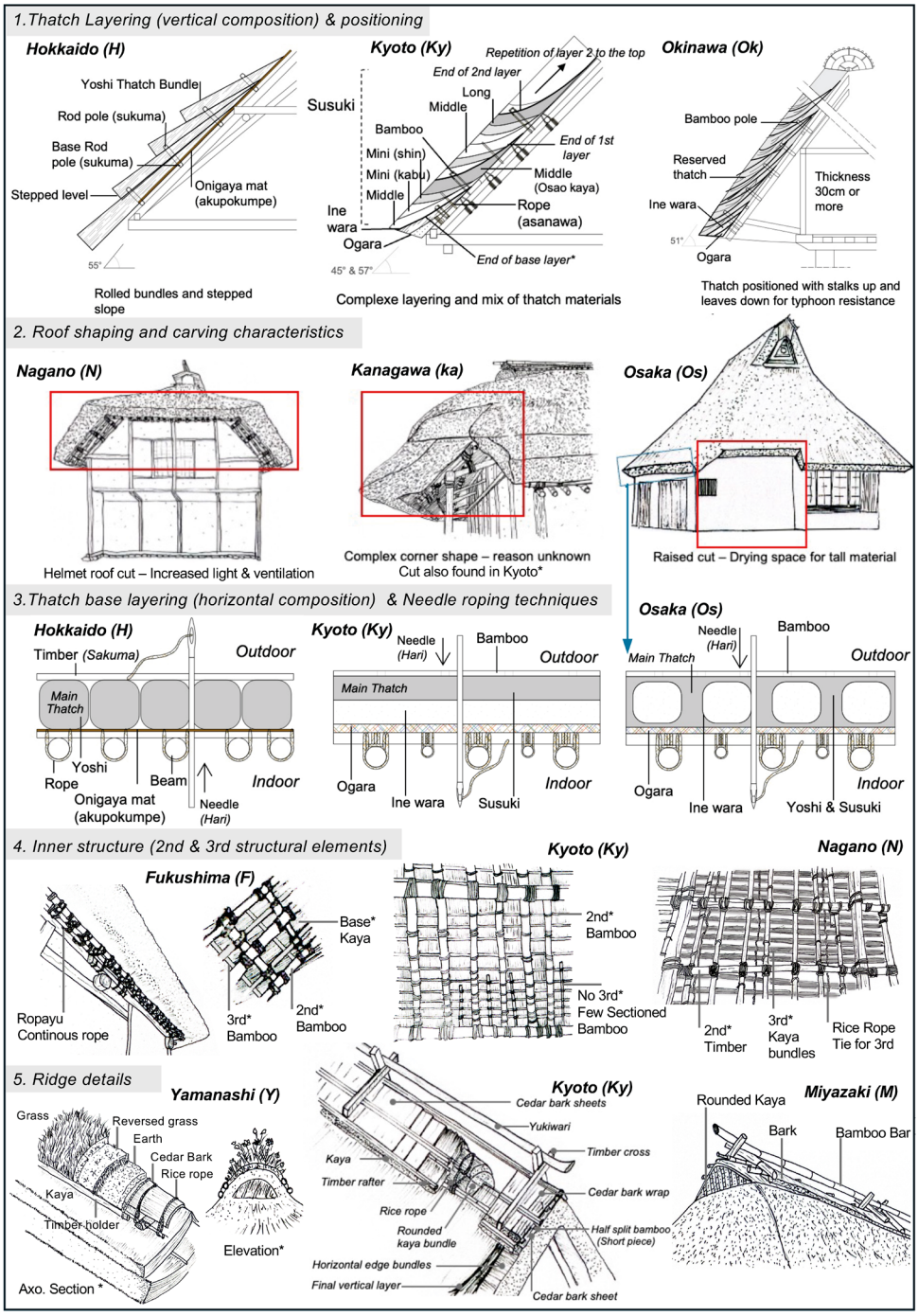

Fig. 4 – *Selected variation in technical characteristics of Japanese Thatch.*

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Climatic adaptation: Climatic adaptations in Japanese thatched architecture showcase a deep integration of environmental responsiveness, with roof designs tailored to address climatic challenges, reflecting a clear division between northern/eastern regions and western/southern regions in their approaches to durability and functionality. In Northern Japan (Hokkaido), which is prone to heavy snow and cold weather, *cise* houses feature upside-down fan-shaped thatch bundles to improve water runoff and prevent infiltration (Fig. 4.1.H). Thatch is bundled together to form a thick insulating layer, using an "envelope performance" mechanism to retain heat. In the snowy regions of East Japan (e.g., Nagano, Gifu, Toyama, and Yamagata), thatch roofs are steep and thick to shed snow effectively. In contrast, West and South Japan, especially typhoon-prone areas like Kyushu and Okinawa, feature gentler roof slopes to withstand strong winds, with horizontally layered thatch that reduces the wind impact. The Okinawa region for instance employs reversed thatching that enhances resistance against typhoon impacts (Fig. 4.1. Ok).

Material adaptation: Traditional thatch materials in Japan, *Kaya* were once locally sourced according to regional availability (Table 2). Today, they are often purchased from large kaya-producing fields, marking a shift away from local specificity, though professionals still strive to use varieties best suited to their regional context. In Northern Japan (Hokkaido), *cise* houses use timber as the tertiary structural material. They are directly sourced from forests and remain uneven, thereby adding to the uniqueness of the structure (Fig. 3.1.H). Onigaya roof mats, bound with grapevine bark, provide sturdiness and fire resistance. In Eastern Japan's Fukushima region, bamboo is frequently used for rafters, although it requires more frequent repairs than timber, typically every 10 years (Fig. 4.4.F). In snowy Yamagata, areas prone to water accumulation see thatch strengthen with wooden plates along the valleys, resulting in greater durability. In both Eastern and Central regions, Shiba mune, or planted ridges, function as water-resistant features and natural fire indicators (Yamaguchi, 2022), with plant wilting signaling dry air and fire risk (Fig 4.5.Y). In regions like Nagano, while timber is used as the secondary structure, bundles of thatch serve as the tertiary structure, helping to support the weight of snow by bending without breaking (Fig. 4.4.N). West Japan, particularly Kansai, relies on longer-lasting wood rafters, with a lifespan of around 20 years, and Bamboo is used for its secondary structure (Fig. 4.4.ky & 4.5. Ky). Techniques harnessing the material properties, such as layering *Shin,* the upper part with leaves, to absorb moisture and keep *Kabu,* the stalk section, dry, are also used for maintaining roof durability (Fig. 4.1. Ky). In Kyushu, thatch lengths are chosen to match human proportions, making the thatching process efficient and reflective of local practices.

Maintenance and usage: In Northern Japan (Hokkaido), the construction of *cise* houses is notable for its efficiency, requiring minimal manpower while using precise techniques, such as securing thatch bundles with perpendicular needles aligned with the grain, from the inside to the outside (Fig. 4.3.H). Usage patterns show a clear East-West distinction. In East Japan, roofs were carved into new shapes to create additional usable space, serving both to increase storage on outer walls and add light openings inside, aligning with the region's focus on farming and animal raising, particularly silkworms (Fig. 4.2.N & Ka). Across Japan, hearth smoke traditionally preserved thatch by repelling pests. However, lifestyle changes and the shift to modern kitchens have accelerated thatch decay, necessitating alternative preservation methods.

Structural improvements: Structural improvements in traditional Japanese architecture demonstrate region-specific innovations that prioritize safety, resilience, and efficiency, addressing environmental challenges In Northern Japan (Hokkaido), *cise* houses are constructed with roofs built on the ground first, improving safety and enabling precise weight management during assembly. In East Japan, unique rope-tying

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methods like Roppayui secure bamboo rafters tightly, essential in snowy conditions (Fig. 4.4.F). Complex roof features such as valleys and ridges are reinforced with bark layers between thatch to prevent erosion or sagging. In Okinawa, reverse thatching is used to quickly restore roofs in disaster-prone regions.

Human Resources: In the worst cases, the inability to perform re-thatching due to a shortage of skilled or knowledgeable thatchers has led to the disappearance of minka structures in certain regions, highlighting once more the critical need for knowledge preservation and craft transmission. In Northern Japan (Hokkaido), traditional *cise* houses are no longer used as residences but have been repurposed for ceremonial and public cultural purposes, ensuring their continued relevance and value. East Japan, notably Gokayama, has turned to forestry associations for thatch management due to the scarcity of skilled thatchers. Nationwide, training for thatching has extended from five to eight years to account for regional diversity in techniques and materials, reflecting the differing demands across regions. When working outside their zone of expertise, professional thatchers gather information on roof details and re-roofing procedures by consulting local or retired thatchers, reviewing archives and, as a last resort, taking inspiration from old photographic records and documenting the roof's layers and details during the dismantling work. Despite these efforts, accurately restoring the exact slope shapes and details can remain challenging (Fig. 4.2. Ka). Beyond the clear indigenous distinctions between the North, South, and main island, this analysis reveals a striking East-West divide within Japan's main island, as well as an integration of both sides within the central region, shaped by economic and cultural activities. This distinction highlights the profound interaction between local environmental challenges, technical regional specificities, and the ingenuity of traditional craftsmanship to adapt and expand their technical knowledge, ensuring resilience and continuity in the face of diverse needs.

5. Conclusions

Despite its simple appearance, the thatch roof is a highly specialized architectural element, deeply embedded in Japan's vernacular heritage. This study reveals that innovation within traditional thatch craft is essential for its longevity, demonstrating that the evolution of Japanese thatched architecture is not merely a response to environmental constraints but a dynamic process shaped by socio-economic shifts, material availability, and knowledge transmission. Rather than threatening authenticity, technological adaptations, past and present, have sustained regional thatching by integrating symbolic heritage with essential architectural performance. By examining historical and contemporary modifications, this study highlights key technological solutions tailored to Japan's diverse climate zones. The expansion of thatchers' expertise beyond their local regions marks a shift where contemporary practitioners now have to rely on archival documentation, expert networks, and intergenerational exchanges to adapt their skills. When no other options are available, they depend on their own knowledge and expertise to document the roof themselves, learning from its structure as they dismantle it during conservation work. This process allows the craftsmen to analyze past techniques before beginning the re-roofing conservation work. Extending Kobayashi's (2014) framework, this study underscores the importance of natural, human, and intellectual resources in sustaining thatched heritage. The decline of high-quality domestic materials and shifts in usage patterns, such as the loss of hearth smoke as a natural preservative, have accelerated thatch decay cycles. Addressing these challenges requires improved maintenance strategies, stronger material production, and documentation of expert knowledge, particularly by engaging and recording the knowledge of retired master thatchers. This study further argues that authenticity in Japanese thatched architecture, as a living tradition, is fluid and shaped by necessity rather than rigid conservation principles. Looking forward, revitalizing the craft depends

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on expanding adaptive techniques, strengthening professional training, and re-establishing traditional and local material sourcing to meet the ecological and cultural demands of our time. Guided adaptations contribute to resilience, allowing thatched architecture to respond meaningfully to present-day challenges. These findings provide insights for policymakers, craftspeople, and conservationists working to sustain vernacular thatch architecture where forward-oriented strategies ensure thatched architecture remains both resilient and relevant in the face of ongoing socio-environmental change. A holistic approach integrating material innovation, skill transmission, and adaptive maintenance is essential to sustain this living heritage in meaningful and sustainable ways. While the complexities of these dimensions go beyond the scope of this article and are the focus of ongoing parallel research by the authors, they also offer valuable directions for future studies.

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Solaque: Examination of a Traditional Construction Technique for Water-repellent Continuous Rendering

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Abstract

The city of Sucre, Bolivia, listed as World Heritage in 1991, characteristically displays a unique urban landscape, defined by white façades and contrasting red roofs. Beneath the layers of white paint, rooted in Sucre's collective identity as the "white city of America", this distinctive visual element reveals a traditional render which has survived the passage of time: solaque. This water-repellent continuous render is a key element in local architectural heritage, for both its functionality and connection with traditional construction practices and knowledge passed down over the generations. This work aims to present an in-depth study of solaque, examining its material composition and application process. An analysis is carried out on the slaked lime, puzolana aggregates (sand and ground brick), and organic additives which make it up, together with its different finishes. In addition, a comparison with similar techniques such as Italian cocciopesto highlights the unique nature and potential of solaque in the field of heritage conservation. The etymological and linguistic origin of the term solaque in its role as a continuous render is also examined. This work highlights the need to learn about and document solaque in order to maintain the authenticity and historic value of buildings in Sucre. Emphasis is also placed on the fact that an in-depth understanding of the construction process and traditional knowledge allows points of reference to be established for the sustainable conservation of built heritage. This traditional knowledge can spur the development of contemporary architectural proposals, merging historic practices with modern needs.

Keywords: *Solaque; zulaque; lime; water-repellent render; puzolana; cocciopesto*

1. Introduction

In 1991, the city of Sucre, capital of Bolivia, was declared World Heritage by UNESCO for its urban landscape, resulting from cultural interaction. Throughout history it has been known by different names: Charcas, La Plata, Chuquisaca and, finally, Sucre. Given these different names, which reflect different stages and cultural, historical and political significance, Sucre is known as "the city of the four names", as well as being known by other names including "The Cultured Charcas" and "The White City of America".

This last name is a direct reference to the characteristic image of its urban landscape, where white façades contrast with red-tiled roofs, giving it a unique visual identity.

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Fig. 1 – *Panorama of the city of Sucre* (Serrano, 2022).

> "In the Audiencia de Charcas, white is also mistakenly associated with Spanish colonial architecture which, during the early viceroyal period in the second third of the 16th century, adhered to the canon of the Late Renaissance, adopting circa 1630 an exuberant and profuse Baroque style, which lasted for more than two centuries, until it embarked on the austere tenets of Neo Classicism which appeared in these regions circa 1790" (Author's translation; Izquierdo & Peñaranda, 2017).

This last stage, with a more widespread French influence, was manifested in its monumental architecture. Subsequently, the rich colours of the Baroque period melded with the aesthetic creativity of the American peoples, whose need for recognition inspired the incorporation of ornamentation with native flora and fauna, as well as the use of polychromy on doors, retablos and other architectural elements. This period is considered the most extensive within the viceroyalty. This Baroque chromatic display is widely found in religious architecture, and also spread to residential architecture, where more sober formal resources were adopted. Although white is currently perceived as a distinguishing feature of Sucre, the façades hide vestiges of original renders. Different hypotheses explain the whitening of the city:

> "Towards the end of the 18th century and early 19th century, Sucre underwent a transformation of its style and colour palette. It is agreed that the new style which reached the city was enlightened academicism, based on the aesthetics of classical architecture. This movement found the basis for its architecture in the classical canons, giving rise to the neo-classical era and, in turn, monochromatism" (Author's translation; Izquierdo y Peñaranda, 2017).

Although it is risky to attribute the hypothesis of the change of colours in Sucre to epidemics it is not far-fetched to consider the possibility of the mass use of lime in response to a health crisis, as has been seen in other regions of the world throughout history.

At present, white is the only colour permitted on the façades of the historic centre, as established in Article 35 of the regulation of historic heritage: "the only colour permitted for the façades which give onto public thoroughfares in this area will be white; grey or pastel shades will only be considered acceptable as enhancement for certain mouldings...". The Municipal Government has launched several campaigns of 'beautifying the city' for the annual national celebration of 25th May.[1], encouraging the painting of façades in white. However, beneath the many layers of white paint, easy to peel off, there are traces of a traditional colour render, *solaque*.

The persistence of *solaque* can be seen in the details, particularly in buildings which show some degree of abandonment (Fig. 2). The odd imperfection in the many thick layers of white paint reveals picturesque chromatism, an ancient witness, at least providing a record of its existence.

[1] Revolution of Chuquisaca of 1809, considered the first separatist uprising of Latin America, an event which paved the way for a series of movements which eventually led to the Independence of Bolivia in 1825.

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Fig. 2 – *Tripped ceramic mensula and mouldings, Casona La Galería* (Serrano, 2020).

Fig. 3 – *Removal of layers from mouldings and decorative motifs of the El Telégrafo office, Casa de La Libertad* (Serrano, 2022).

Fig. 4 – *Detail of caryatid with latex paint peeling off, Casa del telégrafo* (Serrano, 2022).

The persistence of solaque can be seen in the details, particularly in buildings which show some degree of abandonment (Fig. 2). The odd imperfection in the many thick layers of white paint reveals picturesque chromatism, an ancient witness, at least providing a record of its existence. This article aims to examine not only the colour, but also the render, which rejects synthetic elements and endures over time. Going around the city simple observation reveals the mysterious *solaque*, predominantly found in shades of red, (Fig. 3) and perhaps less frequently, in yellow ochre (Figs. 4 &5).

2. Objectives and methodology

This research proposes a close examination of *solaque*, a construction technique currently at risk of extinction. Its composition, materials and construction process are analysed in order to contribute to the preservation of Sucre's architectural heritage. The qualitative approach followed in this study takes into consideration the importance of knowledge of traditional construction for the conservation of heritage. A theoretical-descriptive methodology is followed, based on in situ tests and interviews with experts and teachers from the Escuela Taller Sucre, a body in charge of the preservation of the city's monumental architecture. Tests were conducted on the *solaque* in various interventions including the rehabilitation of the Casona "La Galería" (2020), the *Proyecto Barrios Blancos* in *Casona Santa Ana* (2021), and the *Taller de Experimentos del Seminario de Tierra e Identidad* (2021).

In addition, monitoring was carried out on the tests from the vaults of the Metropolitan Cathedral of Sucre (2018) and the Church of *Nuestra Señora de La Merced* (2016). This work was complemented with interviews with the director of the Escuela Taller Sucre and craftsmen specialising in traditional techniques, whose testimonies have enabled a closer examination of the use and application of this type of render. Given the lack of scientific or academic research on this topic this study is exploratory in nature. Although still in its initial stages, this work constitutes a starting point for expanding future research. It also seeks to prompt reflection and find new specialities for research, proving the need for studies that contribute to the preservation and understanding of *solaque.*

3. Examination of *solaque*

According to Carrió's (2003) definition, *zulaque* is "a betún paste made up of burlap, lime, oil and ground glass slag to seal the joints of the fittings in water pipes and other hydraulic installations". According to the definition provided by the Real

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Academia in Spain the term "*zulaque*" derives from Andalusí Arabic to refer to the paste made from burlap, lime, oil and ground glass slag to cover the joints of the fittings in water pipes and other hydraulic works. Rejón (1788) defines *zulaque* as "the same as betún". However, when describing betún, he defines it as a mix made up of lime, oil, ground ceramic tile and slag, used to consolidate stone and brick in underwater works. There is also mention of variants which include hemp and even a hot mix of resin, wax, and fat. In addition, in the reference from Fray Lorenzo de San Nicolás, another formula is mentioned: "you can also make betún by mixing five parts of lime to one of crushed ceramic tile, and half of slag, all sifted, together with cut-up goathair, mixed with oil". This historic document establishes a connection between *zulaque* and betún, highlighting their composition and use in traditional construction. Furthermore, Rivasplata (2013) describes the system of hydraulic connections in the Ecuadoran colony stating:

> "Once the piping was manufactured, one of the greatest difficulties was installing it correctly and especially sealing the joints, for which special pastes called betunes or zulaques were used. In Renaissance Spain, zulaque was the one most commonly used, made up of lime, ground brick (sometimes replaced with ashes from a kiln or glass or slag) and oil, which made this paste suitably malleable. Ceramic piping had to be waterproofed using boiling fat mixed with bristles or cowhair to improve adherence". (Author's translation; Rivasplata, 2013).

These definitions and examples focus their use exclusively on hydraulic works and pipes, as well as considering it only a joint mortar. Therefore, when does it transition from being used to cover joints to becoming a continuous render? This distinction is clarified to some extent recognising that the semantic content of 'zulaque' is not the same as the meaning attributed to *solaque*. However, an examination of the state-of-the-art to date shows no record of the term *solaque* referring to any construction element, system or material providing clarification. The term 'zulaque' may have undergone a process of phonetic transformation during the process of cultural mixing. It is posited that difficulties in pronunciation among the native peoples of America may have been a determining factor in the evolution of the term, eventually leading to the current denomination, *'solaque'*.

Despite the above, the complete definition for the terms *'solaque'* and 'zulaque' do not match. As a result, the use of the term as a continuous render should be studied, analysing components and forms of execution which are almost extinct and only known through oral transmission.

The specialist nature of these techniques, traditionally protected by craftsmen and passed down within the family or from master to student, suggests the existence of technical secrets. Its progressive abandonment has also led to a significant scattering of information, increasing the risk of its total disappearance.

3.1. Definition and application of the technique

Solaque can be described as a water-repellent continuous render made up of a mix of materials such as lime, sand, ceramic dust (brick or tile), puzolana and several organic additives including tuna cactus mucilage, egg white and bovine blood. This construction technique has historically been used as a waterproof render on structures, walls and facings, both earth and brick, highlighting its resistance and water-repellent properties. It is applied in several coats, whose composition and process are detailed below.

It should be stressed that the following description is the result of several tests based on trial and error, carried out in experimental workshops during the rehabilitation of the Casona La Galería (2020), the Casona Santa Ana (2021) and in demonstrations carried out as part of the Seminario de Tierra e Identidad (2021)

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(Fig. 6). The mix presented is the one applied to the vaults of the Metropolitan Cathedral of Sucre (2018), the vaults of the Church of Nuestra Señora de La Merced (2016), and the El Telégrafo office at Casa de La Libertad, an intervention in which the team of the Escuela Taller Sucre pooled their knowledge and experiences.

A rough coat or first layer of a mix of lime paste, sand, puzolana, and ground brick is applied to the original structure in order to cover any irregularities, smoothing these over and guaranteeing maximum adherence for the render.

This is the thickest layer, with a higher ratio of aggregates and higher granulometry. Subsequently, a thinner intermediate coat of render, with a lower ratio of aggregates, and lower granulometry, is applied. Its purpose is to connect the initial layer and final coats, improving texture in preparation for the last layer. Stucco is the final and thinnest coat of render, composed only of very fine brick and puzolana dust, sifted through a synthetic elastic filter (nylon stockings). Its purpose is to provide hydraulicity and an aesthetic finish to the render.

This process, known as *repretado*, involves applying pressure to the surface to compact the mortar, prevent fissuring, and increase mechanical resistance. In some cases, this action is carried out using a heated trowel.

Finally, in some cases, a layer of soap or polish is applied with animal grease and lamb's wool to give it an almost glazed texture. This application is conditioned by socioeconomic and functional factors. Representative samples of this technique and the final application can be found in the Castillo de la Glorieta and Palacete de la Florida, as well as in the domes of the Cathedral, La Merced and Santo Domingo, where the hydraulicity of roofs is essential.

Fig. 5 – *Solaque tests applying different pigments, Casona La Galería* (Serrano, 2021).

3.2. Materials

As with all artisanal techniques, different materials have been used throughout history – some more unusual than others – to optimise application. This study analyses the materials whose existence is only known through the oral transmission of the few artisans who still have some knowledge of this technique. Empirically, these materials have been proven to be effective, as can be seen in the following section.

Lime: The quality of this bonding agent depends on both the slaking process and the site of origin. Since times of the viceroyalty major lime deposits, including Cal Orck'o[2], could be found in Sucre and valued for the accessibility and richness of the raw material. Historic documents such as an agreement from 1549, provide evidence of the use and commercialisation of lime for construction, as described in:

> "Agreement between the master Juan Candidato de Cárdenas, presbyter of the chapel of the Metropolitan Cathedral, and doña Elena López de Nogales, unmarried, for the former to deliver 350 fanegas of cooked

[2] A name which in Quechua means 'lime quarry'

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> lime to the door of the kiln at chacra de Huata, property of the latter." (Author's translation)

Buildings in Sucre feature what is known as *cal en pasta* or *cal grasa*. The most recent tests have established that in order to apply lime in the *solaque*, it must have a fine paste-like consistency, like that of yogurt. Once slaked, it is left to settle under at least 30 cm of water in large tank and covered to prevent contamination. It remains there to settle for at least 40 days, improving its quality for rendering. Different studies, such as the one by Zalbidea Muñoz (2018), pointing out that a longer settling time increases the fineness, malleability and water retention capacity of lime, support this practice. This is due to the crystallization process, gradually transforming the disordered structure into crystals.

Sand: Aggregates provide resistance to the mortar and prevent it from fissuring, counteracting the contractions of the binding agent. For the first layer, there is a preference for non-absorbent siliceous aggregates, with angular grains, capable of reacting to lime and forming calcium silicates, thus increasing resistance. Granulometry ranges between 700 and 900 micras.

3.2.1. Components which provide hydraulicity

The arrival of the Spanish to America in the 16th century led to the development of additives providing hydraulicity to harden the mix in contact with water. According to Gárate Rojas (1993), the Greeks obtained water-resistant mortar by adding earth from Santorini and ground tiles, while the Romans popularised the use of lime and puzolana. These materials react to lime, forming hydrosilicates, which are similar to modern hydraulic bonding agents. *Solaque* features these components and combines ground tile or brick and puzolana to improve its properties.

Ground brick: Acts as an aggregate in *solaque*, conferring hydraulic properties. Its granulometry varies depending on the coat of render being applied.

Puzolana: In *Cal Orck'o*, where lime is extracted, puzolana is also quarried. Although on its own this material cannot serve as cement, when mixed with calcium hydroxide and water the resulting chemical reaction forms components with properties similar to those of cement. In *solaque*, puzolana is considered an essential bonding agent in the dosage of mortar.

3.2.2. Additives in the composition of mortar

Although organic additives in the composition of mortar have been the subject of debate, their use has traditionally been backed by the experience of craftsmen.

Fig. 6 – *Intervention in Castillo de la Glorieta, application of solaque* (Serrano, 2017).

Fig. 7 – *Intervention in Castillo de la Glorieta, application of solaque* (Serrano, 2017).

Binding agent – tuna cactus mucilage: The tuna mucilage, extracted from the leaf of this cactus, improves the cohesion of the mix by generating a fermentation process. Collection follows a specific ritual: it must be collected at a full moon and before dawn. After removing the prickles and outer skin, the pulp is left to sit in water for a day before the mucilage is obtained.

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Retardants – egg white: Different cultures, including the Romans, used linseed oils and animal glues, for instance, "in Italy milk, egg white and sugar were used as retardants to apply Tedelakt*"* (Coquemont, 2017). In the technique of *solaque*, egg white delays the hardening of the final layer of stucco, allowing a longer-lasting polish and improving the shine.

Hardeners – bovine blood: This additive increased the resistance of mortar. In other regions the use of urine, on its own or mixed with beer, to attain a similar effect has been documented empirically and orally.

Fixing agents and pigments – soap, animal fat: Natural soaps, natural resins, animal fat, oils and animal skin glues were used to improve malleability, humectant and protective qualities, as well as to improve the combination of the different components, homogenising the distribution of pigments. The term *jaboncillo* can cause confusion due to its use in different contexts.

In some communities in Spain, the expression '*jaboncillo* plaster' refers to 'a glossy and lustrous finishing technique, similar to stucco, applied with talc or rosin'. This is explained by Sandoval (2023, p. 204), who describes this procedure as a plaster coating incorporating a specific surface finish. However, the soapstone used in the process of applying the *solaque* does not correspond to this same technique. In this case, it is a mixture of water and dissolved soap used to moisten the surface of the coating and allow, by means of pressure and friction, a very smooth and shiny finish to be achieved.

In terms of pigmentation, there was a preference for inorganic pigments such as ochre earths and mineral oxides, which were more resistant to the elements. The characteristic reddish shade of *solaque* (Fig 7 & 8) was obtained from ferrous oxides, while the use of muted yellow was less frequent. Although these additives were advantageous at the time, their application can involve some uncertainty, as their properties can be affected by climatic, physical-chemical, and biological factors, which can now hinder monitoring results. Thus, *solaque* bears some resemblance to *jaboncillo* plaster only in its last application for a smoother and shinier finish and to a greater extent to *cocciopesto*, a building material used since Ancient Rome, characterised by its water resistance and hydraulic capacity. This material is obtained from ground fragments of ceramic or brick, mixed with lime and sand. However, *cocciopesto* lacks some of the specific components of *solaque*, such as puzolana and other organic additives which influence malleability and durability.

4. Discussion

The comparison between *solaque* and *zulaque* allows us to identify an evolution in the use and meaning of these techniques, reflecting cultural and material adaptations in different contexts. While the *zulaque* responds to a hydraulic solution applied to joints and pipes, the *solaque* consolidates as a continuous coating system with water-repellent properties, linked to a broader and more refined constructive knowledge. This technical and semantic transition is evidence of a process of material and linguistic crossbreeding, the lack of formal documentation of which jeopardises its continuity. In this sense, the *solaque* should be understood not only as a functional technique, but also as a bearer of cultural memory and specialised knowledge transmitted orally. Its study, documentation and recognition within the field of heritage conservation are urgently needed, especially in view of the danger of its disappearance due to the loss of its last bearers and the scarce intergenerational transmission.

Despite its technical qualities and its climatic and cultural suitability to the Andean context, the applicability of *solaque* in contemporary conservation processes presents significant challenges. The lack of standardisation of its components, the variability in its preparation

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according to the empirical experience of artisans and the absence of technical manuals make its incorporation into projects governed by international standards or strict heritage regulations difficult. In addition, the lack of knowledge on the part of technicians and professionals trained under modern criteria generates an undervaluation of this type of vernacular solutions, considering them obsolete or unreliable. This gap between traditional knowledge and current technical practice requires integration strategies that recognise *solaque* not only as an effective cladding, but also as a valid heritage technology, whose recovery can offer sustainable responses that are coherent with the authenticity of the built heritage.

5. Conclusions

The term *solaque* refers to the continuous render used in the monumental architecture of Sucre, and could be derived from '*zulaque'*. Although both share hydraulic properties, their uses are different. *Zulaque* was used in mortar to seal joints and channels, while *solaque* – with water-repellent and aesthetic qualities – was a water-resistant render that was ideal for use in walls, paving and structures exposed to damp. The term *'solaque'* should be officially recognised within the field of traditional architecture, potentially prompting more studies on it.

This technique is currently at risk of disappearing due to the lack of documentation and the waning numbers of expert artisans. The research and preservation of *solaque* are essential for maintaining the authenticity and historic value of the constructions in Sucre. Future studies should focus on further exploration of its components and drawing up a systematic classification of techniques for conservation and use in the restoration of architectural heritage.

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The Construction Techniques of Vaulted-Stone Buildings in the Taihang Mountains Region of Hebei, China

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Abstract
The vaulted-stone dwellings of the Taihang Mountains in Hebei Province represent a distinctive form of vernacular architecture shaped by local environmental conditions and socio-economic realities. The construction techniques employed in these buildings transform static spatial forms into dynamic processes, reflecting both the adaptability to natural conditions and the preservation of traditional craftsmanship. This study systematically investigates the construction practices of these dwellings, focusing on three key phases: site preparation, material sourcing, and construction execution. The site preparation phase explores the influence of Feng Shui principles, orientation, and topographical factors, emphasizing the cultural logic behind spatial decision-making. The material sourcing phase analyzes stone quarrying, wood selection, and the strategic use of bricks and tiles, highlighting methods of resource optimization under material constraints. The construction phase details essential procedures, including foundation laying, wall and vault construction, roof assembly, and the installation of doors and windows, underscoring the craftsmanship's flexibility and context-responsiveness. This research demonstrates how vaulted-stone construction techniques are deeply embedded in the region's socio-cultural fabric, sustained by manual labor and intergenerational knowledge transmission. These practices exemplify the integration of traditional architecture with local identity, offering valuable insights for the preservation of vernacular heritage, cultural continuity, and rural development.

Keywords: *vaulted-stone dwellings; construction techniques; double-centered arch; regional culture*

1. Introduction

Vernacular architecture represents a distinctive cultural phenomenon defined by its 'primitive' and 'local' characteristics. It is spontaneously designed and constructed by local inhabitants using indigenous materials to meet regional needs.

Beyond addressing functional requirements, vernacular architecture embodies the aspirations, emotions, and social values of its residents, while also reflecting the interplay between the environment, social structures, and cultural ideologies. It carries the imprint of a specific historical stage and regional identity.

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The vaulted-stone dwellings in the Taihang Mountains of Hebei Province exemplify a unique architectural form and construction method. Shaped by rugged terrain and abundant local stone resources, the region's inhabitants developed a distinctive building style by adapting to environmental conditions and utilizing readily available materials. These structures integrate harmoniously with the mountainous landscape using span-hollow masonry, where stone arches effectively transfer gravity and pressure to sidewalls. This design capitalizes on the strength and durability of stone while preserving the superior thermal insulation qualities reminiscent of traditional cave dwellings.

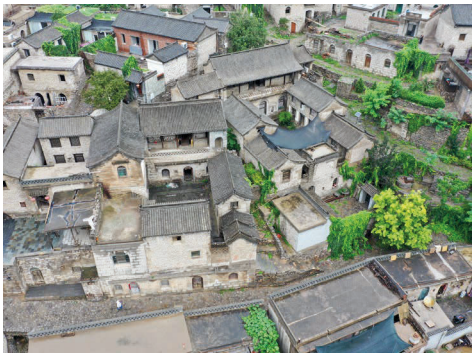

Fig. 1 – *The vaulted-stone dwellings in Lvjia village* (Zhenkun, 2020).

The construction techniques of these buildings are deeply rooted in kinship networks and geographic proximity. Within a traditional agrarian economy, the immobility of land and the stability of agricultural practices fostered a relatively insular and enduring social structure. In this context, building knowledge was transmitted orally and sustained through neighbourly cooperation, forming a resilient and community-based construction paradigm. However, ongoing social transformations pose significant threats to the continuity of these traditions. The rise of modern materials and construction techniques has disrupted local craftsmanship, placing this indigenous architectural knowledge at risk of disappearing.

A systematic study of vaulted-stone construction in the Taihang Mountain region is essential to understanding the area's cultural heritage and traditional society. These dwellings embody ecological architectural principles—such as adaptation to local conditions and the use of indigenous materials—and reflect the ethical values and rural social structures of traditional communities. This paper aims to contribute to the documentation, interpretation, and preservation of local architectural knowledge, with a particular focus on the relationship between construction practices, natural resources, and cultural identity.

2. Methodology

To comprehensively investigate the construction techniques of vaulted-stone dwellings in the Taihang Mountains, this study adopts a mixed-methods research design that combines field investigations, semi-structured interviews, and direct observations. This approach allows for the triangulation of qualitative data and facilitates a holistic understanding of both technical processes and their socio-cultural contexts. Fieldwork was carried out between May 2020 and October 2022, involving on-site documentation, photographic records, and systematic observation of construction practices.

Additionally, semi-structured interviews were conducted with three experienced local craftsmen, selected based on their expertise in traditional masonry techniques. The interviews, which lasted 60–90 minutes, were audio-recorded, transcribed, and thematically analyzed to identify key construction patterns, material applications, and adaptive techniques. To complement and contextualize the empirical findings, a comparative review of scholarly and historical literature on vernacular architecture in northern China was also conducted. This methodological framework enables a multi-perspective and contextually grounded analysis of vaulted-stone construction, integrating experiential knowledge, empirical observation, and historical discourse.

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3. Site Planning and Preparation

3.1. House site selection and layout

Before house construction begins, owners typically consult a Feng Shui master to determine the optimal site. A compass is used to assess the spatial relationship between the proposed homestead and surrounding geographical features, such as terrain, mountains, and water bodies.

The master identifies auspicious orientations to promote prosperity, ensuring the house can "receive vitality" and bring good fortune to its residents. According to Feng Shui principles, the southeast ("巽" position) is believed to influence career prospects, while the south ("离" position) governs family well-being.

Furthermore, the spatial relationship between the house and its immediate surroundings must be carefully considered. For example, it is important to avoid aligning the main entrance directly opposite a neighbor's courtyard or an alley, as such configurations are traditionally thought to generate negative energy.

3.2. Dimensions and material planning

Once the site is selected, key dimensions—such as building width, depth, and floor height—are determined based on spatial constraints. The local measurement system uses 3 or 5 "寸" units (approximately 3.33 cm per unit), with a typical minimum building width of 2.6 meters to accommodate interior furniture. Floor heights usually range from 7 to 8 "尺" (approximately 33.33 cm per unit), with the second floor slightly lower than the first.

In traditional practice, craftsmen rarely use formal architectural drawings. Instead, they rely on accumulated experience to proportionally define the layout and make real-time adjustments. As one craftsman remarked, "It's all engraved in my mind and can be adjusted at any time."

3.3. Component Size and Material List

After defining the house's basic dimensions, the master craftsman prepares a comprehensive material list and determines the dimensions of individual components. Since most construction materials are locally sourced and irregular in size, craftsmen must adapt the dimensions of structural elements to the actual materials on hand. When necessary, smaller components may be stacked or joined to achieve the required length or cross-sectional dimensions of larger elements.

4. Material sourcing and processing

4.1. Stone mining and processing

Stone is the primary construction material used in vaulted-stone dwellings. Locally sourced stone is generally preferred, and skilled stonemasons are employed to quarry and shape the material to suit specific structural needs. Even under resource-constrained conditions, craftsmen skilfully repurpose offcuts to maximize material utilization, reduce construction costs, and maintain structural quality.

Two primary techniques are employed for stone extraction: the wedge method and gunpowder blasting. The wedge method involves using a hand hammer and iron wedge to drill holes 4–5 cm deep into the rock, spaced 15–20 cm apart depending on the stone's size. After drilling, two workers alternate hammering the wedges until the stone splits. This technique typically yields 100–150 kg of irregularly shaped stone per session. In contrast, the gunpowder blasting method—more efficient for large-scale quarrying—involves drilling blast holes directly into the rock and filling them with homemade gunpowder. Controlled explosions allow precise regulation of the size and orientation of the extracted stone, producing more uniform blocks. Stone processing consists of three main steps:

1. Splitting – using a sledgehammer and wedges to break large rocks

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2. Rough chiseling – locally referred to as "cutting the wasteland," it involves using a hammer and square chisel to remove excess surface material and flatten the stone
3. Fine chiseling – where a chisel and hammer are used to create even, linear tool marks on the stone surface.

This manual process is labor-intensive and time-consuming. Processing a single stone measuring 60 × 30 × 30 cm may cost 200–300 yuan and requires a full day's work.

4.2. Timber selection and processing

Due to high transportation costs, timber is typically harvested locally. Felling is carried out in autumn and winter to avoid using spring timber, which has a higher moisture content and lower durability. Timber selection follows the principle of "large timber for main structural elements, small timber for minor parts, and curved timber for curved components." For instance, thick but curved logs are used for beams; straight, slender pieces for purlins; and thin branches for rafters.

In a standard three-room, two-beam, three-purlin building, each beam frame requires three main beams, eight columns, two intermediate "melon" columns, and a ridgepole—adding up to six beams of substantial size. Additional components include purlins, rafters, and diagonal supports, selected and assembled according to on-site conditions.

4.3. Brick and tile sourcing

Roof tiles are usually fired in small kilns within or near the village. As the process is manual, tile dimensions often vary. Brick firing is more complex and typically not feasible at the village level due to its technical and economic demands. As a result, bricks are purchased from external suppliers at approximately 1.5 yuan per piece. Given their cost, the use of bricks has become a marker of relative economic status within the community.

5. Construction sequence and techniques

5.1. Construction team organization

Once building materials have been prepared, the homeowner begins organizing a construction team. A master craftsman, typically a skilled stonemason, is appointed to serve as the foreman. This individual is expected to possess strong technical expertise, extensive experience, and effective leadership and coordination skills. The master is responsible for assembling and managing a team typically composed of five to six members, including both craftsmen and laborers. While the craftsmen focus on the execution of core construction tasks, laborers are tasked with supporting duties such as transporting stone, mixing mortar, and general logistics. Clear delineation of roles and responsibilities contributes to the team's overall efficiency.

5.2. Foundation treatment

The foundation, typically 1 to 1.2 meters deep, is excavated to a width slightly exceeding that of the wall. The process includes site leveling, layout marking, masonry placement, and tamping to ensure a stable base. Stones are laid in staggered arrangements to enhance structural cohesion and prevent linear fracture lines.

5.3. Wall construction

The side legs refer to the supporting walls that extend from the foundation up to the springing point of the arch. These elements are critical for bearing lateral pressure and maintaining structural integrity. The side legs and back wall are constructed simultaneously to ensure interlocking and mutual stability. Double-leaf wall systems are commonly employed, with thicknesses ranging from 0.55 to 1.2 meters. This method combines an exterior and an interior masonry layer, characterized by "blocks on the outer wall, pieces on the inner wall." Cross-stones are inserted at 2-3 levels to connect the two wall leaves and reinforce horizontal joint capacity.

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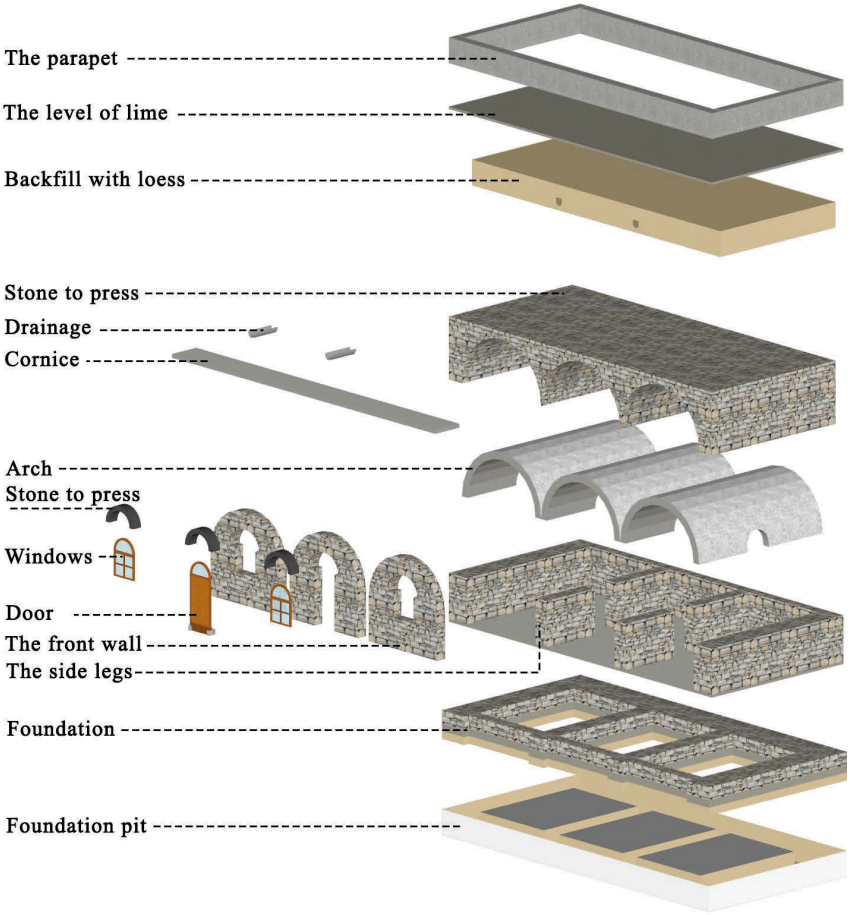

Fig. 2 – *Exploded view of vaulted-stone buildings* (Authors, 2025).

Stone masonry follows the dry-stone technique, with vertical joints deliberately misaligned for better load distribution. Gaps between stones are filled with smaller stones, and joints are secured using light straw-clay mixture or lime mortar.

5.4. Arching assembly

Once the side legs are securely built, the construction advances to the key step of arch assembly. Taking the double-center arch as a reference, the process begins by determining the arch geometry (Fig. 3). The midpoint between the two springing points is identified, then points 15 – 20 cm to the left and right along the horizontal axis are marked. Arcs are drawn from these two centers with equal radii, and their intersection defines the apex of the arch. This technique is locally known as "Kai Xin" (开心), meaning "double center".

The second step involves erecting the formwork, locally referred to as "Da Niu" (搭牛). Wooden columns and beams are erected on the side legs to ensure stability. Build a wooden frame according to the curvature of the arch. Wooden rafters or planks are laid atop the frame and covered with a 3–5 cm layer of yellow clay to level the surface.

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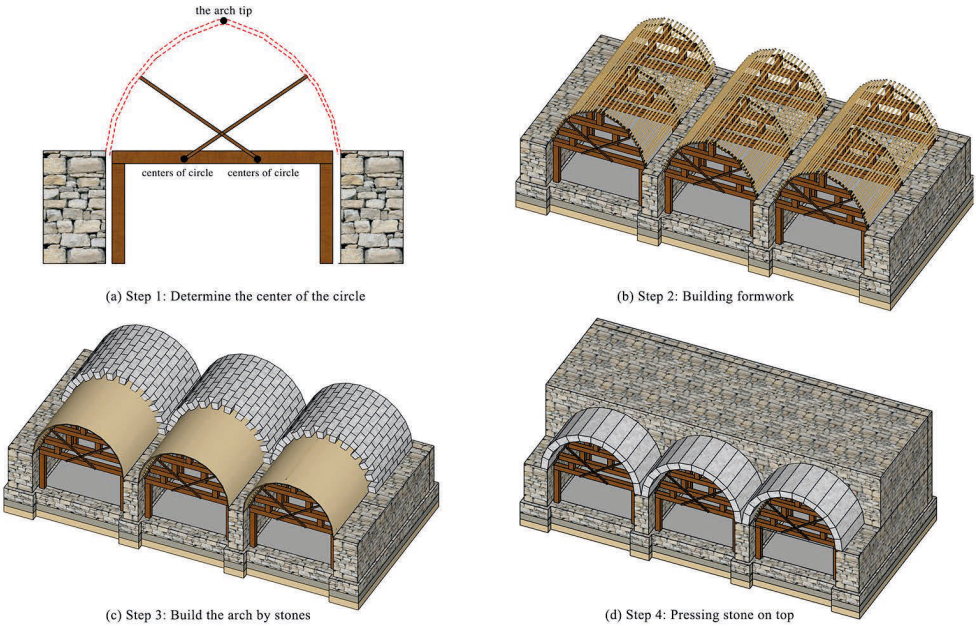

Fig. 3 – *Steps to build the arch* (Authors, 2025).

Next, stone blocks are laid along the formwork in staggered courses, starting from both ends and progressing toward the center. Larger stones are placed at the base, with smaller stones at the top. Gaps between stones are tightly filled with infill material. Finally, the trench above the arch is backfilled with 30–40 cm of compacted stone, distributing load evenly and preventing structural deformation or cracking due to uneven pressure.

5.5. Roof construction

Roof construction begins with the erection of parapet walls along the building's perimeter and the reservation of drainage outlets. The roof is filled with compacted loess, with a typical thickness of 100 cm, ranging from a minimum of 50 cm to a maximum of 200 cm depending on design requirements. Construction starts by compacting the soil along the perimeter and progressively filling the center, maintaining a gentle slope to ensure proper drainage and prevent water accumulation.

While the roof is not specifically waterproofed, it is re-compacted after each rainfall to maintain surface density and prevent erosion. Rainwater drainage is managed using stone troughs measuring 50–80 cm in length. The direction of drainage is determined based on on-site conditions and may be oriented either inside or outside the courtyard, provided it does not adversely affect neighboring properties. A parapet wall, typically 40–120 cm in height, is constructed above the roof surface to prevent stored grain from rolling off (Fig. 4).

5.6. Doors and windows installation

Prior to constructing the front wall, the shape and dimensions of door and window openings are pre-determined. Regardless of whether these openings are built simultaneously or separately, the process begins with constructing the wall segment below the intended arch height. A pressure stone is placed for the window lintel, followed by the assembly of a masonry arch above the opening.

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Once the arch geometry is stabilized, the front wall is built upward to align with the height of the main structure's roofline. The final step is the installation of doors and windows. Doors are designed to open inward. During installation, the upper section of the door frame is slightly tilted outward, while the fixed sash is slightly inclined inward, facilitating both ventilation and natural lighting (Fig. 5).

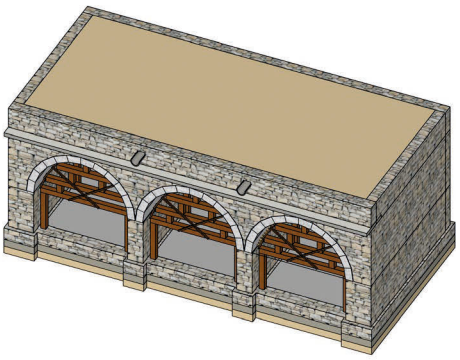

Fig. 4 – *Filling with loess* (Authors, 2025).

Fig. 5 – *Build the front wall install doors and windows* (Authors, 2025).

6. Discussion and conclusion

As a unique cultural phenomenon, traditional vernacular architecture embodies the social memory and cultural values of a specific region. The vaulted-stone dwellings in the Taihang Mountains of Hebei Province serve as a representative subject in vernacular architecture research.

These structures reflect the survival wisdom of agrarian communities and illustrate the complex interactions between humans, nature, and society. From a macro perspective, the construction process relies on manual labor, drawing upon experiential knowledge while aligning with broader construction traditions. The material preparation phase is time-consuming, and the building process itself is intricate rooted in the emulation of established techniques and the cumulative transmission of craftsmanship. Despite its seemingly conservative nature, the process is characterized by the creativity and initiative of local craftsmen.

In particular, the construction process displays strong adaptive qualities: the flexible application of Feng Shui principles and tolerance for approximate site positioning during the planning stage; adjustments in processing depth according to material properties and economic conditions during the preparation stage; and real-time modifications in construction methods based on on-site conditions. This adaptability not only reflects the ingenuity of individual craftsmen but also testifies to the resilience and vitality of traditional building knowledge.

It is important to emphasize that the construction practices described in this study represent a contemporary evolution of traditional methods. As society progresses, building techniques continue to evolve—not abruptly, but through an incremental process grounded in established customs. This reflects both the continuity and adaptability inherent in vernacular traditions.

Ultimately, the construction model is shaped by the level of regional socio-economic development. Rooted in the embodied experience of craftsmen and sustained through manual labor, it constitutes a unique and collectively recognized production model. Beyond technical practice, it serves as a powerful expression of social culture, revealing the wisdom, adaptability, and resilience of agrarian communities in the Taihang Mountains.

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The *Jaboncillo* Gypsum Plaster in the Traditional Architecture of the Northwest Region of Murcia (Spain): History, Technique and Conservation

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Topic: T1.2. Study of traditional materials, techniques and construction crafts

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Abstract

Plaster has been a fundamental material in the Murcian region architecture, playing a significant role both in past and present. Its historical use includes various techniques that not only embellish local constructions, but also add functionality to spaces. Among these techniques, stands out « The jaboncillo », a traditional method of exterior cladding characterized by its smooth and glossy finish that imitates marble. This finish reflects the cultural and architectural richness of the region, integrating itself into the local identity. The jaboncillo is used in the architecture of the Northwest region of Murcia (Moratalla, Calasparra, Caravaca de la Cruz, Bullas and Cehegín) until the 1990s. This technique is relevant not only for its physical and aesthetic properties, but also for its deep connection with the regional culture. The research will focus on 'jaboncillo' technique, analyzing its construction characteristics and its current state of conservation, carrying out a bibliographic and historical review to analyze the literature of this technique and document examples of «The jaboncillo» in the Northwest of Murcia. It is essential to understand how this technique has been applied in the historical architecture of the region, especially on the facades of emblematic buildings that form a part of Murcia's cultural heritage. An essential aspect of this research is the review of the history, evolution and applications of The jaboncillo, as well as the identification and classification of the main pathologies and deterioration processes affecting this material in historic buildings. The aim is to provide a comprehensive understanding of «The jaboncillo» technique and its application in the historic architecture of the northwest region. By examining the pathologies, we seek to preserve a valuable heritage and promote the continuity of the cultural identity of the región, as well as rescue its associated intangible heritage.

Keywords: *plaster; jaboncillo; Cehegin; technique; conservation*

1. Introduction

The *jaboncillo* gypsum is a traditional coating technique widely used in the architecture of the Northwestern Region of Murcia (Moratalla, Calasparra, Caravaca de la Cruz, Bullas, and Cehegín), especially in old residential mansions.

This material was appreciated for its marble-like effect and its ability to provide façades with a distinctive texture and tonality.

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1.1. The North-West region

The Northwest Region of Murcia, located in the extreme northwest of the province, borders the provinces of Albacete, Granada and Almería. It is composed of the municipalities of Bullas, Calasparra, Caravaca de la Cruz, Cehegín, and Moratalla (Fig. 1) and possesses a rich history that has profoundly influenced its construction techniques and use of materials over the centuries. During the Roman era, constructions reflected the use of local materials such as stone and gypsum, due to the mountainous terrain and an architectural tradition linked to local resources. After the Reconquest in the 13th century, the exploitation of natural resources such as wood and minerals intensified, impacting architecture and construction (Águila Guillén et al., 2018).

By the end of the 19th century, mining activity in the Northwestern mountains boosted the exploitation of deposits and natural resources of the region (Ruiz & Serrano, 1999). Gypsum, abundant in the region, has been fundamental in the construction of walls, ceilings, and ornamentation because of its capacity to regulate humidity, making it ideal for the local climate.

Fig. 1 – *Location of the north-west region (Murcia)* (Instituto Geografico Nacional, 2007).

1.2. "The *jaboncillo*" in the Northwest region of Murcia, past and present

Jaboncillo gypsum is a coating technique with a long tradition in Spanish architecture, particularly in the Northwestern Region of Murcia. Despite its historical and heritage value, its origin and composition have not been fully documented. The first written reference dates back to the 18th century, when master Alonso Jiménez de la Fuente used it in the Casa Jaspe of Cehegín (Alcázar, 1991), describing its application and noting that even then it was already considered an outdated technique. At the end of the 20th century, some vocational schools attempted to recover the technique using gypsum, pigment, and talc, but there are no records of its continued use in the 21st century (Sandoval, 2023).

This technique has gradually disappeared due to the lack of written documentation and the loss of oral transmission between masters and apprentices, a traditional teaching model that has vanished with the industrialization of construction. Recent studies highlight that the lack of specific training in the conservation of these types of coatings has led to the application of inadequate techniques (Sandoval, 2023), such as the use of industrial cements in restorations, accelerating deterioration instead of preserving the material.

2. Objectives and methodology

This study aims to deepen preliminary knowledge of the *jaboncillo* gypsum technique in the Northwestern Region of Murcia, analyzing its evolution, conservation state, and potential intervention strategies. To this end, the following objectives are proposed:

- Analyze the history, evolution, and applications of the *jaboncillo* gypsum technique in Northwestern Murcia.

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- Identify the use of gypsum and *jaboncillo* techniques in the Northwestern Region.
- Study and classify the main pathologies and deterioration processes affecting *jaboncillo* gypsum in historic buildings in Cehegín.
- Evaluate intervention methods compatible with the properties of *jaboncillo* gypsum to ensure the conservation of its historical and aesthetic value.

The study has been structured into three main approaches: documentary research, fieldwork identifying pathologies in the specific case of Cehegín, and a preliminary evaluation of conservation methods. Thus, a descriptive-deductive methodology has been developed.

3. The traditional technique of *jaboncillo* gypsum plaster

Gypsum has played a significant role in the Region of Murcia, both in its historical use and in contemporary techniques. Among them, the *jaboncillo* gypsum stands out a traditional coating technique used in the architecture of Northwestern Murcia.

3.1. History and definition

The *jaboncillo* gypsum technique has an uncertain origin but was widely used in the Northwestern Region of Murcia. It is based on two fundamental materials: gypsum, extracted from local quarries, such as the Pateta Gypsum Quarry in Cehegín, operated by the Muñoz family (La Spina, 2016), and *jaboncillo*, derived either from pine resin a common species in the regionor, more recently, talc, a white mineral. Its commercialization facilitated its use in exterior coatings, where pigment acquired importance, adapting the technique to new materials and environmental conditions to improve the durability of historic façades.

In its traditional form, the glossy finish was achieved through a laborious process of polishing with a trowel. In its contemporary evolution, the use of talc subtly modified its texture, maintaining its silky and satin appearance.

3.2. Composition and properties

Composition: *Jaboncillo* gypsum is a mixture of gypsum, water, pigments, and *jaboncillo*. In interiors, *jaboncillo* is documented as colophony (pine resin), which, along with polishing, provided brightness. In exteriors, white talc has been used since the 20th century to improve resistance (Alcázar, 1991).

The gypsum, abundant in the region, has a low hardness (H=2 on the Mohs scale) and a water solubility of 2.05 g/L at 20ºC (La Spina, 2016).

Natural pigments were key in the decoration of façades: ocher tones from iron oxide and limonite, reddish hues from almagra and hematite, and blues from indigo, although less frequent due to their high cost. For gray tones, charcoal or ash was used, and over time, exposure to the elements caused chromatic changes through oxidation (Sandoval, 2023).

Properties: *Jaboncillo* gypsum is lightweight, easy to work with, and offers a shiny finish. It was historically used in ornamental coatings for its durability and aesthetic appeal. Due to its gypsum base, it has low thermal conductivity, making it fireproof; when exposed to fire, it releases water vapor, delaying the spread of heat and improving fire resistance. Its porous structure also provides good thermal and acoustic insulation, absorbing and attenuating sound, improving the soundproofing of spaces (La Spina, 2016).

3.3. Technique and craftsmanship

Gypsum stuccoes were used in Europe from the 16th to 19th centuries to imitate noble stones, using pure gypsum, pigments, and additives (Portillo et al., 2022).

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Among them were embedded stuccoes with inlays of different colors and textures, and mass stuccoes with pigmented mixtures polished to a bright finish (Fornés, 1857). *Jaboncillo* gypsum can be considered a mass stucco, applied in thin, polished, pigmented layers to achieve similar finishes.

These techniques were deeply rooted in the local culture, maintaining the architectural tradition of the region until the 1990s when the craftsmanship of this technique was lost (Sandoval, 2023).

In the specific case of *jaboncillo* gypsum, it was used to coat and decorate walls and ceilings, both indoors and outdoors (Sandoval, 2023). Its application began with sample preparation to define the tone, followed by the dry mixing of gypsum and pigment, forming a solution diluted in water known as "creciente." The gypsum was spread, imperfections corrected, *jaboncillo* sprinkled, and polished with a trowel in three passes (Espín, 2010).

Traditionally, *jaboncillo* gypsum was applied in thin, polished layers, achieving smooth, resistant surfaces. Over time, the number of layers and thickness of the coatings were reduced (La Spina, 2015).

The technique evolved depending on geographic context and material availability—from traditional methods using hand-ground gypsum and natural resin to modern methods using industrial gypsum, talc, and water repellents (Alcázar, 1991).

Despite its historical roots, the technique has fallen into disuse due to the introduction of industrial materials and the loss of knowledge about its application.

4. Case study: Historic centre of Cehegín

The historic center of Cehegín, declared a Historic-Artistic Site in 1982, stands out for its architectural richness, composed of numerous palaces built between the 17th and 19th centuries (Espín, 2010).

The use of gypsum was conditioned by its abundance in the region, extracted from nearby quarries, and by the artisanal tradition that transmitted the techniques.In Cehegín, the quarry operated by the Muñoz family, owners of Yesos Pateta, has been active for more than three generations.Although production is now industrial, the artisanal process knowledge is still preserved.

The gypsum kilns of this quarry (Fig. 2), built between 1965 and 1967, operated with a traditional system, using masonry kilns. Grinding was done manually with iron mallets or mechanical crushers.The last batch in these traditional kilns took place in the 1970s (La Spina, 2016).

Fig. 2 – *Traditional ovens in Cehegín, Murcia* (Grau & La Spina, 2016).

4.1. Documented examples of *jaboncillo* gypsum plaaster

Along the emblematic streets of Cehegín's historic center (Fig. 3), various applications of the *jaboncillo* gypsum technique can be observed.

The Casa Jaspe, located in Calle López Chicheri, is a late 18th-century Baroque building whose *jaboncillo* gypsum façade imitates jasper stone in a pinkish tone with veins.

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This solution was used to imitate ashlar in jambs and lintels, while the upper part presents a simple ocher-toned finish, with color variations possibly caused by moisture (Alcázar, 1991).

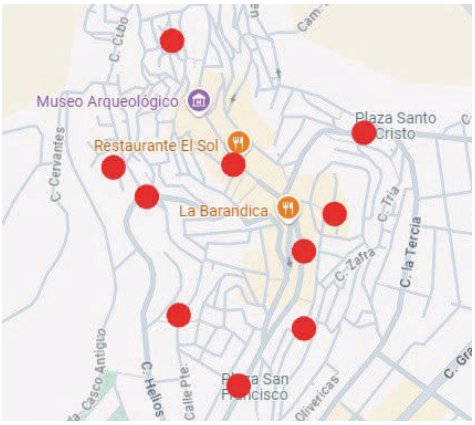

Fig. 3 – *Cehegin visitor points* (Google Maps).

Fig. 4 – *Façade of the Casa Jaspe, López Chicheri Street, Cehegin* (Nezreg, 2024).

Fig. 5 – *Façade of the Casa de las boticarias, Cehegin* (Nezreg, 2024).

On the same street, La Casa del Conde de Campillos, a 19th-century neoclassical building, preserves much of its grayish *jaboncillo* gypsum façade (De la Ossa & Pérez, 1993), contrasting with white openings, although it shows cracks and detachments at corners and openings. On Calle Mayor, from the 17th-18th centuries, features a beige-ochre *jaboncillo* gypsum coating, combining Baroque and Neoclassical elements (García, 2002), although it shows worn areas and material loss.

In Cuesta del Parador Street and Cuesta Moreno (Fig. 6), façades stand out with reddish-toned *jaboncillo* gypsum, derived from iron oxides or almagra. Some areas maintain their original color and texture; others show cracking and detachment, especially in zones most exposed to humidity and thermal changes.

Fig. 6 – *Façade of a house with jaboncillo, Cuesta Moreno Street Cehegin* (Nezreg, 2024).

The architecture the historic center of Cehegín, shows the richness of the *jaboncillo* gypsum in its architecture, as well as the need for its conservation.

4.2. Main degradations processes

The various damages affecting *jaboncillo* gypsum are derived from environmental, construction, and maintenance factors:

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Detachments and loss of material: The degradation of jaboncill gypsum is due to humidity, soluble salts and thermal fluctuations, which causes the progressive loss of its surface layers, leaving the masonry exposed (La Spina, 2016). It is the case of the façades of the façades of López Chicheri and Cuesta Moreno streets, where advanced erosion and lack of maintenance have accelerated their deterioration.

Cracks and crazing: Caused by structural movements. They can be classified as microcracks (affecting only the surface) and structural cracks (compromising the stability of the coating).

Surface cracks have been identified in buildings such as the Casa Jaspe, and the Palacio de los Condes de Arriba (Fig. 7), where cracks have facilitated water infiltration, accelerating the degradation of the material.

Fig. 7 – *Palace Los Condes de Arriba, López Chicheri Street, Cehegin* (Nezreg, 2024).

Exfoliation and lamination: Exfoliation and lamination of *jaboncillo* gypsum, occurs due to water infiltration and temperature changes, generating internal stresses that lead to the detachment of surface layers. This problem is common in areas with high humidity and can be seen in buildings such as the Jasper House and houses on the High Street, where the gypsum peels off in layers, exposing the internal layers of the material.

Salt efflorescence formation: This phenomenon occurs when water carries dissolved salts to the surface, where they crystallise and progressively degrade the coating (La Spina & Grau, 2018). They manifest themselves in the form of whitish stains that not only affect the aesthetics of the material, but also contribute to its disintegration. In Cehegín, the Casa del Conde de Campillos and other buildings in López Chicheri street, cuesta moreno street, and the main street, show visible efflorescence.

Chromatic alteration and staining: *Jaboncillo* gypsum can suffer chromatic alterations due to exposure to UV rays, contamination and pigment degradation, manifesting in darkening or staining due to run-off and dirt (La Spina, 2018). The Casa de las Boticarias shows variations that affect the homogeneity of the original cladding.

Inadequate repairs: Interventions with incompatible materials, such as plastic paints, cements or mixtures of gypsum, cement and water, which generate disruptive "ettringite" salts, have caused significant damage to many plaster façades. These modern materials impede the breathability of the plaster, trapping moisture inside and generating additional spalling and cracking (Sanchez, et al., 2001).

5. Preliminary assessment of conservation methods

The conservation of gypsum in historical buildings has been the subject of various studies aiming to preserve the material without compromising its authenticity or physical-chemical properties.

The conservation of *jaboncillo* gypsum requires an approach based on material compatibility, support breathability, and respect for the original application technique.

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5.1. Assessment of compatible intervention strategies

Reintegration with traditional plaster mortars: Studies have demonstrated that traditional gypsum mortars are the best option for the reintegration of deteriorated areas, ensuring cohesion, adhesion, and compatibility with original coatings (La Spina, 2016). When applied in compacted layers, they preserve the appearance and mechanical properties (La Spina & Grau, 2018).

Their use in restoration has been revived in Albarracín, where an artisanal kiln produces gypsum with natural impurities that improve resistance to atmospheric agents (La Spina, 2015).

Application of breathable water repellents: In many cases, it is not recommended to apply water repellents to gypsum, as they may alter its ability to absorb and release moisture naturally. Some stabilisers, such as silicates, are incompatible with gypsum mortars and surfaces with conventional paints, so the choice of water repellent must consider compatibility with the base material (Solà et al., 2015).

In the Casa Jaspe, the water repellent Durcidry, an aqueous solution based on potassium methylsiliconate, was applied, protecting the plaster without affecting its breathability or colour, and was applied by brush or roller on dry surfaces.

Removal of incompatible materials: The use of cements, acrylic paints, and synthetic varnishes has sealed gypsum surfaces, preventing water evaporation and accelerating degradation (La Spina, 2016).

To reverse this damage, non-invasive cleaning techniques are used, such as mechanical removal with fiberglass spatulas or the application of specific gels that dissolve coatings without affecting the original material (La Spina, 2016).

6. Conclusions and reflections

Traditional Spanish gypsum is at risk of disappearing, affecting both architecture and the associated knowledge.Moreover, its scarce availability and high cost have limited its application to heritage restoration projects (La Spina, 2016).The conservation of *jaboncillo* gypsum requires strategies that combine traditional and modern techniques, adapted to each context.Its preservation faces challenges such as the lack of maintenance and the replacement of traditional methods.Thus, the dissemination of knowledge, the training of specialists, and the implementation of maintenance programs are key to ensuring the sustainability of *jaboncillo* gypsum in built heritage (Sandoval, 2023).

Recovering its application in future restorations is essential to guaranteeing its continuity and enhancing its value in the region.

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Tradition and Didactics. Some Educational Experiences of Intergenerational Transmissions of Artisan Skills for Heritage Preservation

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Abstract

For decades the western world has experienced the loss of traditional crafts possibly leading to a sort of break of the intergenerational transmission of artisan building skills. This paper reports on some educational experiences developed with the scope of enhancing a countertrend in crafts for Heritage preservation and records material culture that is now-a-days at risk of going lost. This has been developed through a collaboration between the Iuav University of Venice and the local artisans' association.

Keywords: *artisan skills; education; intergenerational transfer; preservation; traditional know-how*

1. Introduction

The relationship between tradition and innovation is a crucial topic within Heritage preservation. An intrinsic dialectic developed throughout the historical debate, sometimes clearly expressed, often implied.

The connection between *old* and *new* is strictly related to it and it is one of today's most debated subjects, both in theoretical and operational terms. This relationship has often been conceived in terms of contrast, since the Athens Charter set forth the idea of new additions as to be necessarily distinguishable, through modern materials and techniques. Meanwhile, the western world has been experiencing the loss of artisan skills and a strong impoverishment of local material cultures, with a serious risk of "breaking the chain", i.e. losing the intergenerational transmission of traditional know-how. Actually, an effort to enhance a sort of countertrend is worth consideration and it requires a conceptual change of mind, followed by a cultural and operational strategy[1].

Hence, involving craftspeople in this process is crucial, as they are the repositories of the local material culture and can play a prime role both in education, as well as improving the quality of architectural preservation.

[1] Several efforts are in progress throughout Europe, starting from the historical contribution of the Society for the Protection of Ancient Buildings (SPAB) to more recent both theoretical and operational studies, for instance see Sennet 2008 and Mileto, Vegas 2008.

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2. Shortening the distance between tradition and innovation and between theory and practice: objectives and methodological approach

From a conceptual perspective, this study tries to reconsider the "binomial" relationship between tradition and innovation, not much in terms of contrast but regarding them as complementary approaches, trying to avoid any ideological interpretation, as well as any condition *ad excludendum*. We should rather try to understand how these two concepts can be interpreted in present times, facing new issues, first of all sustainability and environmental impact reduction. Tradition, far from being perceived as a burden to get out of, can be conversely regarded as a resource. Our main aim is to contribute to transfer traditional know-how from the elder custodians to the younger generations, despite the unfavourable Italian economic and social trends. This means opening the academic milieu to the operational world, trying to shorten the distance between theory and practice in order to introduce the local material culture to undergraduate and postgraduate students. The paper reports the results of some educational experiences about traditional building crafts for heritage preservation - mainly seminars, workshops and training programmes - led by the Iuav University of Venice in collaboration with *Confartigianato Imprese di Venezia*, the local artisans' association (from now on *Confartigianato*).

A wider goal is sharing these experiences within an international scope of foreign subjects, engaged in Heritage and artisan skills preservation, so as to enlarge the meaning of present and future ventures. Despite different context, duration and subjects involved, all of these educational experiments aim at starting a process of cross and intergenerational transmission of knowledge, relying on the repositories of the traditional building expertise.

3. Artisan skills and preservation: reporting some educational experiences

Confartigianato has recently published a study (Vettore ed., 2019), detecting two parallel social and economic trends during the last decades in Venice: a demographic decrease of the resident population and a similar decrease of productive activities between 1963 and 2018, that has been assessed at almost 50% among artisans (Vettore, 2019, 16, Fig. 1).

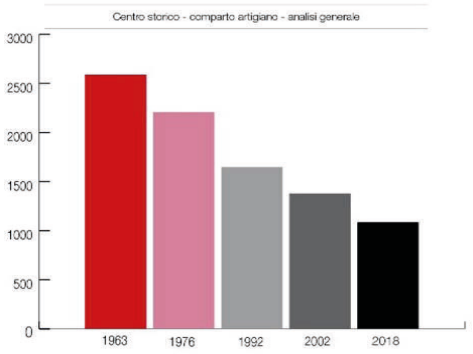

Fig. 1 – *A diagram showing the decrease of the artisan building companies in Venice between 1963 and 2018;* (courtesy of dott. Enrico Vettore, Confartigianato, see Vettore, 2019).

This decline, due to a series of factors, has been leading to a complex process of cultural, social and architectural transformation. First of all, it has a loss of the social tissue of citizens and proximity activities as a result - in the face of about a 67% higher rent cost in the city centre - as well as strong alterations of the non-listed buildings because of fast renewals, addressed by the chance of an easier income from tourism. At the same time, the expulsion of artisan crafts from the city centre is causing further weakening of both the identity of places and of the relationship between dwelling and local services. While low-quality interventions are spreading, which are more and more foreign to the local material culture. Facing the present shortcomings of a supporting policy (Paladini and Wacogne 2021), the role academy can play is trying to provide a cultural countertrend.

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Local craftspeople can be involved in research and educational programmes, a positive way to support Their activities. Workshops and manufacturing places should be treasured as well. They are precious testimonies, in terms of material culture and authenticity, but they can be also key growth factors, providing the city with a more sustainable future.

This is the reason of an agreement between the Iuav University of Venice and Confartigianato, signed in 2022, after some years of informal and episodic collaborations[2]. The first step of this agreement was meant to develop integrated research activities between the university and the local craftspeople in order to foster traditional good practices in Venice's Heritage preservation[3]. In the distance, such an approach should also allow an economic-and-social positive relapse on local building activities.

At the same time, reinforcing connections throughout time is due in order to build a true synergy. Thus, education is a crucial issue and it was developed in a cross and biunivocal way: that is, lecturers giving talks and seminars to craftspeople and professionals - within the so called *third mission* - relying on the support of local Building schools and institutions[4]. And local artisans providing their cultural and operative support through different educational programmes, introducing traditional building crafts to the architectural students. The following reports testify to the positive results of almost a decade of collaboration.

3.1. Workshops between theory and practice

The first workshop, "Construction Wisdom: between past and future to preserve Venice's historical masonries" (2019) was an integrated experiment bringing theory and practice together in order to introduce the architectural students to the local material culture, with the help of an international charity dealing with intergenerational relationships (1st Framework, London).

The workshop was meant to integrate the different contributions, the university aiming at a more effective knowledge, by giving the students the methods and the theoretical principles to recognise and to preserve Venetian historic buildings. While the Venetian craftsmen firstly introduced their activities, technical background and past experiences through meetings, interviews and sharing documents. The objects of investigation were the good practices in the old building worksites, along with the traditional materials and techniques usually adopted. The meeting between students and former craftsmen (some of whom had retired) has also been recorded in order to provide a sort of symbolic inter-generational transfer of know-how.

Afterwards, some selected artisans performed an experiment of practice *hand-over*, whereby the students had the chance of visiting a worksite, where a highly qualified restorer[5] was rebuilding the collapsed portion of an old garden wall.

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[2] "Protocollo di Intesa tra l'Università Iuav di Venezia e Confartigianato Imprese Venezia", rep. n. 593/2022, prot. n.25107 del 13/04/2022, the author being Iuav's scientific director.

[3] The results of the first step of this collaboration was reported in Berto and Squassina 2021 and Squassina 2022.

[4] At present, the building Schools of Venice, Padua and Treviso are collaborating as partners, as well as the Architects' Association, Ateneo Veneto, Fondazione Querini Stampalia and the Chambre of Commerce of Venice have hosted/supported single projects.

[5] The experience was possible thanks to the involvement of a brick manufacturer (Fornace Fonti, Rovigo) and a Venetian restoration company (Co.New.Tech.), which is accredited with some important interventions in Venice, such as the restoration of the Porta della Carta at Palazzo Ducale, but that agreed to work at a simple brick wall just to support the project.

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He explained the students any step of the work in progress, sharing details of his expertise, such as the performances of the different traditional materials and building techniques he resorted to, as well as methods and timing suggested by his own long experience (Fig. 2).

Fig. 2 – *Iuav students attending the 2019 workshop in a working site where skilled artisans resorted to traditional materials and skills.*

Two further workshops followed in 2022 and 2023, dealing with artisan manufacturing-places and focussing on a semi-neglected *squero*,[6] requiring salvage. That place needs particular attention as a fundamental part of the past and present local boat making activity, that cannot be properly transferred to the future without its productive spaces. Architectural students were supposed to survey the place and not to simply suggest any refurbishment proposals. On the contrary, they were expected to consider wider projects, taking into account the role of such places in the preservation of the identity of local people and of the city itself.

3.2. Training Programme

Seminars and workshops are organised for the architectural students to make them aware of preservation issues and good practices within the local building tradition. In addition, they can have the chance of a month of direct collaboration with the craftsmen that will hand over to them theoretical and operational knowledge. Thanks to a training programme, students and professors can meet Confartigianato's members during specific open days (Fig. 3) and agree to spend one month of practical work as interns by artisan workshops and their Heritage preservation working sites.

Fig. 3 – *Open day organized by Confartigianato in order to let artisans, professionals and Iuav student meet and agree an internship* (courtesy of Enrico Vettore, 2024).

Such a practical experience has two different goals:

- letting architect students "touch" the matter of architecture, maybe establish a deeper relationship with the buildings they are supposed to protect as future professionals (Fig. 4);

6 "A Bridge Between Past and Future" (2022), a workshop gathering local and foreign associations in order to discuss the future of the squero, through comparisons with similar european experiences; and "I luoghi del fare. Studi, rilievi, proposte per gli Squeri S. Isepo a Castello" (2023), led by the author in collaboration with the Iuav collegues Greta Bruschi, Cristina Balletti and Francesco Guerra, together with the *Societa' di Mutuo Soccorso Carpentieri e Calafati*, the historical association holding the squero at present.

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Fig. 4 – *A Iuav student on the working site of her internship by Co.New.Tech.'s restoration of a palace in Venice* (Boldrin, 2025).

- at the same time introducing them to the operational world of craftspeople, that soon will be partners of the future architects, sometimes playing the role of counterparts in projects and working sites.

An early sharing of skills and languages will certainly help develope mutual collaboration and address proper interventions. Besides some bureaucratical issues, as the university is not expected to comply with practice, the first interns' responses are encouraging the Iuav University to stabilise the programme, as well as the feedback of the hosting artisans is quite satisfactory. Both the institutions aim at bringing craftmanship and a sensitive use of materials back into use, in order to take efficaciously care of Venice's Built Heritage.

3.3. Exchanging international experiences

A collaboration between university and craftspeople is also meant to open local expertise to an international scope, encouraging a comparison -and hopefully future cross-connections- with subjects of other countries supporting craftmanship.

An international symposium led in 2022[7] was the chance of exchanging experiences of Heritage and artisan skills preservation, gathering significant testimonies from the United Kingdom and from the Czech Republic and developing a reciprocal reflection about the operational and cultural contribution of artisans and trained voluntary work.

Fig. 5 – *A transversal parterre of students - young building school students, Iuav undergraduates and postgraduates - making practice during the "On the Surface" study days in 2022* (Richards, 2022).

Volunteers of the Society for the Protection of Ancient Buildings (SPAB) attended the study days, together with some other associations dealing with Crafts and Heritage preservation in UK and Czech Republic[8]. After the symposium, this group of experts also performed samples of traditional building practice, working with local skilled craftsmen at the Building School of Padua. They involved a transversal parterre of students - young building school students, Iuav undergraduates and postgraduates – in making practical samples of repointing and plastering (Fig. 5).

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[7] "On the Surface. Exchanging Experiences for the Preservation of Historical Surfaces and Artisan Skills. Venice, London, Czech Republic", international study days, lead by the author in collaboration with G. Bruschi, M. Webster and P. Jamieson, within the Postgraduate School in Architectural and Landscape Heritage of the University Iuav of Venice and with the operational support of the Building School Padua, Venice 22-23/3/2022.

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Since 2022 the author is developing a collaboration with *The Friends of Czech Heritage*, an association set in 2007 to help Czech institutions carry out Heritage preservation through working parties, that is weeks of voluntary work (Squassina 2024). Each summer, some Iuav students are now attending one week working under the supervision of local skilled craftsmen, and the university recognises them educational credits for the voluntary work activity (Fig. 6).

Fig. 6 – *Two Iuav students attending the 2023 working party at Teplice in the Czech Republic* (Reynolds Webster, 2023).

Enlarging the scope to some other countries in discussing about craftsmanship and traditional skills is a fruitful way either to revamp the building tradition and to inspire technical and compatible innovation. This is the first goal of a recent experience, developed within a 2023-24 Erasmus+ KA131 "Student Mobility for Studies" in Almograve (Portugal), dealing with rammed earth architecture, a peculiar building tradition shaping the identity of the Alentejo region.

The international workshop (9th-15th September 2024) involved seven European universities[8] and 40 architect students and postgraduates, working in eight project teams, sharing mutual informations and documents about study-project cases, under the supervision of professors and local professionals and craftspeople. The methodological approach entailed defining a process of kowledge, blending research and direct surveys, meeting institutions, and craftspeople still working with rammed earth. The local leader was architect Henrique Schreck, a true expert, being dealing with this technique for decades and applying it both in preservation and in new design (Graça 2020). He supervised all of the students' projects, led the whole group through the region, visiting both old and new rammed earth buildings. Finally, he welcomed students and professors in a private working site where he was building a new rammed earth house, allowing the attendees for some sample of practice (Fig. 7), testifying how tradition can also be a resource for a sustainable innovation and maybe can successfully afford contemporary architecture design.

3.4. Discussion of the results

So far, the educational experiences described above are giving positive outcomes, spurring to stabilise the collaboration between university and the local craftmanship, in order to support the intergenerational hand over of the traditional know-how. The transfer of this intangible heritage to the new generations is necessary and utmost urgent. The remaining few who are holding it now will soon be retired; in a few years, these precious skills will be lost forever. Most architectural students won't become craftspeople but the experience has improved their awareness. Their short-term experiences will be regarded as a way to support and keep alive local building traditions, that have lasted for centuries.

[8] FAUP, the hosting university of Porto, New University of Lisbon, University of Granada and UPV Valencia, Polytechnic of Bari, University of Chiedi-Pescara, University Iuav of Venice, the author being the Iuav scientific director and arch. Federica Parlato as tutor.

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The direct contact with the built matter is one of the utmost significant goals of this experiences, the first step to understand how the building tradition works, how it can be preserved and still enjoyed, at the same time taking account of both the preservative and innovative aspects. The training of young but skilled and sensitive architects - the ones who will have the task of taking care of the historical city centre - looks like an ethical, rather than simply a pragmatic issue, in order to plan a proper maintenance.

Now-a-days, there are several limits to the renovation of building tradition, from technology, product market and regulation, within an ever-changing technological and cultural contest. Hence, craftspeople will hardly overcome obstacles without a true supportive policy.

This means a cross engagement of different institutions, whereby university can give its contribution pushing for a collective reflection about the chances of revitalising and guaranteeing a cultural support to artisans, in order to enhance their productive potential.

4. Toward a countertrend: some final observations

Revitalising historical architectures, needing restoration and structural strenghtening to allow usage without altering the original materials, or their own structural behavior, is a wide goal requiring the reconnection with traditional building skills. That is a meaningful way to contrast the quality worsening of the average interventions, due to the closure of many local companies and to the replacement of craftsmen with inexperienced, unskilled workers. This fact sheds light on a deficiency of the contemporary man, who has almost lost any connection with the material culture of his own places, to the point he often fails at restoring them without deeply altering their character. Such a state of affairs should be regarded with particular concern for the material authenticity of historical buildings.

Bringing craftmanship and a sensitive use of materials back into use is not so much an ideological issue, nor a “chronological incoherence” but a way to take efficaciously care

Fig. 7 – *The students attending the 2024 Odemira workshop while experiencing rammed earth building within a working site in Alentejo (Portugal) under the supervision of local experts.*

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of the built Heritage. On the one hand, resorting to traditional high-quality materials and refined processing techniques, which have proved to grant both a long duration and high standards of behaviour, even after centuries of natural ageing. On the other, resurrecting the intangible "know-how" ancient buildings embody, following a living idea of tradition, that is able to compliment both sustainability and creativity. From an educational point of view, this means addressing students toward a wider object of interest, connecting tangible and intangible Heritage as a whole object of preservation.

On the operational side, a further goal is a more effective control of the architectural changes in Venice – as well as in any other historic centre - conceiving interventions much more in terms of a slight and continuous care-for practice, rather than through episodic and highly impactive operations or radical refurbishments. This might involve that, without denying old cities any chance of future development, it is of the utmost importance to regard their specificity as the result of a centuries-old construction wisdom. Thus, re-enhancing the careful work of craftspeople, as well as supporting the artisan manufacturing companies is not much of a nostalgic attitude but a long-term investment.

Finally, taking care of artisans, that is the strongholds of material culture - as much as rich in educational potential as openly exposed to the risk of disappearing – means protecting the most fragile but also one of the most important resources in Venice, strictly related to the future of the built Heritage. One can envisage positive outcomes for the city as a whole, both from a cultural perspective but definitely from an economic point of view as well, maybe contributing to balance the way of living and working of local inhabitants with a more mature tourist fruition.

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Use and Conservation of Alabaster in Traditional Aragonese Architecture

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Abstract
Since ancient times alabaster has been used in architecture for many different purposes: as a load-bearing material in the construction of walls and columns, in the manufacture of decorative elements (altarpieces, sarcophagi, capitals...), and as a substitute for glass in the illumination of interiors. In Spain, in areas with abundant natural resources, such as the region of Aragon, it is common to find churches and hermitages with alabaster windows and oculi in clerestories and lanterns. In many instances the alabaster plates in these churches and hermitages are broken, detached or have been replaced with different materials. This material can also be found in traditional architecture close to alabaster quarries, including ones no longer in use, and has been used for ashlar plinths or lintel arches. This paper seeks to provide an introductory characterization of the material, the geographical location of natural resources in Aragon, and the techniques most frequently used in the construction of historic architecture in rural areas, It also offers basic recommendations for the prevention, repair and maintenance of the main pathologies identified.

Keywords: *alabaster properties; alabaster techniques; alabaster limitations; Zaragoza; Mallén*

1. Introduction

1.1. Background

Alabaster is a variant of gypsum (calcium sulphate dihydrate) containing a number of impurities, conferring it with unique characteristics. It is known primarily for its translucency, waxy lustre and opalescent sheen, as well as the veining and watermarks giving it a delicate marble-like appearance. However, alabaster is significantly softer than marble, making it easier to carve both manually and mechanically. Throughout history alabaster has therefore become a substitute for marble in sculpture and architecture. Early examples of its use date back to Antiquity, when it was already used to produce objects such as cups, vases, vessels, funerary stelae, sarcophagi, etc (Cantos & Criado, 2011; Artal, 2006). The Late Middle Ages and the Renaissance saw a resurgence in the interest in alabaster, now applied to the production of altarpieces and frontispieces, especially in Aragon.

In architecture, alabaster has been employed for a wide range of purposes, including lighting, the protection of interiors, and used for structural purposes.

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1.2. Objectives and methodology

Most studies on alabaster focus on its artistic value, especially in sculptural pieces (Artal, 2006) as well as on the analysis of its material properties (Gisbert & Muñoz, 2018). Although some studies address the use of alabaster in the architectural context of the region of Aragon (Pano, 2018), only a handful focus on its conservation (Gisbert & Galarreta, 2014-2015; McKenzie et al., 2002).

Fig. 1 – *Map of Aragon (Spain) (Authors). Aragon has a Mediterranean continental climate, with cold winters and hot, dry summers* (Cuadrat, 2004).

This paper aims to introduce the characterization of the material, while also presenting geographical locations of natural resources and the techniques most commonly used in the construction of historic architecture in Aragon. It also seeks to identify the main pathologies observed in alabaster, as well as the basic recommendations for their prevention, repair, and maintenance.

To this end, fieldwork was carried out, visiting several quarries still in operation, and sawing and finishing workshops in order to obtain various samples. This was accompanied by reconnaissance tour of several important architectural works in alabaster. A specialist bibliographical study was then carried out to assess the properties, handling, potential weaknesses, and working techniques of alabaster. This information is presented below in the form of a short illustrated text, concluding with a breakdown of good practices.

2. Characterization

2.1. Properties

From a mineralogical point of view, alabaster crystallizes in the monoclinic system, with crystals that are much smaller and compact than those of ordinary gypsum. It also has a good isotropy.

In geological terms, alabaster is a secondary type of gypsum, resulting from the hydration of long-lasting formations of underground anhydrite (a sedimentary form of primary gypsum) which have come to the surface (Díaz, 1990). In this chemical transformation process, among the impurities it is common to find remnants of basanite (the intermediate and stable hydration stage) and anhydrite (the initial stage) as well as high proportions of clays. The veining, tone, density and hardness of the alabaster may vary depending on the type and proportion of these impurities.

Gypsum alabaster should not be confused with so-called calcareous alabaster, which is not formed by sulphates but by calcite. While calcareous alabaster, also known as onyx-marble, is formed by parallel or concentric layers of growth, gypsum alabaster is usually characterized by discreet and varied veining. A distinction must also be made between alabaster and selenite or *lapis specularis*, a variant of gypsum made up of very thin highly transparent layers, which the Romans used for window panes.

In terms of physical properties, it has a density of about 2,350 kg/m^3, slightly lower than marble. It displays low porosity (less than 3 %) but high expansivity and high solubility (2.6 g/l, (Gisbert & Galarreta, 2014)).

In mechanical terms, alabaster has good compressive strength (24.6-35.6 MPa, according to Alfonso et al. (2012)), and low flexural strength (4 - 8.2 MPa). The linear modulus of elasticity E is 32 GPa and, like all gypsum, it displays low hardness (1.5-2 on the Mohs scale).

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2.2. Alabaster quarrying and processing

Alabaster can be found at different stratigraphic levels. Although some of these are continuous, others consist of nodules (or *bolos*) with a diameter of 0.5-2 metres and an average weight of 250 kg (Alfonso et al., 2012). The high market price can partly be linked to its low rate of utilization, as only 15% of the stone from the quarry is fit for use in building projects.

Whereas in Italy alabaster is often mined in underground galleries (I.T.G.E., 1990, p. 46), in the region of Aragon quarries are open cast. Alabaster is primarily extracted in the Calatayud basin (with deposits in Fuentes de Jiloca) and the Martin (La Puebla de Híjar, Albalate del Arzobispo) and Ebro basins (with deposits in Quinto de Ebro, Fuentes de Ebro, Gelsa, La Zaida, Sástago, Velilla de Ebro). Historically, it was also mined upstream of the Ebro, in the Campo de Borja (Fuendejalón, Pozuelo de Aragón). Together, these sites account for 95 % of the world's alabaster production.

In ancient times, alabaster was often mined in superficial formations and manually worked using wedges and hammers to break the blocks. At times the material could be found in layer form, which allowed it to be cut more easily. During the medieval period, alabaster extraction became more refined. However, with the Industrial Revolution, extraction techniques changed drastically and became more mechanized. This in turn resulted in significant increases in efficiency and scale as larger, more uniform blocks were produced.

3. Alabaster techniques in Aragonese architecture

Throughout the history of Aragonese architecture, alabaster has had three main uses.

3.1. Alabaster as a load-bearing material

One of the less delicate functions of alabaster is that of load bearing, taking advantage of its excellent compressive strength. The merits of its load-bearing capacity were clearly evident from early on, when it was used in the construction of walls, perimeters, and plinths of notable buildings, as well as in more refined architectural elements such as columns and capitals. The choice of alabaster for such crucial purposes can be presumed to be conditioned by proximity. This proximity has been a permanent fixture throughout the history of construction, but even more so in traditional and vernacular architecture.

The use of alabaster in architecture can be traced back to Roman times. It is known that the thick walls of Caesaraugusta were built with alabaster and limestone ashlar, combined with lime and pebble infill. Alabaster plinths have been preserved in Islamic fortifications, as seen in various towers of the Aljafería in Zaragoza.

Fig. 2 – *Apse of the primitive Romanesque church of Mallén, built with alabaster ashlar walls* (Authors).

After the Christian Reconquest, several churches were built using alabaster ashlar in the Borja region, and are seen as prime examples and evidence of the use of alabaster (Criado, 2017). In the town of Mallén in particular, a small Romanesque church with walls made entirely of alabaster masonry was built in the 12th century. The semicircular apse, which survived the Baroque extension of the 18th century, still stands today (Fig. 2). Earlier, in the 17th century, the side walls had been opened up in order to add chapels, and the stones removed were kept and reused for the new façade (Sancho & Hernando, 2002).

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A similar technique was probably employed in the old Romanesque church in nearby Novillas, of which only the foundations and bases remain. In both cases, the preference for alabaster can be attributed to the material's availability in small local quarries, and possibly to the patronage of the military orders, as well as to the symbolism and aesthetic appeal of the pure white of alabaster (Hernando, 2018).

The medieval tradition of certain sculpted architectural elements, such as columns and capitals, continued during the Renaissance. The Patio de la Infanta in the House-Palace of the Counts of Sástago in Zaragoza, carved in the mid-16th century, dates from this period.

3.2. Alabaster as a decorative element

Based on the surviving material evidence, it is surmised that alabaster must have been used first in tombs and doorways, before being incorporated into altarpieces (Cantos & Criado, 2011).

The most impressive carved alabaster ensemble is probably the altarpiece of the high altar of Zaragoza Cathedral (1434-1480). This work later influenced the polychrome altarpiece by Damián Forment in the neighbouring basilica of El Pilar (1509-1518) and, in turn, the high altarpiece of the Cathedral of Huesca (1521-1534), Given the strength and weight of the carved alabaster blocks, a parallel masonry structure had to be built to firmly anchor these monumental pieces (Criado, 2017).

Two of the most notable alabaster façades are those of the former Hieronymite monastery of Santa Engracia in Zaragoza (1511-1517) and the collegiate church of Santa María la Mayor in Calatayud (1525-1528). In contrast to these two, the façade of the church of Santa Isabel de Portugal in the same city is adorned with Churrigueresque alabaster reliefs in gigantic soffits, following a Vignolesque composition (Fig. 3).

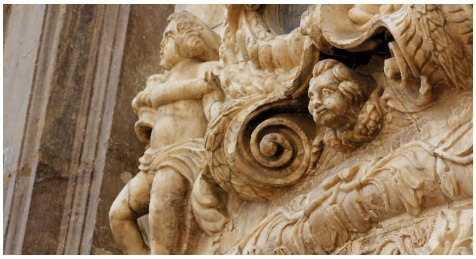

Fig. 3 – *Façade of the church of Santa Isabel de Portugal, Zaragoza. Detail of an alabaster relief* (Authors)

Finally, alabaster can also be found in funerary monuments, both in Zaragoza Cathedral. An early example is that of the tomb of Archbishop Lope Fernández de Luna in the Parroquieta, built in the last quarter of the 14th century. This was followed in the mid-16th century by the understated Renaissance ensemble for Archbishop Hernando de Aragón in the chapel of San Bernardo.

The alabaster selected for carving was the whitest with the least visible veins, aiming to resemble marble more closely. Until the end of the 15th century, it was customary to apply a polychrome finish to polished alabaster, often combined with gilding to cover the entire stone (Anonymous, late 16th century). However, from the 16th century onwards, partial polychromy (for example, the simple carnation of faces and hands) and even the total absence of polychromy became widely accepted and used alternatives (Cantos & Criado, 2011).

3.3. Alabaster in lighting

Although Pliny the Elder already mentions the technique of alabaster for lighting in his *Naturalis Historia*, this was not documented in Aragon until the early 16th century, although its introduction probably predates this. Subsequently, in the late Middle Ages and Renaissance, alabaster plate windows became a more affordable alternative to leaded polychrome stained glass (Criado, 2017), further encouraging their widespread use in clerestories, oculi, and lanterns.

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In order to protect these elements from water, the surfaces were usually sealed by saturating the slabs with oil (Anonymous, late 16th century). Evidence of the decoration of panels with figurative motifs using oil-based paints can be found from the 16th century onwards. One of the few surviving examples of this technique is located in the parish church of Fuentes de Jiloca (Cantos & Criado, 2011).

4. Pathologies and alterations

Although alabaster displays excellent performance, its limited durability should not be overlooked. It should be noted that as alabaster is a type of gypsum it presents the usual disadvantages of mineral compounds used for building materials under certain conditions, especially when exposed to the elements.

4.1. Degradations due to loss of water

4.1.1. Opacification

One of the most appreciated qualities of alabaster is its translucency, a condition that can take on different nuances depending on the type or quarry and the thickness of the slab. However, this property can be altered by exposure to high temperatures (Fig. 4). From 40-45 ºC alabaster begins to lose water and slowly transforms into basanite, while at 110 ºC it abruptly turns into anhydrite. Calcination leads to a loss of translucency and cohesion, weakening its mechanical properties, as well as changes in colour (Gisbert & Galarreta, 2014). This typically occurs due to excessive sun exposure in dry environments, particularly on SW or W-facing surfaces.

The phenomenon of calcination cannot be reversed, since the calcined layer would have to be removed, further weakening the plate. Once degraded, the plate must be replaced if translucency is to be recovered. To prevent opacification, direct exposure to solar radiation in the most aggressive orientations should be avoided using sunshades, setbacks, slats, etc.

4.1.2. Bending

This phenomenon is the warping or differential deformation of a given section, with the exposed surface becoming convex while the interior one becomes concave (Fig. 4). Like calcination, this curvature is attributed to excessive sunlight, which in turn triggers the polygonal retraction resulting from the loss of water molecules in alabaster.

Fig. 4 – *Former Episcopal Palace of Albarracín. Detail of window with alabaster slabs displaying partial opacification and warping* (Authors)

This cannot be reversed or repaired. If the piece affected is replaced, but there is no change in exposure conditions, the phenomenon will recur over a period of about 15 years (Gisbert & Galarreta, 2014). In any case, criteria for replacement will depend on the degree of buckling and any artistic value that the piece may have (e.g. whether it is painted).

4.1.3. Polygonal retraction

This phenomenon (Fig. 5), which is similar to that described above, can be better observed in non-laminar pieces such as blocks, columns, etc. The effect is similar to map cracking, with cracks in multiple directions.

4.2. Degradations due to hydration

4.2.1. Dissolving in water

As gypsum is a water-soluble material and alabaster is a variant of gypsum, alabaster is therefore also soluble (Fig. 6).

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Fig. 5 – *Polygonal retraction observed in alabaster ashlar on the façade of the church of Mallén, facing west* (Authors).

Fig. 6 – *Detail of material erosion due to dissolution in the alabaster ashlar at the base of San Juan de los Panetes, Zaragoza, exposed to rain* (Authors).

This leads to the loss of matter, often in the form of *lapiaz*, leaving sunken grooves that are caused by chemical dissolution. This is further aggravated by physical erosion as a result of run-off, a slow surface phenomenon that appears on the exposed face.

Damage is irreparable as material has been lost. However, damage can be prevented by limiting direct exposure to rain, by means of protection, overhangs or treatments.

4.2.2. Water expansion by absorption

Alabaster undergoes volumetric changes that are not due to the presence of clays seen in other materials such as limestone and sandstone. These are instead produced by a complex process of dehydration-rehydration of the material. Despite its low porosity (< 3 %), alabaster displays very high volumetric expansion values (Artiaga, 2019). According to Gisbert & Galarreta (2014), this is linked to textural transformations, particularly due to the material's exposure to the elements.

The material can be brought back to its initial size if the capillary moisture level is recovered. However, absorption-drying phenomena should be prevented by protecting the material from rain. Although varnishing can help to expel the run-off water, this will be hindered if the panels are immersed.

4.2.3. Mass loss due to freeze-thawing

Freeze-thaw phenomena also negatively affect alabaster when exposed to the elements in cold climates. According to Artiaga (2019), the mass loss observed in a sample of alabaster from Gelsa subjected to accelerated ageing tests through freeze-thaw tests was 4.35 %.

The same research concludes that mass loss is also observed in accelerated ageing tests involving salt crystallization (7.49 %) and in those by thermal shock (0.89 %).

This phenomenon is also prevented by protecting the plates from contact with the rain.

4.3. Mechanical pathologies

4.3.1. Flexural fracture

An alabaster slab can break for several reasons, such as deformation caused by prolonged exposure to sunlight or due to horizontal pressure perpendicular to the plane of the slab, as a result of blows or impact from the wind.

Breakage may also occur due to excessive gravitational load on the panel's edge, insufficient space for potential expansion or an excessively rigid installation. It is important to remember that alabaster is a fragile material with low resistance to bending.

To prevent plates from breaking, metal reinforcements should be placed at the back of the spans to absorb the thrust (Fig. 7). Additionally, any gaps left between the panels and the substructure will facilitate free expansion and preventing unnecessary stresses on any of these elements.

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4.4. Alterations

4.4.1. Scratching

Alabaster hardness is low (1.5-2.0 on the Mohs scale), which makes it vulnerable to abrasion by steel, knife, sandpaper, glass, or even fingernails.

Fig. 7 – *Alabaster stone with metal reinforcing bars in the shape of a cross (only the outer one is visible), fixed at the point of intersection. Dome of the church-convent of El Carmen in Gea de Albarracín* (Authors).

One simple way to prevent scratching is by using physical barriers or changes in level to limit direct contact.

4.4.2. Chromatic change

In addition to the changes in colour and loss of translucency resulting from calcination, mentioned earlier, further changes in colour can also be observed. Stains can appear, caused by metallic elements (such as fasteners, nails, or screws) introducing iron oxide through the network of micropores of a specific surface area (Gisbert & Galarreta, 2014).

This can be prevented by avoiding direct contact between alabaster and unprotected iron or steel. Spacers such as polystyrene mats or neoprene strips should be used in situations involving non-galvanized or stainless steel.

4.4.3. Dirt

Dirt can reduce the light transmitted, either due to dust, differential washing, or staining. Despite its low porosity, alabaster absorbs moisture easily, and in some cases, it is even affected by minimal amounts of certain substances, such as oil. When cleaning alabaster, acidic substances such as vinegar or lemon juice must be avoided completely as they can damage the material. Dust and dirt are best removed with a soft cloth or brush. If necessary, cloths can be slightly moistened with water or a mild soap solution can be applied. In all cases, the surface should be dried immediately (McKenzie et al., 2002).

5. Conclusions

Alabaster is an outstanding material, and Aragon is home to the world's most significant reserves. It has also played a key role in enriching the sculptural and architectural heritage of Aragonese art. However, when maintaining or using alabaster outdoors, certain precautions should be taken:

- Avoid direct sunlight, especially in the south and southwest and in dry climates. While this may seem inconsistent with the choice of alabaster as a translucent material, some form of filter or overhang should be added to prevent incidence from direct radiation.
- Avoid exposure to rain. This applies to both the direct impact on the panel and any indirect splashing. Surface varnish can help to repel water.
- Limit plate size to a maximum of 60 cm to avoid increased costs and deformations, ensuring proper thickness-to-width ratios.
- Avoid mechanical discontinuities, as they promote plate fractures.
- Reinforce the alabaster panels with bending-resistant elements to avoid fractures caused by wind blows, in cases with wide spans.

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- Prevent corrosion and staining of the plates by ensuring there is no contact between the alabaster and oxidizable metal elements.
- Allow possible movements due to expansion and expansion-shrinkage phenomena, leaving gaps between materials of different properties.
- Avoid cleaning with acidic and aggressive products, always bearing in mind the absorbency of alabaster despite its low porosity.
- Rule out the placement of alabaster plates in pedestrian traffic areas, preferably adding some kind of physical barrier or obstacle.

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Vernacular Architecture in Disappearing: Unveiling Japan's Mason Work Huts in Shiga Prefecture

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Abstract

Japan's traditional residential architecture is recognized for its regional variety, but research has primarily focused on main houses, with annex houses, huts, and cabins receiving less attention. However, these structures often played an essential role in supporting local livelihoods and shaping the cultural landscape. This study examines historical masons' work huts in the northern part of Otsu city, Shiga Prefecture—a region renowned as a fine granite quarry site, where high-quality stone products such as lanterns and shrine gates were produced. Since no work huts remain in Kitahira, but in Minamikomatsu, interviews with current and former masons were conducted to understand their structures and construction processes. A measurement survey was also conducted on one existing work hut in Minamikomatsu. The work huts in Kitahira and Minamikomatsu exhibit varying levels of construction sophistication in foundations, wooden structures, roofing, and walls. Although both were gable-roofed, the former, a self-built post-in-ground structure with a thatched roof, contrasts with the latter—a post-and-beam hut with sophisticated joinery, crafted by skilled carpenters. These differences are linked to the locations of the huts and types of stone products produced. The construction methods represent the intelligence of residents in making efficient use of available materials and resources to sustain their livelihoods. Today, with the decline of the stone industry and an aging population, memories of this vernacular architecture are fading. Documenting the stone masons' work and their work huts is crucial for safeguarding the cultural identity of the region and enriching our understanding of its history.

Keywords: *traditional construction; work huts; stonemason; cultural heritage*

1. Introduction

1.1. Background

Located in the northern part of Otsu city, Shiga Prefecture, the foothills of Mt. Hira lie in a granite-rich geological zone known for producing high-quality stones. In this area, granite was quarried from the mountains, brought to the villages, and processed into various products such as house foundations, shrine stone gates, stone lanterns, and water basins. These goods were then transported by boat across Lake Biwa and even to Kyoto. The stone-processing industry once flourished as a local livelihood, with most villagers working as stone masons. Today, some of the masons' tools and stone lanterns remain in local shrines and houses. However, compared to large-scale stoneworks like castle walls, these local artifacts are relatively modest and have not yet gained full

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recognition for their historical and cultural significance. Despite the past prosperity of the stone-processing industry—from the Edo period (1600-late 1800s) to the pre-war years (1930s)—little research has been conducted. The industry declined due to the reduced nationwide demand for stone in residential construction and the implementation of legal restrictions for forest conservation and disaster prevention. In particular, there is a lack of documentation about the structure and characteristics of masons' work huts, highlighting un urgent need for research to preserve and pass on this regional masonry culture to future generations.

1.2. Literature review and research objectives

Huts and cabins have not received much attention in architectural research. Among the existing studies, Kahn's *Shelter* (2000) comprehensively introduces hut architecture around the world, using photographs and illustrations to detail materials and construction methods. In Japan, a relatively large number of studies have been conducted on boathouses. For example, Kobayashi et al. (2018) conducted a survey of boathouses in the Oki Islands to clarify their types and location characteristics. In addition, *Illustrated Guide: Architectural History of Annex buildings and Huts* (Oba, 2024) categorizes various huts in Japan based on factors such as disaster response and livelihoods. However, mason work huts remain largely unexamined in these studies.

Previous studies on masonry in this region have been limited to deciphering masonry inscriptions, archival materials, and fragmentary information collected through interviews from a historical perspective (Educational Committee of Shiga Prefecture, 1982). In particular, detailed research has been conducted on masonry tools in the Kitahira district, where Shimauchi and Watanabe produced a sketch of a mason's work hut based on interviews (Watanabe, 2019). Additionally, research on stonemasons in the Minamikomatsu district, known for its stone craftsmanship, includes Kimura's study on stone transportation tools (Kimura, 1997) and Ochiai's (2023) research on stone lanterns crafted by renowned stonemasons.

The History of Shiga Town (2002) provides a short description of masons' work huts, noting that these huts, referred to as "Ishiya Koya" (stone masons' huts), were once lined up on the lakeside beach before World War II. However, no technical details or regional differences were discussed. Therefore, this study aims to clarify the regional characteristics of these huts, which were deeply related to the region's once-thriving stone industry.

1.3. Methodology

Interviews were conducted with local residents familiar with masons' production activities and with former masons who had knowledge of the work huts' construction process. Among them, three key informants were Mr. MA (male, 80s), Mr. ME (male, 60s), and Mr. H (male, 90s), all of whom had experience in quarrying and transporting stones up to 1951.

Additionally, a measurement survey and interviews were conducted on an existing mason work hut in the Minamikomatsu district, believed to have been built before 1945, when the stone industry was nearing its peak. These surveys were carried out between January 2019 and September 2022.

2. Overview of stone masonry at the foot of Mt. Hira

2.1. Study Area

This study focuses on the Minamikomatsu and Kitahira districts—former villages now part of Otsu City, located at the foothills of Mt. Hira in the northern part of Otsu City in Shiga Prefecture. While agriculture has been a main livelihood since the Middle Ages, stone quarrying and processing also flourished from the Edo period

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(1600 to late 1800s). Historical records regarding stone quarrying date back to 1612, 1649, and the Meiji period (1868-1912) onward.

2.2. Production activities of masonry

Granite was quarried from exposed rock areas upstream along the river. The stones were transported along mountainous roads to the villages using traditional wooden carts called "Tombo guruma" (dragonfly carts), named for their long, slender shape. Different types of stones were quarried and transported to the work huts in different villages. For example, in Kitahira, most products were called "nagamono" (long block stones), which were used in house foundations, staircases, and shrine gates. Minamikomatsu, in contrast, specialized in crafting smaller stone products like lanterns and millstones.

3. Masons' work huts

Masons' work huts served as places for stone processing or crafting stone lanterns. Many of these were simple structures with thatched roofs, walls made of straw or wooden boards, and a single open side. Two types of masonry work huts can be identified based on interviews with Mr. H and Mr. MA: "Hama-goya" (beach huts), located along the lakeshore, and work huts built next to main houses. Figure 1 presents a sketch of a work hut around 1850 in Kitahira and a photo of a work hut in Minamikomatsu (date unknown). The latter is believed to have stood near the lakeshore beach due to its large size (Kimura, 1997).

3.1. Redrawing of a historical work hut in Kitahira village

3.1.1. Structure and Materials

The work hut in Kitahira was a simple, self-built, gable-roofed wooden structure without any transverse beams, as shown in the sketch in Fig.1, above. A standard work hut measured 5m x 7m (larger ones could extend to 5m x 13m), with a height ranging from 1.6m to 3m.

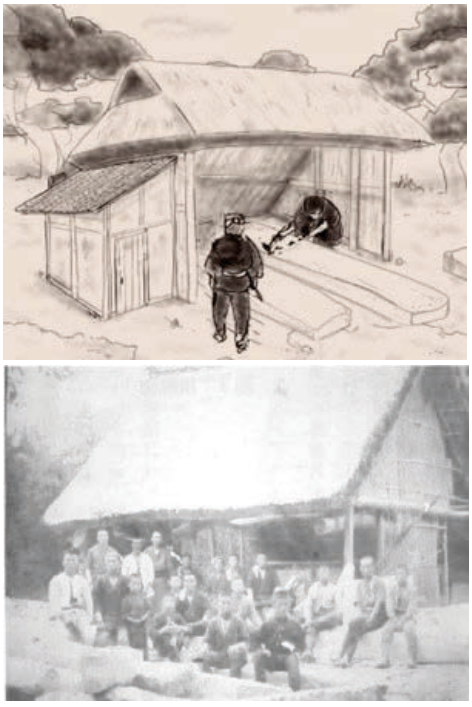

Fig. 1 – *(Above) Sketch of a work hut around the 1850s in Kitahira*. (Watanabe and Shimauchi, 2022). *(Below) Photo of a work hut in Minamikomatsu* (Kimura, 1997).

Entrances usually faced south and were fully open to maximize sunlight, which was essential for day-long work as only paper lanterns lit by candles were used inside. Some huts had a bellows room used for blacksmithing to sharpen masonry tools. For instance, the aforementioned 5m x 7m work hut had a bellows room measuring 2.5m x 1.6m (Fig. 2).

The Kitahira work hut had a post-in-ground foundation, with pillars made of "Nezumisashi" (Cupressaceae, evergreen with needle-like leaves), known for its excellent resistance to corrosion. Cedar was used for ridgepoles and purlins. The roof was thatched with straw and supported by bamboo frames. Due to the high cost of materials like reeds and wheat straw, lower-grade rice straw was used and replaced every three years.

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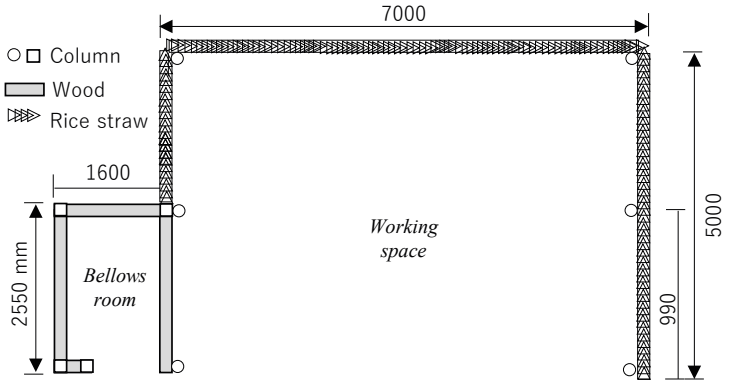

Fig. 2 – *Floor plan.*

In contrast, the bellows room used earthen walls and roof tiles for fire protection. Clay was used to cover the wooden or bamboo walls and purchased from the other side of the lake, Omi-Hachiman, since little clay was available in this area. It was mixed with chopped straw in 5 to 6 cm, kneaded by foot, and rested for a few days to increase adhesion before application. In addition, this clay was also used in roof tiles and made in a neighboring village. Other materials—cedar, rice straw, bamboo, and hemp—were locally sourced. The floor and elevation plans are illustrated in Figs. 2 and 3.

3.1.2. Construction process

Construction began with digging 60-80 cm holes on the beach, placing 20-diameter pillars, and fixing them with embedded stones around the outer side of the pillar through an iron wire to prevent toppling. At the top of the pillar, a "hozo" (tenon) was made, into which two eave purlins and a ridgepole with corresponding "hozo-ana" (mortise) at both ends were fitted (Fig. 4). Carpenters only helped craft the tenon and mortise joints.

The roof pitch on the front side was four suns (≈21.8°), which was slightly shallower than the pitch of six suns (≈31.0°) on the back side, thus allowing for wider front openings. Unlike typical timber rafters set on purlins, the Kitahira work hut used bamboo rafters for its thatched roof. These bamboo rafters were crafted by notching and bending the bamboo sticks at about their mid-length, allowing them to be secured directly to the ridgepole. Bamboo roof battens were then placed on the bamboo rafters, which created a square grid with a spacing of approximately 20 cm for the rafter-batten intersections.

The thatching process began by tying hemp strings onto bamboo battens to form a net, which prevented the thatched rice straw from falling inside. The rice straw was then laid in rows approximately 80 cm in length. Each row was

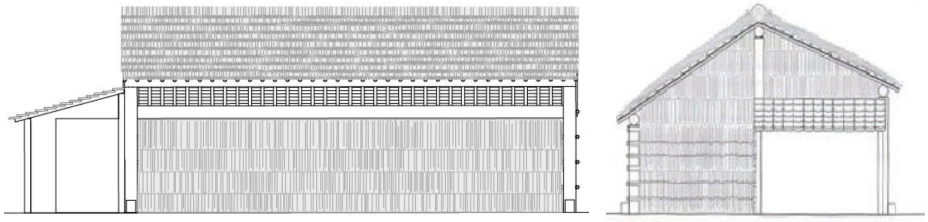

Fig. 3 – *Front and left side elevation plans of work hut in Kitahira.*

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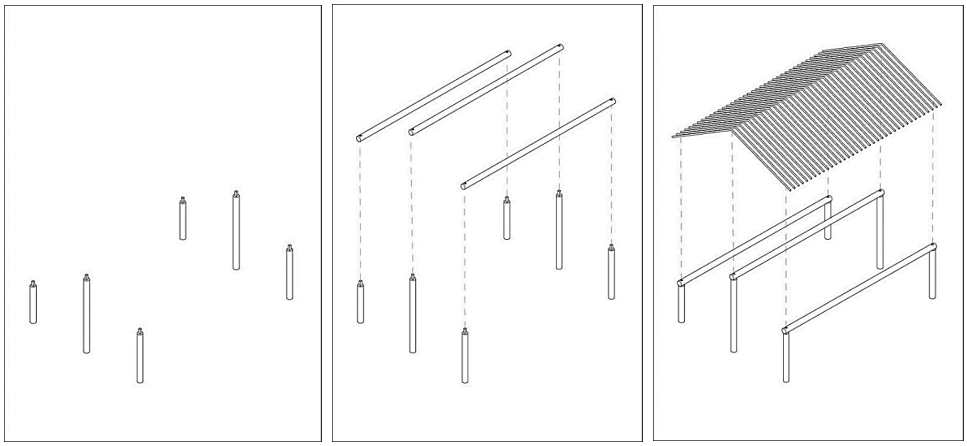

Fig. 4 – *Construction process.*

secured by placing bamboo bars on top of the straw and sandwiching them in place. This layering process was repeated approximately 20 times, and each row was shifted by approximately 10 cm until the entire roof reached a thickness of approximately 20 cm. For the ridge, bundled thatch was placed on top, with cedar bark laid over it, secured by a bamboo bar tied to the roof with wire instead of straw rope to protect against deterioration from rain (Fig. 5).

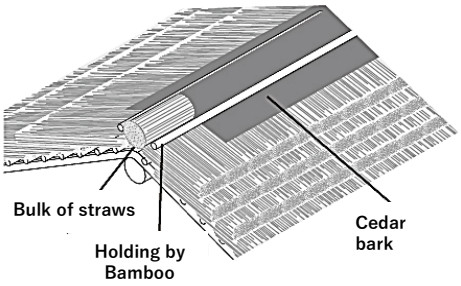

Fig. 5 – *Structural details of the thatched roof.*

Walls were often covered with rice straw, which could also be replaced by scrap wood planks or scraps from sawing logs. For rice straw walls, crossbars and bamboo slats were first installed between two pillars, with straw bundles split into two, placed on the crossbars and secured to the bamboo slats (Fig. 6).

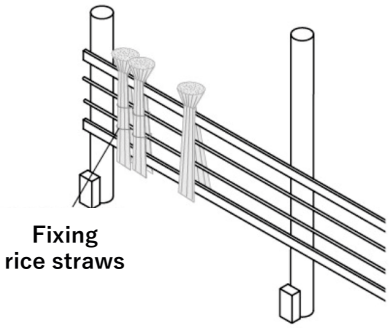

Fig. 6 – *Details of the rice straw wall.*

Walls were often covered with rice straw, which could also be replaced by scrap wood planks or scraps from sawing logs. For rice straw walls, crossbars and bamboo slats were first installed between two pillars, with straw bundles split into two, placed on the crossbars and secured to the bamboo slats (Fig 6). In the case of planks and scraps, crossbars were placed between the pillars, and planks were nailed onto them for stability. In addition, some parts of the pillars were left exposed without being covered with wall material.

3.2. Characteristics of an existing work hut in Minamikomatsu

In Minamikomatsu, two mason work huts still exist but have been repurposed as a warehouse and a car garage, respectively. A measurement survey was conducted at the car garage to understand its structure, size, and materials.

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Fig. 7 – *Photo of the existing work hut.*

Interviews were held with Mr. MA (in his 80s and passed away in 2019), an experienced stonemason and the hut's owner. Mr. MA's work hut was built before the Showa period (1926-1989) by his father, whose family had worked as masons for generations. Its main structure had hardly been renovated since its construction. Therefore, Mr.MA was unable to provide detailed explanations of the construction process. The work hut was built along a road that ran through the center of the village. This road was used to transport quarried stones from the mountain to the work huts in the settlement and the lakeshore. Fig. 7 shows the current state of the work hut.

3.2.1. Structure and materials

The work hut is a gable-roofed post-and-beam wooden structure. Similarly, the hut was fully open on the front side, thus allowing multiple masons to work side by side and facilitating the loading and unloading of heavy stones. Unlike the post-in-ground foundation in Kitahira, feldspar stones were used to support the wooden structure. Sophisticated joinery techniques between the beams, pillars, and purlins suggest that carpenters were in charge of the whole construction (Fig. 8).

The main room of the work hut measures 4m x 5m, while the bellows room is approximately 2m x 3m (Fig. 9), with a height of 2.2m. The wood structure is primarily made of cedar, with 120mm square timbers used for pillars and 100mm tie beams connecting the pillars. Ridgepoles and purlins are made of round logs with diameters between 150 to 200mm.

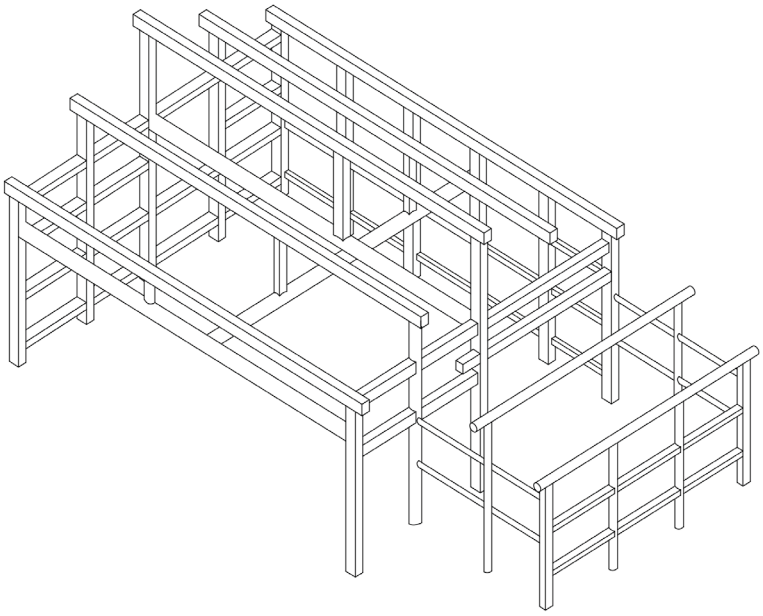

Fig. 8 – *Post-and-beam wooden structure.*

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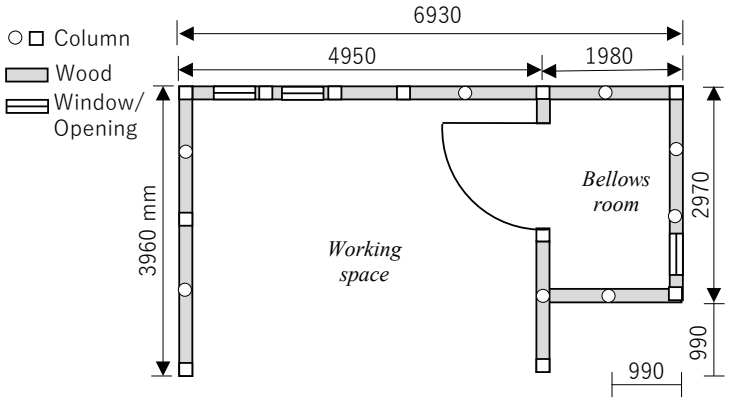

Fig. 9 – *Floor plan of the work hut.*

The walls are constructed from woven bamboo coated with a mixture of soil and straw scraps, and the exterior is covered with corrugated iron sheets. Battens made of half-round bamboo poles are placed on the rafters, which are then covered by cedar bark and roof tiles, with rafters spaced 330mm apart and battens spaced 50mm apart (Fig. 10).

The foundation was originally made of feldspar stones with an earthen floor, but it was later covered with concrete. In addition to the wide opening at the front of the building, there are also openings at the back and sides for ventilation. Given the significant dust generated by stone cutting, which could lead to lung disease—an occupational hazard affecting masons' health—these openings were likely intended to expel the dust.

The bellows room remains nearly intact, thus offering a glimpse into its original state (Fig. 11). The walls were fully coated with soil for fire protection, although the interior is now blackened by ash from burning coke and other materials used in blacksmithing. There is a small window near where blacksmith work was performed.

4. Discussion and conclusion

In the past, mason huts were built in each village at the foot of Mt. Hira, with their locations, structures, and construction methods differing from each other. Work huts owned by the "Oyakata" (master of the mason group) were generally larger than those owned by individuals. Even individual work huts were typically sufficiently large for two to three people to work at the same time. Meanwhile, all the huts shared some basic features, such as gabled roofs, timber structures, and fully open front sides to ensure adequate sunlight and ventilation.

The work huts in Kitahira and Minamikomatsu display varying levels of sophistication in their foundations, wooden structures, roofing, and wall construction.

Fig. 10 – *Photo of the roof.*

Fig. 11 – *Interior of the bellows room.*

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The Kitahira hut was primarily self-built, while construction in Minamikomatsu was led by skilled carpenters. These differences are linked to the locations and types of stone products being produced.

Kitahira masons primarily processed and produced long stones used for the foundations of the houses or the storehouses, and these were often transported to the nearby major cities and across Biwa Lake; accordingly, their work huts were larger and located near the lake, which was public space far from their homes. In contrast, the Minamikomatsu masons produced small stone lanterns, which required less space, and they built huts on their property land next to their houses and carried out their work there. Additionally, the Kitahira work hut near the lakeshore had its opening on the south side, while the Minamikomatsu one in the village had its front opening facing the road and the main house, indicating that the placement of openings varied depending on lighting and accessibility. Both work huts had a bellows room attached to the working space, with walls covered in soil and tiled roofing to prevent fires.

The construction of work huts reflects the intelligence of residents in making efficient use of available materials and resources to sustain their livelihoods.

Today, the stone industry has declined. Once home to over 100 stonemasons, the region now has only one company in operation. As the population ages and declines, fewer local residents recall the traditional stone culture. While vernacular architecture can serve as a reminder of this fading heritage, its value is not always recognized and often lacks clear investigation. Thus, this study offers a way to revive disappeared vernacular structures through drawings grounded in careful interviews with senior residents. We believe that documenting the technical details of the stone masons' work huts contributes to preserving the region's cultural identity and deepening historical understanding from various perspectives.

Acknowledgments

I would like to give special thanks to Mr. Hiraoka, who taught us the processes and materials of masons' work huts, and to Mr. Masuo, who allowed us to measure his work huts and participated in interviews. I would also like to show appreciation to Prof. Keiichi Watanabe for sharing his interview records and knowledge of work huts in the Kitahira district. Many drawings were made by Mr. Owada, a bachelor's student at Graduate School of Engineering, Kyoto University.

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Architectural Heritage and Photovoltaic Solar Panels: Regulatory Framework and Action Criteria in Navarra (Spain)

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Topic: T1.3. Mechanisms of sustainability of vernacular architecture

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Abstract

Nowadays, there is an evident growing social demand for installing self-consumption photovoltaic solar panels on existing buildings. This reality often conflicts with the duty to protect and preserve our built cultural heritage, whose conservation is of public and social interest. And it is not only referring to monumental heritage, which holds the legal protection granted by its designation as a Cultural Heritage Asset, where any intervention is regulated and controlled, but also and especially to domestic architectural heritage: an entire collection of minor traditional architecture spread across our cities and towns, without a clear stylistic classification but of great environmental value due to its presence in the landscape, of which it is an essential and inseparable part. The installation of solar panels on the roofs of all these buildings can lead to a substantial modification of some landscapes and urban spaces that are part of the collective visual memory. It should be noted that this article constitutes, more than a proper scientific text in accordance with the objective of this conference, a reasoned exposition and evaluation of a real situation of conflict between the implementation of certain renewable energy installations in built cultural heritage—primarily photovoltaic solar installations—and the application of their legal protection regime and the duty of conservation.

Keywords: *sustainability; energy rehabilitation; historic centers and buildings; architectural heritage; photovoltaic panels; renewable energy communities*

1. Background

Part of the work as an architect at the General Directorate of Culture–Príncipe de Viana of the Government of Navarra consists of reviewing projects and projects and works related to interventions in protected architectural heritage of Navarra. The experience accumulated over the years and the methodology employed when preparing project reports on interventions in cultural heritage allow to outline some basic criteria about the valuation and legal protection of heritage and its complex integration with certain facilities associated with the associated with the energetic rehabilitation of these buildings.

2. Introduction

Today, the social demand for energy rehabilitation of existing buildings is evident. This aspiration is legitimate and commendable

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but, at times, difficult to reconcile with the duty to preserve our built cultural heritage, whose conservation is mandatory and of public and social interest.

It is clear that most energy consumption in the construction sector comes from the existing building stock, which is generally energy obsolete. A part of this built stock constitutes cultural architectural heritage, which has legal protection and, in some cases, conflicts with energy rehabilitation criteria.

And it is not only referring to monumental heritage, which holds the regulated legal protection granted by its designation as a Cultural Heritage Asset[1] (hereinafter BIC) (Ley Foral 14/2005, 2005), but also and especially to domestic architectural heritage—an entire set of minor traditional architecture scattered throughout our towns, without a clear stylistic classification but of great environmental value due to its presence in the landscape, of which it is an essential and inseparable part.

If the true goal is the sustainable development of society, it is necessary also preserve the historical construction constants that define the traditional architecture of many of towns. This task, in most cases, is difficult to reconcile with the installation of solar panels on rooftops. It does not seem advisable to impose the same requirements on all buildings indiscriminately, without considering the uniqueness of their historical and cultural context or their intrinsic architectural value.

While the goal of using renewable energy sources for self-consumption in buildings is legitimate, installing solar panels on the roofs of many buildings and historic districts that are part of cultural heritage is not always the right solution.

Some significant examples in Navarra that could be affected include towns such as Ziga in the Baztán Valley (Fig. 1), where traditional architecture maintains unique construction constants and integrates harmoniously into the natural landscape, or Ujué, with its cluster of buildings adapted to the topography of the hill crowned by the fortress church of Santa María. Also worth mentioning are the traditional farmhouses of the Navarrese mountains, whose beauty results from logical construction adapted to the natural environment, along with many other examples.

Fig. 1 – *Ziga, a representative village in the Baztán Valley* (Navarre from the sky. Santander Bank. 1997).

It is clear that if heritage interventions are guided exclusively by energy efficiency criteria, it will lose cultural values linked to the built legacy we have inherited. In my opinion, sustainable energy development must consider, in addition to energy efficiency principles, the historical construction constants that define the architecture of many of our towns and cities.

[1] It is one of the three special categories of protection assigned to cultural heritage assets by the Foral Law 14/2005 of November 22, on the Cultural Heritage of Navarra.

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This task, in most cases, is difficult to reconcile with the visual and construction impact of installing solar panels on rooftops or thermal envelopes on historic buildings, which are fundamentally protected by two basic legislative frameworks.

3. Basic legislation

The basic legislation for protecting architectural heritage in Navarra comes from two jurisdictional areas: the Navarra Cultural Heritage Law and the Navarra Territorial and Urban Planning Law (Ley Foral 14/2005, 2005; Decreto Foral Legislativo 1/2017, 2017). Both legal frameworks establish various control and protection measures for listed and declared buildings within urban planning regulations. Additionally, another recent national-level law, though little known, also recognizes the value of built architecture. This is Law 9/2022 on Architectural Quality which aims to protect, promote, and disseminate architecture as a matter of general interest (Ley 9/2022, 2022). It is worth noting that this law states: "As a matter of general interest, architecture shall be subject to protection, promotion, and dissemination by all public authorities" and further establishes that "The Administration is responsible for protecting the values of built heritage and promoting its rehabilitation as a matter of general interest, as well as implementing exemplary public policies to achieve these objectives" (Ley 9/2022, 2022). It is evident that this general duty toward architecture extends even more so to built architecture of cultural value.

4. Sectoral legislation

To briefly review the legislation and regulations applicable to sustainable energy development in Navarra, one must look back to the implementation of the Spanish Technical Building Code (CTE) in 2006 (Real Decreto 314/2006, 2006), which mandated that part of the energy consumption in renovated buildings come from renewable energy sources, thus requiring the installation of solar thermal collection systems on roofs (Real Decreto 314/2006, 2006). At that time, after analyzing the impact of this requirement on architectural heritage protection, the General Directorate of Culture- Príncipe de Viana Institution of the Government of Navarra issued several resolutions exempting certain buildings from the obligation to install solar panels on rooftops.

These exemptions were applied in varying degrees across five geographic areas of Navarra: the Pre-Pyrenean basins, the humid northwest of Navarra, La Ribera, the Pyrenean valleys, and central Navarra (Resolución 281/2007, 2007; Resolución 282/2007, 2007; Resolución 283/2007, 2007; Resolución 301/2007, 2007; Resolución 302/2007, 2007). These resolutions have since been incorporated into the urban planning regulations of municipalities that have approved plans since then.

4.1 The regional climate change law

If we move forward in time, also within the scope of Navarra, in 2022, the Government of Navarra approved the Regional Climate Change and Energy Transition Law. Among other provisions, this law establishes in Article 33.2 that:

> Buildings for residential, industrial, commercial, and institutional use with more than 500 m² of roof area must install individual or shared photovoltaic systems covering at least 35% of their surface area on south, southeast, and southwest-facing roofs (Ley Foral 4/2022, 2022).

The law itself, however, in Article 39.1, mentions an exception for buildings of cultural value, considering the possibility of substituting the obligation to install solar panels in those buildings with a contract with energy providers that ensure more than 35% renewable energy. This, in my view, is a requirement that is difficult to justify. In any case, this law is pending further development through regulations that will define these obligations.

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4.2 Energy Communities

It is interesting to bring into the discussion, as a means of reconciling the energy transition and the protection of built heritage, Regional Order 64/2022, issued by the Minister of Economic Development and Business, which establishes measures to promote energy communities in Navarra, with the aim of creating a favourable legal framework for their implementation (Ley Foral 4/2022, 2022). In many localities, photovoltaic panel installations, if there is interest and management capacity, could be considered through energy cooperatives, located in selected areas that integrate properly into the locality and do not harm its cultural and environmental values. This means community installations developed on land or on rooftops of buildings that do not have cultural or urban protection. The implementation of these energy communities represents an interesting alternative to consider in towns with protected historic centers, where their monumental designation, justified by their architectural and urban values, logically limits these types of installations.

5. Basic action criteria

The Architectural Heritage Section of the General Directorate of Culture- Príncipe de Viana Institution, in exercising its responsibilities, prepares impact reports on architectural heritage in two main areas related to renewable energies: The first refers to the installation of wind or photovoltaic parks in non-urban land, and the second concerns the authorization of thermal envelopes and photovoltaic panels on the rooftops of buildings cataloged in the municipal urban planning or located in protection areas of a BIC[2].

In the first case, as a general rule, most reports on wind and photovoltaic parks, given that they are located in non-urban areas and far from built-up areas, are usually favorable as long as they do not directly affect protected architectural heritage. This is the case of the monumental BIC surroundings, historical routes such as the Camino de Santiago, or cataloged buildings.

Another issue is the impact on archaeological heritage, especially regarding the routing of underground evacuation lines of photovoltaic solar parks, which falls under the Archaeology Section's jurisdiction[3]. This may impose more restrictions, as these lines could be located on land with potential archaeological value. And it is not appropriate to assess, because it is not within the competence of the Architectural Heritage Section, the impact on the natural landscape or the restriction of agricultural land use, which is limited by the occupation of land for these parks.

Regarding municipal urban planning, it is worth noting that the Architectural Heritage Section issues reports during the approval process of urban plans. Among other protection measures, it is reviewed that the regulations include the prohibition of authorizing the installation of solar panels on the rooftops of cataloged buildings when they are visible from streets or public spaces. This criterion also applies to all buildings that are part of historic centers declared as BIC, which in Navarra include Burguete, Estella, Olite, Pamplona, Puente La Reina (Fig. 2), Sangüesa, Santesteban, Tudela, and Viana, as well as the historic complex of Cerco de Artajona.

[2] These are reports issued by the technicians of the Architectural Heritage Section during the administrative approval process of the projects.

[3] Section of Movable Assets, Archaeological Heritage, and Registry of the General Directorate of Culture - Prince of Viana Institution

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Fig. 2 – *Orthophoto of BIC historic center of Puente La Reina* (Archive of the Principe de Viana Institution).

To properly assess the criteria described, it is appropriate to reflect on an essential consideration. Roofs are an integral part of cataloged buildings, contributing to their external appearance and architectural value. Sloped ceramic tile roofs are the traditional roofing solution in many old town centers in Navarra, particularly in most cataloged buildings in municipal urban planning regulations.

Photovoltaic panels do not align either materially or aesthetically with tile roofs—due to characteristics such as the glassy surface and color, the mounting structures and the inevitable aesthetic mismatch with roof slopes, especially considering that many roofs have triangular or trapezoidal shapes.

Since they are superimposed, they obscure the ceramic tile covering, which defines the appearance of protected buildings. For this reason, their installation on rooftops generates a negative visual impact on the preservation of their architectural value.

For these reasons, the Architectural Heritage Section considers photovoltaic installations inappropriate on cataloged buildings when they are visible, either from a distance or up close, from streets or public spaces (Fig. 3).

Nevertheless, it should be noted that certain exceptions to this general criterion have been accepted. Below, it is worth mentioning some recent examples.

In the case of protected surroundings of a BIC-listed building, the installation of photovoltaic panels has been authorized when the installation is placed on the ground within the surroundings and not on rooftops, ensuring no direct visual impact on the listed building. A concrete example is the photovoltaic installation carried out at the monastery of Leire, which is detailed below [4]. The site chosen for the installation is one of the former orchards of the monastery, located southeast of the monumental monastic buildings, south of what was the path to the Fuente de las Vírgenes.

[4] By Resolution 117/2024, of May 17, of the General Director of Culture-Principe de Viana Institution, the works for the installation of a self-consumption photovoltaic system at the Monastery of San Salvador de Leyre were awarded to the company Construcciones Leache S.L., according to the project drafted by the technicians of the Architectural Heritage Section, as part of the execution of project C14.I04.subproject 3 of the 'Recovery, Transformation, and Resilience Plan - Funded by the European Union - Next Generation EU.' The works were completed in May 2025.

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Fig. 3 – *Negative visual impact due to the installation of solar panels on a tile roof.* (Archive Architectural Heritage Section. General Directorate of Culture–Príncipe de Viana Institution).

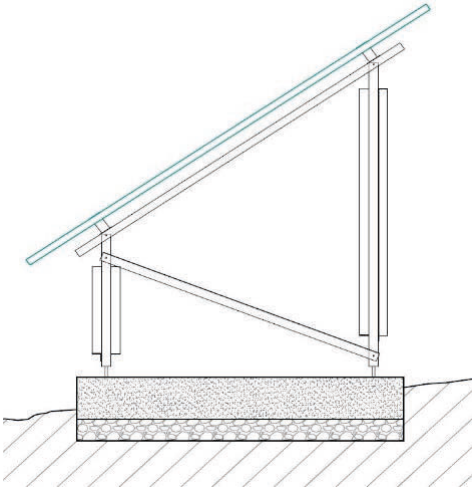

Fig. 4 – *Cross-section of the installed photovoltaic modules* (Archive, Architectural Heritage Section. General Directorate of Culture–Príncipe de Viana Institution).

The land was partially covered by a small wooded area planted by the community a few decades ago. The location was selected based on certain conditions. On one hand, there were no unfavorable visual impacts nearby from the monastery and its urbanization concerning the installation. There were also no distant visual impacts from the slopes to the south, southeast, and southwest, nor from the upper slope and the ridge of the mountain range. On the other hand, the topography of the land, with a slight slope towards the south, was favorable.

Lastly, the chosen area is integrated into the enclosure of the monastic community and the distance from the monastery's transformation center was considered adequate. The land chosen for the installation had traditionally been used as an orchard.

The installation was promoted by the General Directorate of Culture–Príncipe de Viana Institution, as it is a photovoltaic installation linked to the use and operation of the monastery, since its goal is to generate electricity for the monastery's self-supply. The installation consists of 580 photovoltaic modules with a total capacity of 261 kW. The modules are oriented south with a 35º tilt and are grouped into tables arranged longitudinally in an east-west direction, forming intermediate passage aisles between rows (Figs. 4–6).

Another case of exceptionality is that of the historic center of Tudela, declared a Cultural Asset of Heritage (BIC), for which a modification of the PEPRI (Special Plan for the Protection and Renovation of the Historic Center) has been favorably reported, allowing the installation of photovoltaic panels on the roofs of buildings located in the peripheral areas of the declared historic center, that is, former suburbs or orchards outside the medieval walled enclosure - except for the cataloged properties located in these areas. The urban planning of these areas does not follow the usual parameters of the historic center, and detailed regulations have been established regarding co-planarity with the roof slopes, limiting the surface area to a percentage of the slope's surface and specifying minimum distances of separation from the eaves and ridgelines of the pitched roofs.

The new regulation establishes a framework, including specific guidelines on orientation, coplanarity, surface area, and required distances from the eaves and ridgelines, in order to reduce the unfavorable visual impact. Specifically, the approved regulation stipulates that:

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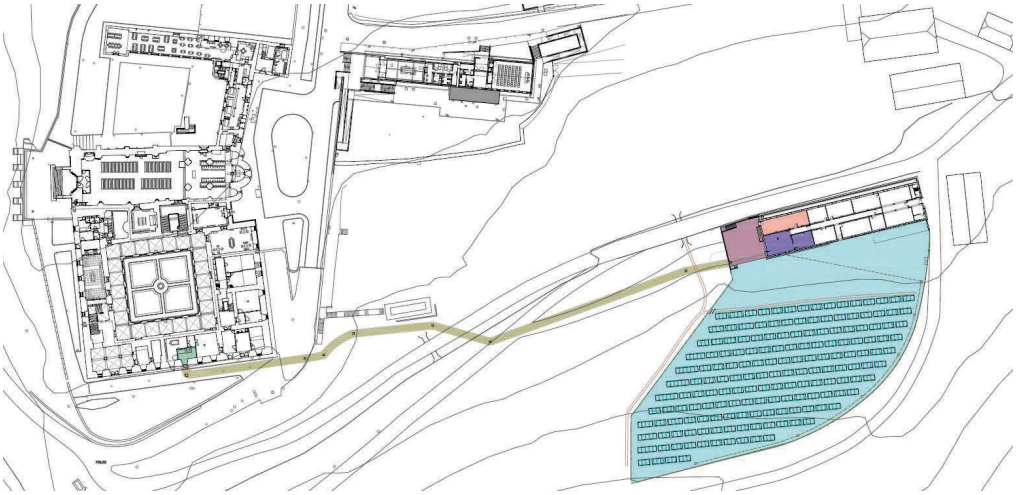

Fig. 5 – *Leyre monastery. Plan of the complex showing the scope of action: in blue, solar orchard with photovoltaic modules; in green, connection conduit to the monastery's transformer room* (Archive, Architectural Heritage Section. General Directorate of Culture–Príncipe de Viana Institution).

1. Photovoltaic installations on rooftops must be located on the sloped sections of roofs oriented towards the south (±30° deviation). They must consist of flat, non-reflective panels fully integrated into the roof slope, maintaining its plane and orientation. Roof tiles with photovoltaic cells are permitted.

2. The surface area of solar panels must be equal to or less than 40% of the surface area of the roof slope where they are installed, and they must always be placed at a distance of at least two meters from the edge of the eaves.

3. No devices, mechanisms, and/or auxiliary elements of the solar energy production systems may be installed on the external façades of buildings. They also may not be placed in roof areas visible from public roads or spaces.

6. Conclusions

It is essential when assessing the suitability of energy rehabilitation installations in protected buildings to consider: The uniqueness of the historical and cultural context in which they are placed and the intrinsic architectural value of the buildings. Although the goal of utilizing renewable energy sources in buildings is commendable, certain installations are currently not appropriate for historic buildings and town centers that are part of cultural heritage. It is evident that technological advancements in these installations are on the horizon, and within a few years, new solutions may emerge that better align with the regulatory framework for protecting these buildings. These developments could help reconcile the so-called energy transition with the preservation of the architectural values of buildings that form part of cultural heritage.

Fig. 6 – *Leyre monastery. View of the photovoltaic installation located in an area of former monastery orchards. In the background, the monastic complex.* (Archive, Architectural Heritage Section. General Directorate of Culture–Príncipe de Viana Institution).

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An example might be the technological development of photovoltaic solar tiles, although still conditioned by the improvement of their chromatic appearance and energy efficiency. Their implementation would reduce the current visual impact of photovoltaic panels and their anchoring systems on roofs, assuming that the roof is the part of the building that is most frequently renewed and, therefore, does not usually preserve the original historical covering; we would not be talking about solar panels overlaid on a roof, but about solar tile roofs. In any case, time will tell, but in the meantime, caution is advised.

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Co-thinking the Language of Vernacular Heritage through a Transdisciplinary Approach: Mapping, Regenerating and Creating

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Abstract

The research aims to analyse and valorise the material and immaterial heritage of vernacular architecture, with particular focus on Basilicata and its masserias as emblematic examples of deep-rooted and sustainable building knowledge. Through the mapping of traditional materials (such as raw earth, clay, wood and straw) and the study of construction and decorative elements, the work has developed a transdisciplinary methodology that combines architecture and design to support the creation of new design objects inspired by these elements. This approach interweaves digital innovation with the historical memory of techniques and traditions that define the identity of these places. The process was enriched by a comparison with similar contexts and realities, such as those in Spain, to explore parallels that contribute to a European perspective on the topic. In this vision, masserias, like other examples of vernacular architecture, are considered not only objects of physical restoration but also opportunities to narrate and enhance territorial identity through methodological strategies that combine design and architecture. These processes can activate dynamics of cultural, environmental, social and design sustainability, fostering new opportunities for interaction and promoting wide recognition.

Keywords: *cultural heritage; traditional materials; digital innovation; vernacular architecture; co-design; transdisciplinary approach*

1. Introduction: vernacular architecture as an expression of identity and sustainability

Vernacular architecture constitutes a pivotal element of cultural heritage, embodying local building knowledge, territorial identity, and the principles of building sustainability (Vellinga, 2021). This study explores the potential of Basilicata's masserias, emblematic examples of rural architecture stratified over time, to analyse their material and immaterial aspects and enhance their role in the contemporary context. The research stems from the need to fill a critical gap in studies on Lucanian vernacular heritage, often neglected in the international debate despite its relevance as a model of environmental and socioeconomic adaptation (Oliver, 2006; Mileto et al., 2015).

Through an analysis of construction techniques, traditional materials and the historical context in which these structures evolved, the study aims to

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define a methodology that can be transferred to the design field. The main objective is to demonstrate how vernacular architectural language can inspire contemporary design solutions, bridging tradition and innovation. This approach is part of an increasingly popular global transdisciplinary research trend that combines the hybridisation of architecture and design to combine sustainability and cultural identity (Awan et al., 2011). Experiences like those of the Formafantasma studio or the designer Fernando Laposse, cited here enigmatic cases show how traditional materials can generate new design narratives without renouncing experimentation.

The research questions, particularly, how vernacular heritage knowledge can be translated into operational strategies for sustainable design. How, for example, can the analysis of masserias guide the use of digital technologies for the conservation or creative reworking of these models? How can their technical and cultural heritage contribute to defining innovative objects while rooted in tradition? These questions guide the investigation, which aims to go beyond a purely conservative vision of heritage and instead propose a dynamic reading of it, capable of generating participation and circular innovation.

The research is therefore structured as a theoretical-practical contribution to demonstrate that the recovery of traditional architecture is not an exercise in nostalgia but an active process of regeneration. The synthesis between past and present can respond to our time's environmental and social challenges, provided that an adequate critical contextualisation supports the dialogue between disciplines.

2. State of the art: transdisciplinary perspectives in the conservation of vernacular architecture

In recent years, the increasing focus on environmental sustainability and preserving local identities has led to a critical reappraisal of vernacular architecture. No longer regarded as mere evidence of the past, it is now interpreted as a reservoir of technical and cultural solutions capable of responding to contemporary challenges, from energy efficiency to low-impact materials.

The most recent studies, such as those conducted by Correia et al. (2020), emphasise how traditional building techniques - linked to skilful use of local resources and a profound knowledge of the climatic context - still represent current models of environmental adaptation. However, some architectural typologies remain on the margins of academic research despite their recognised potential. This is the case of Lucanian masserias, rural complexes that, while embodying a balance between functionality, territorial identity and sustainability, have not yet received systematic analysis in the international debate.

A comparison with similar European experiences shows how the recovery of vernacular heritage can combine tradition and innovation. In Spain, for example, the reconversion of Valencian barracas-traditional structures made of wood and straw has shown how ancient techniques can be reinterpreted in a contemporary key. Projects like the one the Azalea team developed for the Solar Decathlon (2019) have redefined these buildings through passive solutions and bio-based materials, achieving energy performance comparable to that of modern constructions.

At the same time, a growing dialogue between architecture and design can be observed, resulting in the emergence of collaborative practices. Collectives such as Hypereden (Milan) or researchers such as Spanish architect Irene Roca Moracia demonstrate how the reuse of abandoned structures can generate new spaces and design objects capable of reinterpreting the material identity of places. Based on listening to the context and experimenting, these approaches lay the foundations for a circular regeneration of heritage, in which the past becomes a resource for the future.

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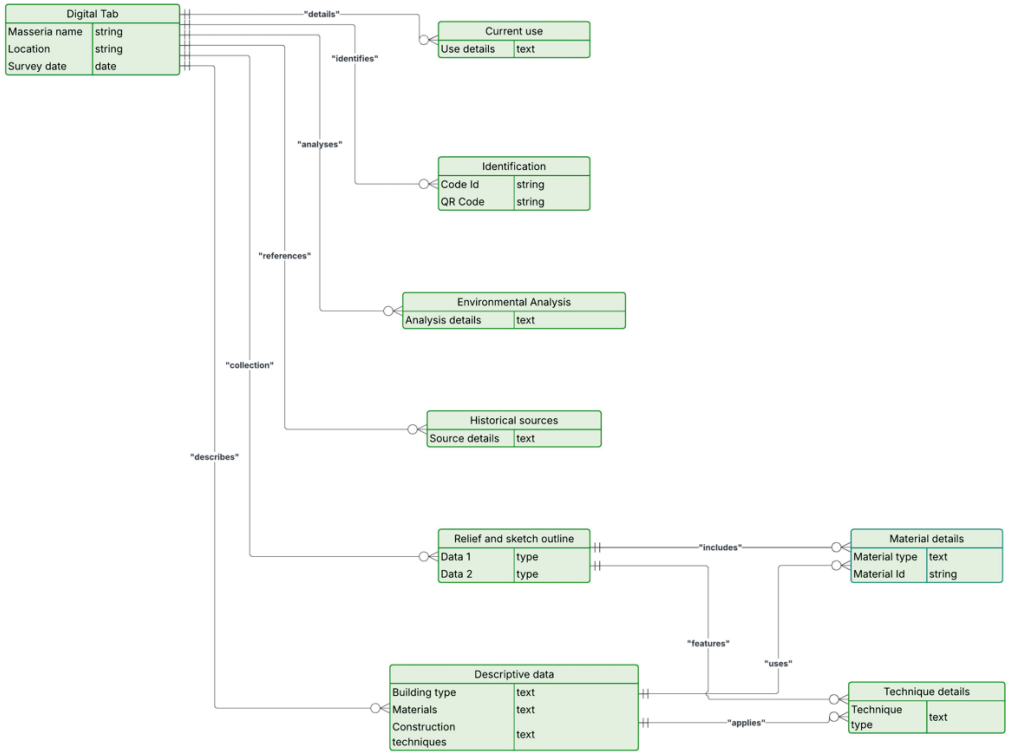

Fig. 1 – *Flowchart structure for the digital card in the mapping phase* (Authors, 2025).

Digitisation plays a key role in transforming architectural documentation from a simple archive into a dynamic design tool. Methodologies such as HBIM (Historic Building Information Modelling) or laser scanning make it possible to preserve accurate data and simulate conservation interventions and assess their impact. Platforms such as Europeana and Google Arts & Culture, moreover, widen the accessibility of heritage, promoting an informed enjoyment of it.

However, as Di Giulio (2024) points out, technology is not an end in itself: its effectiveness depends on its ability to integrate with a critical reflection on buildings' cultural value. It is precisely in this balance—between technological innovation and territorial roots—that the challenge of contemporary conservation lies.

3. Methodologies: an integrated approach between material analysis, digitisation and sustainability

3.1 Mapping

The methodological approach adopted is based on a transdisciplinary analysis, founded on the principles of Heritage Studies and sustainable design theories, with a particular focus on the interaction between material culture, environmental sustainability and design innovation.

The mapping phase consisted in the detailed mapping of the traditional materials used in the construction of Lucanian masserias, paying particular attention to their environmental impact and link with the historical identity of the area.

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This analysis involved an articulated and stratified data collection: through site visits, materials, construction techniques and architectural details were directly documented; in parallel, an archival and documentary analysis was carried out to reconstruct the historical evolution of technical and decorative solutions. This was accompanied by a preliminary survey of the area to identify good practices for the sustainable reuse and valorisation of materials already used in the tradition.

All the information collected is being systematised in digital files (Fig. 1), containing architectural descriptions, information on materials, analysis of construction techniques and historical backgrounds. Advanced digital tools, including photogrammetry, 3D modelling and geospatial technologies, were used to support the survey, with the aim of creating accurate, sharable and replicable documentation.

3.2 Regenerating

The second phase focuses on regenerating knowledge and practices related to traditional materials, reinterpreted in light of the challenges of sustainable architecture and the circular economy. Through a critical analysis of construction and decorative elements (Fig. 2), recurring technical solutions were identified and their evolution, adaptability, and durability understood. The theoretical framework draws on the studies of Dokter et al. (2021), which highlight the need to cross disciplinary boundaries between architecture and industrial design. Architects focus on building-scale reuse, while industrial designers favour circular business models: regeneration occurs when these perspectives meet. To support design choices, environmental assessments through LCA (Life Cycle Assessment) are necessary to estimate the ecological impact of local materials compared to industrial ones and highlight the environmental benefits of recovering and reusing vernacular resources.

Fig. 2 – *This scheme provides a detailed analysis of the masserias, highlighting its construction, decorative and material characteristics* (Authors, 2025).

These initial stages allow for an in-depth study of the link between historical identity and traditional materials and their adaptation to the local context. Initial case studies of the recovery and reuse of traditional materials were examined to highlight good practices and sustainable valorisation strategies.

3.3 Creating

The final phase, creating, corresponds to the design moment when architects and industrial designers work in synergy, translating the acquired knowledge into concrete, sustainable, and contextualised solutions. Starting from the data collected and the analyses carried out, a shared brainstorming process was activated to generate design ideas integrating traditional knowledge, innovation, and circularity. This phase is guided by the principle that 80 per cent of a product's environmental impact is determined in the design phase (European Commission, 2014). For this reason, interdisciplinarity is not only desirable but indispensable: it makes it possible to develop solutions that are rooted in the territory, but scalable, adaptable to other contexts, and compatible with contemporary needs (Fig. 3). The comparative comparison with Spanish realities, which explored European strategies for conserving and adapting rural architecture to the new paradigms of sustainable design, revealed a modus operandi oriented towards sustainability, the reuse of materials and the active involvement of local communities.

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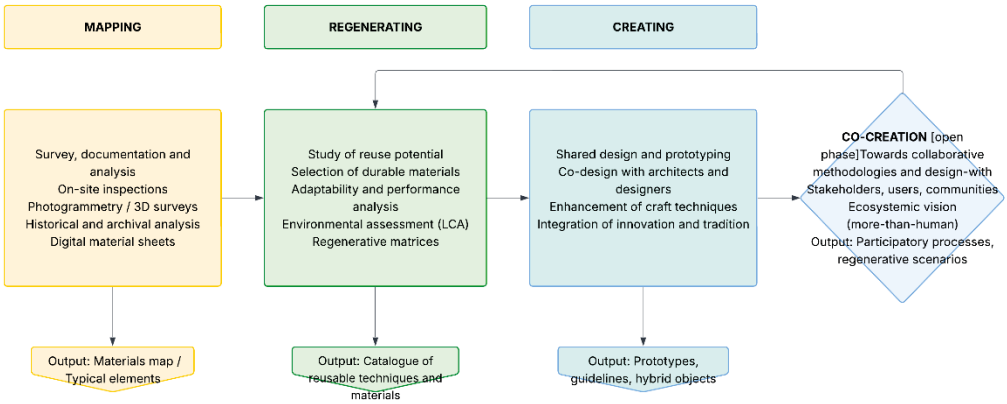

Fig. 3 – *Summary of the various phases adopted. These highlight not only the different outputs produced, but also the transdisciplinary approach that guided the entire process* (Author, 2025).

In many regions, the approach combines technical-digital surveying (such as laser scanning and photogrammetry), documentation of traditional building techniques and participatory design. Relevant examples are the case studies conducted within the framework of European projects such as RURITAGE or the regional experiences of rural regeneration in Catalonia, Andalusia and Galicia. Natural materials - such as unfired earth, lime, marsh cane and wood - are encouraged for environmental reasons and the valorisation of local identities.

Although there is a lack of dedicated national legislation, several European funds and regional programmes support restoration initiatives compatible with local landscapes and climates, thus promoting a rooted but adaptable model of architecture. This phase can, therefore, be further extended by opening up to broader collaborative practices: collaborative methodologies such as co-design, co-creation and participatory design, highlighting how such approaches can facilitate cultural and territorial reactivation through the active involvement of local communities (Di Bernardi et al., 2024), and generate sustainable solutions.

4. Results: an innovative model for preserving vernacular heritage

The survey highlighted a rich repertoire of traditional building techniques and practices that constitute the architectural identity of Lucanian masserias. This identity is strongly intertwined with local materials and vernacular building technologies in a relationship of interdependence: on the one hand, these techniques depend on available resources and environmental conditions, and on the other, they contribute to defining the cultural and architectural character of the territory. In Basilicata, this link is manifested in the analysis of the masserias, whose configuration changes over time and space: from rural residences in periods of urban decadence to defensive structures in the Middle Ages, to assuming religious functions.

The morphology of the land has profoundly influenced their architectural features, which are often equipped with defensive elements such as towers and loopholes (Guida et al., 2016). These rural buildings are built with local materials such as limestone and lime plaster, guaranteeing breathability and durability.

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Fig. 4 - *Exterior view of Masseria Mandola Lena (MT). Evident state of abandonment and degradation evidenced by textural erosion.* (Authors, photographic documentation collected during the field research, 2024).

The adoption of thick walls, small openings, and internal courtyards for natural ventilation and drainage systems to collect rainwater not only met climatic requirements but also represented a handed-down knowledge, which generated a coherent and recognisable aesthetic, now a source of inspiration for sustainable design approaches.

The digitisation and mapping of these architectures offer fundamental tools for their protection and valorisation, which are often neglected in planning and conservation processes (Fig. 4). In this context, integrating local materials with contemporary technologies is an effective strategy to promote sustainable building rooted in the territory. A first important aspect emerges from the analysis: the remarkable resilience of traditional structures concerning climate change, which highlights the adaptive value of historical building techniques. A second element concerns the need to classify digitisation levels applied to vernacular architecture. To this end, a grid was developed that distinguishes historical and archival documentation, survey and digital modelling (through HBIM, photogrammetry and laser scanning), valorisation through design and accessibility through open data platforms. An analysis of existing digital platforms, such as Europeana, the ICCD, Hispania Nostra's Lista Roja (Rubio Zorzano, 2022), Google Art & Culture, and tools for sharing HBIM models is underway. Urban Periscope offers an interactive inventory for heritage documentation and analysis. At the same time, Chimera represents an advanced integrated BIM-GIS system for the multi-scale management of 3D models, point clouds, maps and 2D images (Rechichi, 2020). These technologies open up important perspectives for innovation and accessibility in research and conservation.

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Finally, integration with contemporary co-design practices can stimulate the preservation of these assets and their reinterpretation in a design key, generating objects capable of narrating the territory through materials and forms.

These objects, intimately linked to their place of origin, absorb their essence and reflect their identity, counteracting phenomena of homologation and loss of cultural specificity. Masini and Galli (2023) emphasise the importance of recognising the value of the place where an object was born, highlighting how meaning is not assigned a posteriori but inherent in its origin.

If the dialogue with the social and economic disciplines is well established, the relationship with design, be it product, material or communication, opens up a still ongoing reflection. However, it is clear that both architecture and design, in their desire to work "with" and "for" the territory, recognise the value of the local dimension. Magnaghi (2000) observes that ignoring this relationship has led to a growing loss of awareness over time. Adopting shared methodologies, capable of highlighting the material and immaterial qualities of heritage, can generate new practices and strengthen the link between identity and design (Bevilacqua, 2007).

5. Conclusion

The lack of systematic research on these buildings limits understanding of their potential in integrating local materials, traditional building techniques and advanced technological solutions. A targeted investigation in this direction has made it possible to develop recovery and reuse strategies consistent with current environmental and social needs, contributing to sustainability models applicable in similar contexts. However, the detailed mapping of traditional materials and the study of the construction and decorative elements of masserias are excessively articulated and time-consuming: in-depth documentary and archival research and fieldwork are followed by reasoned cataloguing. Another limitation of the research concerns the conduct of the co-design tables between architects and designers, in which the objective may not appear clear, being accustomed to a more competitive and less collaborative system. To this end, clarifying the criteria that led to such collaboration can open up dialogue between the different parties. Finally, it may be difficult to objectively evaluate the outcomes of the co-design tables if evaluation parameters are not introduced over the medium to long term, which change according to the final product obtained. Greater comparison with global experiences is necessary to identify best practices and provide a more articulated picture of rural heritage valorisation methodologies.

In conclusion, the results of this research have highlighted the potential of an integrated approach combining historical memory and technological innovation to preserve vernacular architecture. Lucanian masserias have emerged as objects for restoration and narrative elements capable of strengthening territorial identity. Although they are often abandoned places, they have preserved traces, material or immaterial information, that highlight the relationships and networks involving the built and natural territory, productive economies, and signs of knowledge; these traces provide us with significant hints for future trajectories.

In addition, the application of digital tools and the adoption of advanced environmental analysis methodologies have opened up new perspectives for the valorisation and reuse of vernacular architecture, but also for a joint design that does not stop at construction elements but dialogues with the immateriality of the territory and traditions. In this context, the study, recovery and

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valorisation of these structures, and the materials and techniques associated with them, represent a key strategy for fostering cultural, environmental and social sustainability, encouraging new practices, both of reuse and urban regeneration (Dipasquale et al., 2021).

The research suggests that a conservation model based on a transdisciplinary approach can serve as a reference for other similar realities, helping to develop sustainable management strategies for vernacular architectural heritage in the long term. In this sense, this methodology may not only trigger new approaches to design, bringing different, complementary, but different disciplines into collaboration, but also improve the visibility and interest of these settlements and the materials used by a wider, international audience of designers.

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From Vernacular Wisdom to Contemporary Design: Bridging Traditional Patterns with Modern Sustainability

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Topic: T1.3. Mechanisms of sustainability of vernacular architecture

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Abstract

From Christopher Alexander's Pattern Language and The Timeless Way of Building to the algorithmic structures shaping contemporary communication and Large Language Models, can we trace a continuity between traditional and modern patterns of design? What are we missing to reconnect human artifacts with planetary boundaries? Ecodesigner Edwin Datschefski's early 21st-century five principles for ecodesign provide a more comprehensive understanding of design impacts compared to prevalent certification models like LEED, DGNB, or WELL. These principles highlight the need for a broader perspective on sustainability, one often overlooked in standardized frameworks. Vernacular architecture, by necessity and human scale, addresses embodied energy through immediate, intuitive assessments rooted in lived experience. Its efficiency in evaluating resource use outpaces modern technological approaches, offering critical lessons in sustainable design. This research explores strategies and knowledge developed by craftsmen from past and present, presenting case studies and interviews from workshops and field studies in the Cap de Creus area. The goal is to create guidelines for integrating traditional wisdom into modern construction practices. Far from simply replicating forms or using local materials, vernacular architecture reveals profound insights into the design-build relationship. By learning how to tradere —to transmit— this knowledge, we aim to inform a future where humanity, technology, and the planet coexist in harmony.

Keywords: *vernacular architecture; parametric design; embodied knowledge; ecodesign principles; pattern language; sustainable construction*

1. Introduction

1.1. From patterns to practice: revisiting architectural intelligence

The evolution from Christopher Alexander's *Pattern Language* to contemporary algorithmic design systems reflects both continuity and rupture in how design patterns shape human environments. Alexander (1977) described patterns as community-tested, iterative solutions rooted in lived experience, ecological context, and what he called the "quality without a name." Today's computational tools —parametric platforms like Grasshopper or generative models like GPT— rely on similar logics of combinatorics and iteration (Tanaka et al., 2024; Salingaros 2025; Henriques, 2022). Yet, they often lack the cultural and ecological grounding that defined Alexander's vision (Alexander, 1977, 1979; Leitner, 2015).

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While algorithmic systems echo the structure of pattern languages, they risk detaching design from embodied, communal, and planetary realities. Addressing global sustainability challenges requires more than technical optimization; it demands a reintegration of vernacular intelligence into design thinking. (Johnson Mary, 2025; Yang et al., 2024).

1.2 Eco-design beyond certification

Datschefski's five eco-design principles—cyclic, solar, safe, efficient, and social—offer a more integrated approach to sustainability than standardized certification systems like LEED or DGNB, which rely on abstract metrics and exhaustive documentation (U.S. Green Building Council, 2019; Deutsche Gesellschaft für Nachhaltiges Bauen, 2023). Datschefski (2001) emphasizes systemic coherence and social responsibility —qualities often bypassed in performance-based audits—. Even the EU's more holistic LEVEL(s) framework (European Commission, 2020) remains rooted in auditability. By contrast, vocational models like ECVET (Auzinger, 2021; Rainer, 2023); prioritize tacit knowledge and transmission through practice, foregrounding adaptation over abstraction. These differences underline the importance of addressing certification systems with lived, community-based design processes (Bin, 2024) (Fig.1).

1.3. Vernacular architecture as embodied sustainability

Vernacular architecture exemplifies real-time environmental intelligence. Case studies and literature (Rycke, et al, 2022; Maini, 2025) show how traditional methods —dry-stone, adobe, lime— achieve sustainability through localized, intuitive practice. Builders evaluate materials through bodily experience, creating a resilient design logic that Hinton (2025) describes as "non-formalized knowledge". Ignoring this intelligence limits the scope of computational sustainability models. Vernacular knowledge thus offers more than nostalgia, it embodies dynamic, adaptive systems that remain relevant today (Priavolou, 2020; He et al., 2024).

1.4. Fieldwork, transmission, and the logic of *tradere*

Through fieldwork in Cap de Creus, this study documented living craft traditions —dry-stone techniques, lime mortar use, and context-sensitive geometry— within GRETA-led Studies (GRETA, 2024). These practices revealed an embodied logic, where decisions evolved through hands-on interaction, environmental cues, and communal memory. Alexander's (1979) idea of patterns as situated responses resonates here: each construction act reflects a recurring spatial intelligence. This process exemplifies *tradere,* not just the transmission of skills, but of ways of knowing through doing. The research triangulated these findings with literature and practitioner interviews to reconstruct vernacular design as a generative, pedagogical system.

1.5. *Tradere* as epistemology for sustainable design

Reframing architecture through *tradere* —the act of handing down— highlights transmission as an epistemic foundation. This shifts focus from formal metrics to experiential, relational learning. Sustainable design emerges not from detached optimization but from recursive, site-specific engagement with materials and communities (Rudofsky, 1964; Eglash, 1999; Capra, 2013). Jakes, reveal the contextual and methodological gap relating to the role of traditional knowledge in sustainable development (Jakes, 2024). Any digital integration —through BIM, LCA, or AI— must preserve this contextual intelligence. Without it, technical systems risk becoming extractive, severing design from its ethical and ecological roots. By emphasizing pedagogical continuity, this research calls for a reinvestment in embodied knowledge and slow learning as central to a truly sustainable architectural future (Grundschober et al., 2016).

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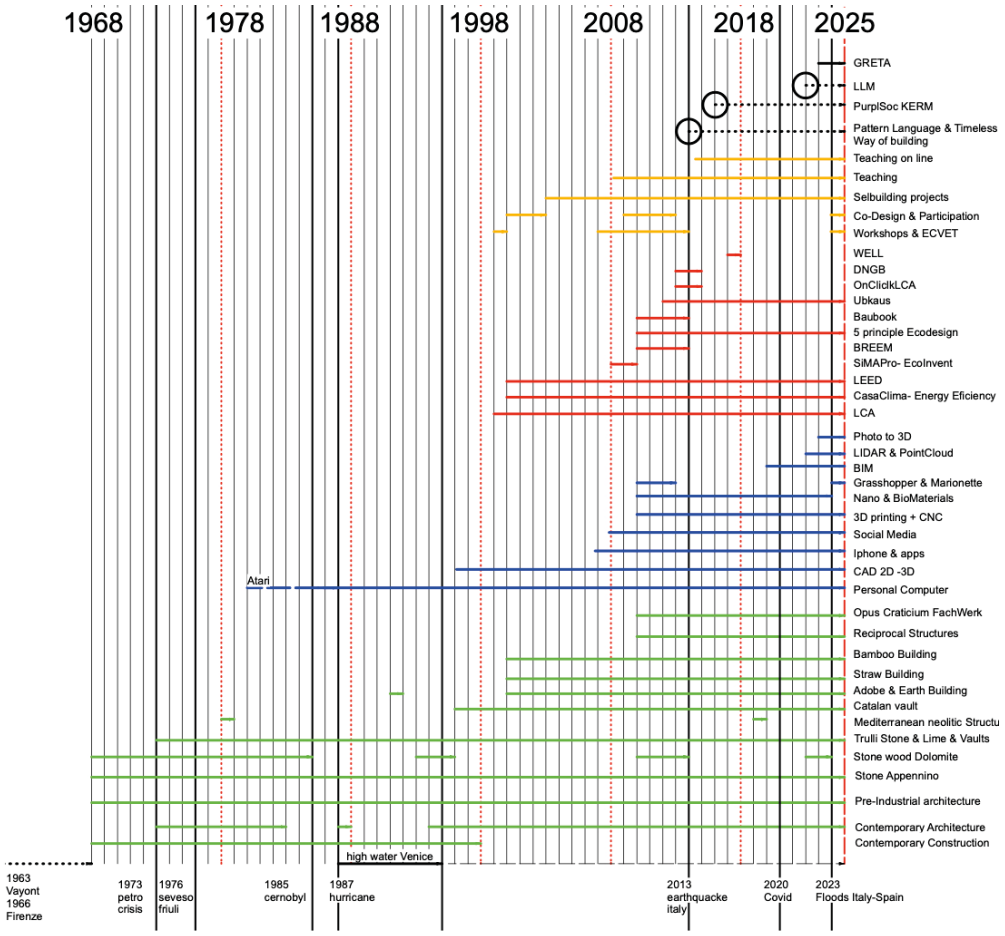

Fig. 1 – *CrossDomain map in time* (Author, 2025).

2. Objectives

This research pursues three interconnected objectives. First, it investigates the potential for meaningful integration between parametric design tools —including those driven by large language models (LLMs) and generative algorithms— and the embodied, context-specific knowledge systems of vernacular architecture.

Second, the study critically examines the limitations of prevailing sustainability certification frameworks —such as LEED, DGNB, and LEVEL(s)— in their capacity to recognize and value the adaptive, iterative, and place-based dimensions of vernacular design. These systems often prioritize quantifiable metrics over the more intangible yet essential features of ecological harmony, cultural resilience, and community knowledge.

Finally, the research seeks to develop a practical and pedagogical framework for embedding vernacular architectural logic —grounded in material experience, locality, and intergenerational transmission— into contemporary design education and architectural practice. The goal is to foster a design culture that is both technologically proficient and deeply attuned to environmental and cultural continuity.

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3. Methodology

3.1. Theoretical and comparative frameworks for vernacular logic

To explore how traditional architectural intelligence can inform contemporary sustainable design, this study began by constructing a robust theoretical framework through the analysis of seminal literature and comparative document analysis (Dipasquale et al., 2023; Teodosio & Talenti, 2022; Lidón De Miguel et al., 2025).

3.2. AI-Augmented experimentation and dialogical reasoning

To evaluate the feasibility of integrating vernacular logic into digital design workflows, the study adopted a dialogical and experimental methodology using large language models (LLMs). GPT-4 was employed as a reflective interlocutor in a series of structured exchanges modeled on Alexander's "15 properties of life" (Zhu & Friess, 2024). Through iterative prompts and Socratic questioning, the research tested whether AI could simulate pattern-based reasoning and articulate what Alexander called the "quality without a name."

These dialogues unfolded within the "Architectural Theory Analysis" (Fig. 4). academic chat environment, enabling recursive synthesis and the co-construction of conceptual frameworks While the AI demonstrated an ability to reproduce formal spatial logics and design analogies, it also revealed epistemological limitations —particularly its inability to grasp embodied, contextual knowledge—. These "hallucinated" outputs (Hinton, 2025) underscored the importance of grounding computational design in real-world experience and cultural specificity. Ultimately, this phase demonstrated both the potential and limitations of LLMs as tools for architectural thinking, highlighting the necessity of hybrid workflows that blend digital capacity with vernacular insight.

3.3. Case study and parametric translation

The applied component of the methodology focused on a field-based case study of dry-stone retaining walls in the Cap de Creus region. These constructions —composed of vertically placed slate slabs laid in gently curving arcs— demonstrate sophisticated environmental intelligence, offering stability, water management, and material efficiency without the use of binders (Fèlix Franquesa, 2023; GRETA, 2025). Selected for its clarity of construction logic and deep climatic-geological integration, the case served as a bridge between embodied knowledge and computational modelling (Fig. 2).

Fig. 2 – *Retaining wall with vertical stone placement Cap de Creus* (GRETA, 2025).

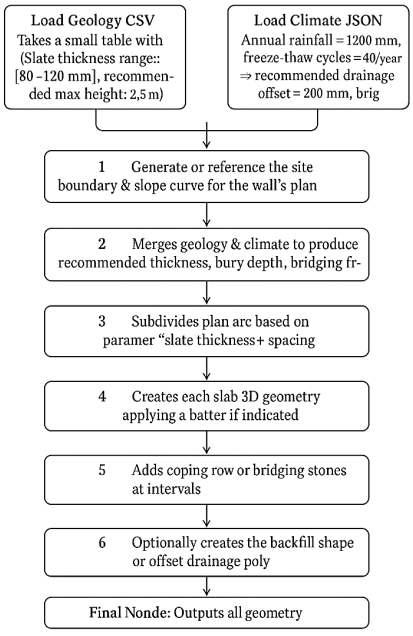

Fig. 3 – *Marionette Nodes* (Author & GPT, 2025).

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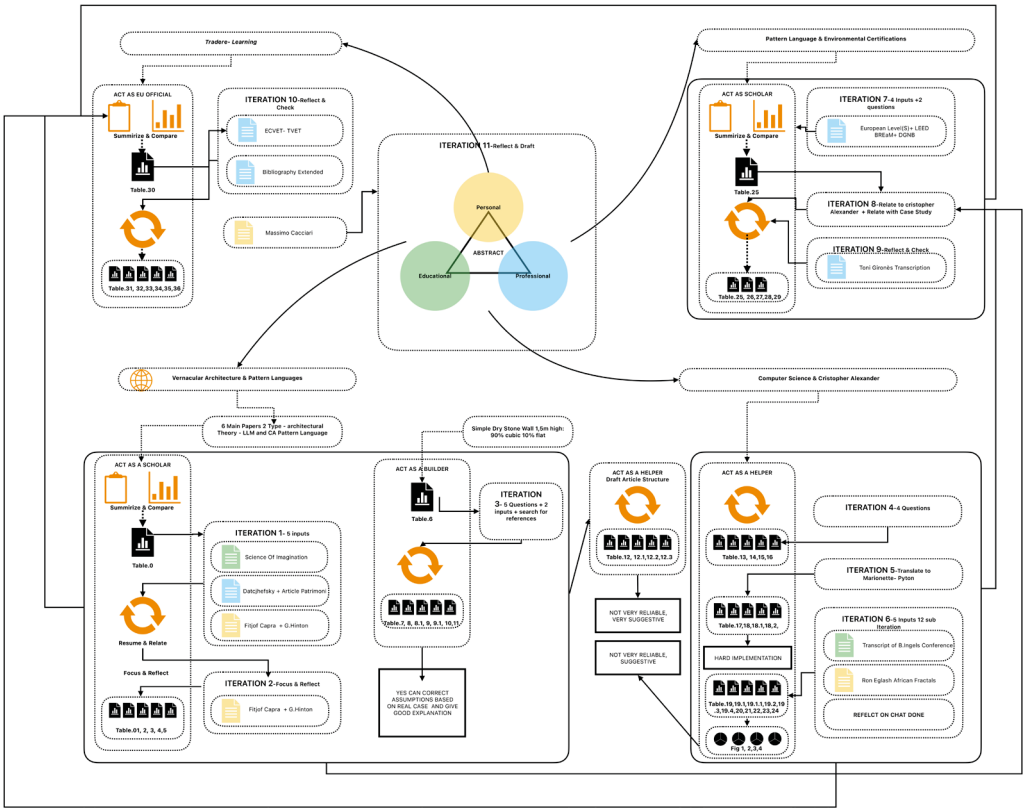

Fig. 4 – *Flow Map of interaction of the dialogical process held with ChatGPT for this research* (Author, 2025).

A parametric translation was developed using a Marionette script that incorporated topographic data, slate stratification, and environmental factors such as freeze-thaw cycles and prevailing rainfall. Importantly, the model also integrated tacit knowledge shared by local craftsmen —e.g., stone spacing, inclination, and ergonomic handling— not as rigid inputs but as soft constraints guiding design flexibility. This approach preserved the adaptability and human-scale logic of vernacular practice while leveraging the simulation and optimization potential of parametric design. In doing so, it operationalized a hybrid method capable of encoding traditional intelligence within digital systems (Fig. 3).

4. Results

4.1. Theoretical and comparative frameworks for vernacular logic

The cross-disciplinary literature review conducted in this study provided a robust theoretical scaffold for analyzing the epistemological and ecological logic of vernacular architecture. Through a curated corpus of 60 scholarly documents, complemented by critical texts from Alexander, Cacciari, Capra, and Hinton, the research established a theoretical matrix that spanned architecture, systems theory, ecology, and AI ethics. These texts were systematically summarized and cross-referenced in comparative tables that not only captured architectural theory but also embedded ethical and technological dimensions (Fig. 5).

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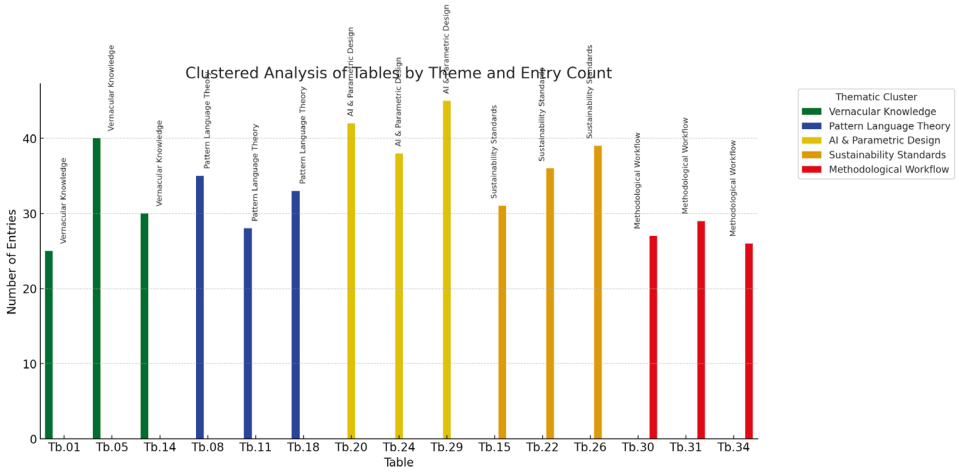

Fig. 5 – *Chat's entries type* (LLM revised by Author).

This intellectual scaffolding enabled a pattern-recognition approach that extended across domains, revealing recurring motifs —such as "living structure," "embodied resonance," and "non-metric sustainability"— in both architectural theory and AI design discussions. The cross-domain integration offered by the user's references allowed the research to frame vernacular architecture not merely as a technical relic but as a living epistemology, capable of informing both digital and cultural design logic. The result was a comparative framework with sufficient conceptual depth and breadth to support the hybrid methodologies that followed. The quality and diversity of the academic and empirical sources enriched this foundational layer and made the theoretical triangulation uniquely generative.

4.2. AI-Augmented experimentation and dialogical reasoning

The dialogical structure of the research unfolding through over 300 curated prompts and responses in the "Architectural Theory Analysis" (Figs. 4 & 6) chat, demonstrated how AI can support iterative theory-building and cross-disciplinary synthesis when guided by expert human curation (Johnson Mary, 2025). Over the course of the chat, the author posed targeted, escalating questions regarding vernacular design, eco-certification frameworks, philosophical underpinnings, and AI's epistemic boundaries. The AI (ChatGPT) responded by synthesizing, cross-referencing. This dialogic recursion led to the construction of tables, annotated excerpts, and speculative mappings that would not have emerged in a conventional linear writing workflow.

This method effectively simulated a research co-laboratory where the model served as a heuristic partner rather than an answer engine. The process modeled how LLMs might support reflective architectural inquiry when steered by situated, critical input. Moreover, it showcased the value of conversational scaffolding: knowledge was built not through standalone queries, but through cumulative layers of insight, critical feedback, and reflexive clarification.

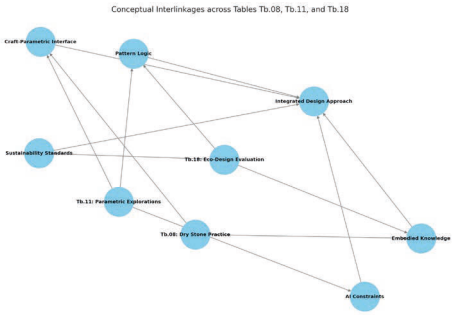

Fig. 6 – *Relations in chat* (LLM revised by author).

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5. Discussion

The epistemic vulnerability was exposed in the AI-assisted co-writing process (Holmér, 2025). Specifically, the phenomenon of partial hallucination and distorted memory resonates deeply with Massimo Cacciari's critique of the so-called "*macchina spirituale*" (Cacciari, 2025), a concept describing AI as a disembodied yet increasingly autonomous system with profound implications for human cognition, ethics, and freedom. Cacciari's most urgent philosophical question *"Chi insegnerà alla macchina spirituale?"* ("Who will teach the spiritual machine?") raises the stakes of human–machine interaction beyond technical development, framing it as an educational, ethical, and civilizational challenge. The question of who teaches the machine —and what is transmitted — extends beyond philosophical discourse into the realm of professional education and training systems, where frameworks like ECVET become pivotal in structuring how vernacular, craft-based, and site-specific knowledge is valued and transferred.

6. Conclusions

The embodied intelligence of vernacular architecture offers invaluable insights for contemporary sustainable design. When translated through parametric systems informed by ecodesign principles and local knowledge, these traditions can evolve into a "new tradition" where past and future meet. A well-curated, open-access repository of vernacular architectural knowledge could offer a concrete response to Cacciari's critical question. The act of *tradere* the ethical and epistemic transmission of wisdom across generations emerged as both a method and a metaphor. It implies a shift from extraction to stewardship, from optimization to resonance.

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Passive Thermal Performance of Glazed Balconies from Northern Portugal Vernacular Architecture and Contribution to a Regenerative Built Environment

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Abstract

The construction industry faces significant environmental challenges that necessitate a regenerative approach and the use of local resources. Features such as glazed balconies can dramatically lower energy consumption and carbon emissions. This research investigates the impact of glazed balconies through a case study of vernacular architecture in Northern Portugal, emphasising their function as passive heating systems that capture solar energy while minimising heat loss. The methodology involves short-term and long-term thermal condition monitoring and occupant comfort surveys. The quantitative findings demonstrate that glazed balconies alleviate indoor discomfort during sunny days in the heating season by effectively utilising solar gains. However, overheating risks during the cooling season underscore the importance of adequate shading and ventilation. Ultimately, the study validates the effectiveness of glazed balconies as a passive heating solution in regions with cold heating seasons and highlights the critical role of user behaviour in enhancing building performance. Unfortunately, a lack of awareness about the benefits of this passive approach is leading to the decline of this vernacular technique, which is a key aspect of Northern Portugal's architectural identity. Consequently, this research seeks to raise awareness about the need to preserve this climate-responsive vernacular strategy and explore how the associated knowledge and benefits can be integrated into modern buildings to foster a regenerative built environment.

Keywords: *glazed balcony; indoor comfort; passive design strategies; thermal performance; vernacular architecture*

1. Introduction

The built stock accounts for nearly 40% of CO2 emissions (European Commission, 2021). In response to this issue, the European Union has established ambitious targets to decarbonise the building stock by 2050. As part of this effort, recent regulations under the Energy Performance of Buildings Directive (EPBD) mandate the assessment of life-cycle Global Warming Potential (GWP) for new buildings, starting in 2030 (Energy Performance of Buildings (Recast), 2023).

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The building sector must adopt low-carbon technologies, sustainable materials, and efficient manufacturing processes to meet decarbonisation goals. Vernacular architecture provides valuable insights, aligning with modern sustainability goals. Research shows that climate-responsive design and local materials—adapted to specific geographical conditions—effectively reduce environmental impacts, lower energy consumption, and decrease CO2 emissions (Fernandes et al., 2020; Martín et al., 2010)

Among the various passive design strategies, glazed balconies have emerged as a promising solution for improving thermal performance in residential buildings across diverse climatic contexts. Empirical studies show that glazed balconies can reduce heating loads by up to 80% (Sabatell-Canales et al., 2023). Their effectiveness has been demonstrated in climates ranging from cold and sub-arctic regions to Mediterranean environments (Babaee et al., 2016; Ribeiro et al., 2024).

While the energy-saving potential of glazed balconies is significant, it is crucial to address the risk of overheating. This can be mitigated through strategies such as natural ventilation and adjustable shading devices (Babaee et al., 2016). Fernandes (2020) compared three energy simulation scenarios for a vernacular building, showing that a glazed balcony greatly enhances thermal performance. The adjacent bedroom in the scenario with the balcony needed roughly 25% less heating energy. It also reveals good performance during the cooling period by promoting ventilation and acting as a shading device.

Toroxel et al. (2024) studied glazed balconies in northern Portugal, finding they can cut energy demands by 47% and extend indoor comfort by nearly 900 hours annually compared to buildings without them. These results highlight glazed balconies as a viable strategy for new and renovated construction projects.

Despite their benefits, standardised quantitative data on traditional architectural techniques' thermal and environmental performance is lacking. This absence complicates professional comparisons with conventional practices and hinders improvements. This paper analyses the thermal and environmental performance of a specific glazed balcony in Northern Portugal, emphasising its energy efficiency contribution and the importance of preserving such strategies.

2. Methodology

In situ assessments evaluated indoor thermal performance through both short-term and long-term monitoring of hygrothermal parameters (air temperature, relative humidity, mean radiant temperature, and air velocity) that affect heat exchange between the body and the environment.

The Short-Term Monitoring was conducted at least once per season, involving objective measurements using a thermal microclimate station (Delta OHM 32.1) to assess thermal comfort quantitatively. Data collected helped determine operative temperature, while subjective evaluations of indoor environment quality were gathered via the ASHRAE 55 (2017) Thermal Environment Survey to gauge occupant satisfaction.

The Long-Term Monitoring measured indoor and outdoor air temperature and relative humidity in each season (for at least 30 days) using thermo-hygrometer sensors placed in representative rooms and outdoors, recording data every 30 minutes.

The Portuguese adaptive thermal comfort model was used to analyse thermal comfort conditions, as it is the appropriate model for naturally conditioned buildings (Matias, 2010). It adapts ASHRAE 55 (2017) and EN 15251 (2007) to the Portuguese context, considering local climate, lifestyles, and building designs. This model indicates that:

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- occupants tolerate broader temperature ranges than recommended for mechanically conditioned buildings;
- outdoor temperature significantly influences occupants' thermal comfort perception/sensation.

3. Description of the case study

3.1. Site and climate

The case study is located in the Douro Valley region, in Salzedas, municipality of Tarouca. The region has a temperate climate - Type C, according to the Köppen-Geiger Climate Classification, co-existing with the sub-types Csa (temperate with hot and dry summer) and Csb (temperate with dry or temperate summer) (AEMET & IM, 2011). Salzedas is in a narrow valley connected to the Douro River and, in the transition between the two climate subtypes - the Csa in the valley and the Csb in the higher altitude areas. The annual average temperature is 15 °C (AEMET & IM, 2011). The mean winter temperature is 7.5 °C, while the summer mean ranges from 22.5 to 25.0 °C. (AEMET & IM, 2011). Winter is a harsh season here, with 10 to 20 days where the temperature drops to 0 °C or below (AEMET & IM, 2011).

3.2. Building

The case study is an extraordinary glazed balcony building example of Northern Portugal vernacular architecture, presenting a set of strategies to promote heat gains and reduce heat losses. The building is a single-family house integrated into the urban mesh in a special protection zone due to its proximity to a Cistercian monastery founded in 1168. It has an irregular floor plan, and the main facade with the balcony faces southeast. However, the balcony also curves to the southwest facade (Fig. 1). The gross floor area is approximately 350 m^2 divided into three storeys (Fig. 2).

It has two storeys with stone walls and small openings, to avoid heat losses, and a third storey with a balcony, aiming to capture solar gains.

Fig. 1 – External view of southwest and southeast facades.

Fig. 2 – Floor plans.

Like other constructions in this region, the ground floor was prepared for storage and the cattle (to take advantage of the animals' body heat), while the upper floors were for human occupancy. Nowadays, this building retains the features of the upper floors, and the ground floor is only for storage.

The building envelope consists of granite walls (65 cm thick) on the ground floor and the first upper floor main facade. The other external walls are in *tabique* (earth-filled timber frame walls). It has a pitched roof with ceramic tiles and a wooden frame, separated from the indoor space by a horizontal timber slab. The building has wooden doors and framed single glazed windows with indoor wooden shutters. Indoors, the

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partition walls are in *tabique* (earth-filled timber frame walls). The ground floor is on earth, and the upper floors are wooden with a timber structure. The volumetric configuration of the building allows cross-ventilation.

Its signature feature is a considerable glazed balcony to promote indirect heat gains and better thermal comfort conditions (Fig. 3). It is well orientated facing SE and SW, capturing more hours of direct solar radiation. It also has a singular feature to promote ventilation by using operable wooden shutters below windows.

The building has no HVAC system.

3.3. Passive strategies

In the northern inland region of Portugal, vernacular architecture has adapted to the climate by implementing strategies to cope with cold winters. These strategies generally aimed to maximise solar gains and minimise heat losses during winter, as exemplified in the case studies:

Balconies are a defining architectural feature of Northern Portugal's vernacular buildings. Since many of these structures originally had low daylight levels and limited comfort, balconies served as spaces to enjoy sunlight, carry out tasks with natural light, and passively heat adjacent rooms, especially on sunny winter days. A glazed balcony represents an enhanced version of this feature, functioning as a sunspace that captures solar energy while limiting heat loss. So, during winter, it benefits from prolonged exposure to solar radiation. Although primarily designed for heating, the cantilevered structure and the ability to keep windows open without compromising security also make it effective during the cooling season by shading walls and facilitating natural ventilation.

The interior layout of these buildings also contributed to reducing heating needs. Bedrooms were typically located near the kitchen and rarely had exterior windows, allowing them to benefit from the warmth generated by the fireplace.

4. Thermal performance and indoor comfort assessment

4.1. Winter

The winter monitoring was carried out between 21 December 2019 and 19 February 2020. During this period, the minimum outdoor temperature was low, reaching a minimum value of -1.5 ˚C, and it remained below 5 ºC most days. The maximum outdoor temperature reached 17.9 ˚C, and the mean temperature was 8 ˚C.

The temperature profiles in the glazed balcony and in the living rooms (1st and 2nd floors) were not stable and followed the outdoor temperature variation (Fig. 4).

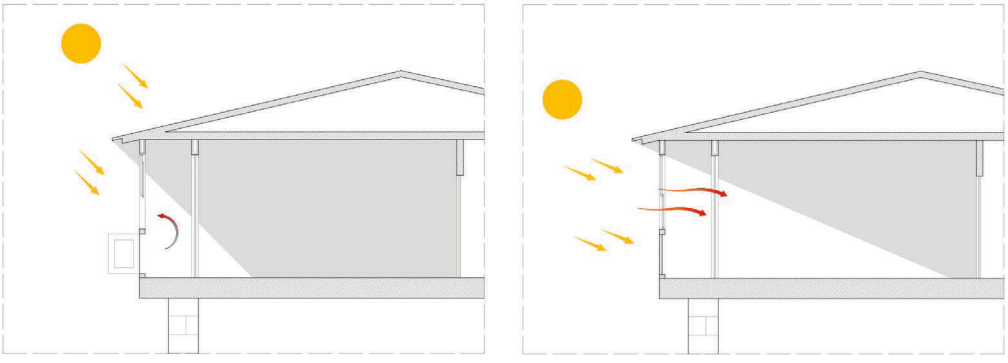

Fig. 3 – *Schematic section of the glazed balcony operation.* ***(a)*** *Summer solstice;* ***(b)*** *Winter solstice.*

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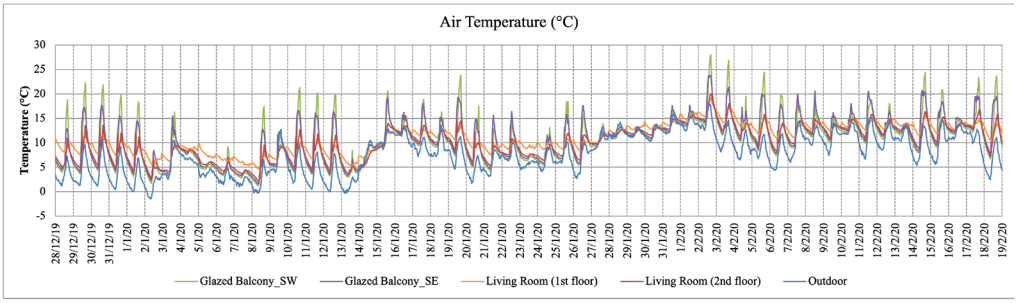

Fig. 4 – *Winter monitoring: Indoor and outdoor air temperature profiles.*

The maximum indoor temperature reached 28 ºC in the glazed balcony and 20 ºC in the adjacent living room. Figure 4 indicates that the balcony has high-temperature peaks during sunny days, often 10 to 13 ºC above outdoor levels. However, during winter, the living room struggles to maintain comfortable conditions, remaining below 15 ºc most of the time (Fig. 4). The balcony's large glazed area and favourable solar orientation provide passive solar gains to heat adjacent spaces and reduce energy demand for thermal comfort. However, poor maintenance, including rotten wood and broken windows, increases heat losses and low minimum temperatures at night.

Regarding the assessment of thermal comfort (Figs. 5a & 5b), the thermal environment conditions were measured during a typical winter day in the two living rooms (1st and 2nd floor) without any active heating. Results show that on the 1st floor, the thermal environment was very uncomfortable, below the lower limit (Fig. 5a). On the 2nd floor, the influence of the balcony improved comfort conditions and was close to the limit but still below. In the survey, the occupants also expressed their thermal sensation for the same two rooms, answering as being “slightly cool” in the first and “neutral” in the second. These results are close to the ones from the objective measurements and the differences are related to the different levels of clothing insulation, which influence their thermal sensation.

4.2. Summer

The summer monitoring was carried out from 21st June to 20th September 2020. The analysed period is from 5th July to 5th August since it includes the hottest weeks and the short-term monitoring. In this period, the mean outdoor temperature was 25.9 ºC. There was a high daily thermal amplitude, with almost all days reaching maximum values around 35.0 ºC (and a peak of 38.2 ºC), and minimum values were frequently around 20 ˚C (Fig. 6).

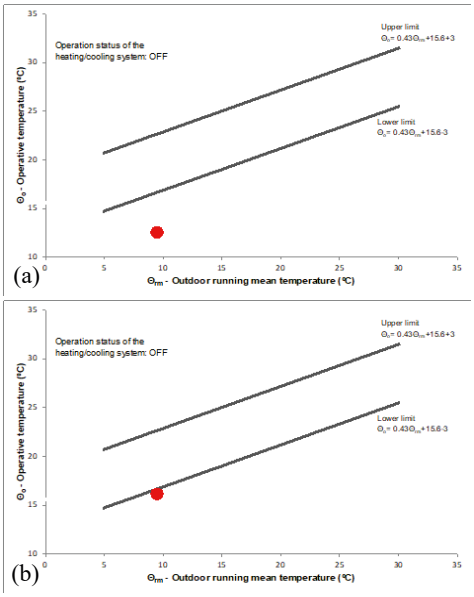

Fig. 5 – *Adaptive comfort chart during a representative Winter day: (a) Operative temperature in the living room (1st floor); (b) Operative temperature in the living room adjacent to the balcony.*

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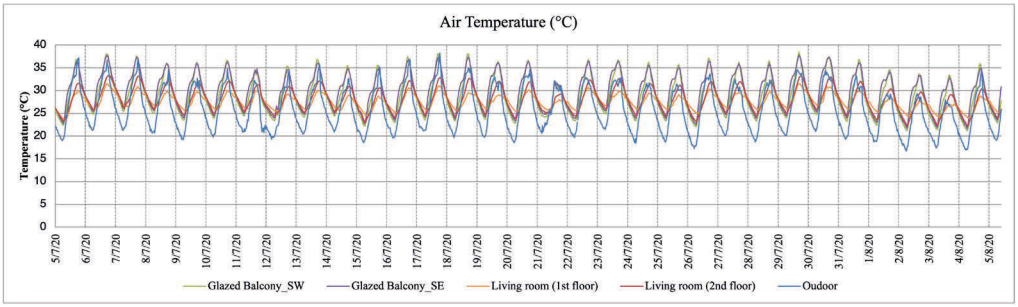

Fig. 6 – *Summer monitoring: Indoor and outdoor air temperature profiles*

From the analysis of Figure 6, it is possible to verify that the living rooms had a daily thermal amplitude around 5 ºC (lower than the variation in the balcony and outdoors), with a high mean temperature of around 28 ºC and maximum peaks of 31.5 and 33.3 ºC, 1st and 2nd floors respectively (Fig. 6).

It has to be highlighted that the high indoor temperatures in the living room adjacent to the balcony were not directly caused by it, but by the high daily temperatures during the period, as seen also in the 1st floor living room that is shaded by the balcony. It is also possible to see that the peak temperatures in the balcony are very close to the maximum outdoor temperature, not directly affected by direct solar radiation since the roof overhang shades part of the glazed area during the day.

It had to be noticed that this balcony has an ingenious ventilation system with many small shutters beneath the windows to promote heat dissipation. However, as explained before, the lack of maintenance does not allow us to open them due to safety conditions.

Nevertheless, the use of this strategy during the summer has to guarantee good ventilation and shading to avoid heat gains and overheating conditions.

In the thermal comfort assessment, the living rooms showed a thermal environment in the higher limit or above of the comfort range (Figs. 7a &7b). The operative temperature in the two rooms was of 29.1 and 31.9 ºC in 1st and 2nd floors, respectively. The results of the survey confirmed the measurements with the five occupants answering as being "hot" and "very hot". This thermal condition shows the risk of overheating during summer and the need to use a more effective shading/solar protection system and ventilation.

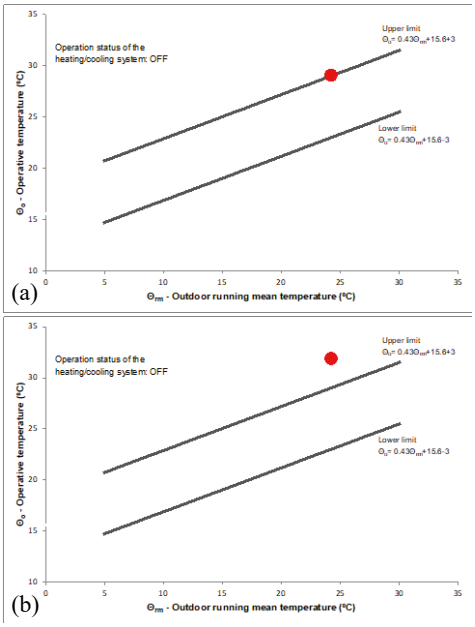

Fig. 7 – *Adaptive comfort chart during a representative Summer day: (a) Operative temperature in the living room (1st floor); (b) Operative temperature in the living room adjacent to the balcony.*

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6. Conclusions

Research findings indicate the effectiveness of glazed balconies as a passive heating solution in a region with cold winters. On sunny days, indoor air temperature can rise significantly, with the balcony functioning as a sunspace that enhances heat gain and as a buffer zone that minimises heat loss, reducing energy demand. Nonetheless, achieving thermal comfort without an active heating system proves challenging.

During summer, while thermal comfort conditions exceed comfortable limits, the discomfort is primarily due to prolonged high daily temperatures rather than overheating from the balcony itself. Implementing external solar shading devices and ensuring operational ventilation shutters can mitigate excessive solar gain and prevent overheating during warmer months.

The glazed balcony serves as the main passive strategy for this building and contributes to its unique character. Unfortunately, its poor maintenance undermines its effectiveness and the overall aesthetic appeal of the structure. Renovating this balcony, and others like it, could serve as a model for preserving architectural uniqueness and inspire future interventions in the region, given that similar cases have often been overlooked or altered due to insufficient understanding of their benefits. This example could also influence the design of new buildings in the area, helping to retain elements of traditional knowledge while enhancing thermal performance.

Despite being an iconic element of northern vernacular architecture, glazed balconies lack recognition and appreciation, leading to their gradual neglect or demolition. Traditional materials are often supplanted with modern industrial options such as aluminium and steel when maintained. To counteract this trend, efforts must be made to preserve and promote the advantages of these balconies, particularly regarding thermal comfort and energy efficiency. Furthermore, as evidenced by previous studies, advocating for their incorporation into new constructions is essential for reinforcing this beneficial architectural feature.

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Qualities and Values of Rural Vernacular Architecture: by Way of a Decalogue

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Topic: T1.3. Mechanisms of sustainability of vernacular architecture

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Abstract

Recognising that something has value means that the qualities defining it hold interest or significance for an individual or a group. Research begins by constructing the state of the question, and the same applies to the act of valorising rural vernacular architecture. These are pre-industrial architectures whose obsolescence often leads to abandonment and ruin. Thus, the act of valorisation becomes the first step in protecting these architectures. To this end, it is important to approach the most significant reflections made on this subject within the academic field, reviewing precedents to better understand and delve deeper into the nature of these architectures and their qualification. This theoretical foundation, combined with research and fieldwork focused on rural and vernacular architectural environments, will validate the architectural considerations proposed in this study, which is the main objective of this work. Since the early 20th century, many architects have investigated and acknowledged the values of vernacular and rural architecture. However, it is especially in recent decades that more numerous studies have been conducted, forming a transdisciplinary network of knowledge that elevates the recognition of these small constructions and intellectualises their values and contributions to contemporary times. From this foundation, a decalogue of values or architectural qualities inherent in rural, productive, and small-scale vernacular constructions is distilled, which will be explained in this text, include: functionality, sustainability, territorial positioning, integration and adaptability, repetition and transmissibility, infrastructural value, landscape value, ethnographic and identity value, and didactic value.

Keywords: *productive rural architecture; territory; landscape; rural heritage*

1. On rural vernacular architecture: a pre-industrial tradition

Rural vernacular architecture, typically associated with productive functions, can be considered a heritage construction category, as it meets two widely accepted criteria among researchers: cultural relevance and tradition. This category encompasses buildings linked to agricultural practices and the culture of labour and production, and it represents one of the most significant forms of civil architecture in the south of the Iberian Peninsula (Olmedo Granados, 2002, p. 15). It comprises a wide variety of typologies, each emerging as a specific response to the functional needs for which they were created. These are traditional architectures born from ancient practices, developed independently of academic architectural theory. Their spatial distribution is generally dispersed, and they are deeply rooted in their natural and cultural landscapes.

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Grinding, storing, weaving, breeding, extracting, drying, melting, and transforming. These activities and the associated know-how are integral to rural life and have shaped a diverse architectural landscape: from large, imposing estates and farmsteads to modest, utilitarian constructions, which are minor architectures far removed from ideas of monumentality and focused solely on fulfilling specific purposes. As such, they are often referred to as pre-industrial architectures, with the prefix highlighting their origins prior to the Industrial Revolution. These practices, knowledge systems, and building techniques belong to the past, and so do the architectures they produced. However, this does not suggest that they should be discarded or excluded from consideration as part of the heritage. Engaging with this form of architecture, historically overlooked but now increasingly recognised, yet still largely unprotected, requires us to reflect on when it first began to capture the interest of intellectuals and how this attention has evolved. By examining the attributes and values identified in prior research, we can further elevate its status and contribute to its recognition as heritage architecture.

2. Architectures of interest from the early 20th century

Although research into traditional rural architecture has grown significantly in recent decades, perhaps prompted by environmental instability and climate change, interest in these architectural forms dates back much further. Over a century has passed since they first became a subject of discussion in cultural circles.

At the international level, attention to traditional architecture began in the 19th century. Marcel Vellinga (2013) identifies figures such as George

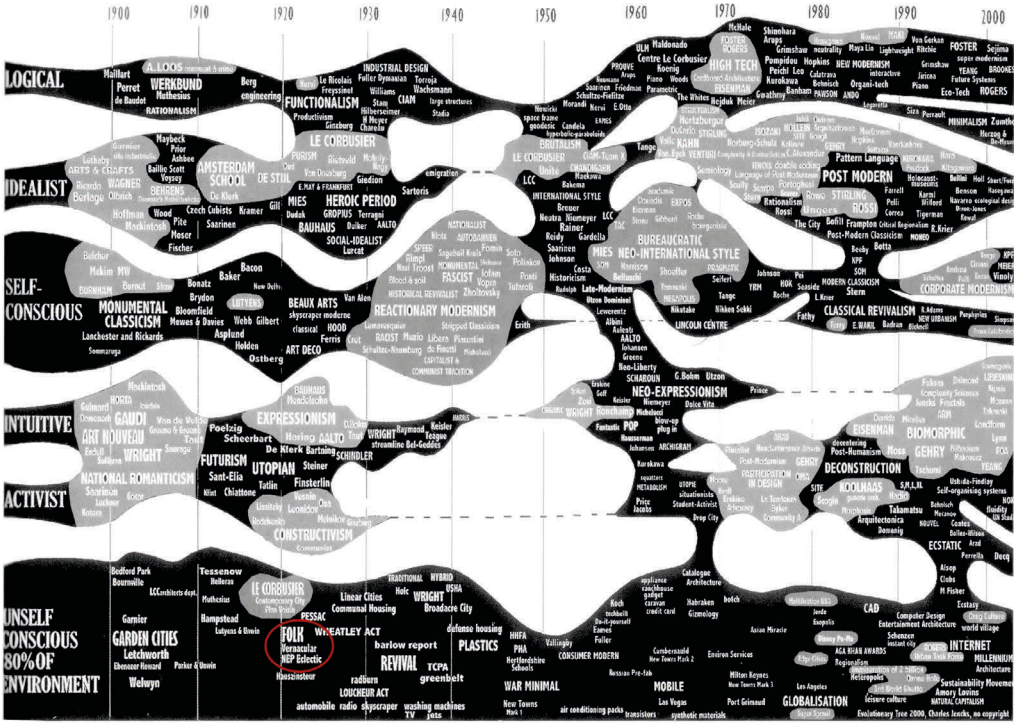

Fig. 1 – *Evolutionary Tree of the 20th century architecture* (Jencks, 2000).

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Gilbert Scott in the United Kingdom, and Norman Morrison Isham, Albert F. Brown, and Fiske Kimball in the United States, as pioneers who carried out detailed studies on regional constructions, later termed "vernacular," with a focus on their ordinary and local character. Charles Jencks, in his synopses from 1971 and the revised 2000 edition (Fig. 1), situates the VERNACULAR movement in the 1920s, linking it to FOLK and NEP ECLECTIC. This period coincides with the architectural work of Heinrich Tessenow and the research of Giuseppe Pagano (1936), who documented Italian rural architecture in travel notebooks, capturing constructions made with traditional materials rooted in popular culture and the rural world.

In Spain, scholarly attention had traditionally focused on monumental and ecclesiastical heritage. It was not until the early 20th century that rural and vernacular architecture began to be recognised as subjects worthy of academic interest. This shift was driven by cultural transformations at the turn of the century, which ushered in the 20th century with a pessimistic atmosphere and a general erosion of traditional values. Such a context prompted concern among a generation of intellectuals seeking to reconstruct Spanish national identity through a re-examination of its past.

This process began in 1913 with a text by Manuel Bartolomé Cossío for the catalogue of an exhibition on popular art organised by the Pedagogical Museum. The journal *Arquitectura* was first published in 1918 and remains in circulation today. It has played a crucial role in promoting research into popular and traditional architecture. Particularly noteworthy during these decades are the studies by Vicente Lampérez y Romea and Leopoldo Torres Balbás.

In addition to *Arquitectura*, other influential periodicals began to emerge from the 1930s onward, enriching the ongoing debate on the identity of Spanish architecture, with tradition and modernity as dominant themes. Among these were *Cortijos y Rascacielos*, directed by Casto Fernández-Shaw, as well as *Agricultura and Estudios Geográficos*. Other publications dedicated entire issues to vernacular architecture, such as the final issue of *AC. Documentos de Actividad Contemporánea*, published by G.A.T.E.P.A.C. between 1931 and 1935 (Fig. 2). This issue emphatically rejected the mimetic, superficial, and uncritical approach to traditional architecture being promoted in architectural schools, which was purely formalist.

In post-war Spain, Julio Caro Baroja explored the anthropological and ethnological dimensions of popular traditions. In 1944, he founded *Revista de Dialectología y Tradiciones Populares*, which remains active, and in 1946 he published *Los Pueblos de España*. Within this intellectual milieu, Fernando Chueca Goitia (1947) sought to expand the understanding of traditional architecture, seeing it not merely as a repertoire of forms, but as a coherent system embodying timeless values relevant to the quest for a national architectural identity. Another key contemporary figure was Miguel Fisac, who published *La arquitectura popular española y su valor ante la arquitectura del futuro* in 1952.

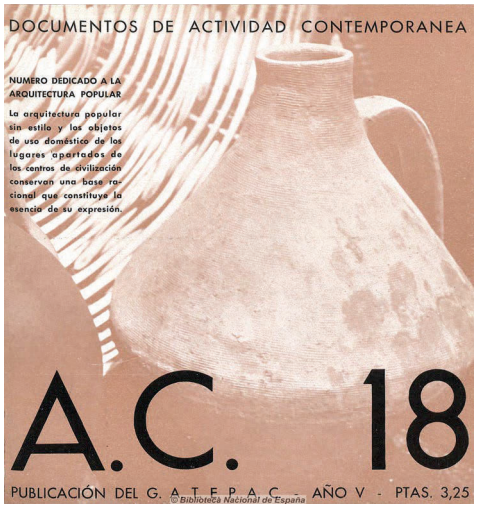

Fig. 2 – *Cover of the journal* AC. Documentos de actividad contemporánea*. 1935, vol. V, nº 18.* (Hemeroteca Digital. Biblioteca Nacional de España).

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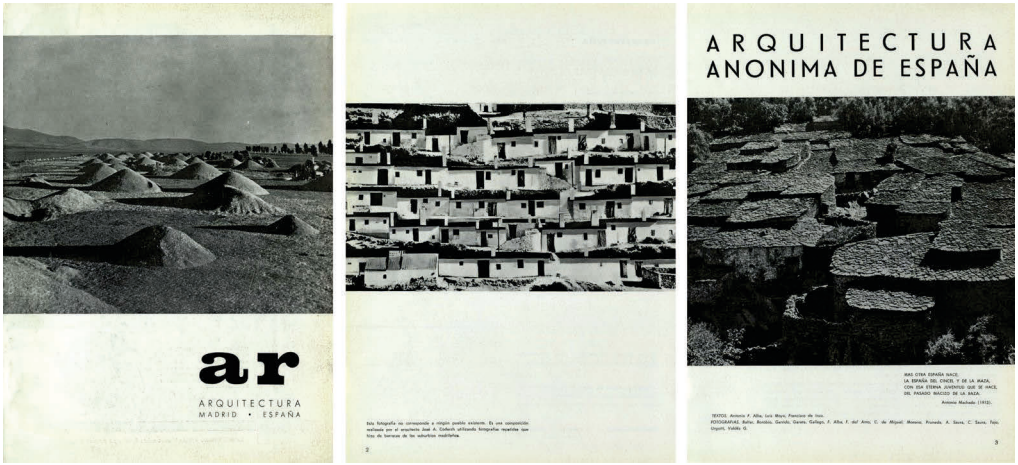

Fig. 3 – *Front and back covers of the journal* Arquitectura*. 1962, nº 46*
(Biblioteca del Colegio Oficial de Madrid).

From the 1960s onward, there was a surge of interest in traditional architectures at the international level, mirrored by growing momentum in Spain. New approaches and frameworks for studying and engaging with vernacular architecture emerged, shaped by the dynamic cultural and intellectual climate of the time. These were decades marked by intense political, social, and academic change in Europe and the United States. Landmark works were published by Bernard Rudofsky (1964), Paul Oliver (1969), and Amos Rapoport (1969). Their interdisciplinary research went beyond documentation and cataloguing to explore the essence and cultural significance of vernacular architectures from around the world, integrating geographic, environmental, social, and economic contexts.

In Spain, the journal *Arquitectura* published its first special issue dedicated to traditional architecture in October 1962, titled *Arquitectura Anónima de España* (Fig. 3). The organisation of four National Congresses on Regional Traditional Architecture, held in various Spanish cities between 1964 and 1968, also marked a significant advance.

By the 1970s, the recognition of traditional and rural architecture as part of cultural heritage was firmly established. Two important international works, newly translated into Spanish, played a decisive role during this period. In 1971, Aldo Rossi's *L'Architettura della Città* was published in Spanish. While primarily focused on typology and traditional urban living, it also emphasised the reevaluation of tradition and collective memory.

In 1973, Bernard Rudofsky's *Architecture Without Architects* became available in Spanish through an Argentine edition. In Spain, two major figures dominated the discourse: Carlos Flores López and Luis Martínez Feduchi. Once again, *Arquitectura* dedicated a special issue to this topic: *Arquitectura popular en España*, published in two volumes in December 1974 (no. 192) and January 1975 (no. 193) (Fig. 4).

With the end of the dictatorship and the creation of autonomous communities, a new legal and cultural framework emerged. Traditional heritage began to play a fundamental role in shaping regional identity within the autonomous state.

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Fig. 4 – *Covers of the journal* Arquitectura*. 1974, nº 192; 1975, nº 193* (Biblioteca del Colegio Oficial de Madrid).

Consequently, regional-level studies became increasingly common, along with numerous investigations focused on specific provinces, areas, or typologies.

As a result of this context and the extensive body of references and publications produced, significant progress has been made in documenting and understanding traditional architecture, gradually overcoming the initial lack of knowledge. However, this intellectual and academic advancement has not fully prevented the abandonment and neglect of many structures, particularly in areas or regions that have received limited research attention.

3. Exploring architectural qualities and values

As previously noted, since the early 20th century, numerous architects have explored and acknowledged the values inherent in rural architecture. However, it is particularly in recent decades that the number of studies has grown substantially, creating a transdisciplinary network of knowledge that elevates these modest structures and frames their values and contributions within the context of contemporary architectural practice.

This theoretical foundation, combined with fieldwork focused on rural and vernacular architectural settings, supports the architectural perspective proposed in this study. From this approach, a set of architectural values or defining qualities emerges, attributes that, in our view, characterise vernacular rural constructions.

3.1. On functionality

This type of architecture is distinguished by a strong sense of practicality, rooted in its pre-industrial and artisanal origins, as well as its required productive efficiency.

Functionality, as an architectural value, was extensively examined by Adolf Behne; his reflections can be extrapolated to vernacular rural architectures, which reflect a balance between purpose and form, between the individual and society, and between economy and politics (Behne, 1994, p. 74). This attribute has been

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widely recognised in defining these modest constructions by geographers such as Horacio Capel and architects like Miguel Fisac, James Stirling, and Giorgio Grassi, who emphasise their simplicity, the precision of their means, and the reliability of their solutions (Grassi, 1977).

"Form and Function" is one of the chapters that, together with "Site and Climate" and "Materials and Skills", constitutes a seminal work on vernacular studies: *Native Genius in Anonymous Architecture*, by Sibyl Moholy-Nagy, published in 1957. In this chapter, she reflects on coherence as a distinctive quality for evaluating the merits of buildings. This coherence derives from the functionality and simplicity with which these architectures are constructed by anonymous creators, who, intuitively and logically, "created with the artlessness of pure conscience that looks for nothing but fulfilled purpose. This purpose included physical and spiritual needs. The form mediated between the strength of materials and the interior space" (Moholy-Nagy, 1957, p. 108).

3.2. On sustainability

The use of local materials (readily available, non-polluting, and either recycled or recyclable), the integration of passive technologies (such as proper orientation, optimised openings, thermal massing, solar protection, cross ventilation, and water harvesting), the utilisation of natural resources for their operation (such as hydraulic energy in the case of mills), and the way their formal and constructive systems interact with, adapt to, and respect specific climatic and geographical conditions, all contribute to architectures that harmonise with their natural context. These architectures are ecologically appropriate, do not deplete resources, and cause minimal environmental damage. Ultimately, these are sustainable architectures.

These aspects have been recognised by scholars in this field, more quantitatively, analytically, and precisely in recent works, and in a more theoretical and general manner in earlier studies. These studies link vernacular construction and technical issues to economic, social, or climatic conditions in broader terms (Vellinga, 2013, p. 571).

One of the architects who has most eloquently built upon tradition, local construction techniques, and vernacular structures is Charles Correa, regarded as one of the pioneers of sustainable architecture. He encapsulated his work under the principle *Form follows climate*, which also served as the title of a compelling article he published in 1980 in the American journal *Architectural Record*. Other contemporaries have embraced this approach, further exploring the principles of sustainable design that define these architectural styles. Their aim is to adopt and apply these principles to new constructions and raise awareness. One such figure is the Japanese environmental architect Ken-ichi Kimura (1994).

The most recent studies on traditional architecture and sustainability have gone further, quantitatively analysing materials, construction techniques, formal systems, orientation, openings, and more. These elements are graphically represented through plans, diagrams, tables, photographs, etc., and provide precise data on energy performance, technical specifications, as well as lighting and ventilation conditions. Nevertheless, the Egyptian architect Hassan Fathy underscores the importance of not solely considering the quantitative aspects of these architectures, but also focusing on the principles that gave rise to the solutions (Fathy, 1986, p. 69).

3.3. On positioning

Orientation and location are crucial for optimal climatic performance. However, their positioning relative to the topography, transportation routes, rivers and streams, other hydraulic infrastructures, or scattered buildings is also key to establishing territorial control and ensuring proper functionality within the socio-economic

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and productive system to which they belong. The act of positioning rural architecture is the result of a selection process by the anonymous author, following a thorough site assessment. As noted by Amos Rapoport (2000, p. 148), “vernacular environments [...] are the result of “selectionism,” an evolutionary process whereby environments gradually become congruent with activity systems, lifestyles, meanings, etc.”.

It is an interpretation of the territory, supported and guided by the accumulated vernacular tradition and the wisdom it encompasses, which leads to decisions and choices that are primarily functional. Focusing on the positioning of productive architecture reveals the optimal sites within the area to achieve maximum profitability with minimal construction resources.

3.4. On integration and adaptability

Recognising the positioning strategies of rural architecture and analysing them within their territorial context reveals one of their key values: their integration and adaptability to both natural and cultural environmental conditions. To such an extent that these buildings come to be regarded as constitutive elements of the geographical landscape on which they are placed. They reshape the terrain, imbuing it with anthropological significance (López de la Cruz, 2020, p. 14). Traditional architecture does not seek to dominate its environment; rather, it adapts to and coexists with the territory, utilising its resources in the most rational and natural way possible. Bernard Rudofsky (1964) already identified this as a crucial lesson drawn from such architecture: “Instead of trying to 'conquer' nature, as we do, they welcome the vagaries of climate and the challenge of topography.”

3.5. On repetition and transmissibility

The repetitive nature of these pre-industrial architectures is a quality that arises from the continued use of certain models, which, despite having no known author, have proven their effectiveness throughout history.

In addition to the value of repetition, it is important to recognise the transmissibility of these architectures, which have been passed down from generation to generation, along with a body of constructive and artisanal knowledge capable of creating spaces, regardless of the anonymous builder.

3.6. On infrastructural value

Rural landscapes were structured around paths, trails, waterways, land divisions, and other features that emerged through human activity, following the development of smaller constructions. These dispersed architectures have acted as activating nodes, prompting the construction of infrastructures that enabled their functionality and connectivity with other scattered structures or population centres.

3.7. On the landscape value

The landscape value of rural productive architectures is recognised because observing them involves acknowledging the territories in which they are embedded. These architectures create dispersed focal points that encourage movement and facilitate a deeper understanding of the landscape. In line with Francesco Careri’s hypothesis (2005, p. 20), walking and, consequently, the rural paths generated by these architectures contribute to the interpretation and reading of the territory, allowing for a better understanding and explanation of the uniqueness and diversity of its landscapes.

4. By way of conclusion

Vernacular rural constructions encapsulate the knowledge associated with the primary activities developed within a territory, serving as enduring testimonies to the diversity of lifestyles, land uses, and traditions shaped throughout history. These traditions, preserved in part through the remnants of such structures, have endured to the present day. While these architectures may now be regarded as obsolete, they have played a pivotal role in shaping the identity of their

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surroundings. Their significance extends beyond mere functionality, contributing to the establishment of ways of life that transcend temporal boundaries. As evidenced by the foregoing discussion, the architectural qualities of rural productive constructions, which could be considered heritage, are numerous and diverse. Scholars who have reflected on them consistently advocate for their recognition and study, as they embody knowledge that is both potentially valuable and relevant to contemporary society. This leads to the final attribute that concludes the set of developed qualities and, in many ways, synthesises all the preceding ones: their didactic value. It is essential to learn from these architectures, which, due to their various attributes, serve both intellectual research and the education of professionals and craftsmen (Choay, 2007, p. 99). They not only illustrate the activities once carried out within them and past ways of life but also encompass values and design strategies (tectonic, functional, sustainable, adaptive, and landscape-related) that can contribute to enriching architectural axiology.

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The Alfano Ironworks in the Cilento National Park (Italy): An example of Vernacular Architecture

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Topic: T1.3. Mechanisms of sustainability of vernacular architecture

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Abstract

Designed to be sustainable, vernacular architecture as defined by the ICOMOS Built Vernacular Heritage Charter represents «the natural and traditional way in which communities have produced their own habitat. It forms part of a process that includes necessary changes and continuous adaptation as a response to social needs». This integrated approach, combining local resources, adaptation to the natural context and cultural continuity, constitutes a model of sustainability respecting the Genius loci*. Recognizing that the outcome of this type of architecture is distinguished by its adaptability to both the territory and practical needs, this paper analyses a case study located in a relatively unexplored area of southern Italy, specifically in the Cilento National Park: the Alfano ironworks. Immersed in a varied natural environment and marked by the presence of the Faraone river, the ironworks are part of a larger network of hydraulic mills that have developed along the watercourse since the 15th century. The complex consists of two mills and the ironworks, all powered by a single millrace (the* Gora*), demonstrating the balance between the use of natural resources and local economic development, representing a concrete example of integration between functionality, efficiency, and respect for the territory. This paper aims to analyse, through bibliographic and archival sources, the environmental sustainability mechanisms of 'water-related architectures,' specifically the Alfano ironworks. The goal is to demonstrate that the conservation and restoration of these historical structures can safeguard them for future generations and underscore their exemplary role as models of sustainable architecture.*

Keywords: *built vernacular heritage; water-related architecture; sustainability mechanisms; resilient architecture; ironworks*

1. Introduction

Vernacular heritage is a fundamental historical and architectural record of our country, reflecting the way local communities have adapted to their natural landscape. It represents the result of a layering of knowledge that took shape, in close relation to the morphology of places, local resources, through climatic and environmental characteristics and cultural needs.

These architectural forms, arising from everyday and direct relationships between people and their environment, embody a unique equilibrium in which the territory is not merely a passive backdrop but rather an active and fundamental element in defining the cultural identity of communities. Such heritage not only offers insights into historical building practices but also provides a model for modern sustainable development.

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One of the most significant reference documents in this field, the ICOMOS Charter on Vernacular Built Heritage (1999), defines vernacular architecture as "the natural and traditional way in which communities have produced their own habitat. It forms part of a process that includes the necessary changes and continuous adaptation in response to social needs". This definition emphasizes that every architectural intervention is the outcome of a dynamic process, where tradition is continuously negotiated with the practical necessities of the present.

In the last years, my research group at the University of Naples Federico II has been investigating the relationship between water resources and the built environment in the Campania region. Several studies (Ceniccola, 2017; Russo et al., 2018; Pollone, 2022; Romano, 2022) had already initiated a detailed examination of local construction techniques and their interaction with hydrological systems. Particular attention has been devoted to identifying factors of structural vulnerability and current conditions of decay, with the aim of informing strategies for the conservation and sustainable management of historic settlements. The research has highlighted the central role of water in shaping both urban and rural landscapes, revealing how systems of water management have contributed to the identity and evolution of the region's settlements.

Within this broader framework, the present study focuses on an understudied yet historically significant example: the Alfano Ironworks, located in the Cilento National Park (Fig. 1). This complex exemplifies an integrated "water-related architecture" system that ingeniously harnessed local hydraulic resources. Its materials and construction techniques reflect a close relationship with the local socio-economic supply chain, favouring readily available resources and perfectly aligning with the concept of *Genius Loci*.

Through the analysis of bibliographic and archival sources, this work aims to shed light on the mechanisms of construction sustainability inherent in the Alfano Ironworks. In doing so, it situates this case within the broader context of Campania's water-related vernacular heritage, demonstrating that the conservation and restoration of such historic structures not only safeguards a legacy of sustainable practices, but also can offer a valuable reference for modern design and restoration projects.

Fig. 1 – *Ruins of the Alfano Ironworks.*

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2. The Water-related Architecture system in the Cilento National Park

Within the wide array of water-related built heritage in Campania, the Mingardo River system stands out as a particularly noteworthy case study due to its varied vernacular architectures, many of which remain identifiable and some of which are exceptionally well-preserved. Here the blending of natural elements with human-made remains forms a cultural landscape characterized by rich environmental presence alongside a wealth of hydraulic structures and watermills that attest to the rivers' strategic role and human ingenuity (Gambardella, 2003).

Although some of these structures were constructed as early as the Medieval period, most of the ironworks were built between the 17th and 19th centuries, a period during which the presence of the bourbons in the region may have influenced – either directly or indirectly – the planning of territorial development interventions. While a direct causal link cannot be definitively established, the influence of Bourbon policies on the economic and social fabric suggests that the construction of these infrastructures, such as the Alfano Ironworks, was part of a broader modernization process and the sustainable exploitation of local resources. The ironworks is in the municipality of Alfano, in the province of Salerno, in what was formerly the Principato Citra –suppressed after the unification of Italy–, within the Cilento National Park along the Faraone River, which, after merging with the Molpa sites, takes the name of Mingardo. This is part of a broader system; in fact, there are fourteen rural architectures in the municipality (Fig. 2), including mills, ironworks, kilns, and other facilities, many of which are in a good state of preservation[1], while others remain in a state of disrepair. In this context, for example, the Ironworks of Morigerati (Fig. 3) stands as enduring evidence of traditional industrial architecture within the Cilento National Park, offering a tangible glimpse of what these structures might have originally looked like.

In fact, it is therefore essential to implement measures that mitigate. Conservation efforts must preserve the unique physical and perceptual relationship between the natural environment and the remnants of human activity at the site.

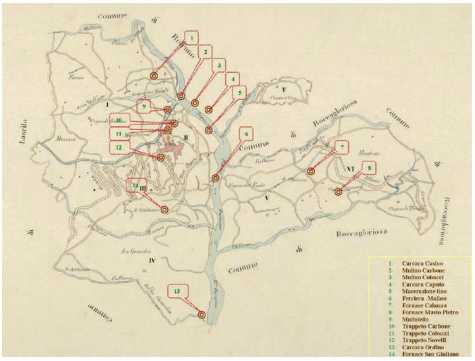

Fig. 2 – *Alfano, Mingardo Basin. Distribution of rural architecture along the Faraone River* (Lombardo, 2023).

Fig. 3 – *Morigerati, Ironworks of Morigerati restored with the funds of the integrated project National Park of the Cilento and Vallo Diano POR, 2004*.

[1] Mulino Cobucci in 2013 there was an intervention of recovery and redevelopment on a project by PSR CAMPANIA.

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3. The Alfano Ironworks: A sustainable water management system

The Alfano Ironworks was built in 1837 in the "Foresti" district by Mr. Pietro Novelli, who, as landowner, decided to establish the works within an integrated system of rural architectures along the course of the Faraone River, a tributary of the renowned Mingardo River. This system (Fig. 2) was characterized by a holistic approach to water management: the combined presence of ironworks, mills, and other functional structures demonstrated an integrated and sustainable vision, in which water was not merely a source of energy but a crucial element for the economic and social development of local communities. Our knowledge of the Alfano Ironworks comes from the appraisal conducted by the Civil Tribunal of Salerno in 1857, prepared by the architect Domenico Antonio di Napoli and preserved in the Salerno State Archive. This appraisal, produced in the context of a dispute between Mr. Pietro Novelli of Alfano and Commander Pietro Pecorelli of Castelruggero regarding the possession of the land hosting the ancient works, included a topographical geometric plan (Fig. 4) that illustrated the locations of both the mill and the ironworks in the Foriesti district.

The survey reveals that Mr. Novelli had decided to exploit the original watercourse (PSR) with its inlet at point (L):

> Da detto punto (L) della presa d'acqua ha principio il canale del molino, ossia vedale, così chiamato. Questo canale è lungo palmi[2] 960, fiancheggiato da muri in fabbrica, e si allarga progressivamente fino a raggiungere, presso la fabbrica del molino, una larghezza di palmi 12, completandosi con una cataratta con portellone (R) a circa palmi 60 di distanza, utile per regolare il volume d'acqua[3].

Mr. Novelli's reasoning proved particularly effective: the water of the Mingardo River, originally destined exclusively for the mill, yielded an annual return that increased up to four times with the construction of the Ironworks. This architectural solution not only demonstrates the ingenuity and technical sophistication of 19th-century hydraulic engineering but also embodies a forward-thinking approach to sustainability. By integrating multiple production systems around a single, efficiently managed watercourse, the design maximized resource utilization and minimized waste. Such a sustainable water management model serves as an example of environmental stewardship, balancing economic growth with the careful preservation of natural resources – a principle that remains highly relevant in contemporary sustainable architecture.

Table 1 – *Fig. 4 Legend* (Giuliana Vinciguerra, 2025).

ABCDE	Mingardo River
F	Public Space Locality Foriesti
ABC	Street leading to Rofrano
DE	Street leading to Alfano
DF	Street leading to Laurito
O	Hydraulic chamber
KL	Main building Ironwork
K	Forges
L	Battimento (Beating)
M	Old mill with two millstones
N	Hydraulic pressure towers
LBL	Elevated rail
V	Embedding in the wall
X	Hydraulic square tower
R	Cataract with hatch

[2] Ancient unit of measurement that has been equivalent to 0.264 metres since 1840.

[3] Translation: The mill's channel, known as the vedale, begins at the water intake point (L). It is 960 palms long, flanked by masonry walls, and gradually widens to 12 palms at the mill complex. The channel terminates in a cataract with a gate (R) about 60 palms downstream, which regulates the water flow.

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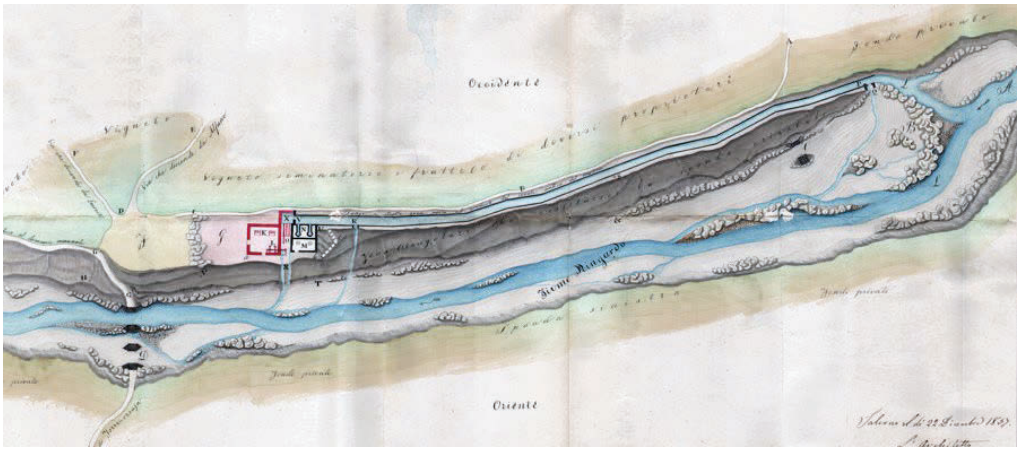

Fig. 4 – *Topographical plan of the Alfano ironworks and mill* (ASSa, TCpu, b.928 40 582).

4. Construction of the Ironworks Building

The detailed account of the Alfano Ironworks is based on an 1857 appraisal, which meticulously documents the building's architectural composition and offers essential insights into the original function of its various spaces. This serves as an invaluable resource for understanding the complex, particularly because many of its spaces are now only partially preserved. Testifying to the state of the ironworks as it was originally conceived, the document provides critical evidence that aids scholars in reconstructing both its historical operation and architectural evolution. According to the report by the architect of Naples, the ironworks was composed of two main spaces: a hydraulic chamber (O), constructed in local stone (Fig. 5) with a barrel vault and equipped with bellows for the forges, and a large, covered main building (casone, KL) measuring 57 palms (14.80 m) in length and 52 palms (13.50 m) in width. This main structure housed two forges (K) and featured a "bottimento" mechanism (L) for rolling the iron into bars. As can be inferred from the appraisal and the extant ruins on site, the ironworks were accessible via a large door on the south side – where an extensive flat area (G) supported the building – and via a smaller door on the east side.

The state of preservation of the hydraulic chamber (Fig. 6) has allowed for a reconstruction of the typical operational mechanisms of such ironworks. It reveals the presence of the bellows, which consisted of two parallel masonry tanks over which two wooden, leather-covered lids alternately lowered and raised to compress the air within the tanks, which were connected to the forges via a tunnel. The lids were lowered until they engaged with a specialized groove that sealed the tanks.

Fig. 5 – *Vaulted hydraulic chamber with tanks and location of the ironworks bellows.*

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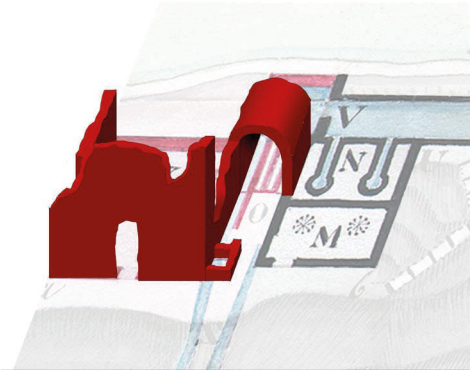

Fig. 6 – *Axonometric reconstruction of the ironworks ruin in its current state with respect to the plan drawn up by architect Domenicantonio Napoli.*

Both the hydraulic chamber and the *casone* (it was the single four-sided building where the forges and cooperage were located) were specifically designed to accommodate the machinery required for efficient ironworking and proper water management.

Behind the hydraulic chamber, the survey indicates the presence of a square tower (X) used to collect water that, in turn, powered the cooperage mechanism. This water was conveyed through the same channel that fed the mill; however, the mill featured two separate towers for water supply. The separation of these towers was ingeniously designed to allow the ironworks and the mill to operate independently, despite both being powered by the same watercourse. In fact, the ironworks were constructed adjacent to the old mill, as indicated by the plan, in which the latter, depicted in black, was composed of two grinding stones (M) for cereal processing and two hydraulic pressure towers (N).

The water intake system was divided: the mill's conical hydraulic towers stored and discharged water under pressure onto two horizontal wheels, which, via vertical shafts, drove two sets of millstones for cereal processing. In contrast, the ironworks drew water from the same channel through a square tower that feeds a large vertical waterwheel (Fig. 7).

This waterwheel powered various iron forging mechanisms, such as a wooden camshaft that operated hammers and two hydraulic bellows. The mechanism of this wheel was also used in other Ironworks (Fig. 8) in fact, this configuration exemplifies advanced hydraulic engineering techniques that not only maximize the use of locally available resources but also optimize overall economic performance.

Fig. 7 – *Alfano Ironworks, Location of the water wheel and ironworks cylinder; Air ducts connecting the tanks to the forges; Tanks: The interlocking groove for the lid is highlighted.*

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Fig. 8 – *Morigerati, vertical waterwheel.*

5. Conclusion

The case study of the Alfano Ironworks illustrates the ingenuity and sustainability embedded in traditional vernacular architecture. As defined by the ICOMOS Built Vernacular Heritage Charter (1999), vernacular construction reflects a dynamic process of adapting local resources and techniques to meet social and economic needs.

This study has shown that the advanced hydraulic engineering techniques, such as the dual use of the water channel and the strategic positioning of the hydraulic chamber and square water tower, were fundamental in maximizing the utility of the available water resource. These technical solutions offer valuable insights into how local materials and traditional methods were harnessed to create highly functional, resilient structures.

In addition, the lessons drawn from the Alfano Ironworks emphasize the importance of preserving and maintaining such historical infrastructures. Conservation efforts are essential not only for safeguarding cultural heritage but also for ensuring that the practical knowledge and innovative solutions of the past can be transmitted to future generations. By maintaining these historical systems, we preserve a legacy of sustainable practices that can continue to inform modern water management and construction techniques.

In summary, the approach observed in the Alfano Ironworks serves as both a testament to the adaptive capacity of vernacular architecture and a tool for the preservation of historical techniques. It emphasises the need to intervene with conservation and maintenance plans, ensuring that these ingenious systems remain

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accessible as sources of inspiration and practical guidance. Further research should undertake comparative analyses of similar systems to assess their technological, socioeconomic and cultural significance across different contexts.

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'By concession of the Ministry of Culture' Salerno State Archives, Fondo Tribunale Civile pre-unitario, b. 928 40 582, Verifica se la ferriera del sig. Rocco Viceconte sia stata costruita sul suolo ipotecato al sig. Pecorelli o su altro suolo, 22 dicembre 1859.

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The Montalván Hacienda: Traditional Construction and Thermal Strategies in Cañete, Peru (18th-19th centuries)

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Abstract

The coast of Peru, a naturally arid and narrow territory between the Pacific Ocean and the Central Andes, has historically been an area of culture formation that we can trace through its remnants from the most remote pre-Columbian past to the miscegenation of the centuries of the Spanish viceroyalty. and of the present. Part of this multicolored mosaic was expressed, of course, through territorial constructive interventions - for example important pre-Hispanic irrigation works - and architectural interventions, of which this research shows a specific moment: that of the 18th and 19th centuries, the heyday of the regional coastal area of Cañete, south of the capital Lima, with sugar and wine estates. Once numerous, today a few have been preserved in their more or less original version, although deteriorated. Others have disappeared or have been replaced by other types of structures. The area is so particular in its geographical characteristics - desertic, sandy and hot, prone to strong earthquakes - that everything that has resisted the passage of time and human abandonment has been what most clearly manifested the virtues of local vernacular construction, its materials and techniques. This paper focuses on a specific example of a hacienda house - studied by the authors in depth in recent years - and within the case, on aspects such as flexible and thermally efficient roofs and walls, which have demonstrated the relevance of a traditional historical architecture that in turn has determined the landscape.

Keywords: *traditional construction; vernacular architecture; quincha; haciendas; Peru*

1. Introduction

The enormous expanse of the South American territory under the control of the Spanish crown, which broadly comprised the Viceroyalty of Peru between the 16th and 19th centuries, was managed primarily from its capital and most important city, Lima, the City of Kings. It was there that the viceregal court was located, where the main churches of the religious orders were, where the titled, noble and richest families lived and from where politics, economy and society were generally directed. But, of course, the management of practically a continent needed an infinite number of administrative spaces, both governmental and private, of varying scale, which, connected to each other, allowed the efficient extraction of resources, their use and manufacture, the control of the indigenous, mestizo and slave population, the development

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and maintenance of the agricultural and road infrastructure, among many, many other particularities. Agricultural estates were an important part of this system of territorial management, mostly in the hands of private individuals, families and religious orders - the Society of Jesus in particular played a very significant role, although in the area of our study the convent of *La Buena Muerte* was especially present - which in some cases established themselves as the main presence of the Metropolis in the area, and which undoubtedly influenced its future development: some of them, such as Montalván in Cañete, having overcome the obstacles of national independence, revolutions, the Agrarian Reform of the 20th century and a multitude of subdivisions, changes of use and violence, survived to the present.

In architectural terms, a viceregal *hacienda* is a relatively organized and simple machine, strategically located in the immediate area of the cultivated fields, with a certain control of the infrastructure of canals, irrigation ditches and neighboring roads, and with a house that was both a dwelling and an administrative center as a centrally built element. The hacienda house - that is, the residence of the owners, or sometimes, of the steward or foreman- normally formed one of the long sides of a square that complemented the local church or chapel, the most important storage rooms and services and the servants' and workers' quarters, including, on occasion, the access to the slaves' barracks. Typically, a fountain or well marked the centre of the squared space and provided this resource directly to the inhabitants of the hacienda.

The hacienda house itself was organised around patios, in a similar way to the large patio-houses in the most important viceregal cities, with two important peculiarities.

Firstly, it was always raised off the ground, either with a few steps or even with a full level of height. This allowed a certain control of the immediate space around it but also the presence of basements and semi-basements that maintained a relative temperature stability for products such as wine or *pisco,* the local spirit.

Secondly, the house was surrounded by a gallery, as enveloping and as wide as possible: this allowed both a covered terrace and a rest environment that at the same time maintained the desired visual control. Especially in the haciendas of the Peruvian coast, this also allowed to enjoy a necessary freshness in the intense summers, a factor surely highly valued by the landowners.

Other environments such as living rooms, chambers and bedrooms, were organized in a similar way to urban houses, without the majority of the spaces having a specific purpose.

2. The *hacienda* house Montalván

The Montalván hacienda is located in the Cañete Valley, or *Guarco* in its traditional name, in the south of Lima. Chroniclers of the 16th and 17th centuries, such as Reginaldo de Lizárraga and Pedro de León Portocarrero, describe this area as an incredibly fertile valley, very well irrigated since the time of the Incas and which supplies the capital with all kinds of fruits by taking advantage of currents such as the Lunahuaná River, in a narrow valley.

Montalván was established only in the 18th century, with a main house built in 1787 owned by “a Spanish subject opposed to Independence named Juan Fulgencio Apesteguía, Marquis of Torrehermosa” (Dargent, 2017, p. 47).

This political inclination was negative for him once the independence process was over, to the point that the property was expropriated and then handed over, along with another neighbouring one, the Cuiva hacienda - a winery, of lesser standing and already very neglected - to the Chilean general Bernardo O'Higgins, in gratitude for his support of the cause of emancipation, having financed San Martín's expedition to Peru.

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Correspondence from O'Higgins himself (Fernández Larraín, 1974, p. 161) tells us that the General was very satisfied with his new role as landowner, which reminded him of the country stays of his childhood, and he settled between Montalván and his house on the current Jirón de la Unión in Lima in 1824. By 1827 he had managed to revive the hacienda's sugar cane production and even install what was the first mill in the Cañete valley (Dargent, 2017, pp. 49-50). Upon O'Higgins' death in 1841, his properties passed to his son Demetrio.

The War of the Pacific was the occasion for a Chilean raid in search of O'Higgins relics, but the production of the hacienda was maintained and survived until the 20th century, when it faced the Agrarian Reform of General Velasco Alvarado. The subsequent disorganization led to a change of production towards cotton, for which an industrial processor house was installed on one side of the old plaza, now abandoned and in a ruinous condition.

The hacienda house is poorly preserved, but in the hands of a group of residents interested in its built past. A useful description to understand its original architectural configuration comes from Valencia's text, which indicates the existence of 15 rooms and an exterior corridor with columns on stone bases. Valencia (1980, pp. 431-435) continues:

> After O'Higgins' death, the house underwent two extensions, one in 1860 which added some rooms to the south side and extended the corridor, and another in 1930 which did the same on the opposite side, but breaking the direction of the corridor inwards. In front of the house, a few metres away and on its north corner, stood the chapel, the largest in the valley and demolished half a century ago, with a brick and plaster façade, adobe walls and two towers made of wood and thatch. Next to it was the slave cemetery. On one side and behind the house were the "galpón", the infirmary, the sugar mill, the pot house, the purge house, the sun room, the armoury, the sugar warehouse and the "colca" or granary. The "galpón", 130 meters long and 110 meters wide, was the slaves' shelter and was enclosed by a 5-meter-high wall with a single gate. Inside it, four corridors crossed, distributing 96 rooms with wattle and daub walls.

Despite the brief nature of the text, it is understood that it was an important property, the heart of an even more important *hacienda*: according to O'Phelan, it was "a narrow strip of arable land that extended for more than a league between the town of Cañete and the port of Cerro Azul" (O'Phelan, 2010, pp. 84-85).

To get closer to the spatial distribution, a photographic and architectural survey was carried out in 2024 (Figs. 1-3) that shows the typical patios, the aforementioned corridor or large gallery, the site of the old chapel and even the extensions.

Likewise, aerial photographic archives were reviewed, which allowed the acquisition of old images (Fig. 4).

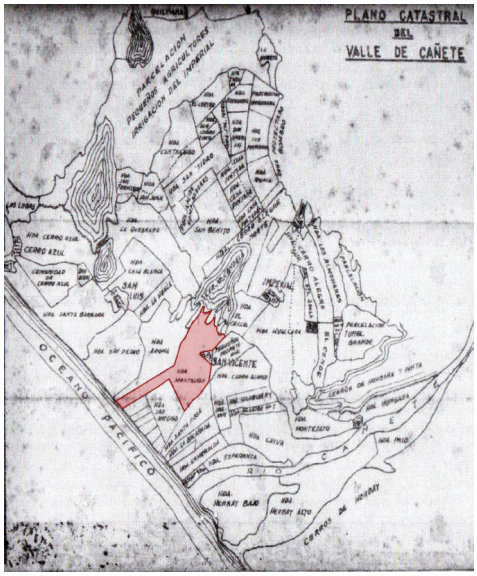

Fig. 1 – *Location of the Montalván Hacienda in the Cañete Valley* (Sarmiento Fernandez, 2019, p.118).

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Fig. 2 – *Exterior view of the Montalván Estate* (Montoya, 2024).

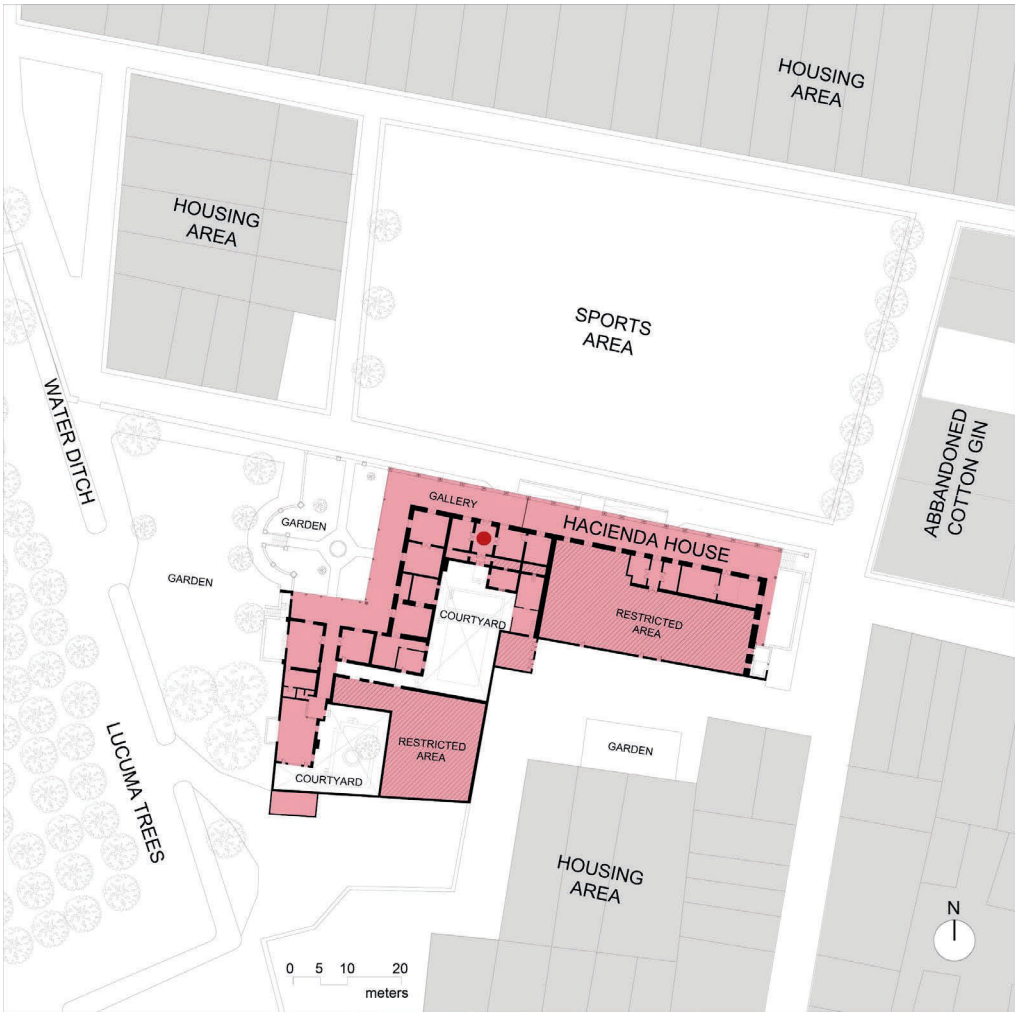

Fig. 3 – *Plan of the Hacienda House and current surroundings* (Authors, 2025).

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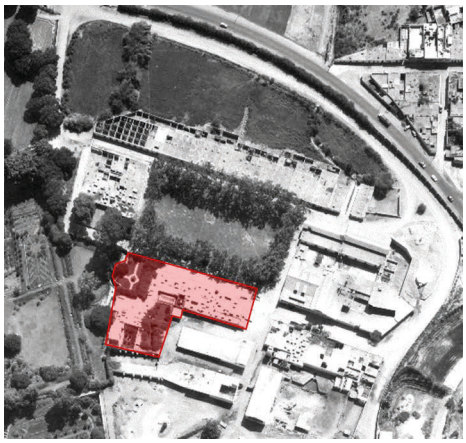

Fig. 4 – *Aerial photo from 1971* (Archive of the National Aerophotographic Service of Peru).

3. Materiality and thermal performance

The Montalván hacienda house is built in the traditional style of the place and the period: on stone foundations, thick adobe walls and mud-cake roofs over wooden planks, some recently restored with bamboo and cane. The local rainfall is so insignificant - the valley survives thanks to the river and its canals, as it practically never rains - that in all cases it is a flat roof, with numerous elements of lighting and overhead ventilation such as lanterns and *teatinas*.[1] oriented in a single direction. These materials, used with reasonable knowledge of their properties, allowed the spaces to survive major seismic phenomena in the region, including serious earthquakes such as that of 2007.

For the analysis of the thermal performance of the building - an aspect in which present-day architecture can still learn a lot from traditional and vernacular construction - temperature and relative humidity recorders ("data loggers") were placed in the most complete and original interior spaces of the complex that could be accessed (Fig. 5), as well as a micro meteorological station on the roof (Fig. 6) during the most demanding period: the summer months.

There is, however, one consideration to take into account: the current use of the spaces analyzed is much less intense than that of housing, since today they function as offices of the agricultural company that occupies them. Despite it, these are interesting references to understand the thermal functioning of the building.

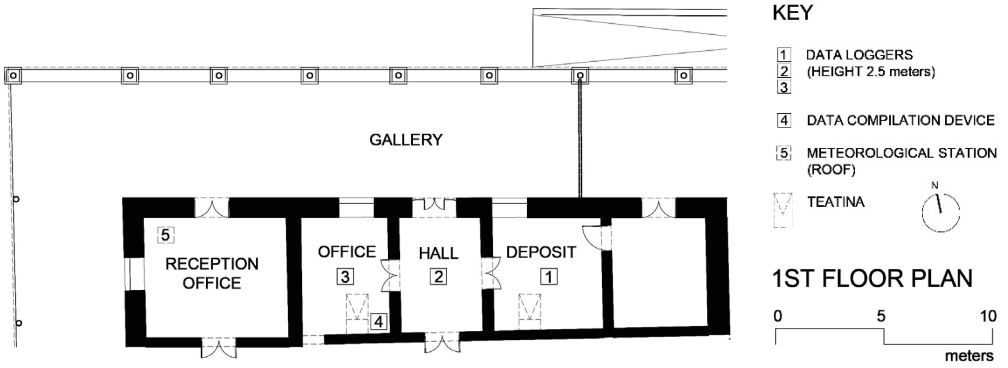

Fig 5 – *Location of data loggers* (Authors, 2025).

[1] A "teatina" is an element of zenithal lighting and ventilation used recurrently in the traditional architecture of the Peruvian coast between the mid-18th century and the beginning of the 20th century. It works fundamentally as a windcatcher and in a lesser measure as a skylight.

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Fig. 6 – *Placement of thermal monitoring equipment* (Montoya, 2025).

In the lower part of the Cañete valley, relatively close to the sea and exposed to sea breezes, temperatures are quite moderate, with average maximum values in summer of 27°C. The proximity to the Equator causes extremely high radiation in summer, with values around 1kWh/m2 in the hours close to midday. The spaces studied show temperature and relative humidity ranges that were compared with those outside (Figs. 7 & 8).

In turn, this has shown that the interior temperature of the selected rooms in the house was kept within the comfort range, according to the adaptive method, assuming contemporary demands (Tartarini et al., 2020).

Indoor relative humidity levels also remain within comfortable ranges (between 65 and 70%), although the outdoor breeze is quite humid due to the proximity to the sea.

It is evident that the presence of more timely ventilation - such as that which could occur if the building were still in residential use and therefore, with the daily opening and closing of windows and *teatinas*- would further improve comfort for users.

This is not the case at present since, as these are offices, they are completely closed at some point in the afternoon to prevent theft and the entry of animals.

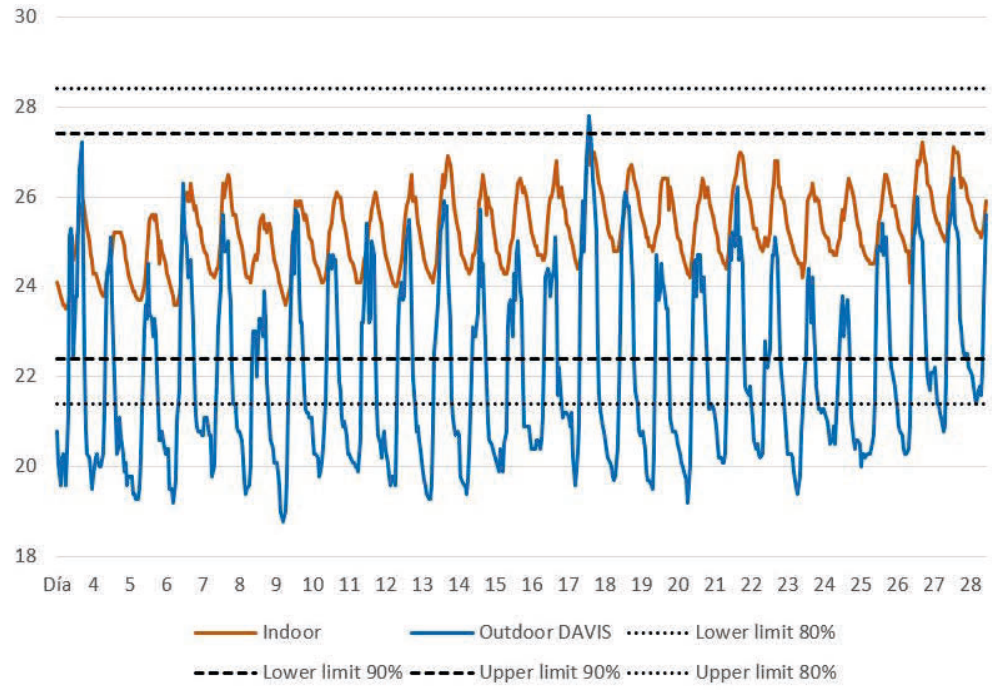

Fig. 7 – *Comparative table of air temperatures (ºC) and comfort limits in the month of January* (Authors, 2025).

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It is, however, important to emphasize that a good part of the comfort is still due today to the significant thermal mass of the construction, which is in turn a fundamental element of its survival in the face of earthquakes: this is ultimately the most notable strategy of buildings of its type on the Peruvian coast.

4. Conclusions

The historic haciendas of the peruvian coast, of which Montalván is a representative example, were built with both their capacity for territorial control and management in mind, as well as the possibilities of comfort and safety for their inhabitants in a region especially subject to high temperatures, high solar radiation and seismic movements. The result is a set of buildings that have shown their resilience over time, with their only and main enemy being human neglect and abandonment, whether due to lack of capital, ownership issues or simply lack of maintenance.

Cases such as Montalván, however, show possibilities for recovery, as many of its spaces can still be said to retain their original materiality and properties.

It is therefore essential not only to study the haciendas and their houses more thoroughly, seeking to understand their construction, material and historical processes -and the ownership of characters such as O'Higgins can very well serve as an incentive - but also to maintain their state in collaboration with their inhabitants and users: their models and systems can certainly help us better understand how to manage the architecture of the present and the future to make it more habitable, more human.

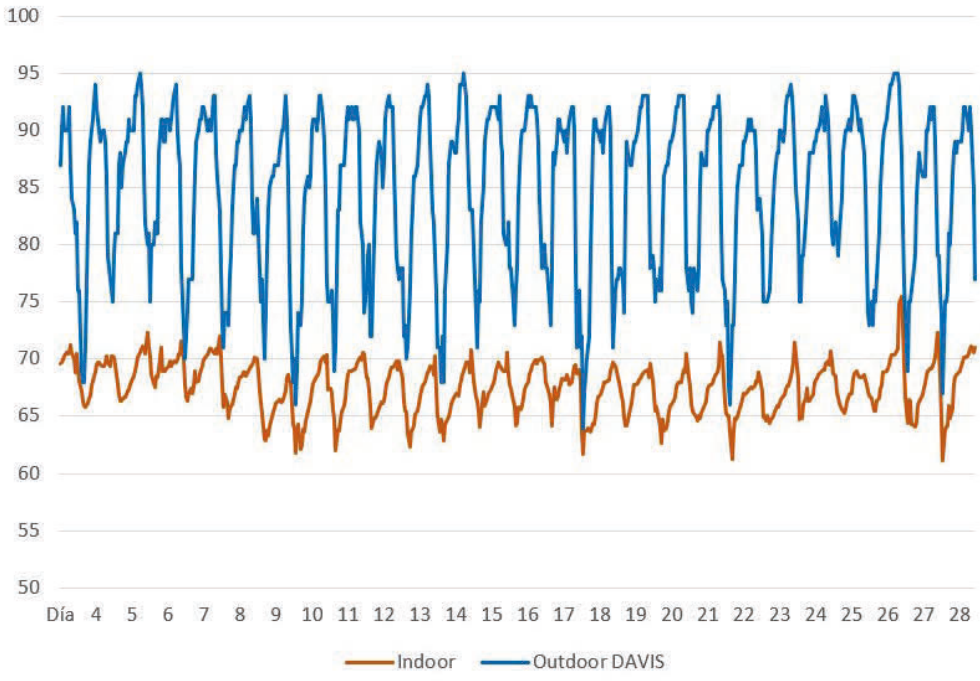

Fig. 8 – *Comparative table of relative humidity of the air (%) in the month of January* (Authors, 2025).

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A Holistic Approach to Vernacular Heritage Conservation

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Abstract

Understanding the built heritage is the first step in its conservation. In the case of the vernacular heritage, a holistic approach must be adopted. Vernacular buildings and settlements are formed by aspects that are beyond their tangible and visual characteristics and attributes. Worldviews, values, beliefs, myths and other aspects of the intangible heritage of the community have contributed to the form, style and other tangible aspects of the built vernacular heritage. The natural environment is another aspect. Moreover, for living vernacular heritage, development needs of the community form the context and dynamics that should be considered in conservation plans. This paper is an essay on the need to adopt a holistic approach in vernacular heritage conservation, starting by a holistic understanding. Examples are used from the vernacular heritage of Muslim-majority communities where Islam is a crucial influence such as Siwa in Egypt and Shibam in Yemen. Also, examples are discussed from transhumance communities such as Hawraman in Iran and Khinalig in Azerbaijan. The study and conservation of vernacular heritage should benefit from the recent efforts to bridge gaps between cultural and natural heritage, movable and immovable heritage as well as tangible and intangible heritage. The essay recommends adopting the three recent developments in the field of heritage conservation, namely the notions of cultural landscape, historic urban landscape and people-centred conservation. Accordingly, a holistic approach to the study, understanding and conservation of the vernacular heritage addressing the 'what', 'how' and 'for whom' could be developed.

Keywords: *holistic understanding; vernacular heritage conservation; cultural landscape; historic urban landscape; people-centred approach*

1. Introduction

The fragmentation of conservation approaches and the conflicts of conservation and development projects produce challenges to the field of built vernacular heritage conservation. The aim of the paper is to propose ways to introduce a holistic approach that overcome the current fragmented approaches. This is done by identifying the current challenges and illustrating them with examples of different vernacular heritage. The examples are selected from Muslim-majority countries, not only because it is the area of the author's interest and expertise, but also to highlight that the influence of Islamic values and worldview are often absent from the study of Muslims' built vernacular heritage. The paper suggests that three recent developments in the field of heritage conservation are highly relevant to the conservation of the built vernacular heritage and could be utilized to develop the needed holistic approach articulating the 'what', 'how' and 'for whom'. These are cultural landscape, historic urban landscape (HUL) and people-centred approach.

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2. Fragmented conservation approaches

The conservation of cultural heritage is studied and practiced in modern times according to separate fields of specialization creating artificial categories, such as tangible versus intangible heritage, immovable versus movable heritage and cultural versus natural heritage resulting in fragmented approaches to conservation (Mahdy, 2022). These divisions should be avoided in the case of the built vernacular heritage.

2.1. Intangible attributes

Intangible aspects are essential for the understanding and valorisation of the built vernacular heritage. Documentation and interpretation of vernacular buildings should include the construction process, construction craftsmanship, regular maintenance traditions, ways of using different parts of a building, ceremonial practices as well as the meanings and symbolic values that may be manifested (ICOMOS, 1999). For example, high rise houses that are built of earth in the city of Shibam, Hadramout in Yemen (Fig. 1) could not be built, lived in and maintained without the intangible attributes of their community.

Fig. 1 – *The urban fabric of Shibam.* (hidden architecture.net, 2025).

The houses cannot be fully understood without understanding the way of life in them. And the urban fabric cannot be understood without understanding the social structure, livelihood activities such as farming and trade, the relationships between families and the common values of the community as well as their relationship to other communities (UNESCO, 1982).

2.2. Natural attributes

Another aspect of understanding the built vernacular heritage is its relationship with the natural environment and the climate, which explains the rationale for the location of a settlement, the choice of building materials and techniques as well as the development of elements, mechanisms and practices based on age-old wisdom and previous experiences including disasters to be avoided or mitigated (ICOMOS, 1999). Shibam should be understood within its natural environment and its relationship with the farms outside the walls and the flooding path within the valley. Transhumance communities are a good example for the inseparable relationship of cultural and natural heritage. A community moves from its settlement to a warmer place in winter, such as in the case of the Village of Khinalig in Azerbaijan (Fig. 2) as they descend from the mountain to the valley (Abbasov, 2019).

Fig. 2 – *A shelter in the valley for the winter seasonal migration of Khinalig community* (Mahdy, 2022).

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Other communities move to a cooler place in summer, such as the villages of Hawraman in Iran (Fig. 3), the communities ascend from the valley to the top of the mountain to avoid the extreme summer heat (Abdi, 2003).

Fig.3 – *A structure from the summer seasonal migration of the community from Nav Village in Hawraman* (Mahdy, 2020).

2.3. Related movable heritage

Objects, tools and other movable heritage resources are essential factors in understanding the built vernacular heritage. Therefore, the establishment of an open-air museum to save a disappearing built vernacular heritage is not limited to the buildings' fabric. It includes the movable heritage and the presentation of the intangible heritage by the employment of actors wearing traditional clothes and performing the functions and using the traditional tools associated with living in a particular vernacular building (Young, 2006). Thus, for living built vernacular heritage, the movable heritage resources that are associated with its heritage values are inseparable from the immovable. The intangible attributes of the heritage is the context and the connecting factor of its movable and immovable components.

In the case of transhumance communities such as Khinalig and Hawraman, their tools, objects, cloths and other movable resources are an essential attribute to their vernacular heritage because they are adapted to their seasonal migration lifestyle (Fig. 4).

Fig. 4 – *Spinning sheep wool in Khinalig Village* (Mahdy, 2022).

3. Missing the Islamic influence

Islamic worldview and values are hardly included in the understanding and interpretation of the vernacular heritage in Muslim-majority communities. Even if these values are highly influential on different aspects of Muslims' lives and are instrumental in the shaping and organization of vernacular houses and settlements (Mahdy, 2017).

Providing shade in Muslim-majority settlements is not a mere environmental treatment but is a manifestation of the significance of shade within the Islamic value system (Mahdy, 2024). Bent entrances of Muslims' houses are an endeavour to reach a balance of keeping the door open and inviting on the one hand and on the other ensuring the privacy of the interior of the house. Courtyards and other characteristics of Muslims' traditional houses are due to the importance of privacy and the sophisticated private-public hierarchy system followed by Muslim-majority communities. Placing two door knockers with different sounds on doors are to differentiate the sex of the visitor in respect of the Islamic male-female segregation. The *qibla* direction (direction of Makkah, to which Muslims pray) influence decisions regarding the direction of buildings and spaces, both in private and public domains. *Tahara* (purity and fit for prayers) of places and spaces is another important aspect in understanding Muslims' built heritage.

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While such meanings and values may be identified as intangible heritage, their deeper and wider spiritual, philosophical and cultural significance is hardly included in the study and understanding of the built vernacular heritage of Muslim-majority communities.

The absence of Islamic values and worldview from a holistic understanding of the built vernacular heritage in the Islamic world is due to the artificial separation of humanities, arts and applied sciences. Heritage conservation professionals are usually trained in arts and applied sciences. They are trained to understand and treat material cultural heritage but are not always fully prepared to dive deep into social, psychological, religious and philosophical dimensions of the heritage. In addition, they often do not have the right communication skills to initiate a truly participatory working relationship with traditional local communities that permit for a full understanding of their values and interests (Muñoz-Vinas, 2005).

4. Challenges by development and change

Development and modernization are often considered a threat by conservationists. However, change and development cannot be avoided by communities living in built vernacular heritage. While the romantic visual impact of vernacular buildings is highly appreciated, communities that live in these buildings have the right to modern living standards and conveniences. For example, the main souq of Shibam was moved to a newer location in the nearby town of Al Hwata to permit for modern vehicular traffic and modern commodities which were not possible in the narrow streets of the historic city. This caused the migration of youth out of the historic city in search for job opportunities (Hallaj, 2003).

Preventing change and development may lead a community to desert or demolish its vernacular buildings in favour of modern ones that fulfil the needs and aspirations for good living conditions. A deserted vernacular settlement or building may keep its scenic visual qualities but would have lost its integrity and authenticity by the loss of its life. For example, the listing of Shali, in Siwa Oasis, Egypt as a national monument meant that the inhabitants were not permitted to introduce modern amenities to their houses. This led to the migration of the community outside Shali and to building modern houses in its vicinity leaving the historic urban fabric in ruins (Fig. 5).

Fig. 5 – *Shali is falling into ruins while the community is moving out and constructing modern buildings on its edges, Siwa Oasis* (Mahdy, 2008).

The relocation to an open-air museum is another issue. Despite its important scientific and educational values, the Qala Archaeological Ethnographic Museum in Azerbaijan is a “death certificates” for the way of life in vernacular buildings (Fig. 6).

Fig. 6 – *The interior of a traditional house of merchant reconstructed in the Qala Archaeological Ethnographic Museum in Azerbaijan* (Mahdy, 2024).

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The relocation of deserted vernacular buildings to an open-air museum does not solve conservation problems and should not be considered unless it is the last resort. As it is an statement that the built heritage is no more living heritage. They lose the original location, setting, function and other aspects that contribute to the integrity and authenticity of a living heritage (Rentzhog, 2007).

Another phenomenon that should be avoided if possible is gentrification. For example, the Village of Tunis in Fayyum, Egypt was gentrified by foreigners and Egyptian upper middle-class individuals and families moving in the old houses and building new houses in the earthen traditional way as second homes. This trend conserved the built fabric of the village and its visual characteristics but did not fully conserve the intangible aspects and the traditional way of life in the village (Fig. 7).

Fig. 7 – *An earthen house by a Cairene artist in Tuins Village* (Mahdy, 2023).

Gentrification takes away much of the invisible and less tangible attributes of the built vernacular heritage, such as the meaning and symbolism of a building and its different parts and aspects as well as the traditional way of managing, maintaining and living in a vernacular building. Moreover, the meaning of the urban fabric and the relationship of vernacular buildings with public spaces and the environment could be lost if the local community is replaced by new commers who do not belong to the same traditions.

5. The need for a holistic approach

There is a need for avoiding a fragmented approach to the conservation of the built vernacular heritage, which is often adopted because of the compartmentalization of different attributes of the heritage. In addition, there is a need to avoid an unbalanced attitude towards development and change. On the one hand insensitive development should be avoided and on the other, sensitive development should be integrated into conservation efforts.

For example, the Flat roofs of the vernacular buildings in the villages of Hawraman should be understood within a holistic approach. They are inseparable from the natural characteristics of the steep mountains, the traditions of using the roofs for drying crops, cleaning carpets and other functions (Fig. 8). Compacting the earthen layers of flat roofs is done by the stone rollers that are made for this purpose (Fig. 9).

Fig. 8 – Drying fruits and vegetables on the flat roof of a house in Zhan Village, Hawraman (Mahdy, 2020).

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Fig. 9 – *The stone roller that is used for compacting the earthen layer on roofs in Hawraman.* (Mahdy, 2020).

Despite all efforts for an integrated approach to conservation, compartmentalisation of different fields of heritage is real. The World Heritage Convention brought both cultural and natural heritage within one listing system. Nevertheless, the advisory bodies to UNESCO are different. ICOMOS and ICCROM are the advisory bodies for cultural sites, while IUCN is the advisory body for natural sites. The fact that universal tangible and intangible heritage are protected by two separate UNESCO conventions is another consequence of the artificial separation between the two categories of heritage. Another artificial separation is between movable and immovable heritage. ICOM is the international organization for the conservation of movable heritage and museum, while ICOMOS is the international organization for the conservation of immovable heritage.

Separation also exists between different specializations of heritage due to a long history of separating the education and training in various fields of heritage. Although heritage conservation is practiced as a multidisciplinary field, the set of skills and knowledge acquired by specialized heritage professionals remain isolated from each other.

6. Relevant developments in the field

Recent developments in the field of conservation attempt to reduce the separation of different attributes of heritage as specialized categories. Nevertheless, the existing separations and gaps between fields and categories of heritage are delaying the potential that these developments offer to the understanding and conservation of built vernacular heritage.

6.1. Historic Urban Landscape (HUL)

Historic Urban Landscape Recommendations (HUL) are relevant to the field of built vernacular heritage as they address the wider context including all the attributes of the natural setting, the built environment, land use patterns, visual-spatial relationships, social and cultural practices and values, economic processes, and intangible heritage. This inclusive scope produces an integrated approach for both the conservation and development of historic places (UNESCO, 2011).

A six-steps implementation is identified for HUL (UNESCO, 2016). They are designed for urban centres but could be adapted to rural and other contexts for the conservation and management of the built vernacular heritage because of their wide and inclusive approach and their layering of cultural and natural attributes.

6.2. Cultural landscape

Cultural landscape is a highly relevant concept to the built vernacular heritage as it includes both natural and cultural heritage. It was introduced to heritage conservation from the field of geographic studies. The German geographer Friedrich Ratzel in 1890 defined it as “landscape modified by human activity”. The term has been widely used in human geography and anthropology since the 1960s (Uzun & Somuncu, 2019). The recognition of cultural landscapes as a heritage category by the World Heritage Convention in 1992 impacted the field of heritage conservation in a positive way

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(UNESCO, 2019). For example, the villages of Hawraman in Iran were listed as a cultural landscape on the World Heritage List. Also, the village of Khinalig in Azerbaijan was listed as a cultural heritage (UNESCO, 2021).

6.3. People-centred approach

Integrating the *Universal Declaration of Human Rights* into the work of United Nations agencies since 2003 resulted in introducing rights-based approach to an ever-growing scope including heritage conservation and management. The 2019 revision of Operational Guidelines for the Implementation of the World Heritage Convention encourages the States Parties (UNESCO, 2019 paragraph 12):

> "To adopt a human-rights based approach, and ensure gender-balanced participation of a wide variety of stakeholders and rights-holders, including site managers, local and regional governments, local communities, indigenous peoples, non-governmental organizations (NGOs) and other interested parties and partners in the identification, nomination, management and protection processes of World Heritage properties".

This is highly relevant to the built vernacular heritage as it put the local communities in the heart of the conservation and management of their vernacular heritage. Our Common Dignity – Rights-Based Approach (OCD-RBA) is a working group that was established in 2011 by ICOMOS to promote people-centred approaches into heritage conservation and management. A guidance was issued by ICCROM on the approach, which influenced the training of conservation professionals since then (ICCROM, 2015).

7. Conclusion and recommendations

The built vernacular heritage is more than the fabric of buildings. It is the manifestation of the interaction of a community with the natural environment. It is the carrier and the envelop of a way of life, a value system and a worldview. It cannot be fully understood without all these aspects as well as the tools, objects and other relevant movable heritage resources. As a living heritage, the needs, interests and aspirations of the community cannot be ignored. They should be balanced with the heritage conservation requirements.

Three recent developments in the field of heritage offer a great opportunity to adopt a holistic approach to the understanding and conservation of the built vernacular heritage. They are the notion of cultural landscape, the recommendations for historic urban landscape (HUL) and people-centred approach. The cultural landscape addresses the 'what', the historic urban landscape (HUL) addresses the 'how' and people-centred approach addresses 'for whom'. There is a need for a proactive endorsement of these developments. Otherwise, they remain applied to limited categories of heritage. It is therefore recommended that:

- The understanding of the built vernacular heritage should be extended to include its natural setting and the impact of the setting on its formation. In other words, it should be understood as a cultural landscape.
- The conservation and management of the built vernacular heritage should consider the recommendations for historic urban landscape (HUL), even if the vernacular heritage is located in a rural setting. As these recommendations recognize the needs and interests of the local communities, including development needs and looks at all layers of heritage and types of attributes.
- The understanding of the built vernacular heritage should be adopting a people-cantered approach. This is essential for a full understanding of the values and worldview of the local communities, the stakeholders and the rights holders as they often are based on principles that are fundamentally different

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than those of conservation professionals. This is clear in the case of Muslim-majority communities. The influence of Islamic values and worldview are often missed by professionals who themselves adopt secular values and worldview.

Implementing the above recommendations should contribute towards the development of a holistic approach. It requires collaboration between different specialists and the implementing of multidisciplinary methods to overcome the existing compartmentalised approaches.

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Assessment of the Material Fabric Through Non-Invasive Tools, Characterization Process, and Formulating Compatible Repair Material: A Case of Kalidas Jethabhai House, Dharmaj, Gujarat, India

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Topic: T1.4. Restoration and conservation of vernacular architecture

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Abstract

The study highlights the importance of an evidence-based approach in conservation through the process of Material characterization and Re-Engineering, for the long-term sustenance of the building with minimal intervention. Vernacular architecture in Dharmaj, Gujarat, India has changed over time in response to environmental, cultural, and physical factors. Kalidas Jethabhai House (KJH) is a composite structure with timber and brick masonry. The structure has gone through various levels of deterioration due to natural and man-made factors. For a conservation professional, it is always a challenge to intervene with such dilapidated buildings. The initial phase of the study involves a detailed assessment of the structure, sample collection and documentation, and material testing at various laboratories. Material samples involve bricks, lime mortar, mud mortar, lime plaster, and lime concrete. One of the major challenges is to deal with material samples from old structures without damage and keep them safe without any contamination. Analysis of results of the existing building is crucial, the various tests are done to triangulate the data. The testing involves wet chemical dissolution, energy-dispersive X-ray Spectrometry, Compressive strength testing, etc. The Re-Engineering process begins with testing of Lime mortar samples made on-site based on the Characterization results. These samples are subjected to XRD to compare their mineral content with the existing lime mortar. Overall Evidence-based conservation helps in optimization of resources, including time, labour, and materials. And by identifying the most critical areas of intervention and prioritizing conservation efforts, resources can be utilized efficiently to achieve long-term sustainability.

Keywords: *heritage conservation, vernacular architecture, material characterization, re-engineering*

1. Introduction

Dharmaj is situated in the western part of India, in the state of Gujarat. The village has a mix of rural and semi-urban characteristics, with agriculture and tobacco industry being the primary occupation of many residents. The historic core of the village displays a variety of architectural influences, from traditional timber-based construction to Postmodern Art Deco typology. In Dharmaj, there is a history of migration. Traditional residences, or havelis, are being abandoned as a result of the younger generation's preference for traveling overseas and the fact that many of those who had already gone there never came back. The area of Dharmaj

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is about 1461 hectares with 2232 households and a population of 10,429 according to the 2019 census.

Kalidas Jethabhai's house (KJH), originally vacant, now accommodates the family, who reside outside Dharmaj. Over time, the heirs have undertaken renovations, including repairing roofs, constructing additional walls to expand spaces, and reinforcing the structure with modern materials like cement through coatings. It suffered from a prolonged lack of maintenance, which resulted in structural deterioration.

The structure can be divided into two parts, with a courtyard in the middle. Wing (1) lies adjacent to the road | wing (2) is at the rear, facing the courtyard. The house is about 340 sq. metres in area facing east. It's a 2-story building with a height of 16 meters. The structure is divided into 2 parts with a courtyard in the centre. It is a composite system with vertical and horizontal timber members as support and lacing. The masonry is of flat bricks with mud mortar and lime plastering.

2. Aim and Objectives

To evaluate the material involved in the composite system of KJH through non-invasive tools, characterization, and formulation compatible repair material.

1. To develop a methodology for evidence-based decision-making in conservation.
2. To study the composite system and the material involved in construction through documentation and material mapping.
3. Assessing timber elements and repair strategies for conservation whether fully replace element/partially or strengthen it.
4. To analyse the mechanical, chemical, and physical properties of material in masonry.
5. To identify different admixtures used and understand their mechanical properties.
6. To understand the process of Re-engineering and make repair material for conservation compatible with the original material used in the structure.

Fig. 1 – *Facade of Kalidas Jethabhai House, Gujarat, India (Before conservation)* (CHC, CEPT).

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3. Research methodology

1. Settlement study of Dharmaj and history of Kalidas Jethbhai House.
2. Decoding the construction system and material involved in the structure through documentation.
3. Evaluating the structural condition through condition mapping.
4. Study various testing process methods for different materials.
5. Identify representative samples through field visits and collect them.
6. Identifying appropriate testing methods and performing those testing methods at CEPT University, Cortex Delhi, and IIT Bombay.
7. Analysing the tests performed and making inferences for the same.
8. Making various samples of different proportions based on the inference.
9. Choosing the compatible material by testing its properties for restoration of KJH.

Fig. 2 – *Wing - 1. Courtyard and Wing – 2.*

Twenty-four mortar and plaster samples are collected from varies parts of the building. In that four representative samples from the façade, sit-out, ground floor and first floor walls are subjected to characterization testing.

4. Vernacular Architecture of Gujarat

4.1. Kalidas Jethabhai House (KJH), Gujarat, India

Vernacular architecture of Gujarat consists of various typologies such Bhunga houses of Kutch region, Pol houses of Ahmedabad and Wooden havelis of North Gujarat. They are constructed out of locally available materials such as clay, brick, stone, wood, bamboo, and thatch. Mud and clay are commonly used for constructing walls, while timber and bamboo may be used for structural elements and roofing. Buildings in Gujarat are designed to withstand the region's hot and dry climate. Features such as thick walls, small windows, and shaded courtyards help regulate interior temperatures and provide natural ventilation. Sloping roofs are common to shed rainwater during the monsoon season. Traditional houses in Gujarat often feature courtyard layouts, where rooms are arranged around a central open space.

Courtyards serve as outdoor living areas and provide privacy, natural light, and ventilation. Gujarat's vernacular architecture is known for its intricate craftsmanship and decorative elements. Facades may feature carved woodwork, ornamental plasterwork, and colourful ceramic tiles. Traditional motifs, geometric patterns, and religious symbols are often incorporated into architectural elements, reflecting the cultural heritage of the region. The composite structure ensures complete stability of the masonry by allowing the timber to take the load uniformly, while the masonry holds the timber in position. Simultaneously, the timbers prevent the masonry from expanding or fracturing by being embedded horizontally within the masonry. This construction method is known as a bearing wall masonry with timber lacing.

5. Scientific approach in conservation

The scientific approach to heritage conservation refers to involves research, analysis, and evidence-based methodologies to preserve and

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manage cultural heritage sites. This includes measurements and documentation of the physical attributes, historical significance, and condition of heritage assets. material analysis, non-destructive testing, and diagnostic studies are used to understand the composition, deterioration mechanisms, and structural integrity of heritage materials. Testing such as acid dissolution, flat jack test, sounding test, Compressive strength test and Energy Dispersive X-ray Spectroscopy are done in this study. Spectroscopy help identify materials, assess their condition, and determine appropriate conservation strategies.

5.1 Timber testing

One of the earliest techniques for examining in-situ timber members is sounding, which offers a rapid inspection process to spot significant degradation in members. With a quick inspection procedure to identify serious decay within members.

Tap testing is done to detect internal defects within timber members, such as decay, delamination, insect infestation, or voids

5.2. Acid dissolution

Table 1 – *Acid dissolution test of Lime mortar samples* (Ram, 2024).

S.No	Sample name	Binder-aggregate ratio
1.	Sample-1	1:3.9
2.	Sample-2	1:1
3.	Sample-3	1:3.7
4.	Sample-4	1:4.5

5.3. Energy Dispersive X-ray Spectroscopy

SEM uses focused beams of high-energy electrons to create signals on the surface of a solid sample. The SEM is also capable of collecting X-rays generated from selected point/area locations on the samples.

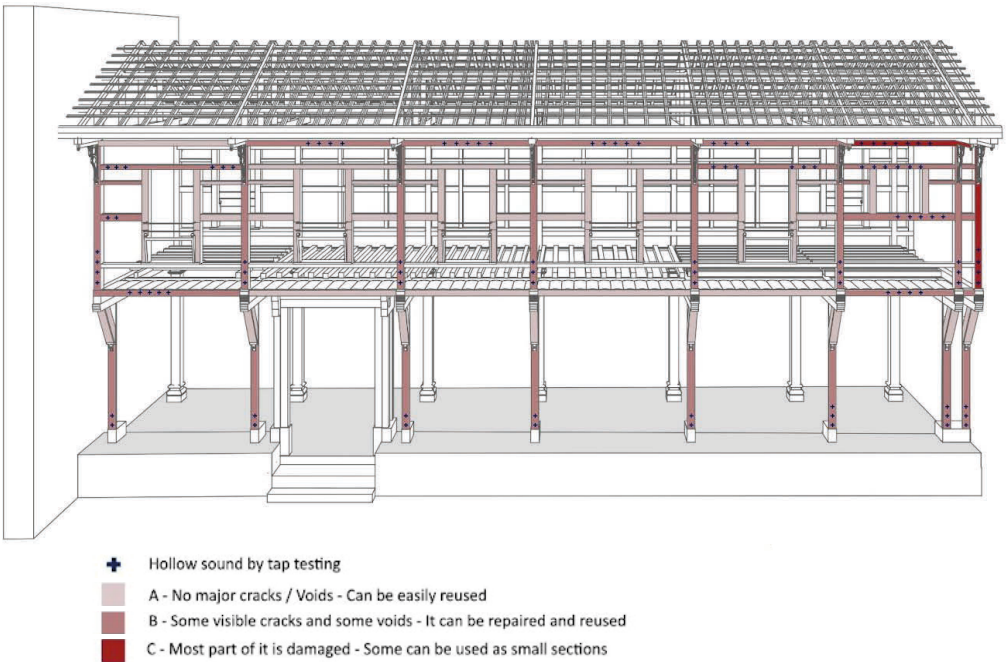

Fig. 3 – *Assessment of Timber members through sounding test.*

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Table 2 – *Compressive strength test of Lime mortar samples* (Ram, 2024)

S.No	Mix ratio	Sample ID	Age (Days)	Size (mm)	Compressive strength (Mpa)	Average Compressive strength (Mpa)
1.	1:1.5:1.5 (with additive)	S-1	20	50x50x50	2.99	**2.74**
		S-2			2.94	
		S-3			2.31	
2.	1:1:2 (with additive)	S-1	18	50x50x50	1.05	**1.04**
		S-2			1.12	
		S-3			0.95	
3.	1:1:2	S-1	18	70x70x70	0.67	**0.82**
		S-2			0.88	
		S-3			0.91	
4.	1:2	S-1	18	70x70x70	0.63	**0.67**
		S-2			0.83	
		S-3			0.56	

This approach called Energy Dispersive X-ray Analysis or Spectroscopy (EDX or EDS) is used to quantitatively determine the chemical composition of the sample. The data is represented in the form of atomic ratios selected to show the composition of the phases present.

5.4. Inference

Al-Kaolinite is identified as a clay mineral. The presence of Silicon dioxide (SiO2) in the EDX peaks suggests the presence of Quartz or burnt brick powder (Pozzoloan). Calcite (Ca) elements are present in EDX peaks, it can be determined that Calcite is a carbonate lime mineral. Sodium (Na), Chloride (Cl), Magnesium (Mg) and Sulphur (S) comes local mud that is called feldspars, brick powder. Iron (Fe) comes from natural adhesive material like Jaggery, Methi (fenugreek), and other Gugal gum (Indian bdellium-tree) These are the common natural additives used in the region.

Fermented Jaggery works as a catalyst in the process of carbonation of Lime. The sticky polysaccharides in jaggery help bind particles together, aiding in reducing shrinkage cracks during curing. Titanium (Ti) could be from sand or mud sourced from sea side.

Fig. 4 – *Prepared lime mortar samples based on Characterisation test results* (Ram, 2024).

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6. Re-engineering

Restoring historic structures require re-engineering of building materials that are compatible with the original ones. This process involves utilizing advanced analytical techniques to gain an understanding of the properties and behavior of the existing materials. To achieve this, a thorough analysis of the structure, and properties of the original building materials is conducted. Various techniques such as XRD, SEM, EDS, FTIR, etc (Gerhard Hübschen, 2016)

6.1. Compressive strength test for Lime mortar sample prepared on site

Samples with a ratio of 1:1.5 (Binder and Aggregate show good results in Compressive strength test. An average of 2.74 Mpa is achieved in 20 days of drying.

7. Discussion and conclusion

Understanding traditional construction systems allows us to preserve the authenticity and integrity of the original building. By reintroducing traditional methods, we can maintain the character and cultural significance of the structure, avoiding modern interventions that might compromise its authenticity. This also ensures the durability and longevity of the structure as it is one of the time-tested systems with timber and masonry that are found in various earthquake-prone regions.

Timber-based construction systems are an important part of the cultural heritage of Gujarat, reflecting the skills, knowledge, and traditions of past generations. By analysing and preserving these methods, Such skills are retained, recorded, and passed on to new generations of craftsmen and builders in education and training.

It is necessary to analyse all the materials involved with equal importance. Although the structure was in major distress, the non-invasive tools helped in understanding the level of deterioration. In this structure, approximately about 20-25 percent of the timber member was decayed, which is identified by in-situ visual assessment and sound testing.

The decayed portion must be replaced while the other timber member can be repaired easily by a prosthetic approach. The wood required for the repair of structural members is entirely reclaimed from the existing structure, ensuring that no new wood is introduced in the restoration of the front wing. Decision-making of the repair strategies,

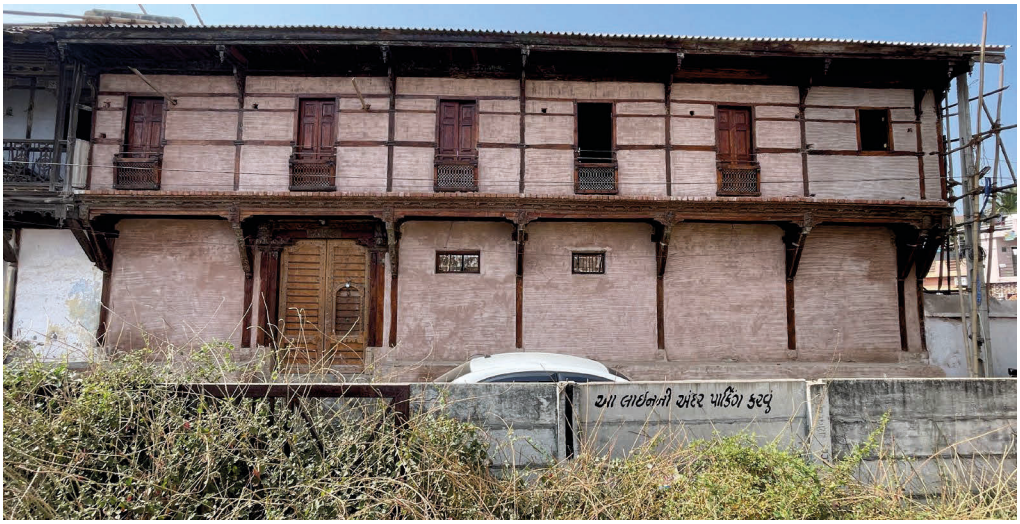

Fig. 5 – *Façade, KJH, during conservation*.

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whether the Strengthened/Partial/Full replacement can be done on-site depending on the level of damage of each member.

As per the previous study and the current study, the lime mortar that is used in the masonry is hydraulic which is either by the usage of limestone with impurities of silicates and aluminates or the addition of pozzolanic materials in the lime mortar mixture. Hydraulic lime mortar is suggested for use in the repair material for its quick setting properties.

The Characterization results show that the binder aggregate ratio of various samples collected from various locations in the structure gives a range of 1:1.5 to 1:3 (Binder: Aggregate). This shows that a very rich lime mortar was used in the construction.

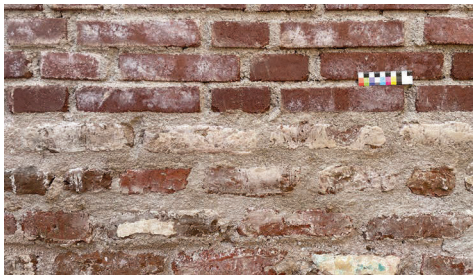

Fig. 6 – *Masonry with old and new brick using lime mortar, during conservation*.

Lime mortar samples are made based on the test results of the existing mortar. These lime mortar samples are subjected to further testing. The hydrated lime (with pozzolanic materials) sourced from Kesarjan lime works (from Ahmedabad, India) with a ratio of 1:1.5 (Binder: Aggregate) and shows a promising compressive strength of 2.74 Mpa in 20 days. These samples are subjected to XRD to compare their mineral content with the existing lime mortar. Further, these lime mortar samples can be tested after 56 days to understand the strength development.

In the front wing, it is evident that they have used mud-based mortar in the masonry. Mud mortar is weaker in strength when compared to lime-based mortar. Hence to prolong the building's life, lime mortar can be used in repairing the masonry in the facade and also in the partial reconstruction of the north side wall of the front wing.

Energy Dispersive X-ray diffraction of existing mortar, reveals the presence of Iron (Fe) in all the samples tested. This could be because of the regional practice of using Fermented jaggery (with Methi and Guggal gum) in the lime mortar mix. Further studies have to be carried out to understand the role of various organic additives in traditional lime mortar.

This study highlights the importance of a scientific approach to conservation. Sets an example by developing a systematic approach to assessing the condition of any historical structures. Techniques such as non-destructive testing, material analysis, and structural analysis help in accurately diagnosing issues and understanding the underlying causes of deterioration. To make decisions based on empirical evidence rather than assumptions or irrational methods. This ensures that restoration efforts are targeted and effective, addressing the root causes of degradation and maximizing the longevity of the structure. This way of approach helps in preserving the authenticity and integrity of historic buildings. By understanding the materials used, construction techniques, and original intent, resources can be allocated efficiently and achieve the least embodied energy possible in the restoration process promoting sustainability in conservation efforts.

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Comparison of Conservation and Repair Methods for Stone Arch Bridges in Spain and Japan

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Abstract
The study compares methods of conservation and repair for cultural heritage buildings in Japan and Spain. This paper focuses on arched stone bridges in both countries, with the Japanese case study 'Reidaikyo', located in Kumamoto Prefecture, and the Spanish case study 'Villafranca del Cid', located between the provinces of Aragon and Valencia. In each case, basic information, survey details and repair work details were collected. As there were many 'case-specific differences' between the two case studies, such as the agency in charge of the repair project, the state of damage and the scale of the repair work, comparisons were made taking these matters into account. As a result, there were commonalities in the survey method, but differences were found in survey areas, survey results and overall repair work contents. In looking at causes of these differences, other than 'case-specific differences', it was observed that for Reidaikyo, the repair work aimed to restore the bridge to its original appearance, whereas for Villafranca del Cid, the repairs tended to blend into their surroundings. These differences in fundamental repair policies are contributed to the differing approaches to conserving and repairing cultural heritage buildings between Japan and Spain.

Keywords: *case-specific differences, original, restoration, repair policies*

1. Introduction

Cultural heritage buildings can be found around the world, with various activities such as surveys, restoration work, and adaptive reuse undertaken to recognize and preserve their value.

This study focuses on arched stone bridges located in both Japan and Spain. Originating in ancient Egypt, the construction method of arched stone bridges spread throughout Europe. In Japan, it was introduced by European engineers in the early 17th century. Although the periods of origin differ between the two countries, the cultural heritage value of these structures continues to be preserved today through ongoing conservation efforts.

2. Objectives

This research primarily aims to compare the conservation and repair methods applied to cultural heritage buildings in Japan and Spain.

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Table 1 – *Basic information* (author, 2025).

Case	Reidaikyo	Villafranca del Cid
Year of construction	1847	14th–16th centuries
Year of repair project	1978	2003(survey) 2007(repair)
Type of stone	Tuff	Limestone
Location	Kiyomizu Misato-machi, Shimomashiki-gun, Kumamoto-ken, Japan	Pobleta de San Miguel (Aragon, Valencia), Spain
Structure (masonry)	Whole: split stone (partially reinforced with mortar) Arch: ashlar	Both ends: drystone Center: broken stone (reinforced with lime mortar) Arch: ashlar (reinforced with lime mortar)
Structure (backfill)	Split stone Sediment	Natural stone (partially lime mortar)
Structure (pavement)	Ashular	Natural stone

Focusing specifically on arched stone bridges structures found in both countries that share similar characteristics the study examines their approaches to preservation. It also highlights the similarities and differences in conservation and repair practices between the two contexts.

3. Methodology

The selected case studies are Reidaikyo in Japan and Villafranca del Cid in Spain. Reidaikyo was chosen as it is one of the few remaining arched stone bridges in Japan that shares construction techniques with Villafranca del Cid, and because detailed documentation of its repair project was available. Villafranca del Cid was selected due to its restoration being led by Fernando Vegas and Camilla Mileto, architects specializing in historical Spanish construction. These two professionals, who also participated in an international academic program related to this research, supervised the study, providing valuable insights into conservation and repair methodologies.Drawing on reports from both repair projects, the study summarizes basic information, survey results, and details of the repair work. It then analyzes the similarities and differences between the two cases, examining their interrelations and underlying causes. Villafranca del Cid is designated as a *Bien de Interés Cultural (BIC)* in the Castellón Region, while Reidaikyo is classified as an Important Cultural Property by the Japanese government.

Although the two bridges are structurally similar, the institutions responsible for their conservation and repair differ. Considering these ‘case-specific differences’, this article focuses on the survey findings and repair processes, offering a comparative analysis of the two bridges.

4. Survey details

Table 1 presents the basic information for each case study, covering the following parameters: year of construction, year of the repair project, type of stone, location, and structural components (masonry, backfill, pavement). For each parameter, the corresponding survey methodology and results are also described.

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4.1. Measurement

Measurements were carried out in both cases, and the collected data was systematically compiled. At Reidaikyo, the displacement of the arches and stone walls was monitored during the repair work to promptly detect and address any anomalies (Fig. 1). This approach was likely adopted because the project involved the complete dismantling of the bridge. In contrast, at Villafranca del Cid, no such monitoring was performed; instead, orthoimages and 3D models were generated based on the survey data (Fig. 2).

Fig. 1 – *Measurement in Reidaikyo* (Report on the Restoration Work at the Reidaikyo an Important Cultural Property designated by the Japanese Government, 1980).

Fig. 2 – *3D models of 'Villafranca del Cid'* (Vegas & Mileto, 2003).

4.2. Masonry

The results from Section 5.1 were used to analyze the characteristics of the masonry. For Reidaikyo, the analysis focused on the wall stone components, examining features such as the continuity of the joints and the size of the gaps. Additionally, due to the complete dismantling and repair of the bridge, particular attention was given to the backfilling process. This allowed for a more detailed identification of features, including the shape of the stones and their stacking arrangement (Fig. 3).

The analysis of Villafranca del Cid concentrated on the pavement, where two distinct paving patterns were identified, suggesting a chronological difference between them. Furthermore, the examination of the wall stones revealed two distinct construction techniques: areas filled with lime mortar and sections of dry masonry (Figs. 4 & 5).

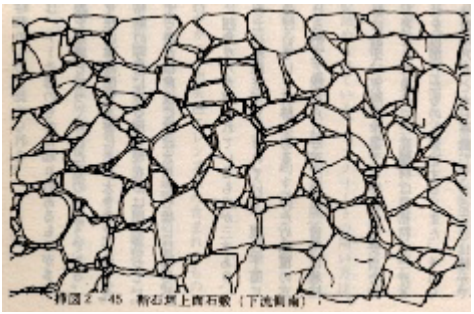

Fig. 3 – *Drawing of masonry in Reidaikyo* (Report on the Restoration Work at the Reidaikyo an Important Cultural Property designated by the Japanese Government, 1980).

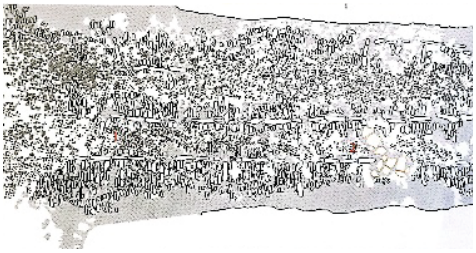

Fig. 4 – *Drawing of one of 'Villafranca del Cid"s pattern of pavement* (Vegas & Mileto, 2003).

Fig. 5 – *Drawing of the other 'Villafranca del Cid"s pattern of pavement* (Vegas & Mileto, 2003).

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4.3. Damage

In both cases, the survey method employed was visual observation, with '*Raccomandazioni NorMaL 1/88*' serving as the damage assessment indicator in Villafranca del Cid. The study results revealed that the damage was attributed to both anthropogenic and environmental factors. Regarding anthropogenic factors, structural damage at Reidaikyo was caused by increased impact loads from traffic, as well as pollution from vehicle exhaust emissions. In contrast, at Villafranca del Cid, stone material loss in the pavement was linked to deliberate human activity and livestock movement. As for environmental factors, at Reidaikyo, the loss of backfill sediment was due to frost damage and prolonged water flow from rainfall, which led to the deformation of the stone walls. Meanwhile, at Villafranca del Cid, damage to the bedding path from vegetation growth and deterioration of the foundation slab due to water flow were observed.

4.4. Similar case

In the survey of analogous structures, differences were noted in the scope of investigation. For Reidaikyo, stone bridges and tunnels within the same province were surveyed as examples of civil engineering structures, and the relationship between the stone materials used was analyzed. In Villafranca del Cid, architectural features in the vicinity of the bridge were examined, focusing on the 'dry masonry' technique used for residential buildings and the stone paving in the plaza (Fig. 6).

4.5. Construction test

In both cases, construction tests were conducted on new supplementary materials intended for use in the repair work. Exposure tests were carried out on the resin used to restore missing sections of structural components at Reidaikyo, and on the lime mortar applied between masonry elements at Villafranca del Cid.

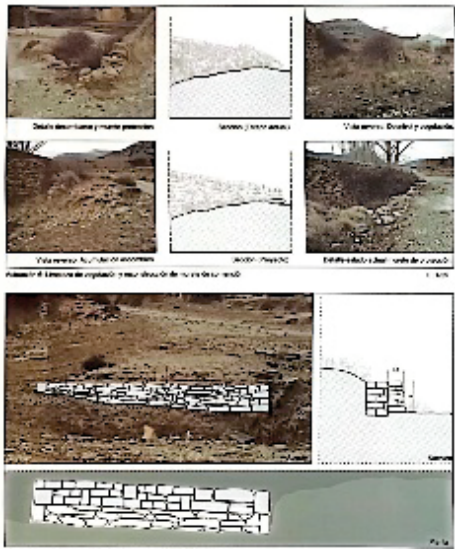

Fig. 6 – *Results of a survey of surrounding case studies in 'Villafranca del Cid'* (Vegas & Mileto, 2003).

4.6. Structural analysis

To determine the stresses generated in the structure under applied loads, computational analyses were conducted in both cases. However, for Reidaikyo, the stress analysis was specifically based on the results of stone strength investigations and arch measurements obtained after extensive demolition work.

4.7. River flow analysis

This analysis was conducted exclusively for Villafranca del Cid (Fig. 7). Since the Castellón River, which flows beneath the bridge, typically has a low flow rate, directly measuring the actual flow rate was challenging. Therefore, an observational survey of the masonry surrounding the bridge was carried out to analyze water flow patterns during periods of high discharge, identify areas of eddy formation, and assess locations where hydraulic forces contribute to structural instability. No equivalent survey was conducted at Reidaikyo.

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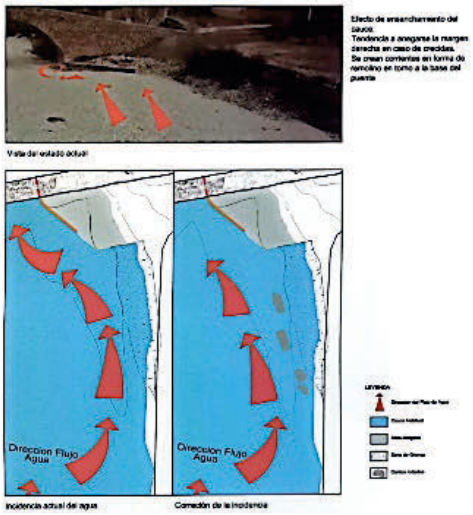

Fig. 7 – *Results of flow analysis in 'Villafranca del Cid'* (Vegas & Mileto, 2003).

5. Repair work details

For each aspect, the construction details of the repair work are presented.

5.1. Stone Procurement

Differences were observed in the prioritization of reusing versus sourcing new supplementary stone materials. At Reidaikyo, priority was given to reusing the original components. When replacement was necessary, new stone was sourced from the same quarry as the original. If sourcing from the original quarry was not possible, stone was obtained from a nearby quarry with a similar texture to the original material. In contrast, at Villafranca del Cid, smaller stones for the paving paths were collected from the riverside near the bridge, while larger components, such as foundation slabs, were sourced from quarries supplying the same type of stone.

5.2. Dismantling

Reidaikyo underwent extensive dismantling due to structural instability in certain areas of the masonry. Each stone was examined to determine whether it was original or introduced during later repairs. In contrast, at Villafranca del Cid, only the severely damaged pavement was removed, along with the clearance of vegetation.

5.3. Stone Repair

At Reidaikyo, cracks and partially chipped stones were repaired using resin infill (Fig. 8). At Villafranca del Cid, the original stone material contained copper, which had developed a green patina over time. In contrast, the copper in the newly introduced supplementary stone retained an orange color. To harmonize the tone, a green-blue patina was artificially applied.

Fig. 8 – *Resin being injected into cracks in Reidaikyo stonework* (Vegas & Mileto, 2003).

5.4. Foundation works

At Reidaikyo, concrete foundations were constructed. In contrast, at Villafranca del Cid, where part of the foundation slab had been lost due to river erosion, the foundation was reinforced with stone slabs, and large stones were placed around it to mitigate the water flow.

5.5. Masonry

At Reidaikyo, the original stone masonry was reassembled to restore its original configuration. The components were placed in their original locations, ensuring that the newly added stone elements were consistent with the original masonry arrangement. At Reidaikyo, small gaps were filled with pebbles, while at Villafranca del Cid, the gaps were filled with lime mortar.

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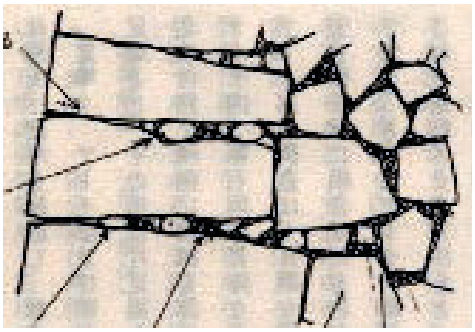

Fig. 9 – *Reidaikyo backfill repair plan drawings* (Report on the Restoration Work at the Reidaikyo an Important CulturalPropertydesignated by the Japanese Government, 1980).

5.6. Backfill

The construction specifications for the backfill at Reidaikyo were modified to address the underlying cause of decay. Initially, earth and sand were used for backfill; however, rain and other environmental factors caused runoff and exerted pressure on the stone walls, leading to surface displacement and necessitating re-stacking with stone and mortar. At Villafranca del Cid, gaps were sealed with lime mortar, in line with the original construction of the masonry.

5.7. Pavement

At Reidaikyo, the pavement was re-laid using hewn stone, and the railings were restored to their original state. At Villafranca del Cid, the paving was re-laid based not only on the pattern identified in Section 5.2 but also by referencing the stone paving used in the surrounding houses and squares. The stones for the paving were selected by temporarily placing them on-site to ensure visual and material consistency with the surrounding environment.

5.8. Surrounding environment

Modifications to the surrounding structures were not made at Reidaikyo. In contrast, at Villafranca del Cid, benches were placed in the square around the bridge, constructed from the same stone as the bridge. Additionally, the electrical infrastructure was concealed using dry stone masonry, integrating it harmoniously into the surrounding landscape (Fig. 9).

6. Results

The following table presents a comparison of the investigation results and repair works conducted at Reidaikyo and Villafranca del Cid. Items exhibiting similarities are marked with □, while those displaying differences are marked with ○. Items marked with ◎ indicate differences attributed to the ‘case-specific differences’ discussed in Chapter 3 (Table 2) (Table 3). In the Survey details, many of the differences were due to these ‘case-specific differences,’ while in the Repair work details, a greater number of general differences were observed.

Table 2 – *Result of survey details* (Author, 2025).

Survey details	Comparison results
4.1. Stone Procurement	□
4.2. Masonry	◎
4.3. Damage	◎
4.4. Similar case	○
4.5. Construction test	◎
4.6. Structural analysis	◎
4.7. River flow analysis	◎

Table 3 – *Result of Repair work details* (Author, 2025).

Repair work details	Comparison results
5.1. Measurement	○
5.2. Dismantling	◎
5.3. Stone Repair	○
5.4. Foundation works	○
5.5. Masonry	◎
5.6. Backfill	○
5.7. Pavement	○
5.8. Surrounding environment	○

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7. Discussion

This chapter presents a comparative analysis of the survey and repair work details, focusing on commonalities, trends in differences attributed to 'case-specific differences,' and differences arising from other factors.

In terms of survey content, many similarities were observed in the survey methods. However, variations in environmental conditions and the nature of the repair work led to differences in results and focus, resulting in the classification of many items as 'case-specific differences.' Among the differences attributed to other factors, the variations in survey targets discussed in Section 5.4 appear to be linked to the distribution range of masonry structures.

Regarding the selection of analogous cases, in Villafranca del Cid, the focus was on surrounding structures that employed the same construction method as the bridge. In contrast, no such structures existed around Reidaikyo, which led to an expanded survey area that included stone bridges within Kumamoto Prefecture. This difference is likely due to the more extensive use of stone as a construction material in Spain compared to Japan, resulting in a more localized distribution of analogous structures.

No similarities were identified in the repair work methodologies. Among the items exhibiting differences, those classified as 'case-specific differences' were primarily associated with the extent of damage. Other differences were attributed to variations in conservation and repair policies.

A shared principle in the conservation and repair methodologies of both cases is the coexistence of original and restored components. The scope of repairs should be minimized, and any interventions should adhere to the original specifications. In Japan, special emphasis was placed on restoring the original appearance. Except in cases where structural stability necessitated alterations, restoration efforts prioritized the retention of the original appearance, including materials and masonry patterns.

In contrast, in Villafranca del Cid, construction methods were chosen to ensure that the repaired areas harmonized with their surroundings. Therefore, the approach described in Section 6.8 appears to have been applied exclusively in this case.

8. Conclusions

A comparison of the conservation and repair methods employed at Reidaikyo and Villafranca del Cid reveals similarities in survey methodologies but differences in survey locations, findings, and repair work details.

Regarding the repair work, differences were analyzed by focusing on aspects that showed the most pronounced contrasts, particularly the 'case-specific differences' observed in each project. It was found that at Lingtai Bridge, priority was given to restoring the original appearance, whereas in Villafranca del Cid, the repair work aimed to ensure that the repaired areas blended harmoniously with their surroundings.

This approach reflects the fundamental conservation policies in each case and is considered a distinctive characteristic of each country. In other words, these differences in repair policies may influence the overall approach to the conservation and restoration of cultural heritage structures in Japan and Spain.

Acknowledgements

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Extrados Vaults in the Chartreuse of San Giacomo in Capri, Italy: History, Knowledge and Conservation of a Vernacular Architecture in the Mediterranean Landscape

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Abstract

This contribution explores the restoration issues concerning extrados vaults in Capri covered by lapilli aggregate, an artisanal mortar realized with eruptive products. In particular, the contribution will focus on the vaults located in the Chartreuse of San Giacomo in Capri, one of the island's oldest architectural landmarks, built in 1371 on the lush southern shore of the island. Different kinds of extrados vaults can be found in the chartreuse, all covered by lapilli aggregate, a special protective surface whose preparation and laying down require a high level of craftsmanship. The adoption of this construction technique makes the ancient chartreuse a precursor of an extensive application of this specific covering to the rural heritage, built either on the island or on the coasts of Southern Italy. The application on the chartreuse is an important contribution to the definition of one of the cornerstones of the collective language of vernacular architecture in the Mediterranean landscape. The study starts from a material-typological reconstruction of the extrados vaults of the Chartreuse of San Giacomo, focusing also on the interventions realized on these structures in the past. Then, the conservation issues have been analysed in order to define the possible scenarios of a sustainable maintenance and restoration interventions. On this point, the study intersects with ongoing research on the identification of new products to substitute/reintegrate the technique of lapillus; this study is being conducted by the research unit of the Department of Architecture at the University of Naples Federico II, part of a PNRR Project promoted by the CHANGES foundation, which seeks to promote sustainable practices in cultural heritage preservation.

Keywords: *chartreuse; Capri; vernacular architecture; vaults; conservation*

1. Introduction

The experiential analysis of the Chartreuse of San Giacomo in Capri, as articulated by Roberto Pane (Pane, 1981, p. 61), immerses us in the unique architectural characteristics that distinguish this construction on the island, representing a distinctive interpretation of the monastic 'rule' of San Bruno:

> The Charterhouse is the triumph of the extrados vaults, in the truly functional movement of the rounded corners of the arches, in the rough surface of the tuff concrete […] To those who walk across the undulating roofs, an unusual pleasure is offered: the feeling of being physically – as well as mentally – involved in a plastic effect (Di Stefano, 1982).

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Fig. 1 – *The Chartreuse of San Giacomo in Capri rural landscape* (Archive of Suprintendence of Naples).

This medieval religious complex is the most recent of the three charterhouses built in Campania (it has been built after the Chartreuse of Padula and the Chartreuse of San Martino) and adheres strictly to the validated plan distribution typical of Carthusian architecture. However, its volumetric realization transforms it into something singular, drawing heavily from a Mediterranean architectural vocabulary that resonates throughout the island (Fig. 1).

The chartreuse is notably characterized by various types of extrados vaults covered by lapilli aggregate, a particular protective surface crafted with a high level of artisanship. This architectural tradition claims that the Chartreuse of San Giacomo in Capri is the first instance of this construction technique applied on the island (Picone 2010). In this context, the adoption of such methods positions the ancient charterhouse as a precursor to the widespread implementation of this unique covering across rural heritage – both on the island and along the coasts of Southern Italy – contributing significantly to the definition of a cornerstone of vernacular architecture in the Mediterranean landscape (Cantone et al., 1982). Consequently, the chartreuse serves as an important case-study to evaluate restoration strategies of a complex and fragile vernacular architectural system.

Implementing a proper intervention on these protective surfaces is particularly challenging due to the limited availability of raw materials, such as lapillus, a natural product formed from volcanic deposits, as well as the execution technique itself, which involves a labour-intensive process of layering and pressing down materials using specialized tools. The pressing process could not be interrupted, often requiring builders to carry on their work through the evening, aided by the encouragement of traditional local songs.

The complexities of planning a restoration intervention on specific materials not easy to replicate – due to either their material properties or sustainability concerns – are clear. Considering these challenges, modern

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technology and production techniques have sought to propose various alternatives for the integration and conservation of extrados vault systems, often introducing new industrial or combined products that may not fully align with the original structures. Thus, it is crucial to re-evaluate best practices for restoring extrados vaults covered in lapilli aggregate.

At this juncture, the current study intersects with ongoing research aimed at identifying new products to substitute or reintegrate the lapillus technique, facilitated through collaboration with Mapei S.p.A. This study is being conducted by the research unit of the Department of Architecture at the University of Naples Federico II[1] as part of a PNRR Project promoted by the CHANGES Foundation, which advocates for sustainable practices in cultural heritage preservation.

This contribution, by a material-typological reconstruction of the extrados vaults of the Chartreuse of San Giacomo, will focus on the role this construction type plays within the formal typology of the monastic complex and its significant transformations over time. The text will also examine past interventions on these vaulted structures, revealing that the technical solutions employed in their restoration often lack consistency with the ancient protective layers of lapilli aggregate. In the final section, both historical and contemporary conservation issues surrounding the vaulted systems will be analysed to outline possible scenarios for sustainable maintenance and restoration interventions.

2. The role of the extrados vaults in the Chartreuse of San Giacomo in Capri

2.1. The vernacular architecture of Capri and extrados roofing technique

A special contribution to the central role that the chartreuse had in the constructive history of Capri and, at the same time, on the historical transformations of landscape must be addressed to the extrados vaults system. Plastic shapes of vaults define the profile of chartreuse, which recreate a formal connection with colours, materials and formal typology of vernacular architecture of Capri. In this sense, the extrados vaults are one of the most important aspects to preserve in a correct way to respect the landscape and its perception. Besides, the vaulted system links the chartreuse not only to Capri's architecture, but also to that of the Mediterranean.

Thus, the Chartreuse of San Giacomo is the result of two main construction phases: one medieval and one 17th-century. However, as noted by Roberto Pane, the medieval structures, including the vaulted system, are significantly more prominent – particularly due to their explicit reference to the Byzantine architectural style – especially visible in the buildings along the Amalfi Coast.

These medieval elements also had a more direct influence on the island's building tradition, based on artisanal construction techniques: there is a repeated use of extrados vaults covered with tuff concrete, the rustic roughness of white walls, occasionally adorned with simple, perfectly

[1] This contribution is a disseminative product of the research promoted by CHANGES – *Cultural Heritage Active Innovation for next Generation Sustainable Society, "PE5. Humanities and cultural heritage as laboratories of innovation and creativity",* Spoke 6 – *History, conservation and restoration of cultural heritage*, MUR project: PE00000020 – CUP E53C22001650006. The research unit of University of Naples Federico II that is working on the definition of a possible substitute of ancient lapillus aggregate – together with Mapei S.p.a. – is composed by: prof. Renata Picone (coordinator), prof. Valentina Russo, prof. Vincenzo Morra, prof. Lia Romano, arch. PhD Ersilia Fiore, arch. PhD Sara Iaccarino, arch. PhD Maria Verde.

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integrated ornamental details, a departure from the more decorative tendencies typical of the 17th-century style.

On this point, the chartreuse must be considered in close relation to its natural context: the ancient Carthusian desert (Picone, 2008, pp. 29-60), which, since the early 20th century, began to be the site of a violent speculative construction phenomenon. Evaluating cases like the Chartreuse of San Giacomo from a conservation standpoint requires considering the work's values as closely tied to the ecological and environmental conditions surrounding it. As Roberto Pane and, decades later, Giovanni Urbani taught us (Urbani, 2000), it is not possible to effectively restore the first without restoring their surrounding environment as well.

2.2. The extrados vaults system in the 'life' of Chartreuse of San Giacomo: an ancient story of transformations

The monumental complex of the Charterhouse dedicated to San Giacomo is situated in a vast, flat green expanse at the foot of Mount Castiglione in Capri, approximately 100 meters above sea level in the area known as Lama (or Sama). This location fully meets the requirements of the 'Carthusian desert' as stipulated by the *Rule* of Saint Bruno, which mandated a certain distance between cloistered religious settlements and inhabited areas. In this case, the 'desert' was partially formed by a cliff overlooking the northern coast of the island near the Faraglioni. At that time, surrounding dwellings were far removed and fortified by walls, a condition that has gradually diminished due to tourism and subsequent illegal constructions.

The complex came under the ownership of Giacomo Arcucci around 1363 (Cantone, Fiorentino, Sardella, 1982, pp. 192-193; Pane, 1954; Pane, 1965, pp. 40-64), who served as secretary to Queen Joanna I of Angiò and was the Count of Minervino and Altamura, financed its construction beginning in the 1360s, with the medieval phase of the building completed by 1371. It is important to note that the construction of the building should not be viewed as a singular authorial project. Instead, the chartreuse exemplifies a paradigmatic vernacular style grounded in the artisanal traditions of Capri and southern Italy.

The deep connection between the chartreuse and the evolution of its landscape is evident in historical sources suggesting that the Carthusian settlement may have been built upon Roman ruins of the island. This hypothesis has been proposed also by Roberto Pane, but archaeological excavations, such as those led by Amedeo Maiuri, have not found sufficient evidence to confirm the existence of earlier structures incorporated into the medieval building (Maiuri, 1957; Maiuri, 1962; Cerio, 1921; Cerio, 1922; Cerio, 1950).

During the 16th century, the monastic complex suffered significant damage from attacks – first by Frederick Barbarossa (Di Liello, 2004), then by the corsair Dragut, along with numerous other raids. In 1564, the construction of a guard tower commenced, as commissioned by a military engineer sent by the Viceroy of Naples, Parafan de Rivera; however, this tower collapsed in May 1808. These events prompted the Carthusians to abandon the monastery, leading to a prolonged reconstruction phase from 1560 to 1656, which continued in 1691 with the reinforcement of the tower and the renovation of the large cloister and presbytery of the church, completed by 1699. During these renovations, a three-arched bell tower was added next to the refectory, but it was demolished in 1908 due to safety concerns.

The Carthusian complex showcases two main architectural phases: the medieval, characterized by its foundational layout and construction techniques, and the baroque, evident in the few decorative elements that still enhance the simple, textured walls today.

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In both phases, the vaulted system played a crucial role. During the medieval construction, as noted by Roberto Di Stefano (Di Stefano, 1982, p. 60), key areas of the chartreuse were covered by cross vaults, including the church, refectory, and fathers' cells along the sides of the large cloister. Secondary functional spaces, such as the monks' work areas, were covered by simpler barrel vaults.

The vault typologies evolved during the baroque period, notably with the addition of new spaces to the original complex, such as the Quarter of the Prior. This addition, featuring several attractive spaces on the eastern side of the large cloister, was distinguished by pavilion lunette vaults, a popular technique during the 17th century, as seen in the Church of Salvatore, always in Capri (White 1980, pp. 41-42). In the Chartreuse of San Giacomo, this vault type is also present in some of the fathers' cells around the large cloister. This adaptation might seem unexpected, considering the cells were constructed in the medieval phase. Originally, the cells alternated with small private gardens where each monk could pray and meditate. However, in a later phase, some gardens were transformed and enclosed to create additional cells. Several theories exist regarding when these conversions happened; today, these new rooms feature pavilion lunette vaults, suggesting this transformation may have occurred in the 17th century.

While the volumetric transformations up to the 17th century can be considered an architectural enhancement of the monastic complex, the alterations made in the 19th century, following the suppression of the Carthusian Order in 1808, compromised the ancient character of the chartreuse (Iaccarino, 2024). During this period, the properties of the Carthusians were seized by the French, forcing the monks to evacuate. This displacement led to a gradual decline in the complex, which, by 1815, was repurposed as a penal institution, housing war invalids until 1860. Subsequently, it became the headquarters of the Fifth Discipline Company, undergoing modifications that drastically altered the spatial layout and volume of the building, resulting in the loss of many valuable assets. The vaulted structures were particularly affected, being covered by gabled roofs that distorted the geometry of the complex.

This transformation is evident in numerous artistic representations from the 19th century, where the chartreuse is depicted with its medieval extrados vaults concealed beneath large, pitched roofs. Other significant alterations occurred in the cloisters, where the elegant slender columns of the small cloister – remarkable for their Roman capitals from the medieval construction – were replaced with much bulkier concrete pillars.

These changes often undermined the intrinsic quality of the building, prompting key figures in 20th-century architectural restoration to intervene. Their efforts aimed to restore a much-desired unity of image, form, and space. Notably, the work of Gino Chierici between 1925 and 1927, along with subsequent interventions by Roberto Di Stefano from 1975 to 1980 (Picone 2013), allowed the Charterhouse to gradually reclaim its identity as a cathedral of the ancient Mediterranean. This restoration process focused on reintroducing fundamental characteristics that only such dedicated efforts could reveal.

Chierici's interventions were particularly crucial in restoring the ancient appearance of the complex, addressing significant damage inflicted by the alterations in the 19th century. His work concentrated on the church, the small cloister, and the extrados vaults, which had previously been obscured by roofs. Through his efforts, these architectural features became visible once more, allowing the essence of the chartreuse to be reinstated.

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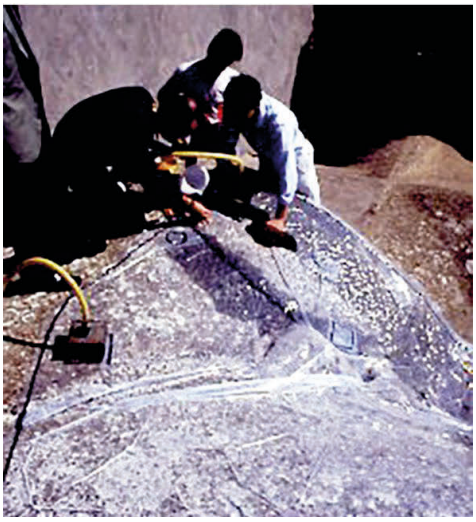

Fig. 2a & 2b – *Two slides of 1980's intervention on extrados vaults system* (Photographic Archive of Suprintendence of Naples, slides 017A, 067B).

3. The extrados vaults system. Conservative issues of a vernacular technique

In the previous chapter, we explored how the more than twenty extrados vaults of the Chartreuse of San Giacomo in Capri symbolize the local vernacular architectural tradition and serve as tangible evidence of the building's historical evolution. Given their significance, these vaults must be regarded as one of the most iconic elements to observe and preserve during the restoration of the monastic complex. For this reason, understanding the common conservation issues affecting this unique heritage is essential.

It is important to note that these horizontal surfaces are directly exposed to various environmental factors, including rain, wind, and solar radiation. The design of the extrados vaults has been specifically crafted to manage rainwater through their shapes. The horizontal surfaces are modelled to create natural slopes and concavities that guide rainwater flow without incorporating foreign materials or elements, such as metal eaves. At the points where two different types of vaults connect, architectural elements have been altered to regulate water flow, such as in the father's cells around the large cloister, where ancient gardens are topped with pavilion lunette vaults interspersed with cross-medieval vaults. In this instance, small, irregular walls have been opened to facilitate the connection between these two systems.

When rainwater reaches the vertical walls, there are no metallic downspouts to direct it. Instead, at the Chartreuse of San Giacomo, water is channelled onto artisanal brick tiles, protecting the mortars and stones of the façades. In this context, the architectural shape serves not only as a formal vernacular language but also as a vernacular 'plant engineering' system.

Upon analysing the vaults of the Chartreuse of San Giacomo, we can identify issues linked to the complex and artisanal nature of rainwater management. Although lapillus aggregate is a waterproof material, it can deteriorate over time, leading to cracks that allow water to penetrate the structural stone of the vaults, thereby triggering humidity infiltration indoors. This issue has manifested notably in the church and the adjacent vestry, damaging 17th-century frescoes and stuccoes. The problem is also evident on the horizontal roof covering the porch of the large

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cloister, which is similarly surfaced with lapillus aggregate. Here, the horizontal condition exacerbates rainwater accumulation, leading to increased degradation, including cracks and biological patinas. In recent years, infiltration on the porch has been particularly pronounced in the southeast area of the large cloister, resulting in damaged arches and cross vaults, along with significant staining and loss of material on the intrados surfaces. When the lapillus aggregate is compromised, robust weed growth occurs, further damaging the surfaces and, in the case of stronger roots, even the structural materials.

Since the second half of the 20th century, numerous maintenance interventions have been carried out on the chartreuse and its vaulted system (Fig. 2a & 2b). We can easily identify them by different chromatic values between original lapillus aggregate and modern interventions of mending (Fig. 3). However, these interventions are not fully compatible with lapillus aggregate, not only for an aesthetic instance. Documentation preserved in the Superintendence Current Archive indicates that many cementitious injections have been applied over time. A more robust evaluation of the vaults' conservation is essential, especially as they continue to be exposed to degrading environmental agents.

This evaluation can be significantly informed by the fact that today the monastic complex is part of the Ministry of Culture's heritage. Since July 2024, it has also housed the *Archaeological National Museum of Capri* in the beautiful rooms of the Quarter of Prior (Fig. 4). As a result, the monument is subject to maintenance and receives funding for larger interventions in specific areas.

In a culturally and managerially virtuous context like the Chartreuse of San Giacomo, it is crucial to assess and experiment with new solutions to integrate the ancient lapillus aggregate, avoiding concrete and chemical consolidation materials or waterproof additives.

To this end, a team of researchers from the Department of Architecture and the Department of Earth Sciences at the University of Naples Federico II is conducting applied research to identify a product compatible with the ancient lapillus aggregate. This research is rooted in the historical composition of the material, as assessed through ancient treatises detailing its recipe, and augmented by direct analysis of original lapilli samples. The study will test various products in collaboration with Mapei S.p.A., a leading company in producing construction materials. The goal of this investigation is to avoid industrial products and to reproduce ancient techniques adapted to contemporary needs and conservation activities.

Fig. 3 – *Extrados vaults of Chartreuse of San Giacomo in Capri. It's evident the presence of different forms of degradation on roof surfaces and, at the same time, the different kind of cementicious integrations* (Facchini, 2018).

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Fig. 4 – *Extrados vaults of Chartreuse of San Giacomo in Capri next to the Quart of Prior* (Facchini, 2018).

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Preserving Heritage, Inspiring Revival: Restoring Traditional Japanese Thatch Culture through Transformative Professional and Associative Initiatives

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Abstract
Thatch roofing, once a defining feature of Japanese rural landscapes, declined sharply in the 1950s due to lifestyle changes, material scarcity, and competition from modern alternatives. However, recent efforts have revived this tradition through overlapping local and national initiatives. This study examines bottom-up collaborative efforts in Miyama, Kyoto, where a professional thatcher has led a local revival, and at the national level, where the Japanese Thatching Culture Association (JTCA) promotes conservation. Data were gathered through expert interviews, participatory thatch maintenance activities, and social media analysis from September 2021 to November 2024. Using a transformative process framework, the study examines how localized initiatives scale into broader networks, ensuring craft sustainability. Findings highlight that thatch conservation requires professional adaptations and collaborative networks. This transformative process integrates community participation, academic engagement, and institutional partnerships, supporting long-term sustainability. The research underscores the importance of evolving technical and organizational practices while maintaining cultural integrity, offering a scalable model for sustaining Japan's thatch roofing culture in contemporary society.

Keywords: *thatch conservation; traditional culture; bottom-up transformative process; collaborative networks; craft adaptations; Japan*

1. Introduction

Thatch roofing, once a defining feature of Japanese rural landscapes, experienced a sharp decline after the 1950s due to shifts in lifestyle, material availability, and modernization (Yoshida, 1985). Today, the number of thatched roofs in Japan has decreased to approximately 100,000 (Ando, 2023). This decline is closely tied to the availability of thatch material, known in Japanese as kaya—a generic term for the Miscanthus, reed and other perennial gramineous grasses traditionally used for thatched roofs (Ando & Ueno, 2019). Historically, these plants were sourced directly from the surrounding environment, where they were once readily available near villages. During the early Meiji era in 1868, kaya fields covered nearly 30% of Japan's land area, but this has since dwindled to an estimated 2–3% in recent years (Ando & Ueno, 2019).

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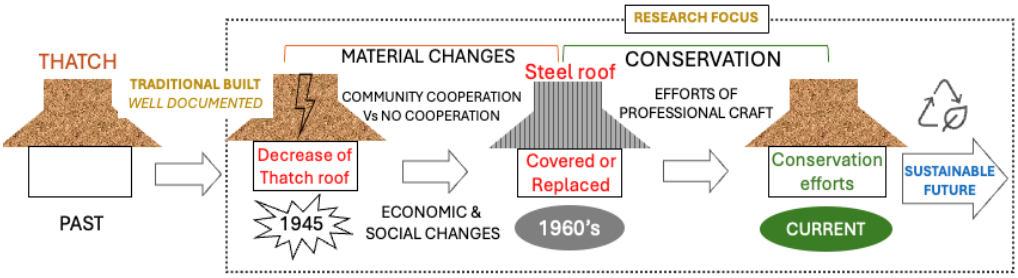

Fig. 1 – *Evolution timeline of Thatch condition in Japan.*

This severe reduction in material availability significantly impacts the feasibility of conserving and continuing Japan's thatch architectural culture (Fig. 1). Despite this decline, recent efforts have emerged to revive thatch roofing, not only as a construction technique but as a cultural heritage practice. These revival efforts address both material concerns (sustainability, maintenance challenges) and cultural concerns (knowledge transmission, community engagement and professional viability). However, ensuring the long-term sustainability and scalability of thatch roofing remains a challenge.

This research examines the need for a structured framework to support the scaling and evolution of thatch craft while maintaining cultural authenticity and ecological integrity. Specifically, the study investigates how traditional thatch practices are being revived, adapted, and expanded through local and national initiatives. The study is guided by three key objectives:

1. Identify the balance between conservation and evolution—determining what should be preserved (cultural authenticity, traditional materials, and ecological sustainability) and what must evolve (organizational structures, outreach strategies, and adaptive technical improvements).
2. Examine a framework for scaling and evolving traditional crafts through two case studies one at the local scale, and another at the national scale, where institutional structures play a role in sustaining and expanding the craft.
3. Analyse the transformative mechanisms that enable the expansion of traditional crafts from localized revival efforts to structured national frameworks, ensuring long-term sustainability.

By addressing these objectives, this study provides insights into how various mechanisms contribute to the transformation of thatch craft in Japan. Ultimately, it aims to inform scalable heritage conservation strategies, offering a model that can be adapted to other traditional crafts facing similar challenges in contemporary societies worldwide.

2. Methodology

The data for this study was collected from a combination of expert interviews, participatory observation, and social media analysis (all spanning from 2021 to 2024) to examine the evolution and scaling of thatch craft in Japan. Expert interviews were conducted with professional thatch craftsmen from Kyoto, Kobe, Nagano, and Hokkaido, as well as members of the Japanese Thatching Culture Association (JTCA), including academics, and architects, providing insights into craft knowledge transmission, conservation strategies, and institutional support mechanisms.

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Participatory observation involved engagement in community-led thatch maintenance programs, including field cleaning, kaya cutting, and the construction of drying towers, allowing for a deeper understanding of localized knowledge systems and collaborative conservation practices. Additionally, a social media analysis was conducted to track professional and associative activities, offering real-time data on networking, advocacy, and public engagement in the thatch revival movement.

For the analytical approach, this study adopts a comparative case study method, using a transformative process framework informed by literature on social capital, transformation theory, and middle-out concepts.

3. Conceptual framework: transformative process and social capital

3.1. Transformative process in traditional craft revival

Transformative processes operate across multiple levels, from individual consciousness to collective organizational realities (Karp, 2005). Key findings of Castro-Arce and Vanclay (2019) indicate that transformative social innovation must extend beyond local initiatives through transformative processes to influence policies, institutions, and agencies at broader levels. This requires structured multi-actor collaboration and bridging organizations to sustain momentum and ensure long-term impact. Successful transformation relies on network enablers, knowledge brokers, and resource-sharing mechanisms that empower communities while integrating institutional support. The transformative process follows three key stages:

1. Mechanisms: Initial conditions engaged by background triggers that lead to intervention.
2. Transformative Actions: The steps taken to evolve and sustain a system or practice.
3. Final Outcomes: The long-term impact and sustainability of the transformation.

This framework is applied in this research to provide a structured analysis of how traditional crafts evolve and scale across local and national contexts (Fig. 2).

It highlights the interplay between grassroots initiatives, professional networks, and institutional mechanisms, all of which contribute to the sustainability and expansion of thatch craftsmanship in contemporary Japan.

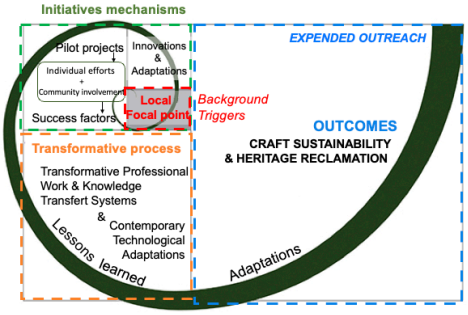

Fig. 2 – *Analytical framework for the evolution of craft adaptation.*

3.2. Social capital and its role in scaling craft revival

Pierre Bourdieu (1986) defines social capital as the resources tied to an individual's or group's durable network of relationships. Specialized craft producers shape social networks, economic wealth, and cultural legitimacy, with artisan identity playing a key role in production systems and social processes (Costin, 2008). In this study, bonding social capital at the local scale fosters trust-based relationships, ensuring knowledge transmission and intergenerational continuity.

At the national scale, bridging and linking social capital connect craftspeople, researchers, and policymakers, facilitating the institutionalization and expansion of thatch practices. This distinction underscores how local trust networks interact with broader institutional frameworks, sustaining and evolving craft heritage.

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4. Framework for scaling and evolving traditional crafts

4.1. Local scale: individual-driven thatch revival in Kita village

At the local scale, transformation is initiated through individual-driven action. The case of Kita village (Figs. 3 & 4) exemplifies how a single master thatcher became a focal point in revitalizing lost practices by opening a thatch company in 1998, at a time when previous regional masters had already stopped practicing. This effort was further reinforced in 2021 by re- engaging thatch-related community activities, which had completely disappeared. Through hands-on training for young practitioners, participatory field maintenance, and local networking, this initiative fosters bonding social capital, ensuring not only knowledge retention within the community but also inspiring interest and pride among the next generation, as children participate alongside their parents. Although this is only the beginning of the process and the current fields are insufficient to supply the necessary amount of thatch for the village's yearly conservation needs, it serves as a successful pilot model that can be scaled up to support the potential revival of old thatch fields.

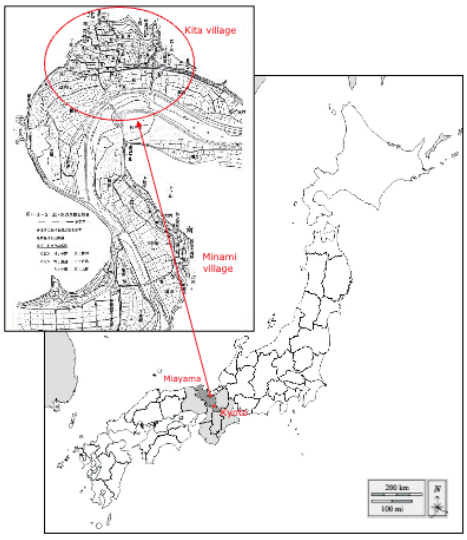

Fig. 3 – *Map location of Kita village in Japan.*

Fig. 4 – *Photo of thatch houses in Kita village.*

Fig. 5 – *Photo of community Kaya cutting event.*

Mechanisms: Near disappearance of local kaya culture within the village. Only held by professional thatchers.

Transformative Actions: Establishment of local activities, knowledge-sharing and revival of traditions including all members of the community with 2-fold: community engagement in thatch maintenance and integration of kaya revival activities into professional training programs.

Outcome: Thatch culture in Miyama experiences a local revival, but sustainability depends on succession planning and community engagement (Figs. 5 & 6). This led to a transformative process where thatching knowledge was reintegrated into training programs and local identity, ensuring its sustainability within the village.

Challenges: Risk of dependency on a single company. Need for structural support to ensure longevity. Additionally, the feasibility of the community managing a scaled-up thatch field revival is uncertain. This may require professional involvement to sustain operations, posing the risk of diminishing community participation and potentially leading to the loss of collective engagement in the long term. This case at local level is a clear Bottom-up, Individual to community-driven transformation.

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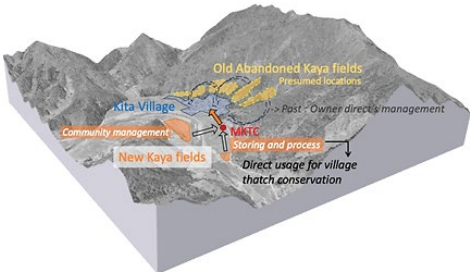

Fig. 6 – *Mapping of Past & Present Kaya fields and their managements systems.*

4.2. National scale: JTCA as a structural driver

The Japanese Thatching Culture Association (JTCA), established in 2010, promotes the preservation and advancement of thatching culture in Japan (Figs.7 & 8). It was certified as a preservation organization for thatched harvesting (2018)[1], UNESCO Intangible Cultural Heritage (2019)[2], and the nationally selected preservation technique of thatched roofing (2024)[3]. As a key stakeholder in the craft's revival, the JTCA organizes workshops for knowledge exchange among thatchers, academics, and the public (Fig. 8). The strong network of professionals enables work beyond regional boundaries, facilitating exchanges across the 10 technical zones of thatch, which were previously confined to their respective regions, and fostering cross-collaboration and learning opportunities (Fig. 9). The JTCA also engages in international collaborations as a member of the International Thatching Society (ITS), contributing to global craft preservation.

Mechanisms: Disappearance of master thatcher craftsmen and fragmented knowledge networks. Lack of structured education in thatch craft.

Transformative Actions: JTCA facilitates co-led training for young members of affiliated companies, engages in national policy discussions, and secures funding opportunities. It has also created partnerships with universities and other educational institutions to establish new knowledge-sharing models. Additionally, it has expanded digital outreach to raise awareness, recruit younger craftsmen, and engage the public through workshops and educational initiatives. The last notable transformative actions is the reconnection of kaya cutters and thatchers, ensuring craft continuity.

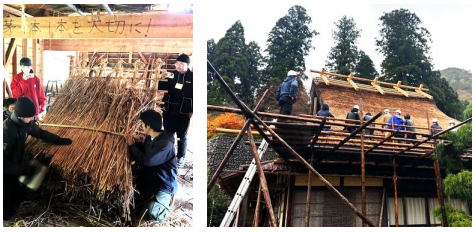

Fig. 7 – *Public workshop event & skills demonstrations.*

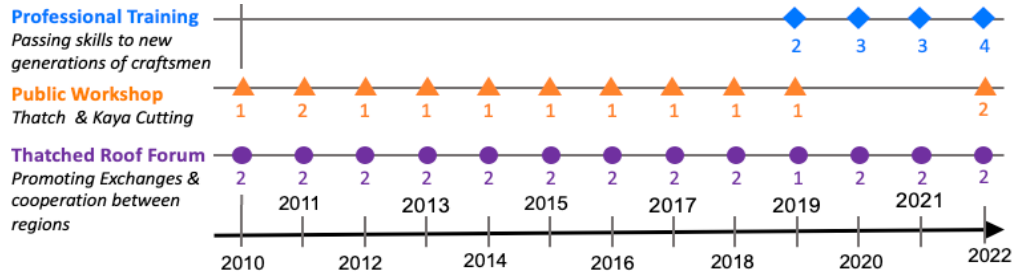

Fig. 8 – *Timeline of JTCA educational events.*

[1] Available at: https://www.bunka.go.jp/koho_hodo_oshirase/hodohappyo/94083202.html

[2] Available at: https://www.bunka.go.jp/koho_hodo_oshirase/hodohappyo/icsFiles/afieldfile/2018/07/19/a1407334011.pdf

[3] Available at: https://ich.unesco.org/en/RL/traditional-skills-techniques-and-knowledge-for-the-conservation-and-transmission-of-wooden-architecture-in-japan-01618

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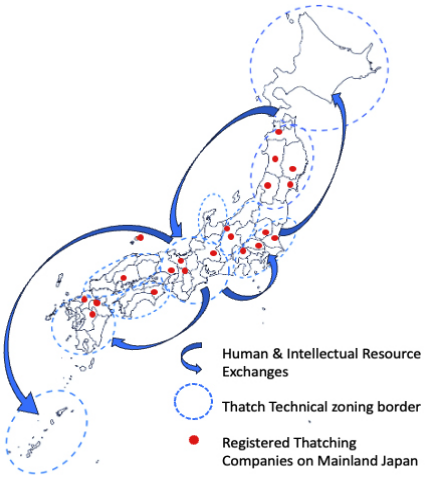

Fig. 9 – *Map of Human resources exchanges between the 10 technical thatch zones.*

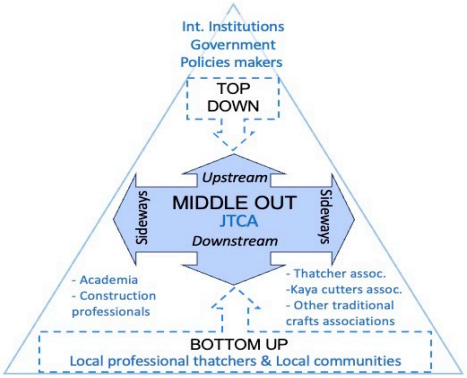

Fig. 10 – *Middle-Out Approach: Interactions with Key Stakeholders.*

Outcome: National recognition and funding. Direct involvement in conservation policies, as well as the training and certification of future professional thatchers**.** Re-establishment of links between kaya cutters and thatchers**,** ensuring a more cohesive and sustainable craft network**.**

Challenges: Institutional constraints and slow bureaucratic processes. Balancing preservation with modernization. This case is particularly interesting as the JTCA plays a crucial role in the revival of thatching culture, acting as a middle-out actor (Janda & Parag, 2013) by facilitating the structuring and integration of traditional craft into policy frameworks. Through its position between grassroots practitioners and policymakers, the JTCA bridges bottom-up initiatives with top-down governance, ensuring both cultural preservation & institutional recognition (Fig. 10).

5. Comparative analysis

5.1. Local vs. National Approaches

This comparative analysis is summarised in Table.1 and Fig.11. They illustrate the revival of thatch culture in Japan as a multi-scalar transformative process**,** driven by both individual agency and institutional structures. This process unfolds through distinct but interconnected mechanisms at the local, regional, and national levels**,** forming a framework for sustainable cultural transmission**.**

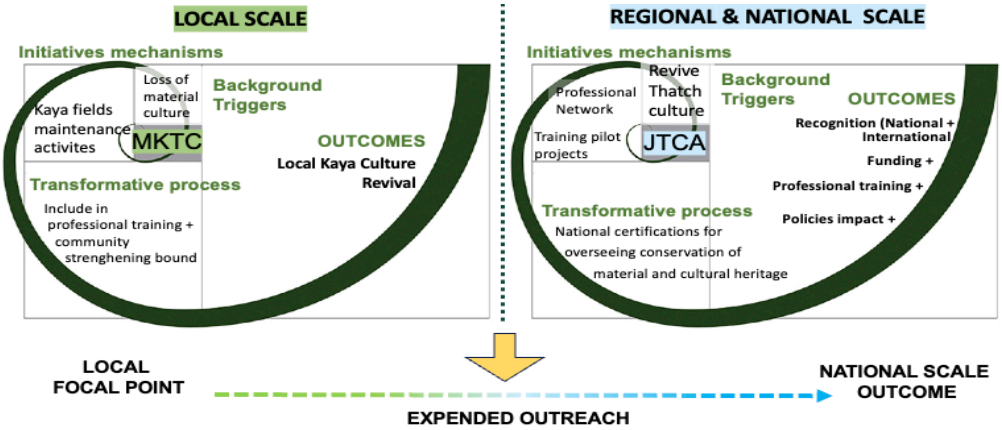

Fig. 11 – *Scalability of thatch heritage revival in Japan at Local and National scales.*

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5.2. Balancing conservation and evolution in thatch craft

A key aspect of this study is the Double-Edged Sword of Evolution in Craft Heritage—a framework that explores the tension between preserving tradition and enabling necessary adaptation. While some aspects of thatch craftsmanship must remain unchanged to retain their cultural and ecological significance, others must adapt to modern economic, environmental, and social realities. This balance is crucial, as over-specialization can lead to vulnerability in cultural knowledge, making it susceptible to loss during demographic or environmental changes.

The research insights are summarized in Table 2.

Table 1 – *Comparative Analysis of Local and National Approaches to Thatch Heritage Revival* (Authors, 2024).

Strengths	Weaknesses	Key Role	Interconnection
Local Miyama Kayabuki thatching company			
– Strong cultural continuity. – Deep community engagement. – Immediate adaptation to local needs.	– Fragile sustainability due to reliance on individuals. – Risk of knowledge loss if key actors disappear.	– Grassroots leadership drives heritage revival. – Social capital bridges community efforts to larger networks.	– Local initiatives feed into larger institutional networks. **Bottom up impact**
Regional and National JTCA			
– Structural support for longevity. – National recognition and funding. – Policy integration and professionalization. – Craft sectors unification	– Slow adaptation to local needs. – Bureaucratic and institutional constraints.	– Institutional backing ensures long-term impact. – Middle-out approach (e.g., JTCA) links grassroots to national policies.	– National programs empower local actors with training and funding. – Connections to other middle level stakeholders **Middle out impact**

Table 2 – *Key Considerations for Thatch Heritage Conservation and Evolution* (Authors, 2024).

	Aspect	Details
Should be Conserved	**Traditional** Thatch **Materials** and **Ecological Practices**	– Maintain and revive the use of local kaya grass and other regionally appropriate materials. – Ensure environmental and structural integrity.
	Regional Variations in **Techniques**	– Protect the diversity of Japan's thatch technical traditions. – Avoid homogenization into a single standard, which can lead to structural damage and inappropriate conservation efforts.
	Strengthening **Professional Networks** and Multi-Level Support	– Establish strong professional networks among craftsmen, associations, and institutions. – Prevent reliance on a single expert and the risk of knowledge loss. Expand associative structures (JTCA, local cooperatives) to integrate local government support for training, funding, and policy backing. – Encourage municipal involvement in heritage conservation.
Should be Evolved	Expanding **Digital** Platforms for **Outreach** and National + International Engagement	– Leverage social media, online workshops, and digital archives for public education and youth engagement. – Use digital networking tools to foster connections and bridge social capital. – Strengthen virtual spaces to build a global professional ecosystem.
	Learning from **Global Thatching Practices** for Selective Technical and Structural Adaptation	– Exchange lessons from Europe, Africa, Asia, and Oceania to inform conservation strategies. (e.g, Further developement of ITS potentials) – Explore selective technological advancements (e.g., modern tools & hybrid reinforcement) to improve durability while maintaining authenticity. – Adopt scalable maintenance strategies from successful conservation models.

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6. Conclusions and recommendation

The Analytical Framework for Craft Adaptation (Fig. 2) illustrates how traditional crafts evolve through both bottom-up and middle-out processes. The evolution starts with local focal points and expands through networking, policy integration, and technological dissemination. This research highlights that craft evolution is dynamic, shaped by key success factors and background triggers, ensuring long-term viability through associative networks, digital platforms, and knowledge-sharing at both national and international levels.

The transformative process demonstrates how local revival efforts successfully integrate into national frameworks. In Miyama, a single craftsman-led initiative attracted wider engagement, leading to structured apprenticeship programs, municipal involvement, and national policy integration. This case illustrates the scalability of craft heritage**,** where a local focal point (MKTC) initiates revival, knowledge dissemination occurs through networking and structured professional development**,** and the JTCA formalizes efforts, ensuring outreach and policy reinforcement**.** To secure the long-term sustainability of Japanese thatch culture, key recommendations include:

- Enhancing multi-scale collaboration to bridge individual efforts with national policies.
- Fostering local government-backed incentives for financial and structural support.
- Developing structured succession strategies through formalized apprenticeship programs.
- Leveraging technology for knowledge transfer and public engagement.
- Expanding international exchanges to foster cross-cultural learning and innovation.
- Strengthening global networks for vernacular craft collaboration and adaptation.

Social capital remains central to both continuity and adaptation in Japanese thatch vernacular architecture, ensuring that craft knowledge is preserved while evolving to meet contemporary challenges. Implementing these recommendations can help balance technical authenticity with institutional evolution, securing the future of Japan's thatching heritage and providing a globally adaptable framework.

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Rethinking Local Heritage Through Networked Perspectives: Mylos Project on Imbros (Gökçeada), Turkey

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Abstract

Imbros (today Gökçeada), once home to a significant Greek population, underwent profound changes after being ceded to Turkey following the First World War. The nationalist policies of the 1960s triggered a large-scale departure of the Greek community, leaving many ancestral homes neglected for decades. In 1991, these old Greek villages were designated as protected areas, accompanied by specific renovation regulations. Since the 1990s, members of the Imbrian diaspora have gradually returned to restore their homes. However, they have faced numerous challenges, including ownership disputes, a lack of skilled artisans trained in traditional construction techniques, and a limited availability of locally sourced materials. Since the 2000s, modern construction materials such as concrete and cement have become common in restoration, authorized by the conservation board. Although these materials meet immediate restoration needs, their long-term effects on structural integrity remain uncertain, raising concerns about future maintenance and the continuity of historical authenticity. This article presents the 'Mylos Project' as an innovative approach to the restoration challenges on Imbros. The project involves the adaptive reuse of a historic stone building that once served as a human- or animal-powered olive oil mill, now repurposed into a restaurant managed by a second-generation Imbrian Greek. By integrating traditional building techniques and collaborating with stonemasons and mortar specialists from the nearby Aeolian coast, the project exemplifies how local heritage preservation can extend beyond geographic confines to include a regional network of expertise. The article uses this case study to explore the concept of the island as a 'unit of connectivity,' challenging the conventional view of geographic isolation and encouraging a broader understanding of heritage adaptation. This analysis underscores the dynamic interplay between tradition and modernity, revealing how local identities are continuously remade through active and processual interactions within historical and contemporary contexts.

Keywords: *adaptive reuse; local heritage; restoration; Imbros; Gökçeada; island as unit of networks*

1. Introduction

Imbros (Gökçeada)[1] has long been an integral part of a well-established network of cultural, social, and material exchange, situated within the archipelago known as the Thracian Sporades (Fig. 1). Due to its geo-strategic position at the Dardanelles, the island has been governed by

[1] The island was originally named Ίμβρος (Imbros or Imvros), which became Imroz under Ottoman rule, before being renamed Gökçeada in 1970. In this research, I use "Imbros" for the island and "Imbrian/(pl.) Imvrii" for its Greek peoples, respecting their self-identification practices.

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various powers throughout history, impacting the way of life of the indigenous population. Archaeological evidence indicates that Imbros has been inhabited since at least 6700 BCE, making it the oldest known Neolithic settlement in the North Aegean (Özbek & Erdoğu, 2014). The island's early settlers were Pelasgians, worshipped the Cabeiri or Cabiri, suggesting a long-standing tradition of religious and cultural practices (Strabo, 2014/translated by Roller). Imbros became an Athenian cleruchy in 480 BCE, marking a significant phase in its integration into the Hellenic world. Between 215 and 168 BCE, the island came under Roman and later Byzantine rule, during which Orthodox Christianity was established, shaping its religious and cultural identity. Following periods of instability, including Slavic raids and Latin rule, Imbros was granted to the Genoese Gattilusio family before being incorporated into the Ottoman Empire in 1470. The island experienced relative stability under Ottoman rule until the Balkan Wars of 1912, later serving as a strategic Allied base during the Gallipoli Campaign in World War I (Münüsoğlu, 2017).

Fig. 1 – *Geographical location of Thrachian Sporades: Thasos, Samothrace, Imbros (Gökçeada), Tenedos (Bozcaada), Lemnos, Agios Efstratious* (Özbek, 2014).

In the aftermath of World War I, the 1923 Treaty of Lausanne granted the Aegean islands of Imbros and Tenedos to Turkey, alongside provisions for the protection of minority rights. However, these protections were progressively undermined by Turkish nation-building policies, leading to the gradual erosion of the Greek community's rights and presence (Babül, 2006). The 1963 Cyprus Crisis marked a critical turning point in this process, exacerbating geopolitical tensions between Turkey and Greece. In response, the Turkish government implemented a series of discriminatory policies, including the conversion of Greek schools into Turkish institutions, land expropriations, and the establishment of an open prison. These measures, which spanned a decade (1964–1974), were accompanied by escalating violence and intimidation, ultimately resulting in the mass displacement of the island's Greek population (Alexandris, 1980).

By the 1980s, state-led resettlement programs had further transformed the island's demographic landscape, reducing the Greek population to approximately 300, while the Turkish population grew to around 8,000 (Bozbeyoğlu Çavlin & Onan, 2001).

In the early 1990s, the status of the island shifted from a military zone to a tourism destination, with the closure of the open prison in 1992 and the removal of special visa requirements. The island was subsequently declared a first-degree development area, promoting it as a site of tourist attraction. This transformation encouraged the return of the Greek diaspora, particularly for annual *Panaygri* (Assumption of Virgin Mary) celebrations, and facilitated the reclamation of expropriated properties (Tsimouris, 2014). The partial return of the Imbrian diaspora to the island was driven by political changes, economic opportunities, and a strong emotional connection to their homeland, helping to revitalize the socio-cultural life of Imbros today.

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Fig. 2 – *An arial photo of the restaurant, 2021.*

As a heritage initiative, the Mylos Project reflects the Imbrian community's efforts to reclaim and reactivate cultural spaces (Fig. 2). The adaptive reuse of a historic olive oil press into a restaurant bistro represents a meaningful and critical approach to heritage that goes beyond basic conservation. This transformation maintains the continuity of vernacular architecture while embracing a dynamic and relational view of place-making, where heritage is understood as an evolving and lived practice. The project reflects the layered nature of cultural narratives embedded in material culture, highlighting how local heritage is shaped by both immediate and distant geographical and historical connections. In this way, the project becomes an act of cultural reclamation—reviving traditional knowledge and practices and reintegrating them into the island's present-day social, spatial and cultural landscapes.

2. Methodology

This paper presents a case study of a restoration project on the island, selected as a representative example of an alternative approach that prioritizes traditional methods and materials. Unlike many current restoration efforts that compromise vernacular authenticity due to practical or financial constraints, this project stands out for its commitment to preserving local architectural and material heritage. The research is based on ethnographic fieldwork conducted between 2020 and 2022, which generated qualitative data through semi-structured interviews, participatory observation, and architectural documentation, including sketches, photographs, and drawings. Expert interviews and technical aspects of the process were documented through audio recordings and analyzed via transcription. Relevant literature on vernacular architecture—primarily in Greek—was translated and critically examined by the author. These combined sources enabled the identification of traditional building techniques and informed an understanding of how local architecture can be meaningfully reinterpreted in contemporary practice.

3. Rethinking Islands: Units of Networks

In contemporary geography, the term *island* is commonly defined as "a piece of land entirely surrounded by water," which emphasizes spatial encapsulation and perceives islands as distinct, bounded geographical entities (Oxford, n.d.). Olwig (2019) critiques this perception, linking it to the Euclidean space of Ptolemaic maps, which emphasize sharply delineated boundaries and foster clear territorial divisions. He contrasts this with the experience of navigating interconnected archipelagic spaces, or *choroi*, where islands, particularly in Greece, are seen as integral components of a broader, dynamic network of cultural landscapes.

From an archipelagic perspective, islands are conceptualized as "units of connectivity" (Horden & Purcell, 2015). To enhance our understanding of an island as a unit for connections and interactions, it is crucial to shift from a distant, bird's-eye view to a more grounded, eye-level perspective. Sectional drawings serve as an effective tool for this shift, as they visually represent the island's complex relationships with its surrounding features, highlighting the seascape as an enriching element in the interplay between coastlines (Fig. 3).

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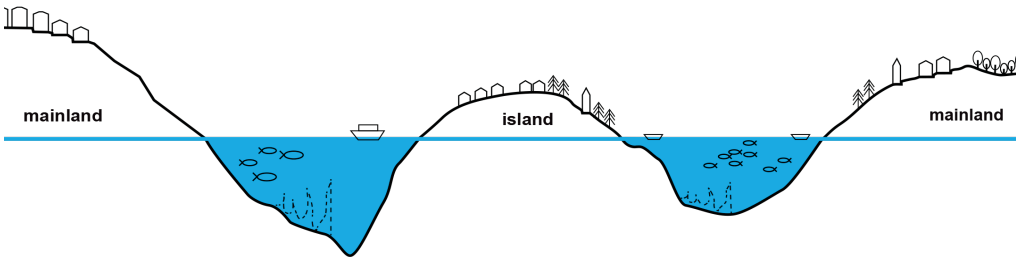

Fig. 3 – *Rethinking Island-Mainland Connection in a Sectional Perspective* (Author, 2022).

Understanding the dynamic relationship between islands and mainlands, as discussed by Broodbank (2000; 2013) and Rainbird (2007), requires the reconstruction of a complex narrative that reflects the evolving, cumulative, and sometimes intermittent interactions between these entities. This relational perspective, as highlighted by Baldacchino (2006), challenges rigid binary distinctions between island and mainland, instead positioning islands as integral parts of wider regional and global networks of interaction. In this context, the concept of the *local* should be understood as a dynamic interplay of material, cultural, and social networks. The Mylos Project embodies this perspective by reinterpreting local resources and traditions, adapting them to contemporary needs while maintaining their relevance within an evolving socio-material landscapes.

4. The Mylos Restoration Project

Located in the northeast of Zeytinli Village ("olive-ville") [Gk: *Agíos Theodorí*], this single-story masonry building occupies a plot of 111.91 m², with a built area of 97.16 m². With a history of over 150 years, it originally served as an oil mill and soap factory until the late 1940s, and was subsequently used as a grocery store until the 1980s. After decades of abandonment, the building experienced significant deterioration; the complete collapse of the wooden roof left the masonry exposed to weathering, leading to the erosion of the mud mortar and the displacement of the wall stones.

Fig. 4 – *In situ inventory* (Alkan, 2020).

Fig. 5 – *Decayed masonry* (Alkan, 2020).

Between 2018 and 2021, the structure underwent comprehensive restoration and was adaptively reused as a restaurant by its second-generation Imbrian owner, S. Berberis. The restoration project aimed to preserve the building's historical character while adapting it to contemporary use, including the addition of a courtyard dining area and a roofed section designated for the kitchen and toilet (Figs. 6 &. 7).

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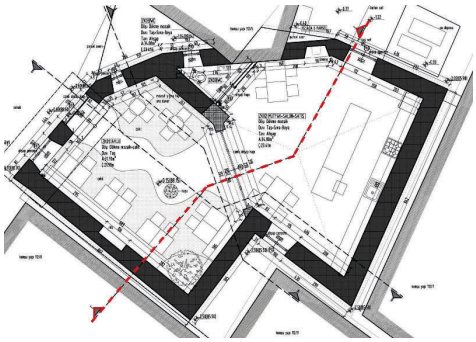

Fig. 6 – *Restoration Plan: Ground floor* (CAD-Drawing by Dafnis Architects, 2019).

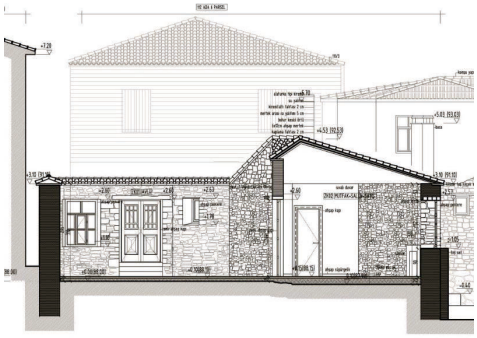

Fig. 7 – *Restoration Plan: C-C Section* (CAD-Drawing by Dafnis Architects, 2019).

The original external masonry was preserved in place, while a new intermediate wall was introduced to support the updated layout. Reusable in-situ materials, such as historic roof tiles and wall-stones from collapsed sections, were collected, conserved and reintegrated into the structure. All wooden components, including the hipped roof extending along three sides, were reconstructed. Windows and doors were kept in their original positions but were realigned and fitted with new wooden lintels, crafted from pine timber sourced from Çanakkale on the mainland.

4.1. Re-Finding the 'Local' in its Networks

While the restoration may appear straightforward and uncomplicated, the process was marked by considerable challenges, particularly in sourcing appropriate materials and skilled craftsmanship. According to the owner, efforts were made to adhere closely to traditional construction methods by engaging both a trusted Istanbulite restorer and a locally experienced architectural firm. Despite this collaborative approach, the procurement of historically accurate materials—essential to maintaining the building's architectural integrity—proved to be a complex and demanding task.

Traditionally, hardened sandstone was widely employed in residential construction on Imbros due to its workability and notable seismic resistance (Kurtuluş et al., 2010). Although stone is still quarried on the island today, its use is largely limited to raw forms such as large slabs or pebbles, as traditional masonry techniques have largely disappeared following the departure of the island's Greek population. In contrast, this architectural tradition has endured along the northern Aegean coast of Anatolia. In towns such as Ayvalık and Cunda—historically home to Greek communities—stone masonry remains a living practice, supported by both skilled artisans and high-quality local materials.

For the Mylos Project, this continuity on the mainland offered a practical solution to the challenges of sourcing traditional materials. Masonry stones, specifically selected for their quality and compatibility with historical techniques, were imported from the Bergama region (ancient Pergamon), known for its enduring stonemasonry tradition.

To accommodate the functional and hygienic requirements of a restaurant, the original compacted earth floor—common in local houses—had to be replaced. A harder and more durable stone was therefore selected from the Assos region for flooring. This small-cut sandstone in four natural shades was laid over the compacted soil base in an irregular, puzzle-like pattern. The gaps between the stones were filled with fine pebbles and sand, a method that ensured structural stability while maintaining a sense of material authenticity and continuity with local building traditions.

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A key aspect of the restoration involved replicating the original mortar, which historically combined clayed lime mud and finely shredded straw. This traditional mix provided strength and flexibility, essential for the masonry's durability in Imbros' seismically active region. The lime created a strong bond with the sandstone, unlike cement-based mortars, which often fail to adhere properly and can cause long-term damage. By using a lime-based mix that matched the original, the restoration enhanced the building's structural stability and preserved its heritage.

In the Mylos Project restoration, this original mortar mix was closely replicated using a traditional *Horasan*[2] mortar formula, consisting of 1/3 clay-sand, 1/3 lime, and 1/3 pozzolanic material (Böke et al., 2004). The clay, sand, and lime components used in the preparation of the mortar were derived from a commercially available hydraulic lime-based product manufactured at relatively low temperatures. This production method contributes to improved adhesion, vapor permeability, and resistance to moisture, thereby enhancing the long-term durability and compatibility of the mortar with historic masonry substrates (Gür, 2019). As part of this formulation, a hydraulic lime binder was employed in conjunction with finely ground *Küfeki* stone—commonly referred to as Istanbul stone—a fossiliferous limestone characterized by its distinctive whitish-yellow hue, as the pozzolanic material. The walls were repointed using this specially prepared mortar mixture, and the surfaces were intentionally left unplastered in order to emphasize the historic fabric and material character of the structure.

Fig. 8 – *Restored masonry with new mortar mix* (left: by S. Alkan, 2021; right: by the author, 2022).

Fig. 9 – *Restored courtyard* (Berberis, 2021).

Once the structural restoration was completed, focus shifted to the interior, where both in-situ elements and salvaged furniture from local cellars were repurposed and carefully restored to preserve their original character while serving contemporary needs. Architectural features such as the milling stone, the well mouth, and a depiction of the *Kalikantzaros*— hand-painted by the owner's grandfather—were integrated as spolia, enriching the site's narrative. These elements not only maintain a tangible link to the building's past but also connect it to broader

[2] *Horasan* Mortar Mix: A historical mortar made by combining lime with aggregates like brick or tile shards, known for its hydraulic properties due to the pozzolanic effects. It is referred to as '*Cocciopesto*' in Roman times (Massazza and Pezzuoli, 1981), '*Surkhi*' in India (Spence, 1974), and '*Homra*' in Arab countries (Lea, 1940).

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Fig. 10 – *Example of material remains from the past: Left: Wall painting depicting Kalikantzaros; center: interior courtyard, well, and millstone; right: handmade embroidery* (Author, 2022).

regional folklore shared across Turkey, Greece, Bulgaria, and Serbia (Fig. 10).

This effort went beyond physical repair, aiming to sustain cultural continuity through the reuse of personal and communal artifacts. Handwoven textiles made by the owner's grandmother and embroidered dowry pieces from his mother were also integrated into the decoration. These heirlooms transformed the building into a living archive of memory and tradition, reinforcing its connection to local heritage. Through this layering of restored materials and family narratives, the project becomes a dynamic expression of identity and continuity within the island's cultural landscape.

5. Conclusions

The Mylos Project exemplifies a critical and context-sensitive approach to heritage restoration that transcends conventional preservation frameworks. By situating restoration within a broader network of regional expertise, material circulation, and cultural memory, the project challenges reductive notions of locality and isolation often associated with island geographies. Instead, it reimagines Imbros not as a static repository of the past but as an active participant in a dynamic network of historical and contemporary relations. Through the reuse of vernacular materials, the revival of artisanal knowledge, and the integration of personal and communal narratives, the project fosters a living heritage that is both resilient and adaptive. Ultimately, the Mylos Project demonstrates how the restoration of vernacular architecture can serve as a vehicle for cultural continuity, intergenerational transmission, and the rearticulation of identity in post-conflict, diasporic contexts.

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The Farmhouses of the Cuma Archaeological Park in Pozzuoli (Naples, Italy): Between Conservation and New Enhancement Strategies

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Abstract
The dual identity of archaeological and rural landscapes in the Phlegraean area is particularly evident in the Cuma Archaeological Park in Pozzuoli. The farmhouses located in the Cuma site, built upon the archaeological remains of the area, are a significant expression of the rich historical and cultural palimpsest that characterizes the Phlegraean territory. There are a total of six farmhouses within the Park, distributed between the acropolis and the lower city, where ongoing archaeological excavations continue to uncover the remains of one of the oldest Greek-founded cities in the West. These structures represent a less investigated example of rural architecture in the Phlegraean territory, a region long defined by its strong agricultural vocation. Despite the various modifications and alterations these architectural features have undergone over time, their historical and typological characteristics, proper of the vernacular architecture of the Phlegraean Fields, remain recognizable. This contribution aims to define interventions that preserve the agricultural identity of the Cuma territory, for which the farmhouses are evidence, while simultaneously outlining new visions for their utilization. Through historical analysis and a critical review of their current state, the study deepens the constructive and formal characteristics of this rural architectural typology. Based on these insights, the work plans to propose new strategies for the conservation and reuse of the Cuma farmhouses. In line with the current functional needs of the area, the farms could be designed as environments to support the archaeological excavation activity still underway (with related material storage), but also as new points of interest within the visit route of the park, integrating them in an itinerary that enhances the dialogue between rural, archaeological and landscape heritage.

Keywords: *conservation; vernacular architecture; Cuma archaeological park; phlegrean fields*

1. Introduction

The Phlegraean Fields, located to the west of the Bay of Naples, constitute a significant volcanic area with a long history of human settlements. The region was colonised by the Greeks between the 8th and 7th centuries BC with the founding of Cuma and underwent profound transformation under Roman rule from 338 BC. Following a period of decline in the Middle Ages, the area regained a rural vocation due to its fertile soil and proximity to the coast. Farmhouses constructed on Roman ruins frequently incorporated pre-existing elements such as *opus reticulatum* walls, cisterns, or thermal structures, following a process of reuse that ensured material efficiency and architectural continuity (Picone, 2014;

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Caputo, 2016). Consequently, the Phlegraean Fields find themselves in a dual state: as an archaeological landscape, characterised by its ruins, and as a rural territory, shaped by centuries of agricultural tradition.

The dual archaeological and rural identity of the area is clearly expressed in the vernacular architecture of the Cuma Archaeological Park. The majority of this architecture is constructed on archaeological remains, and the rich palimpsest that results is of significant value in terms of the territory and archaeology, as well as traditional building techniques and materials. However, the farmhouses, which have undergone transformation and alteration over time, are now under threat from partial abandonment and a lack of adequate protection.

The aim of this contribution is to undertake a comprehensive analysis of the vernacular architecture exemplified within the Archaeological Park of Cuma. This analysis aims to identify potential criteria for the conservation of the material and immaterial values inherent in these architectural specimens. The approach is to integrate these elements into a trajectory of fruition and valorisation, meticulously designed to be attentive to historical values and contemporary necessities.

2. The farmhouses of Cuma Archeological Park in Pozzuoli

The development of vernacular architecture in the fertile plain of Cuma commenced around the 1600s, following the reoccupation of the lower town after the barbarian invasions and the bradyseismic events that occurred during the Middle Ages. During this period, the vast, recently reclaimed plain at the foot of the Acropolis underwent significant transformation, becoming a fertile agricultural landscape. The ruins of ancient structures that were still emerging at the time provided a solid base on which to construct dwellings for humans and animals, as well as a valuable source of marble and precious objects (Foresta, 2016).

The Forum area excavations were initiated in 1606 under the auspices of Viceroy Alfonso Pimentel, leading to the discovery of a substantial structure, hypothesised to be a temple or basilica, in addition to statues and marble artifacts. Over the course of centuries, this vaulted edifice underwent numerous transformations, evolving from a state of partial ruin to become a landmark of historical fascination during the period of the *Grand Tour*. Ultimately, it functioned as the basis for contemporary rural edifices, thereby sustaining a robust association with the original structure (Fig. 1). Until 1994, the site functioned as a farmhouse, housing farmers, livestock, and agricultural products alongside ancient remnants. The site's historical importance was reinforced by the early 17th-century discovery of a statue torso, attributed to Jupiter and known as the Giant, leading to the name *Masseria del Gigante*.

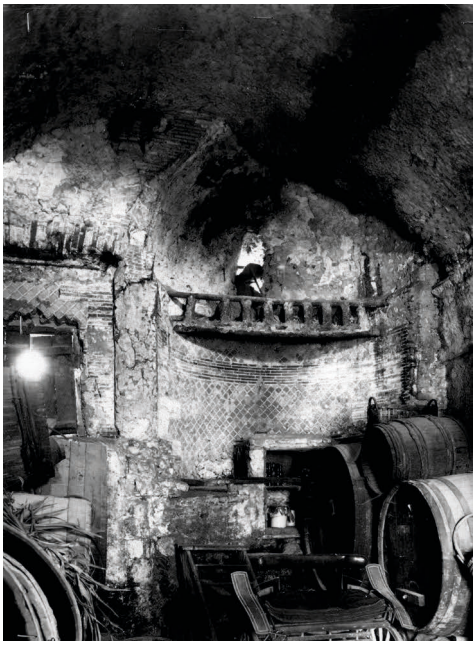

Fig. 1 – *The Temple of the Giant used as an agricultural storage facility* (Photographic Archive of the National Archaeological Museum of Naples).

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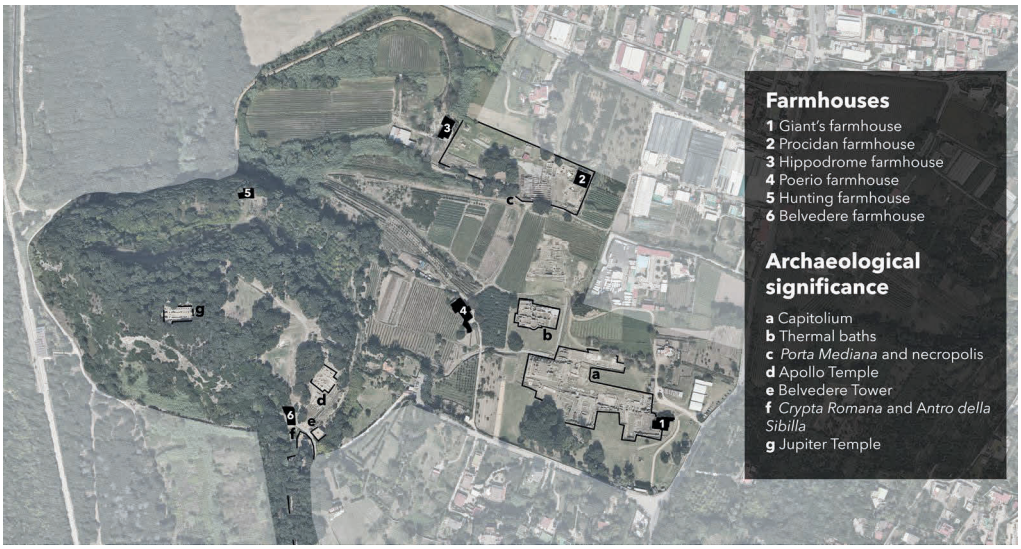

Fig. 2 – *Map delineates the Archaeological Park of Cuma, with the identification of the main archaeological and rural emergencies in the area.*

In addition to the temple, which has been the subject of extensive documentation and is currently undergoing restoration, the Archaeological Park of Cuma contains five other former farmhouses. These were utilised for agricultural purposes until the late 20th century (Fig. 2). Two of these farmhouses are located in the upper town, which historically served as the religious centre of the ancient *pòlis*, while the remaining three are situated in the lower town, the civic hub. To the north of the original civic centre, two farmhouses – Procidan and Hippodrome – were constructed on top of ancient Necropolis structures. The Procidan farmhouse, which was once used by a farmer from Procida, is now in ruins, having lost its original materials. The Hippodrome farmhouse retains its original structure but underwent significant alterations in the late 20th century, including a concrete expansion and an abusive racecourse.The Poerio farmhouse, located in the western lower town near the Cumaean Acropolis, has rooms built using the Roman *opus caementicium* technique and barrel vaults. It underwent concrete modifications in the 20th century and is currently utilised as a support facility for archaeological excavations. On the Cumaean Acropolis, two further abandoned rural buildings are present: the Hunting farmhouse and Belvedere farmhouse. The Hunting farmhouse is likely to have been used for hunting activities, and it is the only one preserving the typical features of Phlegraean vernacular architecture, including double extrados vaults and an external staircase.

3. The Belvedere farmhouse on the Cuma Acropolis

The farmhouse of Cuma Mountain, also referred to as the Belvedere farmhouse, is located on the Cumaean Acropolis, in close proximity to the renowned Temple of Apollo, adjacent to the *Crypta Romana* and the *Antro della Sibilla*. It is situated beneath the Belvedere terrace, offering a panoramic view of the Cumaean countryside and the sea (Fig. 3). this architecture is completely different from the other vernacular examples located in the Park, because is not articulated in architectural volumes with specific formal characteristics, but derives from the adaptation of ancient Roman cisterns, obtained by subtracting the tuffaceous bank of the mountain promontory.

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Fig. 3 – *Photographic documentation of the Belvedere farmhouse*, *November 2021.*

The specific location of the Belvedere farmhouse, in conjunction with the historical and evolutionary trajectory that it represents, make it an iconic example of the coexistence of the two poles of the phlegrean landscape, namely archaeological and agricultural. Consequently, it has been selected as a paradigmatic case for study.

3.1. From Roman cistern to farmhouse

During the Roman occupation, despite natural protection that Cuma Mountain offered by the presence of the sea, it was decided to implement a defence system through the construction of a fortifications made in trachyte blocks, with a single access gate on *Monte di Cuma*, delimited by two towers, namely the Byzantine tower that is still preserved and the corresponding one that collapsed during the Greek-Gothic war (Caputo et al., 1996). In this location, in front of the collapsed tower, a large cistern connected to the defensive system was excavated, divided in late antique or early medieval times into three large tanks, which can still be recognised today by their layout (Fig. 4). The precise date of the transformation of the Roman cistern into an agricultural structure remains uncertain; however, recent archival research has enabled to attribute most of the occupation of the property to the D'Isanto-Grande family, who resided in the rooms on Monte di Cuma from 1890 until the end of the 20th century.

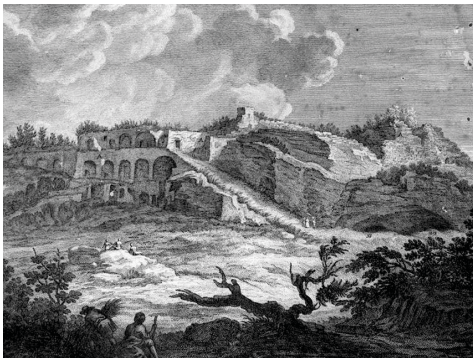

Fig. 4 – *Historical print from 1766 by Filippo Morghen depicting the Cumaean landscape and the Roman cistern system. In the background the remains of the Byzantine Tower and on the right the caves of the Crypta Romana* (ICCD 00440045).

Prior to the 1912 excavations, which unearthed Temple of Apollo, the family resided in a cave near the Temple. During the excavations they relocated to the rooms of the original cistern, whose organisation across two levels and the presence of four rooms built into the ancient masonry have been established. It is evident that the colonists' needs, which were closely linked to agricultural activity, profoundly transformed the layout of the spaces in question. The survey carried out in 2021 (Fig. 5) shows that some rooms of the cistern (areas 1, 2 and 3), which were probably used as storage rooms or cellars, remained unchanged, as evidenced by the still recognisable *opus reticulatum*. Conversely, two additional rooms (areas 4, 5) underwent a transformation towards residential use, evidenced by the construction of intermediate floors composed of girders and hollow core slabs, along with internal vertical connection elements. Beyond the internal construction of a service volume in yellow tuff, reinforced concrete roof, and a connecting ramp that facilitated direct access to the second level. The furnishings unearthed during the survey reveal a dislocation of the service rooms on the alterations, external modifications included the ground floor and the bedrooms on the upper floor, where the barrel vaults in *opus reticulatum* are still visible (Fig. 6).

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Fig. 5 – *Plan of the ground floor of the Belvedere farmhouse, as delineated in the Executive Project survey of Cuma : "A new use of the Archaeological Park restoration and enhancement works*" (2021), graphically reworked by the authors.

3.2. Archaeological landscape and rural landscape: functional conflicts

The historical-evolutionary events that have affected the farmhouse highlight the difficult coexistence between the archaeological vocation of the area and its agricultural-residential function, especially during the 20th century, when housing standards changed, and the first systematic excavation campaigns began.

Even though the Cumaean landscape is particularly suited to agricultural activities, the coexistence of settlers with the «ancient stones»[1] is not so spontaneous. In fact, there is a lack of effective engineering connections In the early decades of the 20th century, the beginning of the excavation campaigns promoted by A. Maiuri (Maiuri, 1981) and the establishment of the Cuma Archaeological Park[2], coincided with a marked intensification of functional conflicts within the locale. A meticulous archival investigation has unearthed a substantial corpus of correspondence between the settlers and the Superintendency, aimed at a balance of interests that ultimately culminate to the final disposition of the sites at the end of the last century.

The archival research has revealed a series of letters of complaint from the settlers, concerning the storage of excavation material in the countryside, the demolition of ancillary structures used for sheltering animals and agricultural equipment, show how archaeological activities interfered with the normal functioning of the countryside and weakened the cultivated land.

[1] *Interview with Biagio Grande, il Mattino di Napoli 05.05.1993*; National Archaeological Museum of Naples, Documentary Archives, C 17/2 1st fascicle, Cuma-Masseria a Monte di Cuma. Terreni in Concessione sigg.re D'Isanto-Lucci.

[2] Founded in 1927, belonging since 2016 to the Phlegrean Fields Archaeological Park.

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Fig. 6 – *Current photo of the disused interiors showing the masonry stratification and adaptation work*, from the Executive Project survey of Cuma : "A new use of the Archaeological Park restoration and enhancement works" (2021).

However, there is no lack of episodes that illustrate the denunciations made by the protection bodies. On 22.10.1994, during the restoration and consolidation of the Roman crypta adjacent to the farmhouse, the Archaeological Superintendence of the Provinces of Naples and Caserta denounced the improper dumping of waste by the farmhouses on the western side of the monument «for which they constitute an obstacle and whose dignity they offend».[3] Functional incompatibilities also led to management and administrative complications, the most emblematic of which was reported in *Mattino* di Napoli on 5 May 1993. The article recounts the paradoxical dynamic in which the Superintendent of Naples was forced to hand over a copy of the keys to the park - with excavations in progress - in order to allow the settlers regular access to the house via a driveway that was difficult to reach by side roads.

Despite the work carried out in 1967 to secure and restore the structures of the Belvedere farmhouse[4] (Fig. 7), which included the consolidation and restoration of the masonry, the concessionaires were asked to clear the rooms of people and objects over the following decades. In their current state, the cistern rooms are in a state of deep decay and abandonment, the tufa supporting structure is severely affected by forms of degradation caused by the proximity to the coast and exposure to marine aerosols, implying a reduction in the load-bearing capacity of the tuff. The situation is different for the upper volumes and the terrace, which are part of the park's visitor route and are currently used to store material for excavations that are still in progress.

Fig. 7 – *Historical photograph which captures the 1967 restoration and consolidation work on the Belvedere farmhouse* (Photographic Archive of the National Archaeological Museum of Naples).

[3] Letter of complaint from the superintendence. National Archaeological Museum of Naples, Documentary Archives, C 17/2 1st fascicle, Cuma-Masseria a Monte di Cuma. Terreni in Concessione sigg.re D'Isanto-Lucci.

[4] National Archaeological Museum of Naples, Photographic Archive, Phlegrean Fields fund.

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4. Strategies for the conservation and enhancement of the farmhouses of Cuma Archaeological Park

In recent years, various initiatives have been undertaken to improve the Park's internal visitor system, integrating vernacular architecture into the visitor route. In 2019, the project “Cuma. A New Use of the Archaeological Park. Restoration and Refunctioning Works”, planned by the Ministry of Cultural Heritage and Activities and Tourism, aims to improve the accessibility system of the area. In this context, the issue of the restoration and rehabilitation of the farmhouses, which will provide educational and information services for visitors, is of great importance. At the moment, the work, which will start in 2023, only concerns the Gigant’s farmhouse, which is currently undergoing restoration and consolidation.

What is lacking, however, is a programme of pratical and economically viable measures that would enable the park to be used again and to achieve its objectives. In line with the projections of the 2019 programme, it is possible to envisage a specific role for the individual farmsteads, which, suitably integrated into the visitor route, can promote knowledge of the site and its multiple strata. Because of the dual polarity of the area, characterised by an archaeological matrix concentrated mainly on the Acropolis and a rural vocation in the valley floor, the new uses to be arranged within the vernacular architectures could adapt to the bivalent nature of the area, varying according to the location.

The farms located on the Acropolis, such as Belvedere and Hunting furmhouse, could be included in the archaeological itineraries for visitors, thus improving the services offered to them. Finally, those in the lower town, such as the Poerio, Gigant’s and Hippodrome farmhouses, where the rural component is still the predominant character of identity, could host, depending on the season, places to support excavations in the necropolis area or structures to host agricultural functions, for the preservation and sale of products. The functional choices must, however, respect the architectural peculiarities and adapt to the different conservation requirements associated with vernacular structures. In fact, the farmhouses are seriously affected by a state of degradation due to the age of the supporting structures and their exposure to an aggressive marine environment.

In addition to the critical conservation issues common to the entire agricultural heritage of the Park, it is necessary to assess the individual material and construction peculiarities in order to understand the suitability of consolidation and functional adaptation interventions. As the research carried out has shown, the farms in the Park are the historicised result of a process of adaptation or extension of archaeological ruins, which in some cases have been incorporated into vernacular architecture, while in others they have retained their archaeological facies, albeit greatly transformed and modified by their agricultural and residential function, as is the case of the Masseria del Belvedere. The task of restoration is therefore to conserve the double historical evidence inherent in each architectural palimpsest, preserving both the archaeological and the vernacular matrix, while allowing for the possibility of removing or modifying elements that, for reasons of compatibility or lack of cultural and architectural value, could compromise the conservation of the historic structures.

5. Conclusion

The vernacular heritage located within the Archaeological Park of Cuma allows us to reflect on the theme of the coexistence of the agricultural and the archaeological landscape, which has historically been placed in tension by the prospect of protection. Already during the excavation campaigns that began in the 1930s in the Park, a hierarchy of protection was established, so that interest in the archaeological

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evidence took precedence over the preservation of the rural emergencies that dotted the site. It is only recently, with the broadening of the theme of protection and the rediscovery of the environmental and landscape value of the farmhouses, that interest has arisen in the protection of the rural architecture that is widespread in the Phlegraean area (Caputo, 2016, Pane, 1928). It is therefore easy to see how the broadening of perspectives in the field of protection and conservation has made it possible to ensure the coexistence of dense and stratified landscapes, where archaeology and rural life merge, often inextricably guaranteeing each other's survival. It is only through the historical knowledge of the artefacts that it is possible to outline conscious interventions that do not erase or favour historical values over others, thus ensuring the future life of rural dwellings, protecting them from poor restoration and incongruous transformations (Pane, Battaglia, 2015). Finally, an interdisciplinary approach combining archaeology, agronomy and spatial planning is essential to protect this stratified heritage, with the aim of recognising the importance of the rural landscape as a testimony to human history by promoting sustainable practices that respect and enhance this cultural wealth.

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The Rehabilitation of the Morisco-era House at *Calle San Buenaventura 7*, Albaicín (Granada): An Over Fifty-Year-Long Project

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Topic: T1.4. Restoration and conservation of vernacular architecture

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Abstract

An exceptional 16th c. house has been restored after having being abandoned and in ruins for over half a century. The new owners entrusted the School of Arab Studies (CSIC) with the restoration project and technical direction of the works in 2019. The goal was to recover the architectural values of this building as well as its original use as a single-family home. The house was built by using traditional techniques and organized around a rectangular patio with porticos and wooden galleries on all four sides. It served as the Rectory of the parish of El Salvador from the late 19th c. to mid-20th c. Fortunately, drawings produced by M. Gómez-Moreno around 1874, as well as descriptions and other sketches from 1887 had been preserved. This documentation has been essential, since the south wing fully collapsed a few years later. In 1969, a cultural association acquired the building, which by then was practically in ruins, promoting two first partial restoration projects which were financed by the Ministry of Culture in 1970 and 1971. After two decades of abandonment, another phase of restoration was undertaken, which mainly served the purpose of repairing the roofs and consolidating the galleries. The house has great heritage interest due to its carved wood and paneled ceilings. The intervention criteria have been based on those used by L. Torres Balbás in the recovery of the coeval Casa del Chapiz in 1929-1932. Its original values have been maintained, as the patio and its porticos and galleries remain opened. The spatial unity of the main rooms has been preserved as well. Traditional building techniques and materials have been used (load-bearing walls, lime mortar, carved corbels, ceramic floors, etc.), while current amenities (good thermal insulation, underfloor heating and cooling, lift, etc.) have been taken into consideration.

Keywords: *morisco-era house, restoration, rehabilitation, Albaicín, Granada*

1. Introduction

This is a presentation of the finished result of the restoration of a Morisco house, a process which has taken place over the course of 55 years. In 2019, the building was acquired by new owners, whose goal was to rehabilitate it and turn it into their primary residence without losing its historical and architectural values. To achieve this, they commissioned the project to the *Escuela de Estudios Árabes* (CSIC), a task led by the architect A. Orihuela Uzal. These works have been carried out between 2021 and 2024.

The building occupies a 210 m² site located on the corner *of Calle San Buenaventura* and *Plaza de Aliatar*, in the Albaicín neighborhood, an urban setting that became a UNESCO World

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Heritage Site in 1994. It revolves around a slightly skewed rectangular courtyard that covers an area of 40.8 m². It has a U-shaped layout with single-bay wings to the north, east and south, and porticos and galleries on all four sites of the courtyard. The entrance space and staircase are located in the eastern wing, along the façade facing *Calle San Buenaventura*. The main wings, to the north and south were two stories high, while the eastern section had three stories of lesser height resulting from a late 19th c. refurbishment. In the middle of the courtyard, there is a small, 3.5 m² pond. A tower exists in the corner where the two facades meet, which provided views through an *ajimez* (projecting wood structure forming an enclosed balcony) parts of which have been preserved (Fig. 1).

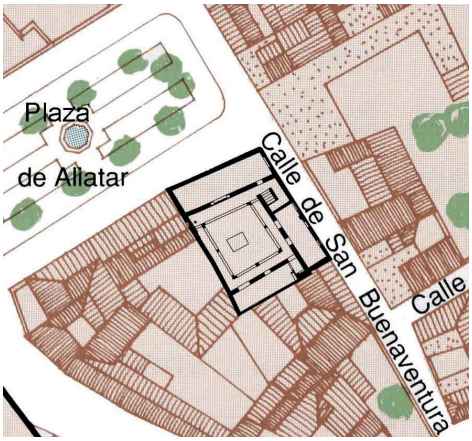

Fig. 1 – *Site plan* (A. Orihuela et al., 2015).

The building, which dates back to the 16th c., is of notable architectural interest. This can be appreciated in its regular layout, the full perimeter of the courtyard's galleries, its large proportions and rich decorative features. On the ground floor, corbels from the Renaissance period can be found, featuring anthropomorphic and zoomorphic engravings. There are also corbels with lobe motifs on this level, elements which can also be found in the galleries. The alfarjes (paneled ceilings) and armaduras (roof frames) in the halls have carved beams and are decorated with paintings. Those in the northern wing are the most outstanding. The building's ties with the Parish of El Salvador, from the end of the 19th c. up until 1969, can be documented thanks to paintings with religious inscriptions on the jambs of the opening that leads to the hall on the upper floor of the northern wing.

2. Historiographic references

The first known reference to the building is the visit that M. Gómez-Moreno González (1834-1918) made to it accompanied by the painter F. Muros Úbeda (1836-1917), before writing his article "Edificios mudéjares de Granada", published in *El Liceo de Granada* (1874). The former's drawings can be found at the Instituto Gómez-Moreno of the Fundación Rodríguez Acosta. These drawings include a sketched perspective of the courtyard taken from its northeastern corner, which provides crucial information regarding the southern wing (which would disappear shortly afterwards), with porticos and galleries homologous to those seen on the northern side, which was entirely preserved. In addition, there are numerous details of the engravings and paintings found on the wood ceilings (Fig. 2).

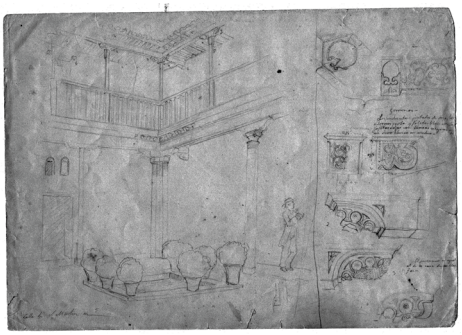

Fig. 2 – *Scketch of the courtyard from de northeast* (M. Gómez-Moreno G., ca. 1874).

In the decade that followed this first reference to the house, which at the time was number 5 of *Calle San Buenaventura*, it was visited by a party of the *Centro Artístico* de Granada. A young M. Gómez-Moreno Martínez (1887, p.41) published the first architectural description of the house in

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the bulletin of the aforementioned institution, considering it "one of the largest and best built of the Albaicín". At the time, Plaza de Aliatar did not exist and on that side the house faced an alley called Postigo del Salvador, which disappeared after the demolition of an entire block of houses in order to create the square. From that visit, a diagram with measurements of the ground-floor plan has been preserved, along with a partial section, drawings of the wooden door belonging to the hall on ground floor and sketches of corbels, together with details of the ceilings, of the plaster lattices and the tilework, all made by different members of the aforementioned visiting party. There is nothing to indicate that either the house or part of it were in ruin at the time.

A few years later, in his *Guía de Granada* (1862, p. 481) M. Gómez-Moreno González, writes about the most interesting Morisco-era houses focusing on the richness of their décor or the peculiarities of their construction. He highlights this house, while also lamenting the almost total disappearance of the plasterwork surrounding its doors. During the last decade of the 19th c., the façade along *Calle San Buenaventura* must have been completely redone in accordance to the ordinances of the time. The reconstruction of this wing with three, rather low stories, which replaced the two originally higher ones, had created problems where they met with the original galleries.

Around twenty blueprints, drawings and watercolors of the house commissioned by the *Comisión Provincial de Monumentos* in 1903 can be found at the Archivo Histórico Provincial de Granada. The upper-level floor plan shows that the galleries had been compartmentalized and closed in, and that the southern end of the western gallery was practically destroyed. A sketch of the courtyard looking towards the south depicts a garden with cane trellises planted on the debris of the demolished southern wing. There are interesting drawings of the latticework that had been preserved in the small western window at the entrance into the ground-floor hall of the northern wing, a piece that was taken to the Archeological Museum of Granada.

The creation of Plaza de Aliatar led to the sealing of the original entrance on *Calle San Buenaventura* and to the opening of a new direct entrance from the square, which in turn led to the division into four spaces of the great hall on the ground floor of the northern wing.

J. Bermúdez Pareja's unpublished PhD thesis *Casas moriscas de Granada y Marruecos* (1956) includes a set of interesting blueprints, probably drawn by Francisco Muros, with the information gathered from the visits he carried out accompanying M. Gómez-Moreno González around 1874. These include the ground floor plan, a longitudinal section, an elevation of the entrance into the hall on the ground floor of the northern wing, etc.

3. Construction analysis

The house's building systems are those found elsewhere in Granada's 16th c. domestic architecture, which in turn are a continuation of the traditional techniques employed during the Nasrid period in the city. Nevertheless, these elements were heavily modified by the reconstruction of the building in the 19th c. and the restoration processes undergone over the course of the second half of the 20th c. The vertical structures are loadbearing walls that are set on rather superficial foundations made of stone and lime mortar. The lower sections of the walls are comprised of a grid of large brick pilasters connected by rows of bricks, the infill between them consisting of a mix of stone and earth, with lime added in small quantities. From there upward the walls are made of rammed earth. Brick pilasters were used to create the openings of the entryways into the halls. The four porticos of the courtyard are sustained by brick pillars. The ones on the corners have an L-shaped section while the central ones on the longer sides are cylindrical, all of which were

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originally rendered. The galleries on the upper floor are sustained by timber posts crowned by engraved corbels.

The horizontal structures include several types of paneled ceilings in the rooms and galleries on the ground floor, as well as on the stairs and alcoves of the hall in the northern wing on the upper floor. In addition, there are roof frames of different types and from different periods in the central hall on the upper story of the northern wing, the staircase landing in the tower and over the tower itself. The stair is built with a succession of brick vaults which were redone during the works carried out in 1970-1971. The roofs are covered with barrel tiles laid directly over the boarding of the roof frames. There is a pitched roof over the hall on the upper floor of the northern wing (Fig. 3).

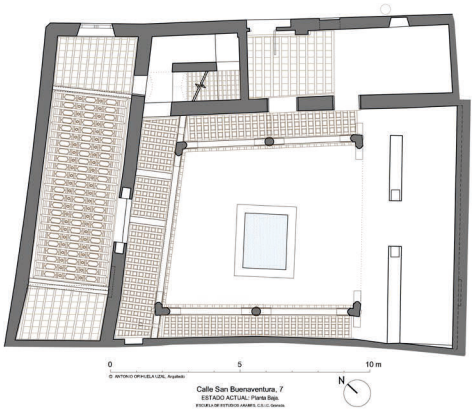

Fig. 3 – *Ground floor plan, with ceiling projection, before restoration* (Orihuela, 2019).

4. Twentieth century restorations

The property was acquired by the cultural association Granada Nuestra in 1969 in order to save the building from ruin and use it as their headquarters. They received financing from the Ministry of Education and Culture for two partial restoration projects carried out in 1970 and 1971 by the architect J. Prieto-Moreno Ramirez (Archivo Central, Ref. C/70943 and C/71121).

With the first project the idea was to avoid the imminent ruin of the house. The roof over the main wing was rebuilt, replacing the original roof that covered both the northern hall and the gallery with two independent roofs. The rammed earth walls were consolidated using brick infill, and the paneled ceilings where reinforced using hidden concrete and steel elements. The pillars on the four corners of the courtyard were disassembled brick to brick and then reassembled reusing the original bricks. The entrance from *Plaza Aliatar* was sealed and the original door to *Calle San Buenaventura* was recovered. The partitions in the galleries were demolished as well as those that compartmentalized the main halls. In the second project, the galleries on the northern on eastern side of the courtyard were consolidated, and the eastern wing was partially rebuilt. However, these works were never finished and the building remained uninhabitable.

Three decades later and with the same goal of making it their headquarters, the *El Legado Andalusí* Foundation, with the support of the World Monuments Fund, financed another project led by the architect C. Sánchez Gómez, with the collaboration of A. Almagro and A. Orihuela (EEA, CSIC). These works were carried out in 1999-2000.

The tight budget was used to renovate all the roofs, including the incorporation of insulation and the placing of waterproof plywood panels to protect the antique timber frames from possible leakage. The roofs over the northern wing and gallery were once again unified, as they had been prior to the works carried out in 1970.

In addition, the western gallery was consolidated, plumbing the central brick pillar without disassembling it. The debris of the southern wing, which had collapsed at the beginning of the 20th c., was removed, leading to the discovery of the base of its stone and brick masonry walls and some initial work on their reconstruction (Fig. 4).

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5. The 2021-2024 Intervention: Criteria, materials and construction techniques

The preliminary design, drawn up in 2020, set out to recover the volumes of the two wings that had disappeared in their entirety, an operation allowed under the ordinances of the *Plan Especial de Protección y Reforma del Albaicín* (PEPRI, 1990) currently in force, in its Article III 37.2. However, the municipality only gave planning permission to proceed in this manner in the southern wing, allowing only the partial reconstruction of the eastern wing.

Fig. 4 – *View of the courtyard towards the southeast, after the works of 1999-2000* (Orihuela, 2019).

The volumetric and functional recuperation of the building was conceived following the criteria used by L. Torres Balbás in the nearby *Casa del Chapiz* during the restoration work he directed in 1929-1932 (Orihuela, 2023). There, in spite of the lack the information regarding their original shape, the volumes and galleries of both courtyards were rebuilt by replicating engraved wood features from existing elements in adjacent galleries. The new timber joists placed in areas where no remains had been preserved did not incorporate any engraved decorations. In our case, thanks to the abundance of graphic documentation produced since 1874, there were no doubts about the models of corbels that had originally existed, and we were able to redo them completely. The risk of falsifying history was non-existent, since the ceilings of the southern wing, of which there was no information, were only schematically rebuilt. The artist and restorer A. Pérez Álvarez was in charge of the engraved woodwork for this project (Fig. 5).

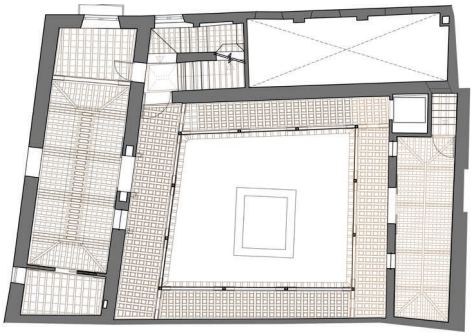

Fig. 5 – *Upper floor plan, with ceiling projection, after restoration* (Orihuela, 2024).

The new walls of the southern wing were raised following the layout of the existing remains, and they were built with a mix of brick and stone masonry on the lower level, and brick bonds on the rest. The aggregate used for the mortar was natural hydraulic lime, of the type i.pro Calix NHL 3.5 by FYM. The main beams of the southern portico and gallery were made of laminated wood, since timber sections of that size are not available on the market. The one on the portico, measuring 20 x 40 x 945 cm was made by joining two 20 x 20 cm sections joined by fiberglass and resin, all in order to enable transport into the house and assembly in situ.

The repair of the beam over the western alcove of the northern hall on the ground floor, which was split, was carried out by specialists from the company Lignum. The first step was to hoist it with two steel struts so it could recover its original curvature. Then, the Beta System was applied by introducing two fiberglass rods and epoxy resin in an indentation on the inner side of the beam. The exceptional original wooden door into the hall on the ground floor of the northern wing was recovered, with its double doors and their corresponding shutters. It had been taken from the house in 1970. Thanks to the detailed drawing of this door made in 1874 and photographs taken circa 1956, its complete

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restoration has been possible and soon it will return to its original position. The flooring that existed in the rooms was a composition of mosaic cement tiles from the Torres y López factory in Granada. Those in the northern wing seemed to be contemporary to the opening of the new entrance onto *Plaza de Aliatar* at the beginning of the 20th c. These tiles were carefully removed in order to be reused; however, because of their deteriorated state, only those that were best preserved were re-laid in one of the rooms on intermediate level 2. In most of the house traditional ceramic tiles from the Castillo Siles factory have been used, except in the bathrooms and kitchens, where porcelain tiles cover the floors.

The courtyard was paved with medium sized cobble stones in gray tones, without a trace of decorative patterns. During the archeological oversight phase, a task carried out by A. Reyes Martínez, not a trace of what could have been the hypothetical original pavement was found, therefore the preexisting cobble stone surface was redone by a specialist in this traditional local technique, Jacinto "el Picante". The edge of the pool was finished with two rows of special ceramic tiles glazed in green, known as *alizares*. With the pieces that had been preserved, two sides of the pond were restored, while for the other two sides new pieces were made by *Cerámicas Viceira*, one of the few traditional workshops remaining.

The natural lighting levels that are required nowadays are much higher than those desired in a medieval *Andalusí* home. In addition, in Western society, the degree of intimacy needed in a family home is moderate. Therefore, the sealing of windows that had been opened over the centuries is difficult to justify for the mere sake of maintaining a certain fidelity to the original architectural type. The main halls in *Andalusí* homes only received natural light through the opening of the door leading into the space, along with the tenuous glow that filtered through the lattice work of the two or three small openings over said door (Fig. 6). There were *tacas* (small niches) on both jambs of the door openings leading into the halls, as well as *alacenas* or cupboards built into the walls. A maximum depth was desired for these, so they were separated from the exterior only by a thin brick partition. After the Morisco population was replaced by new settlers from Castille in Granada in 1570, many of these cupboards became windows onto the courtyard (Orihuela, 2007). Consequently, in the two halls in the rebuilt southern wing, pairs of windows have been designed and built where there would have been hypothetical cupboards. These new windows, however, have a more vertically narrow proportion, which highlights their contemporary nature (Fig. 7).

Fig. 6 – *View of the entrance to the north main room* (Orihuela, 2024).

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Fig. 7 – *View of the courtyard from the north side* (Orihuela, 2024).

The house is heated and cooled by means of a radiant floor, controlled by a Daiking Altherma Bibloc Estándar heat pump. This system also provides hot water. The new windows are made of wood with European standard sections following a simple design; they also include wooden shutters. The doors of the four halls of the northern and southern wings which open directly into the courtyard are all Strugal-made aluminum sliding doors lacquered in gray, with their tracks embedded into the flooring to become invisible when the doors are open. The spaces on the ground floor are insulated from rising humidity by means of a ventilated slab built by using the Caviti system. Accessibility to the upper floor is guaranteed with the inclusion of an Embarba EPV2-90 hydraulic elevator located on the eastern end of the rebuilt southern wing, with 90º openings that allow exiting onto the galleries and intermediate floors of the eastern wing. The finishes of the central columns on the eastern and western sides of the courtyard, the only original renders that had been preserved, have been consolidated by the restorer M. J. Calvín Velasco, who has also carried out the cleaning and consolidation of the paintings on the roof frame over the tower. V. Martín Madrid was the construction manager and I. Arto Torres the structural engineer.

6. Discussion

Up until now, this large house has been considered both in modern historiography (Gómez-Moreno, 1892, p. 481; López, 1987, p. 326-328; Mir, 1996, p. 118) as a Morisco house. In fact, its architectural typology shows a great deal of the characteristic features of Morisco houses in Granada:

- layout organized around a rectangular courtyard and central pool;
- main wings on the shorter sides of the courtyard accommodating halls with alcoves at their ends and *tacas* in the door jambs;
- decorative paintings on its paneled ceilings and roof frames;
- preserved *ajimez* in the tower with its own *tacas,*
- and the construction techniques themselves.

The remains of the *ajimez* are especially valuable, since only two others of its type have been preserved in Granada. The paintings on the paneled ceiling of the ground floor hall in the northern wing are characteristic of the Nasrid tradition, despite the carelessness of their execution. It is almost as if the artisans had forgotten how these details were correctly done.

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7. Conclusions

The house must have been built sometime in the mid-16th c., during the Morisco period, and many of its typological and decorative features are shared with other examples of the time. However, there are other characteristics that are also shared with the Castilian tradition. Therefore, it is reasonable to doubt whether its owner was a Morisco family who had sincerely converted to Christianity or if the family was merely making an effort to appear to have done so. It is improbable that the owner was Castilian, due simply to the fact of the house's location in the midst of the Albaicín neighborhood, a part of town where the Morisco population was concentrated into up until its expulsion.

After 55 years of construction work during which the house has remained closed and uninhabitable, the new owners have managed to restore the building, even recovering its original use, that of a single-family home. This use is more in accordance to this typology than the headquarters of a cultural institution. To achieve this, a great effort was made to recover the building and to change the original objectives. The intervention criteria used fall under the category of what is known as scientific restoration, holding firmly to its fundamental principles but being sufficiently flexible in order to achieve the main goal of the project, which was to turn the house once again into a single-family home. The characteristics of the architectural typology of the *Andalusí* house were fixed in the Lower Middle Ages, and they sought to ensure the intimacy of the family that inhabited the dwelling and its protection from heat radiation and excessive sun exposure.

However, without needing to stick to strict rules, these houses can be adapted to the lifestyle requirements of the 21st c. Western society while maintaining their main architectural values. Among these is the preservation of the courtyard and its open porticos and galleries, as well as the spatial integrity of its main halls. The adaptation to current needs requires a flexible approach to the way in which the interior spaces are connected and to how windows opened during later periods are maintained, including the creation of new openings in accordance to new functions.

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The Transformation of Tradition: Restoring original Estonian Vernacular Architecture in a Situation where Traditional Materials are no Longer Available

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Abstract

The focus of this article is on Estonian vernacular farm architecture and its primary traditional roofing materials. These include thatching materials such as straw and reed, certain wooden materials, and, to some extent, concrete roof tiles. The aim of the study was to map the changes in the use and technologies of traditional roofing materials in Estonian vernacular architecture over the past 150 years and to address the question of to what extent the requirement to use authentic materials—no longer produced or accessible today—is even feasible for heritage buildings and those in museum collections, and what measures should be taken to ensure that knowledge of these traditions is not lost. To achieve this, earlier studies and surveys from the 1930s and 1960s were reviewed, along with handbooks and a database compiled by the museum in recent years containing information on culturally valuable rural architecture still preserved in Estonia. In addition, interviews were conducted with craftsmen who are actively working in this field today. The preservation of cultural heritage and heritage skills cannot be left solely to the efforts of a few homeowners. In today's rapidly changing world, with increasing emphasis on sustainable technologies and reducing carbon footprints, now is the ideal time to rediscover and adopt these traditional techniques.

Keywords: *straw roof; wooden roof; concrete roof tile; traditional material; traditional techniques*

1. Introduction

The focus of this article is on Estonian vernacular farm architecture and its primary traditional roofing materials. These include thatching materials such as straw and reed, certain wooden materials, and, to some extent, concrete roof tiles.

Fired clay roof tiles were primarily used for manor houses, churches, and town buildings, appearing on farmhouses only incidentally or as recycled materials.

Metal roofing also found its place in rural architecture, but only to a limited extent. Unlike thatch and wooden roofs, metal roofs have a significantly longer lifespan, and their restoration does not pose a problem due to the availability of materials.

Yet, by focusing on the first mentioned materials, the aim is to highlight a key issue – the short lifespan of historical roofing materials, their increasing scarcity, and the loss of traditional craftsmanship.

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2. Methodology

The aim of the study was to map the changes in the use and technologies of traditional roofing materials in Estonian vernacular architecture over the past 150 years and to address the question of to what extent the requirement to use authentic materials—no longer produced or accessible today—is even feasible for heritage buildings and those in museum collections, and what measures should be taken to ensure that knowledge of these traditions is not lost. To achieve this, earlier studies and surveys from the 1930s and 1960s were reviewed, along with handbooks and a database compiled by the museum in recent years containing information on culturally valuable rural architecture still preserved in Estonia. In addition, interviews were conducted with craftsmen who are actively working in this field today.

3. Traditional roofing materials of Estonian farm architecture

Between 2021 and 2024, Estonia allocated state-funded grants to preserve the uniqueness of traditional rural architecture and landscapes by restoring farmhouse roofs with original materials. This initiative led to the successful restoration of nearly 100 farmhouse roofs. A key requirement for eligibility was that the building had to be constructed before 1940. When discussing historically preserved farm buildings in Estonia, it is important to note that most surviving structures date back to 1850 or later, with only a few exceptions. Members of the grant allocation committee often encountered questions about the original roofing materials of these buildings and how to ensure that houses – some up to 140 years old – retain as authentic an appearance as possible or at least the look they had after renovations completed before 1940.

Numerous archaeological evidences indicate that split wooden boards were the primary roofing material in present-day Estonia from prehistoric times onward. However, sod, straw, and reed roofs were also used. With the advancement of agriculture and the expansion of winter rye cultivation, rye straw gradually replaced split wooden boards as the dominant roofing material during the medieval period. As traditional smoke huts disappeared, high-pitched barn dwellings[1] with straw-thatched roofs – characteristic of Estonian architecture – became increasingly common. In southern Estonia, however, split wooden boards remained in use to some extent until the mid-19th century (Metslang, 2016, p. 21).

The 1881 Baltic census provides valuable insight into the roofing materials used in Estonian farmhouses. The census gathered statistical data on farm dwellings in the Governorates of Estonia and Livonia (parts of which are now in southern Estonia). It recorded details on wall and roof materials and the presence of chimneys, providing a comprehensive overview of rural construction practices at the time (Viires, 1962, p. 100). Comparing these figures with data from the 1922 and 1934 censuses, and the 1929 agricultural survey, reveals significant changes in construction techniques and material usage over time. In 1881, straw remained the dominant roofing material for rural dwellings in Estonia. In northern Estonia and the islands (the Governorate of Estonia), 86.8% of farmhouses had straw roofs, while 9.8% had wooden roofs. In the Governorate of Livonia (covering parts of present-day southern Estonia), the figures were 72.9% for straw roofs and 19.5% for wooden roofs (Viires, 196, p. 109). It's important to note that the census at the time did not distinguish between straw and reed roofs.

[1] The roof pitch of a traditional Estonian farmhouse ranges from 40 to 45 degrees.

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Straw for roofing was primarily harvested from winter rye, with smaller amounts obtained from winter wheat. In the 19th century, Estonian vernacular included terms like *suured rukkid* (large/great rye), *rootsi rukkid* (Swedish rye), *võsu rukkid* (bushy rye), and *jaanirukis* (St. John's Day rye or Midsummer rye) to differentiate bushy rye from the usual one (Kihno, Jääts, Laane, 2015, pp. 217, 218.). These types of bushy rye were known for their high productivity and yields, though their stalks were shorter and more fragile than modern varieties. A single seed could produce a large cluster, sometimes with 70–80 stems.

Fig. 1 – *Farmhouse with straw-thatched roof from Halliste parish, southern* Estonia (Estonian National Museum, 1925).

From the early 19th century, the Estonian manors began cultivating foreign landraces introduced from aboard, and by the mid-19th century, they had started using formally bred rye varieties. Rye breeding in Estonia began in the late 1860s under Count Fr. G. M. von Berg at Sangaste Manor. In the 1920s, a local variety named 'Sangaste' began to spread and gain popularity.

3.1. Thatched roofs

In the 1881 census, straw and reed were grouped and not differentiated as separate materials. However, by the 1922 census, special attention was given to distinguishing between these materials. At that time, 44.8% of farmhouse roofs were thatched with straw, 2.75% with reed, and 46.7% were covered with wood (Viires, 1962, p. 112).

It was only in the late 19th century that Estonia developed a long-stemmed winter rye variety known as 'Sangaste.'. The aim was to produce larger quantities of high-quality thatching straw and bedding for livestock. Before this, various bushy rye varieties were mainly used, which had significantly shorter, thinner, and more fragile stalks. (https://metk.agri.ee/sangaste)

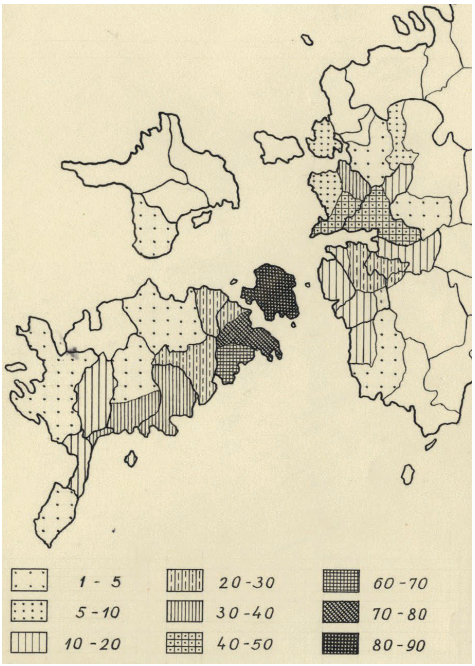

Fig. 2 – *The percentage of reed roofs on rural dwellings in western Estonia in 1922* (Estonian National Museum).

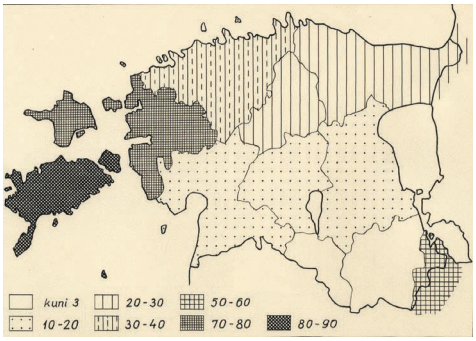

Fig. 3 – *The percentage of rural dwellings with straw and reed roofs in Estonia in 1934* (Estonian National Museum).

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The islands and the Läänemaa region in western Estonia, lacking in abundant forests and lagging behind other parts of Estonia in agricultural development, found reed to be a valuable alternative to straw. Areas such as the Kassari meadows, Matsalu Bay, and the Väike väin (Small Strait) (Saaremaa, 1934, pp. 73, 491, 631, 689, 719), rich in reed, provided an excellent resource for roofing material, offering a sustainable option where straw was less available.

Threshing machines became widely used in Estonia at the turn of the 19th and 20th centuries. During this period, the sickle was gradually replaced by the scythe, and soon after, grain harvesters were introduced. These machines no longer produced the neat, uniform sheaves typical of earlier methods.

As a result, reeds began to be used more frequently for roofing, with construction techniques for reed roofs being quite similar to those for straw roofs. The use of reed for roofing declined significantly during the Soviet era. However, in the past few decades, it has made a notable comeback across Estonia, even in regions where reed has never historically grown. Reed roofs resemble traditional thatched straw roofs, making them hard to distinguish for those without expertise. At times, reed roofs seem to have become a status symbol in Estonia, with new reed-roofed houses popping up like mushrooms after rain.

With regular maintenance and periodic brushing (replacing the ridge), a reed roof could last up to 50 years. Unfortunately, the lifespan of modern reed roofs is considerably shorter.

Fig 4 – *A special splitting bench was used to split* pilbas *shingles by hand with a drawknife* (Estonian National Museum, 1947).

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3.2. Wooden roofs

During the 19th century, split wooden board (*kisklaud*) roofing gradually declined across Estonia, with shingle roofs becoming the most common type. However, board roofs still accounted for 41.4% of roofs in northeastern Estonia, especially on outbuildings (Viires, 1962, p. 112). One of the main factors behind the rapid spread of the new roofing methods was the availability of inexpensive industrially produced roofing nails. Before 1940, the rapid shift from thatch to wood shingle roofs became common in rural dwellings.

At this point, describing four different, yet superficially similar, wooden roofing materials is necessary. In English and German, these materials are generally referred to as "shingle" (Eng.) and "der Schindel" (Ger.). However, in Estonian, four distinct terms are used: *pilbas*, *laast*, *sindel*, and *kimm*.

Pilbas refers to a thin hand-split wooden strip, approximately 43 cm long, 6–7 cm wide (with each strip varying in width), and 3–4 mm thick.

Fig, 6 – *Hand-slit thin pilbas shingles compared to mechanically produced laast shingles* (Lutsepp, 2019).

The primary material is pine, although spruce or aspen could also be used. *Pilbas* shingles were produced in only two regions of Estonia. The process is labor-intensive and requires specific skills. *Laast* refers to a mechanically cut wooden strip. At the end of the 19th century, *laast* shingles were about 53 cm long and up to 13 cm wide, whereas today they typically measure 61–62 cm in length and 10–12 cm in width, with a thickness of 4–6 mm (Metslang, 2016, p. 90). Historically, pine was considered the best material for *laast*, though today spruce and aspen are more commonly used. As *laast* shingles are machine-cut, they are more standardized and easier to produce in larger quantities.

Sindel refers to a thin wooden strip cut from a board, with a groove along the wider edge that gives it a slightly triangular profile. This groove allows the shingles to fit tightly together, but it can also be a disadvantage, as it may prevent the material from drying properly. In the late 19th century, *sindel* shingles were made by hand, primarily by itinerant merchants of Jewish origin. By the turn of the century, mechanical production of *sindel* shingles began.

Historically, *sindel* shingles were typically 56 cm long and 7.5–9 cm wide. Modern *sindel* shingles vary significantly, ranging from 50–70 cm in length and 7–12 cm in width. By the 1930s, *sindel* had become such a common roofing material that it was produced in local sawmills (Metslang, 2016, pp. 95, 96).

Kimm refers to a wedge-shaped wooden shingle sawn from a log or plank, measuring 7–10 cm in width and 50–70 cm in length. Its thickness varies from 14–15 mm at the bottom end to 2–3 mm at the top (Metslang, 2016, p. 102). Although *kimm* has been used in Europe and the Nordic countries for centuries, it was only introduced to Estonian farm architecture in the 20th century (Metslang, 2016, p. 101). Initially used mainly on churches and manor houses, *kimm* is becoming more common on historical farmhouse roofs due to its superior durability compared to the previously mentioned wooden materials.

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3.3. Concrete tile roofs

Concrete tiles are made from sand, cement, water, and color pigments. They became more widespread in the first half of the 20th century, particularly during the 1920s and 1930s when the Republic of Estonia promoted fireproof building materials and supported the domestic cement industry. Roof tiles could be easily molded on construction sites using forms, and with proper maintenance, they were expected to have a long lifespan. For years, hand-operated presses with various profiles were used to manufacture the tiles.

4. The current situation

Corrugated asbestos cement, introduced in the 1960s, was often installed directly over existing

roofing materials. As a result, in many farm buildings, straw, *laast* shingles, and, to a lesser extent, *sindel* or *pilbas* shingles can still be found beneath the asbestos tiles. Overall, it can be said that thanks to asbestos cement, many of our farm buildings have been preserved to this day.

4.1. Is it possible to restore thatched straw roofs?

Today, the winter rye is entirely harvested using combines, making it nearly impossible to find a farmer willing to grow rye for experimental purposes. For a typical traditional farmhouse, such as a barn dwelling with a roof area of about 360 m², it would take the harvest from at least 9 hectares of land to gather enough thatching straw.

As a result, no Estonian Open-Air Museum has been able to restore a thatched straw roof on any of its exhibits.

The most recent straw roof in Estonia was built in 2009, covering the 70 m² roof of the Malvaste Chapel on Hiiumaa Island. The roofer, when asked, complained about the quality of the straw grown in Hiiumaa (variety 'Matador'), noting that the stalks were too short and weak for proper thatching.[2] By autumn 2023, the roof had already begun to deteriorate.

4.2. The present day of wooden roofs

The construction of hand-split *pilbas* shingle roofs ended about 10 years ago with the passing of the last *pilpameister* (master craftsman of making shingles).

However, over the past 15 years, there has been a notable increase in the construction of *laast* and *sindel* shingle roofs. This growth has been supported by various roofing training programs across Estonia, including those organized by the Estonian Open Air Museum's Center of Rural Architecture. As mentioned earlier in this article, the cultural value of wooden roofs has also been emphasized through state funding. *Laast* shingle roofs are the most commonly built, primarily because they are more affordable than *sindel* roofs.

However, it must be admitted that the lifespan of modern wooden roofs is considerably shorter than that of historical ones, mainly due to the decline in wood quality caused by intensive forestry practices. Our climate has become warmer and more humid, affecting the wood's durability. Yet, an even greater issue is that modern homeowners, with their updated lifestyles, are often not accustomed to the idea that wooden roofs require annual maintenance.

The restoration of wooden roofs raises several concerns, including the cost of materials and labor, the challenge of finding skilled workers with traditional craftsmanship, the durability of the materials, and the availability of modern industrially produced alternatives, which are often advertised with lifespans of up to 100 years.

[2] Phone interview with Siim Sooster on 28.11.2023. Notes in the possession of the author.

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4.3. There are no concrete roof tiles

Only a few molds have survived, and it is unclear whether they are still usable. Modern concrete tiles produced by European manufacturers are consistent in quality and relatively affordable for today's builders. However, the problem is that these tiles often replicate the profiles and colors of fired clay roof tiles, which diminishes the authenticity of the material.

4.4. How can we preserve and pass on knowledge of heritage technologies and traditional skills?

It is not enough for a few educational institutions in a small country to teach heritage technologies to a small group of future builders. This knowledge does not reach the broader public, especially homeowners. Following an original example, the Estonian Open-Air Museum (EOAM) has set a goal to reconstruct a thatched roof made of straw to replace the reed roof on at least one exhibit building within the next 10 years. This could serve as a valuable model for other open-air museums as well.

So far, the Estonian Open-Air Museum has organized practical workshops for building traditional wooden roofs. However, the corresponding heritage building tools have been collected randomly, and the existing tools are currently stored away from the public's view. It's not just the collection itself that matters, but also the opportunity to introduce these technologies to museum visitors through this collection.

5. Conclusions

National support measures are essential to preserve traditional skills and materials and promote their wider use, as shown by the number of grant applications during the 2021–2024 call for proposals.

The preservation of cultural heritage and heritage skills cannot be left solely to the efforts of a few homeowners. In today's rapidly changing world, with increasing emphasis on sustainable technologies and reducing carbon footprints, now is the ideal time to rediscover and adopt these traditional techniques.

Fig. 7 – *A roof of original concrete tiles on the Härjapea farm dwelling relocated to the Estonian Open-Air Museum* (Pärdi, 2007).

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Although this article focuses on a small region of Europe, the same issue is likely present in many other European countries and beyond. Preserving the authenticity of vernacular architecture at any cost is neither practical nor reasonable for society. Perhaps we must acknowledge that safeguarding this aspect of our historical memory should remain the responsibility of museums. However, museums require both material and theoretical support to carry out this important work.

An increasing number of architects are incorporating local traditional materials into their designs, creating buildings that reflect a modern architectural language while honoring rural heritage. This approach emphasizes the history and techniques behind these materials and breathes new life into old traditions, resulting in fresh, innovative creations.

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The Vernacular Architecture of the Island of Ibiza (Balearic Islands, Spain): a Brief Overview of the Current State of Research

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Abstract

This article provides a brief overview of the development of traditional architecture, locally available resources and building techniques, and the course of research. It then highlights the challenges and threats to which it has been exposed in recent times from the perspective of heritage preservation: above all, the lack of original materials and the lack of knowledge about their use. In addition, the fact that they have recently been regarded in the context of mass tourism as attractive speculative investments on the real estate market is causing the loss of historic buildings on a huge scale.

Keywords: *agglutinate architecture; landscape adaption; local resources; indiano "colonial" style*

1. Introduction

The vernacular architecture can be defined as a type of construction whose sole purpose is to satisfy the needs and most urgent requirements of its users. Since it usually develops in parallel with the prevailing ideas of the respective historical era and even in parallel with the technical possibilities available, popular architecture uses the same construction methods over long periods of time, which means that everything superfluous is eliminated in a process of perfecting a simple and 'basic' form. In this type of architecture, form and function are therefore determined by various factors, above all by the economic situation of the user. Popular architecture is usually closely linked to the place where it originated. Therefore, the traditional architecture of the island of Ibiza cannot ignore its immediate surroundings, which become a fundamental element of the overall architectural composition (Fig. 1).

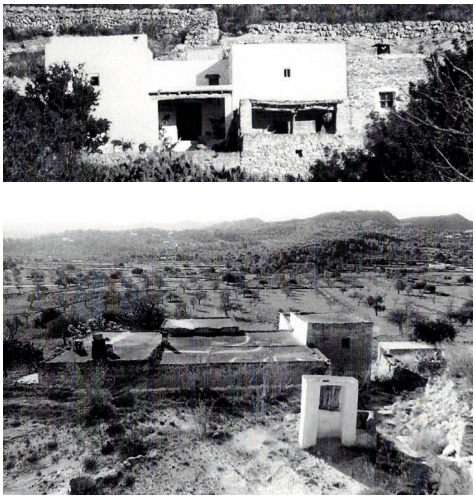

Fig. 1 – *Can Frare Verd. A well-preserved example of an Ibizan farmhouse, skilfully integrated into the landscape. Top: front view (looking north); bottom: rear view (looking south). In the foreground the entrance to the cistern* (Muhle, 2002, pp. 74-75).

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Rural houses or *casaments* are usually scattered throughout the area and well adapted to the morphology of the terrain. They are designed to be self-sufficient, having each one its own land for agriculture, livestock farming and various other productive activities.

Since the surroundings are an important part of rural architecture, residential buildings must be understood together with their outbuildings and elements related to their rural activities. These elements are extremely important, as they ultimately connect the architectural ensemble with its surroundings. In the Ibizan landscape, for example, we find farmhouses (*casaments*) or *païsses,* a type of shed house surrounded by dry stone wall extensions, such as terraces (*marges*), fences (*tancons*, *tanques*) or walled paths (Fig. 2).

Fig. 2 – *Can Pere Mosson. Example of casament with defence tower and fence in front, in this case plastered and whitewashed* (Ferrer, 1998, p. 11).

Within the traditional architecture of Ibiza, two main subgroups can be distinguished: on the one hand, the actual rural architecture, which is undoubtedly the most interesting, and on the other hand, the urban architecture, which includes the buildings constructed in the city of Ibiza and in some rural centres.

Farmhouses are not only of great aesthetic value due to their adaptation to the landscape, but are also historical documents that provide us with information about the way of life of farmers and their development over time. These buildings are constructed without a pre-designed plan, but follow general types, whose common features include the use of typical local materials, adaptation to the climate, human scale, integration and connection with the surroundings, and the use of simple geometric volumes as the basic form.

In his dialectological studies published in 1936 and 1937, the German philologist Walter Spelbrink provided us with the first comprehensive terminological compendium on aspects of traditional architectural typology, materials, construction techniques, different room functions, even furniture and household items, and much more. This research has a worthy predecessor in the work published in Leipzig in 1869 by Archduke Ludwig Salvator of Habsburg, who provided the first illustrations of traditional architecture (Mari, 1992).

2. The *casament* as the architectural form for a family group

The word '*casa*' (Catalan for "house") is not traditionally understood as an architectural form that provides a solution for the needs of a family group, but rather refers to the community that inhabits the building. Each house has a name, which is also given to the '*casament*' (Ibizan dialect for farmhouse, but also marriage), thus becoming a distinguishing feature.

The landscape of Ibiza has always been characterised by scattered rural settlements. Each family, i.e. each *house* and each estate (cat. *finca*), struggled to make a living, with distribution linked to the division of agricultural property. In rare cases, we find them grouped around a fertile valley where they share a common infrastructure, such as the house groups of Balàfia, Atzaró and Morna in the centre of the island (Cortellaro, 2007).

The development of the family group and other events are the main causes of architectural changes to the building (Ferrer, 1998; Sansano, 2016). As demand grows, more rooms ('houses', cat. *cases*) are built, i.e. more cubes are added

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around the existing core to accommodate large families in accordance with local customary law. In addition, at certain times, day labourers or relatives who visited from time to time or helped out on the farm during seasonal peaks could also be accommodated (Sansano, 2016).

The simplest and probably oldest structures consisted of just one central room and one or two extensions (*cases*). The casement, as a combination of rooms (*cases*) with specific functions, developed over time and adapted to the requirements of the day in order to improve living conditions and meet new demands in terms of work and production (Fig. 3). In addition to the new rooms, further elements had to be added to the house as extensions, which were necessary for defence (defensive towers) (Fig. 2) as well as for agriculture and livestock breeding. This group includes: various types of stables *(corrals*), warehouses (*magatzems*), ovens (*forn*), drying rooms (*sequers*), cisterns (*aljubs*), mills and presses with different types of drive (*molí de sang, trull*), threshing floors (*era de batre*), barns (*cases de palla*), water-lifting systems with water basins (*senia, safareig*) and irrigation channels (*sequies*).

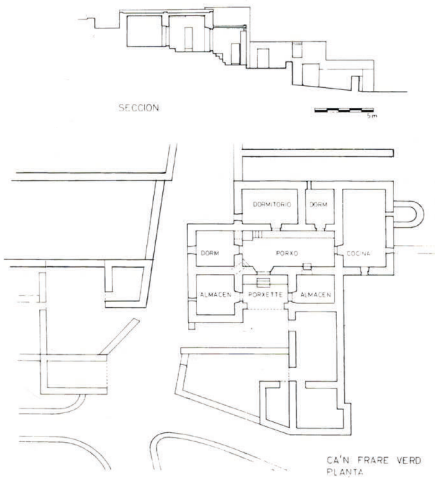

Fig. 3 – Can Frare Verd. Section and ground plan. On the right side attached to the kitchen (cocina) we see the oven (Muhle, 2002, p. 75).

3. The *païssa* as a specific architecture form of the Ibizan landscape

These simple structures were built on plots of land far away (about a two-hour walk) from the owners' main residences. They were very basic, mainly rectangular shapened huts that primarily served as accommodation for shepherds and their flocks. As these places were frequently visited, they could also be used as overnight accommodation or shelter from the rain during the sowing and harvesting seasons. This is a unique phenomenon in the popular and historical culture of Ibiza.

In his historical and cultural study, Josep Marí Ribas (Marí & Roig, 2014) mentions 238 of these structures, which are scattered across the southwestern part of the island of Ibiza and are limited to the coastal and mountainous region of the municipality of Sant Josep – the region that was last settled after the Conquest by the Catalan and Aragonese forces in 1235. However, the constructions examined in this study date from the 18th century to the mid-20th century, which attests to the long continuity in the construction of these buildings.

4. The concept of traditional rural architecture

In general, the construction of a farmhouse begins with the search for a suitable location, choosing a slightly elevated spot within the property that is protected from flooding during heavy rainfall and also facilitates visual control over the land and defence. The selected sites were not always flat; often the houses were built on slopes in the less fertile parts of the property, with the different parts adapted to the varying ground levels (Figs. 1 & 3).

The houses were built by the farmers themselves with the help of their families, friends and neighbours. Each house is adapted to its location, not only to the surroundings but also to the soil, the slope and the light conditions, always taking

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into account the needs of each family. For this reason, all the houses are different, although they always share some common features and characteristics. Despite these physical and human factors, rural farmhouses in Ibiza follow some basic rules:

1. They are always located within the boundaries of the farm and must therefore adapt to local conditions.
2. For defensive reasons, coastal areas were avoided and houses were mainly built on slopes with their backs to the sea so that they could not be seen from there.
3. There are no foundations as the houses were built on rocky slopes to save farmland.
4. The main façade of the house faced south to avoid the cold (and especially the damp) brought by the tramontana wind; due to that, the north façade always has only the number of openings necessary for ventilation.
5. The materials used are those most commonly found in the region, as the houses were built by the farmers themselves: stone for the walls, juniper wood for the beams, clay and seaweed for the roof.
6. The rural Ibizan house is not completed at a specific point in time, but is extended as the family's needs grow and their economic situation improves, with new living and working spaces being added. It is based on a functional architecture based on the concept of agglutination, in which cubes are added according to the functionality and needs of the family.

5. Local resources and constructional techniques

It is well known that traditional architecture uses natural materials from its surroundings, transforming and adapting them over time to meet the requirements of habitability in relation to geographical and climatic factors. This use of local materials results in a distinctive architecture that shapes a unique cultural landscape, whereby the same materials can lead to a variety of technical solutions in different contexts. On an island such as Ibiza, the materials available are perhaps more limited than in other contexts, but this has not led to a lower quality or functionality of the architecture.

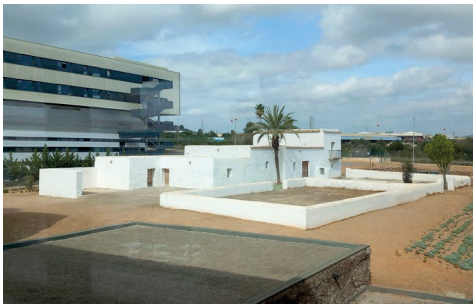

Fig. 4 – *Es Porxet. Restored farmhouse located in the open space between two of the eastern wings of the Gran Hospital Can Misses, Ibiza town* (Author).

In terms of the materials used, rural architecture could be described as economically and ecologically sound, since, from an anthropological perspective, it not only fulfils the basic requirements for the effective and functional use of available resources, but also presupposes sufficient skills to process these resources oneself. They rarely needed the help of a specialised craftsman such as a blacksmith or carpenter, neither an architect. These are simple techniques that did not require a complicated learning process, so that farmers could build, repair or maintain their buildings themselves (Blakstad, 2013).

The following materials are mainly available on the island of Ibiza:

1. Walls: ordinary dry stone masonry with lime mortar. The building material used was unworked quarry stone arranged irregularly or in a herringbone pattern, sandstone blocks (*pedra marés*), calcareous sinter stone (*pedra tur*) or quarry stone, and, in later times, solid concrete blocks. The joints of the masonry

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walls may be grouted or have an irregular, continuous lime mortar plaster coat, which is painted over with lime paint.

2. Openings (lintels): Standard dry stone masonry with sandstone blocks (*pedra marés*), calcareous sinter stone (*pedra tur*) and wood.
3. Flat roof and ceiling: wooden beams (pine, juniper) and panels made of olive wood (*tegell*), reeds or twigs and insulating layers of clay/lime, charcoal and seaweed (Posidonia oceanica). More recently, ceramic vault blocks (*revoltons*) have also been used.
4. Gabled roof and ceiling: wooden beams (mostly pine), Arabic ceramic roof tiles and later French-style roof tiles.

6. Origins and influences

It is evident that the appearance of these *casaments* has also evolved over time. Similar to how the rooms that became necessary could be added, depending on the financial situation, a floor could also be added (*casa de dalt*, upper house), usually to accommodate the parents' bedroom and/or a *sequer*. According to the development outlined in the bibliography, the open entrance hall (*porxo*) on the ground floor as the open spaces on the first floor were closed off over time with columns, lintels or arcades (Fig. 5).

Fig. 5 – *Alqueria de Santa Gertrudis [Can Bet]. The still open porxo is easily recognisable* (Mari, 1992, p. 157).

Many authors who have researched the origins of Ibizan popular architecture believe that it has its roots in the buildings of the prehistoric and protohistoric periods in Asia Minor and was brought here by the Phoenicians, who settled in Ibiza in the 7th century BC. According to Rolph Blakstad (Blackstad, 1989), the Ibizan country house has its origins in the rectangular houses of the Neolithic period in the Middle East, which were also arranged around a rectangular main room (long room) with the entrance door on one long side and two or three rooms attached to the opposite side, a floor plan that was completed by adding further rooms on one or both ends. In other words, a floor plan similar to that of the Ibizan farmhouse, in which the *porxo* corresponds to the long room as the main structural element. According to Erich Muhle (Muhle, 2002), the vernacular architecture of Ibiza belongs to the group of agglutinated architecture, which is characterised as a conglomerate of horizontal and vertical buildings structures without a predetermined orientation. The emergence and growth of agglutinated buildings are disorderly, without a fixed time frame and determined solely by the functional needs and economic possibilities of their users. They are widespread in the Middle East and the Mediterranean region since the Neolithic period.

This idea was challenged by archaeologists Benjamín Costa and Jordi Fernández (Costa & Fernández, 1989), who argue that, despite the sparse archaeological and documentary evidence, there is insufficient evidence to trace the origins of the Ibizan farmhouse back to Oriental roots that were brought to Ibiza. Costa and Fernández base their argument on an analysis of the most characteristic house-types from the Carthaginian period, whose basic element is a courtyard around which the various rooms are arranged, as well as on an examination of the known buildings on the island, whether from the Carthaginian-Roman period, the Islamic period and the beginnings of Catalan-Aragonese settlement after the conquest in 1235. The thesis that a particular type of building

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has survived for more than 25 centuries without significant changes is therefore untenable. This would mean that this model, which is considered the main reflection of the socio-economic organisation of its inhabitants, would not have been significantly influenced neither by Romanisation nor Islamic or the Catalan conquest, an unlikely fact that is fundamentally difficult to explain.

With the inauguration of the Pereira Theatre in 1898, a new architectural ornamental style of classical inspiration and colonial origin was introduced to Ibiza. The creators of this architecture were self-taught builders or construction managers who returned from overseas colonies in the Caribbean (especially Cuba), South America (especially Argentina) and the United States of America and put the knowledge they had acquired during their stay abroad into practice here (Cervera, 2003). Similarly, French-style roof tiles may have been introduced as a new building material by emigrants returning from Algiers at that time.

The influence of this architectural style, also known as Indiano, lasted until the 1940s and introduced, albeit selectively, a series of classic, even Art Nouveau-inspired stylistic elements into rural architecture mainly for accentuating the main façade (cf. Fig. 5; Elements such as the wrought iron balcony railing or the row of tiles on the roof ridge); although this influence is most evident in urban architecture showing balustrades, relief decoration or colourful façade design. At the same time, starting in the 1930s with the growing interest in tourism on the island, these elements were also transferred to a new type of building, namely second or holiday homes located outside the city along the main roads both in the new suburban areas of Santa Eulalia and Ibiza Town, each of them with different characteristics.

The traditional architecture of Ibiza attracted the interest of artists, architects and painters from the very beginning of tourism. The notebooks named Kleine Notizkalender of the artist Raoul Hausmann were particularly noteworthy (Pizza, 2022). The local architecture was particularly appreciated by the members of the Grupo de Arquitectos y Técnicos Catalanes / Españoles para el Progreso de la Arquitectura Contemporánea (GATCPAC / GATEPAC, founded in 1929 and 1930), who emphasised the balance between traditional architectural forms and the figurative and spatial aspects of their appearance. In its functionality and aesthetic design, they found confirmation of the criteria they advocated in the modern architectural movement: adaptation to the environment, human scale, order and clarity, to name but a few. The personal 'Mediterranean' style of architects such as Josep Lluís Sert, Josep Torres Clavé (and later also his son Raimon Torres) and Erwin Broner (Broner, 1936) are good and well-known examples of this architectural style, which is strongly – but not exclusively – influenced by the local architecture of Ibiza. Thus, even after 1950, a strong regionalist tendency can be observed in local architecture, without neglecting the parallel lines of historicism and rationalism. From the 1960s onwards, radical changes can be observed, partly due to the introduction of new building materials such as Portland cement and reinforced concrete.

7. The protection and preservation of Ibiza's traditional architecture

Traditional architecture in general is at serious risk of decay once the social circumstances that gave these buildings their functionality no longer exist. On the one hand, this means that a wealth of information is lost that would provide us with many new insights into the history and settlement of, in this case, the island of Ibiza. On the other hand, this change in the use and appearance of farmhouses is also a clear loss for the historical and ecological heritage, as they are important landmarks of the island and silent witnesses to a way of life from another era, which is increasingly threatened by a serious tendency to view these buildings, after substantial modernisation, as mere objects of economic speculation on the real estate market.

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Three factors have contributed most to the fact that rural farmhouses are not yet being fully recognised as part of cultural heritage: their status as private property, the delay in developing a suitable methodology for their scientific study, and the slow and inadequate measures taken to protect them. Although a methodology developed for the conservation of architectural heritage has now been widely adopted (Ferrer, 2011 – Vegas & Mileto, 2018), it is inadequately applied to the countless renovations of farmhouses carried out each year on the island, which destroy and erase the historical character of these buildings; some of them can be reliably dated to the 16th century, but are probably even older (Ferrer, 2003).

In recent decades, efforts have been made to understand, catalogue, explain, protect and rehabilitate this cultural heritage. Specific studies (Ferrer, 1998), PhD theses (Verdera, 1973; Cachón, 2013; Manzano, 2019) and other publications on this topic (Blakstad, 1989, 2013; Davies, 1998; Ferdinant & Rotthier 2013; Ferrer 2013; Rotthier, 1990, 1997) have been presented. The lists and catalogues compiled by the Archivo de Cultura Popular (ACP) and commissioned by the former Island Council of Ibiza and Formentera, among others, had a clear patrimonial purpose, as they were conceived from the beginning as a working tool and not as a mere recompilation of information. Unfortunately, however, this extensive document has not yet been legally implemented (Ferrer, 1998) and only a very small number mainly of *casement*-ensembles have been listed as historical monuments according to the Protection Act, the Law 12/1998 on the historical heritage of the Balearic Islands.

In addition to meeting the basic regulatory requirements for preserving this cultural heritage, there are also numerous technical aspects that must be taken into serious consideration. Due to their conditioning factors and components, the elements that make up traditional architecture as a whole exhibit a number of specific pathologies (Cachón, 2013): abrasion, soiling and blackening due to smoke, cracks and fissures, washouts, moisture due to both roof leaks and capillarity, material loss and detachment, etc. In order to preserve and maintain a building that is part of the traditional architectural heritage, these pathologies should be remedied as quickly as possible and never used as an argument to diminish the historical significance and condition of the architectural heritage and to approve therefore the demolition of a ruinous building: cultural heritage is a limited resource – not only as part of the local identity but also as an essential component in terms of tourism.

One of the principles of monument preservation is that the original material of traditional architecture should be preserved as far as possible, both in terms of volume (material relevant to cultural heritage) and in terms of its character, which is mainly expressed in its appearance (surface texture and plaster). During renovation, projects should generally preserve the building's character by restoring and consolidating the original structures and materials used, while keeping their condition and position within the structure (Vegas & Mileto, 2017).

Some of the features of historic buildings inevitably conflict with today's norms and standards: insufficient ceiling heights, low door lintels, inadequate lighting and uneven step heights are just a few examples. However, the greatest danger lies in a lack of sensitivity due to a lack of knowledge and understanding of the building to be renovated, as well as in the loss of knowledge and skills in working with older building materials – skills that have themselves been partly protected as intangible heritage.

8. Conclusions

The farmhouses of Ibiza are undoubtedly an essential part of the island's cultural heritage and must be treated as such, avoiding their complete transformation through measures that show little or no respect for the forms and materials of a long-standing local tradition. The government's efforts mostly focused on public buildings,

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whether owned by the state or the church, and went hand in hand with historical research and attempts to partly implement protocols for preserving architectural heritage. Nevertheless, it is clear that much remains to be done in terms of protecting farmhouses or even traditional architecture as a whole, as a comparison of the various inventories compiled to date shows a striking decline of the original building number.

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Traces of Vernacular Architecture in the Royal Palace of Portici (Naples, Italy) between Knowledge and Restoration

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Topic: T1.4. Restoration and conservation of vernacular architecture

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Abstract

The aim of the paper is to examine Palazzo Caramanico, west wing of the Royal Palace of Portici (Naples), as the living material testimony of the oldest rural farmhouse. Built in the 16th century and conceived as a rural house, it was transformed, during the early 18th century, first into a noble Maison and then into the Royal Palace. Despite changings over time, of ownership and amplification, the Palace still retains the typical constructive design of vernacular architecture from Neapolitan kingdom: low-rise buildings in local yellow tuff, characterized by two levels: the ground floor for services and animals, the first floor for the residence. The Palace, which eventually became the property of the University of Naples, has been deeply intertwined with major historical events since the early 18th century. However, following changes have significantly altered the complex, impacting both its internal and external surfaces. The study, grounded in an interdisciplinary approach, seeks to trace the history of these transformations to better understand the remnants of vernacular architecture over time. It also aims to establish possible strategy and sceneries for the conservation, enhancement, and the storytelling of this complex heritage, which embodies rural, noble, royal, and institutional dimensions.

Keywords: *Royal Palace of Portici; Bourbonic residence; Carlo III of Bourbon; vernacular residence; Miglio d'Oro; cultural heritage; Vesuvius*

1. Introduction

The script examines the transformation of a particular farmhouse into aristocratic residences in the 18th century: Palazzo Caramanico. Originally a rural building, it underwent a transformation into a noble palace in the early 18th century and subsequently became part of the Reggia di Portici in Naples.

The present study focuses on the adaptation of architecture and landscape to the requirements of new aristocratic ownership, thereby creating a sacred and royal space. This research employs a multidisciplinary approach, ranging from iconography to material analysis, combining various methods to achieve the most reliable results.

The study of the palimpsest of Palazzo Caramanico ultimately aims at the preservation and enhancement of the architectural qualities typical of rural architecture that have survived to the present day, through the noble function.

The urban expansion of Naples originally extended beyond the city itself, extending from the Sebeto River to Mount Vesuvius.

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Fig. 1 – *Reggia di Portici.*

2. Vernacular Architecture in Portici: A Historical and Territorial Analysis

This area collectively received the designation "*foris fluben*", although each location retained its distinct name. The territory outside the river was divided into four *casali*, of which one was flat (San Giovanni a Teduccio) and three were sloping (San Giorgio a Cremano, known as Crematum; Portici, known as Castanetum; and Ercolano, known as Ripa). Of these topographical features, the central area, Portici, was distinguished by a rich chestnut forest, hence the name *Castaneta*, and was further distinguished by two additional parts: one deserted—at the foot of Vesuvius—due to the eruptions, and one washed by the sea (Alagi, 1984).

The cities experienced a challenging existence due to the recurrent eruptions of Mount Somma, which resulted in the inundation of the lands with lava and debris. This led to a continuous and increasingly unsystematic evolution of nature as the territory was reclaimed, transforming it into areas characterised by extreme naturalistic features. This transformation is evident in the depictions of the region, as evidenced by the works of Masculo (1633) with its title "Il Vesuvio prima dell'eruzione del 1631" and Didier Barra (1647) with its title "Veduta di Napoli". Within this unspoiled territory, a few scattered farmhouses were built on the foundations of those houses destroyed by magma, and with simple forms, they predominantly expressed their productive function. The ideal location for such endeavours was on the hills, a considerable distance from the sea, for the purpose of cultivating vineyards and orchards.

Fig. 2 – Il *Vesuvio prima dell'eruzione del 1631* (Masculo, 1633).

Fig. 3 – *Vedeuta di Napoli* (Didier Barra, 1643).

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2.1. Development of the territory during the Bourbon era

In 1738, with the international recognition of Charles of Bourbon as the King of the Two Sicilies, the Bourbon dynasty was established. This event marked the onset of significant transformations within the kingdom, including the flourishing of several architectural masterpieces such as the Royal Palace of Caserta, the Royal Palace of Capodimonte, and the Royal Palace of Portici, along with notable engineering works such as the *Miglio d'Oro* (Golden Mile).

The transformation of Portici can be attributed to the personal fascination of Queen Amalia and King Charles with the city, which, at the time, was still in a rural and undeveloped state. The king himself described it as a *locus amoenus*, a pleasant place suitable for the construction of a new royal summer residence that would cater to his various interests. The vast expanses of greenery would satisfy his love of hunting, while the presence of the *Granatello* port would satisfy his passion for fishing. Consequently, the construction of the *Miglio d'Oro*, also known as *Strada Regia delle Calabrie*, was initiated over the ruins of the ancient Roman road that connected Capua to Regium, with the objective of enhancing the connection between the royal palaces of Naples and Portici.

These significant events led to a drastic transformation of the Vesuvius territory, to the point that the Bourbon court, in an effort to be closer to the sovereign, began urbanizing the Vesuvius region, sometimes acquiring existing rural buildings to convert them into villas, and at other times constructing new architectures.

2.2. Identification of 17th-century farmhouse construction archetypes

From the medieval period until the 17th century, rural families residing on the slopes of Mount Vesuvius initiated the construction of farmhouses, which were spaced apart from one another with the intention of securing a substantial portion of land for cultivation and productivity.

The rural dwellings present in the Vesuvius area at the time can be categorised into three distinct types:

- Those arranged around a common courtyard;
- Those arranged in block form;
- Those arranged in a linear arrangement.

The most prevalent type of building was the courtyard house, distinguished by the presence of an internal courtyard, from which common facilities such as the oven, rainwater cistern, stable, and chicken coop were accessible (Casale, 2015).

The archetypal *masseria* is composed of two floors: the living space, situated on the upper one, and ancillary terraneous rooms such as the stable, the warehouse, or the woodshed.

The entrance is often characterized by a cramped, lintel design, featuring a step that functions as a rainwater or wastewater runoff barrier in the absence of adequate sewer systems or levelling. The staircase connecting the floors is almost always external in full masonry. The roof, composed of a wooden structure with a scaffolding system consisting of beams and boards, is covered with tiles.

The ceiling, as previously mentioned, is wooden, and the vaulted ceiling (called "*lamia*") is found only in the ground floor rooms intended for elevation.

Balconies, loggias, terraces, pillars, and other architectural elements are conspicuously absent in traditional rustic architecture. The arch is infrequently employed to support stairs and doorways, and facades are devoid of friezes, with the cornice being scarcely mentioned.

In more developed hamlet houses, the only decorative element is the portal, which is also made of local stone.

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Fig. 4 – *Detail of Capania Felix* (Antonio Bulifon, 1642).

3. The case study of Palazzo Caramanico

3.1. From the origin to the transformation

A thorough analysis of historical maps, including those by Giovanni Antonio Magini (1620) and Antonio Bulifon (1642), reveals that the landscape of Portici was depicted as a small village founded on a hill with minimal development and an extensive natural terrain. This territory, akin to other regions within the vicinity of the Vesuvius mountain, had been dedicated predominantly to agricultural practices. Nonetheless, since Roman times, it had been traversed by the Capua-Regium road, which facilitated the connection of the estates.

Along this route, several rural residences were established; among them, after the eruption of Vesuvius in 1631, there was a farm owned by the farmer Cuto, situated on the hill and characterised by the typical arrangement of Vesuvius farm estates (Jones, 2017). These estates typically comprised a courtyard building developed over two floors with vaulted rooms and dual access, the main one on the Capua-Regium road and the secondary one leading to the agricultural property. Due to its strategic location, this building was acquired in the early 18th century by the noble d'Aquino family. Presently owned by an aristocratic family, the estate underwent a transformation into a modest upper-class palace, yet it retained the qualities and features of the original villa, becoming more sophisticated solely through the period's decorative style. This process has rendered the building the most enchanting of the palaces along the Vesuvius coastline.

Upon arriving in Portici, King Charles selected this location for the construction of a new summer royal palace. A survey was conducted to select the most picturesque location for the new royal residence.

The King acquired the Palazzo Caramanico, widely regarded as the most beautiful in the Vesuvius landscape, along with the adjacent Palazzo Palena, which was also owned by the d'Aquino family. The King began to use the site as a royal residence, while still maintaining the original rural aspects and layout.

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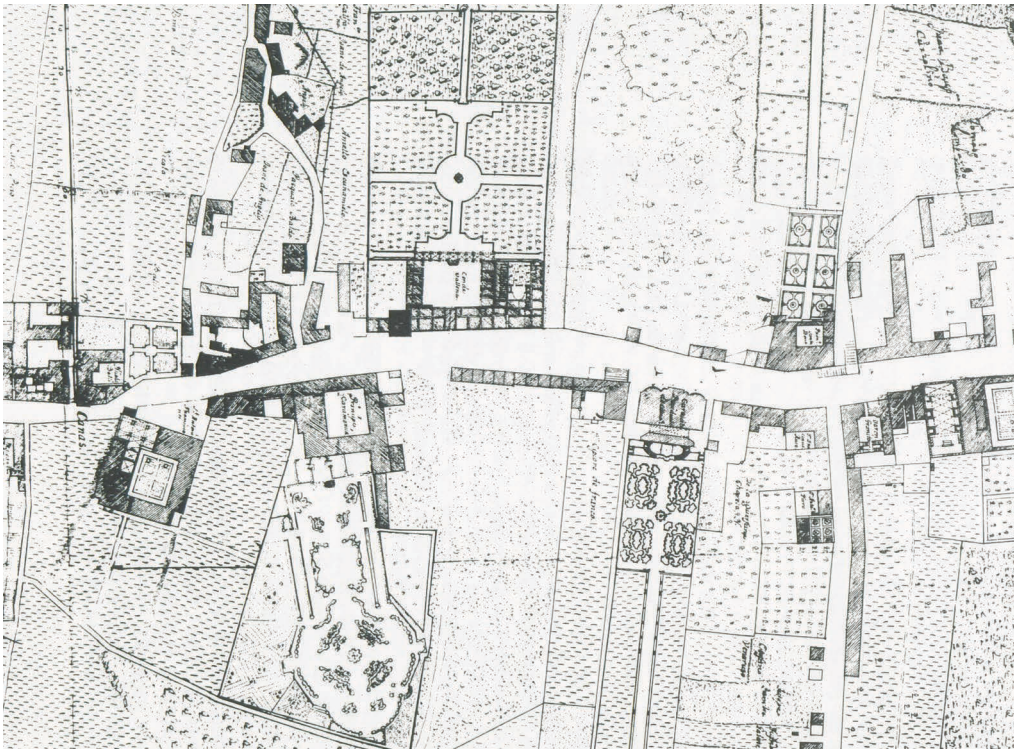

Fig. 5 – *Detail of I dintorni del Palazzo Caramanico prima della costruzione della Villa Reale* (ASN, Piante e Disegni, Cartella X, n.° 22).

The Vesuvius farmhouse, having been transformed into an aristocratic palace, was again preserved and became the Royal Palace in 1738. However, in 1741, the initial endeavour to repurpose the d'Aquino palaces as a royal residence proved unsatisfactory. Consequently, the decision was made to construct a new royal palace. However, it became evident that the new project had to contend with the existing structures, and thus the new palace was designed to incorporate and adapt to the original architecture, even following its orientations, architectural style, and composition(de Seta, 1980).

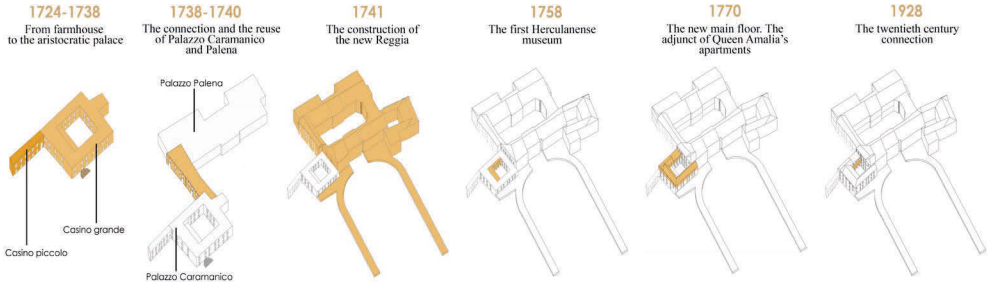

Fig 7 ─ *Evolution of the complex* (Author, 2025).

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In 1770, there was a further transformation of the manor, as a new noble floor was added: the original two-story building was elevated by a third level, which was dedicated to the residence of Queen Amalia. The new floor was not connected to the lower floors, but was solely linked to the more modern royal complex.

3.2. Analysis of the State of preservation

The historical research, which was carried out through various sources, has been compared with the material analysis of the structure. This comparison has allowed for a more thorough understanding and verification of the changes that have occurred over time. These transformations underscore the complexity of the palace, which, despite the changes that have transpired throughout its history—particularly those that ensued following the unification of Italy, leading to the conversion of the Royal Palace into the High School of Agriculture, thereby compromising the quality of the interior spaces—still permits the discernment of the characteristics of its original rural reality.

The analysis of the historical evolution is primarily derived from the study of the typological characteristics of Vesuvian architecture, which have already been defined, with particular attention given to cornices, decorations, the presence of lamia, the absence of balconies in the original rural villa, and the distribution of interior spaces, among other elements. This approach unveils compositional and decorative disparities between the architecture of the original *masseria* and that of the eighteenth-century royal palace. These disparities are attributable to the evolving preferences and construction methodologies of the era. These distinctions are most pronounced in the courtyard, which has undergone substantial modifications, resulting in the loss of the original layout of the rural villa. A rich palimpsest of transformations attests to the changing needs and uses of the palace over time. These transformations include the enlargement of the portico and the subsequent elevation in 1758, when the palace housed the Herculaneum Museum; the elevation of the new main floor and the subsequent roofing with a Palladian system in 1770, which was completely detached from the original roofing of the estate, which, like other Vesuvian farms, was characterized by flat roofs used as terraces (Pane, 1936), the definition of a steel walkway door crossing the courtyard in the twentieth century at the time of the School of Agriculture was established in 1936.

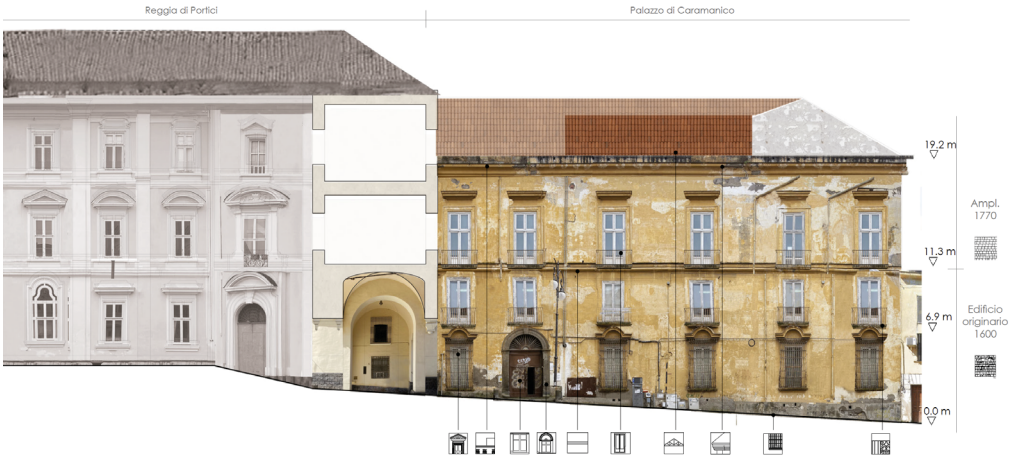

Fig 6 – *View from Via Università* (Author, 2025).

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Fig. 7 – *The second floor of Palazzo Caramanico* (Author, 2025).

The presence of dichotomous transformations between the historic floors and the more modern third floor is also evident in the interior spaces. This observation is corroborated by an analysis of the disparate construction techniques employed in the original building and the raised floor of the late eighteenth century.

The analysis reveals the presence of masonry vaulted ceilings in all rooms on the first two floors of the building and the presence of con canniccio vaults on the third floor. Additionally, a discrepancy in room height is observed between the rustic floors and the current floor.

4. Conclusion

The wealth of information, archival, and material collected thus far corroborates the profound significance of Palazzo Caramanico. The edifice stands as a testament to the architectural and constructive intricacy of the Vesuvian farm system. Moreover, it functions as a pivotal repository for the historical, social, and political analysis of the city of Portici. It exemplifies a multifaceted approach to the preservation of rural architecture, integrating a noble-regal function that facilitated the preservation and interpretation of the farmhouse's material and constructive characteristics, as well as its original plan layout. However, this approach entailed the complete loss of the original agrarian function and substantial modification of certain rural architectural features.

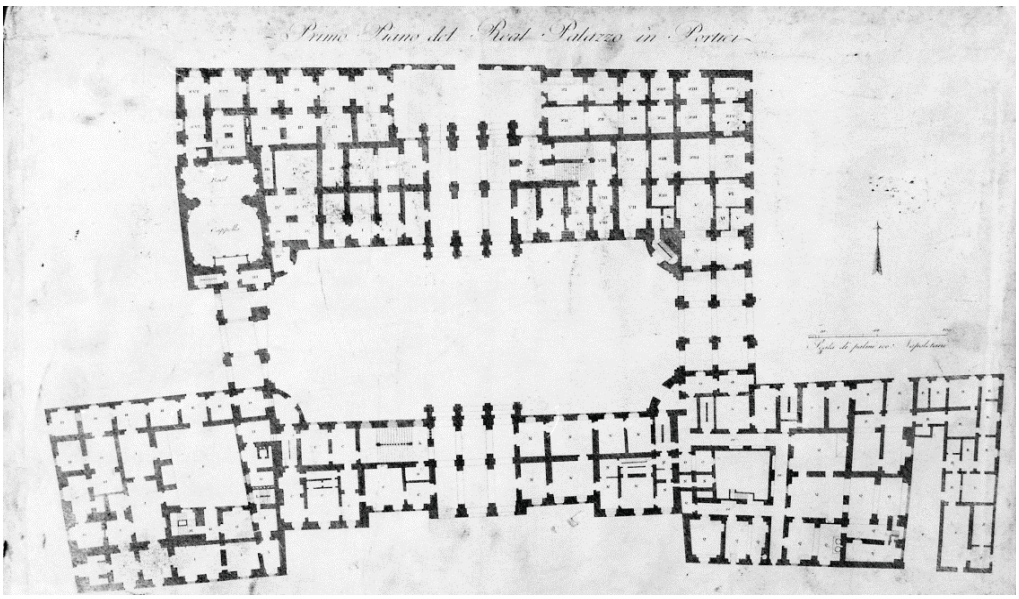

Fig 8 – *First loor plan of the Royal Palace of Portici. Segoni Vincenzo (1740 Ca. / 1820 Ca). Museo Archeologico di Napoli. Palazzo Caramanico bottom left.*

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While the reuse of the structure from the Bourbon period to the present has ensured the preservation of the architectural complex, in more recent times there has been a paucity of efforts to enhance it. In comparison to the more contemporary Royal Palace, it is in a state of semi-abandonment and degradation.

This study, derived from the author's master's thesis, aims to elucidate the criteria for restoration interventions. These interventions should prioritize the enhancement and highlighting of this exceptional specimen of architectural evolution, emphasizing the historical transformations that occurred up to the 20th century.

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Vernacular Rural Architecture with Extradosed Vaults. Case Studies from the Inland Areas of Southern Italy

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Abstract

This paper examines rural dwellings characterized by extradosed vaults, a vernacular architectural typology prevalent throughout the Mediterranean basin. From the Berber ghorfas to coastal residences, and from rural complexes in the Vesuvian area to the traditional structures of the Sorrentine Peninsula, this architectural form has a rich history. While often associated with coastal regions, this typology also manifests inland, as demonstrated by the municipality of Santa Maria a Vico in the Caserta hinterland. Here, many surviving examples- despite frequent alterations - retain essential original features, shedding light on a broader, often overlooked diffusion of this architectural tradition. These structures typically consist of load-bearing masonry walls made from local limestone and vaulted roofs, with the extrados frequently visible. Arranged in south-facing rows, their layouts commonly include shared elements such as courtyards, cisterns, ovens, and rainwater harvesting systems, which are vital in areas lacking natural springs, reflecting a profound adaptation to local environmental conditions. This study focuses on several settlements within Santa Maria a Vico, evaluating their state of conservation through archival research, on-site inspections, as well as detailed metric and material surveys. This methodology has uncovered a wide range of transformations over time, including the enclosure of extradosed vaults and reconfigurations of internal spaces. Ultimately, the research aims to establish guidelines and best practices for interventions that not only preserve the physical integrity of these dwellings but also maintain the intangible heritage they represent - such as historical memory, cultural identity, and traditional construction techniques - while accommodating contemporary functional needs.

Keywords: *rural dwellings; vaulted roofs; restoration; traditional construction techniques*

1. Introduction

The architectural typology of extradosed vaults is typically associated with insular and coastal landscapes, as demonstrated by similar examples found along the shores of Greece, Tunisia, and other Mediterranean countries. In these varied contexts, the typology is adapted to local conditions, resulting in variations that respond to different climatic challenges and the availability of materials. For instance, Tunisian ghorfas, constructed from rammed earth, provide effective thermal insulation in desert regions, whereas the *dammusi* of Pantelleria utilize vaulted forms to direct rainwater into underground cisterns. Moreover, along the Amalfi Coast and on the Campanian islands, the widespread adoption of extradosed vaults stems from the scarcity of sturdy timber suitable for flat or pitched roofs (Fiengo & Abbate, 2001; Arena,

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2011; Valenza, 2015). Notably, this architectural form is also present in the inland area of the province of Caserta, specifically in the municipality of Santa Maria a Vico, where numerous rural structures have retained their distinctive characteristics. Its presence in a non-coastal and culturally dissimilar setting prompts inquiries into the settlement and construction dynamics that led to its adoption in such an unconventional context.

2. Methodology

The research adopted an integrated approach structured into several phases, aimed at investigating the vaulted rural architecture found in the hilly terrain of Santa Maria a Vico. The initial phase involved analyzing satellite imagery, which facilitated the identification of an initial set of buildings characterized by vaulted roofs. These findings were subsequently verified through on-site inspections. Simultaneously, bibliographic and archival research was conducted to explore the dissemination of a construction typology typically associated with insular and coastal regions, within the comparatively rare context of a hilly inland area of Campania. This phase underscored how these structures contributed to shaping the local rural landscape. In the subsequent phase, the investigation focused on two representative building clusters: one fulfilling a productive function and the other designated for residential use. This selection aimed to further examine the typological, material, and functional characteristics of these architectural structures. For both sites, a comprehensive survey campaign was undertaken, combining direct measurement techniques with photogrammetry. Data acquisition was performed using a digital camera, followed by processing through Agisoft Metashape software. The integration of field observations and surveying techniques allowed for a nuanced understanding of the material composition and construction methods employed. Ultimately, the main transformations undergone by this typology over time were analyzed to develop intervention strategies aimed at its conservation and enhancement, from both architectural and landscape perspectives.

3. The geographical, historical and cultural context of the area

The vaulted buildings under examination are located within the historical settlements that line the slopes of Mount Burrano, in the northern section of the municipality of Santa Maria a Vico. This area, commonly referred to as Monticello, is home to approximately one hundred examples of structures featuring extradosed vaults. While these buildings are interspersed among more conventional rural architecture, they retain distinctive characteristics that indicate the former presence of a cohesive and widespread rural settlement. The development of this architectural style in the region is attributed to a combination of geographical and environmental factors. The lack of local water sources prompted communities to create systems for collecting and storing rainwater, while the scarcity of sturdy timber rendered the construction of wooden floor structures impractical.These limitations directly influenced the adoption of a construction technique that effectively met the practical needs of the residents (Ruggiero & Campagnuolo, 1997).

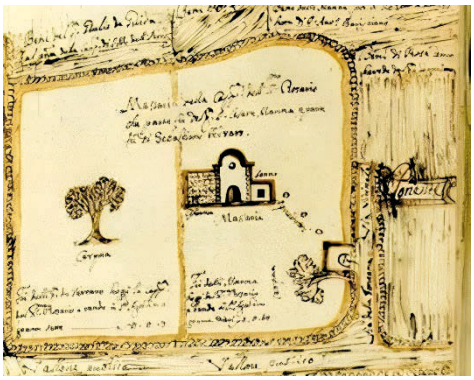

Fig. 1 – *Barrel-vaulted farmhouse* (Episcopal Archive of Sant'Agata de' Goti, 1696, sketch by Tommaso Cognetta).

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As for the chronology of these structures, it can be suggested that they began to proliferate from the 16th century onward, following the migration of artisans from coastal areas who introduced this building practice. The earliest iconographic evidence of these barrel-vaulted structures can be found in a depiction from the 17th century (Fig. 1).

3.1. The construction of the hillside landscape

For centuries, agriculture has served as the principal economic foundation of the region, profoundly influencing both the landscape and land management practices. The cultivation of olive trees, orchards, and vineyards has flourished across a hilly terrain characterized by significant elevation changes and sloping ground, necessitating the implementation of adaptive agricultural strategies aimed at optimizing arable land. A crucial aspect of this adaptation involved the construction of agricultural terrace interventions designed to create flat surfaces conducive to cultivation. The process of excavating and leveling the terrain not only reshaped the landscape but also generated residual materials predominantly composed of limestone. This material was subsequently repurposed in the construction of dry-stone retaining walls, locally known as *murecene*. These structures, constructed without the use of mortar, played a vital role in stabilizing slopes and ensuring effective drainage of rainwater, thereby facilitating the cultivation of steep areas and, in certain instances, integrating dwellings that occasionally acted as retaining elements. The morphological characteristics of the terrain, along with the technical solutions employed in its transformation, can be viewed as manifestations of influences exerted by skilled builders hailing from coastal regions. Upon migrating to the inland territory, these builders transferred and adapted their existing construction knowledge, which had been established in contexts such as the Amalfi Coast. The area under examination exhibits several significant parallels with the Amalfi region, particularly in relation to the availability of local building materials, orographic conditions, and the agricultural utilization of the terrain. These factors underscore a cultural and technical continuity between the two areas, as evidenced by the adoption of shared construction strategies (Fiengo & Abbate, 2001; Russo & Pollone, 2022; Villani, 2024).

4. Architectures of the hillside landscape

The architectural forms that define this landscape have been constructed utilizing the residual materials resulting from land excavation, thereby integrating seamlessly into the terrain as essential retaining elements that adhere to the pre-existing hillside topography. These structures consist of homogeneous rows of independent modules, each occupying an approximate area of 30 m². Openings within these modules are minimal, generally restricted to a single entrance door and one window, both of which are oriented toward a shared open space designed for communal activities and services, including the oven, cistern, and washhouse. Although these structures may appear uniform at first glance, a closer examination reveals several variations, largely concerning their intended use and internal spatial configuration. Consequently, two distinct clusters have been selected for in-depth analysis: one that is rural and production-oriented, and another that is residential and urban in character. The first case study focuses on a row of three interconnected units located in a non-urbanized area that has retained its original agricultural function. The contextual framework, characterized by a network of terraces, highlights the cohesion between the constructions and the surrounding landscape. This particular cluster serves as an olive and grape press (*frantoio*) and is composed of a central unit housing a stone mill, with masonry vats strategically placed at each of the four interior corners for the collection of produce. The lateral units are presumed to have been employed for supplementary functions, thus enhancing the overall utility of the cluster (Fig. 2).

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Fig. 2 – *Production unit and masonry* (Author, 2025).

The residential typology most commonly found in the study area is the *casa a botte*, or barrel-vaulted house. The cluster analyzed is located on Papi Road and represents one of the last dwellings at the edge of the natural landscape. It comprises a row of four units, organized around a courtyard that includes a washhouse, a cistern, and a communal oven. Each unit constituted a modest, essential dwelling, characterized by a single interior space. The core of this space was the hearth, which served as the primary architectural and functional element, while small niches carved into the masonry were utilised for storing household items. Some instances of a mezzanine are present, which meet domestic and storage needs simultaneously, suggesting a rational use of space (Fig. 3).

5. Construction and material features

The investigation brought to light a series of recurring constructional patterns - most notably, the consistent use of a specific lithotype and the adoption of a uniform masonry technique - coexisting with substantial variations linked to functional purpose, the number of aggregated housing cells, and the range of solutions employed for vaulted roofing systems. Such variability reflects a pronounced adaptive capacity, grounded in a collectively developed and historically sedimented body of constructional knowledge, capable of articulating spatial configurations in response to functional demands and environmental contingencies (Pane, 1936; Pagano & Daniel, 1936).

5.1. The construction of walls and vaults

After the excavation of the terrain and the construction of the foundations and cisterns, the building process progressed with the construction of the perimeter walls (Ruggiero & Campagnuolo, 1997). The technique utilized involved arranging the wall facings according to the method known as “periodic horizontal courses”, also referred to as the “worksite method”. The masonry was crafted out of roughly hewn limestone blocks of varying sizes, with the largest stones typically positioned at the base of each construction phase (Fig. 4) (D’Aprile, 2001).

Fig. 3 – *South orthophoto of the residential cluster, Via Papi* (Author, 2025).

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Fig. 4 – *East orthophoto of the residential cluster: the masonry with periodic layers* (Author, 2025).

These segments, which varied in size, were erected sequentially, and at each stage, a generous layer of mortar was applied to ensure proper settlement and bonding of the masonry.

It can be inferred from the construction technique that employs irregular worksite segments - commonly found in various buildings throughout the region - that the masonry core in question was of a compacted type. This indicates that it was constructed using a three-dimensional method, where the inner and outer facings, alongside the core, were erected simultaneously.

Following the completion of the walls, the construction progressed to the roofing phase. Instead of using centring during this process, a temporary platform was established at the springing level. This platform served as a base where soil was shaped and compacted to create a formwork for the vault. The tuff blocks were then placed, with their arrangement varying according to the geometry of the vault - primarily barrel vaults, and occasionally sail vaults (D'Aprile, 2001). In the case of barrel vaults, the tuff voussoirs were aligned along the vault's geometric generatrices. On the other hand, sail vaults required a different structural configuration, as they rest on a quadrangular base. Geometrically, a sail vault can be described as the intersection of an ellipsoid with four vertical planes.

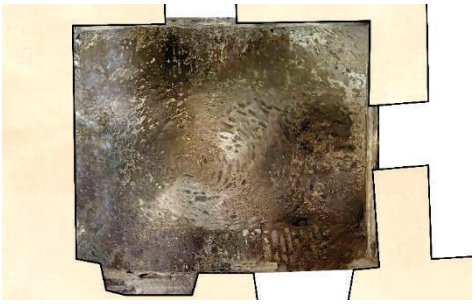

Fig. 5 – *Ortophoto of the vaulted ceiling of the production unit* (Author, 2025).

This layout consists of two distinct construction elements: an elliptical calotte formed with small tuff blocks arranged in concentric circles, and the pendentive zones, composed of larger squared tuff blocks laid out in a radial pattern (Fig. 5).

Following the removal of the formwork, the vault was waterproofed at the extrados using a *battuto di lapillo*, a mixture of compacted volcanic ash. This compound, approximately twenty centimetres thick, was applied to the vault's surface and tamped down with wooden poles, occasionally moistened with limewater. After a full day of compaction, the mixture, having partially hardened, was levelled and given a slight slope to facilitate rainwater drainage. After about a week, the roof received further protection with a layer of straw and soil, which was kept in place for an additional twenty days to shield the surface from atmospheric conditions (Ruggiero & Campagnuolo, 1997). The curved profile of the roofing system enhanced rainwater runoff, directing water onto the narrow flat surfaces between adjacent vaults. From there, the water was channelled into a network of terracotta conduits known as *cantarelle*. These channels guided the water toward cisterns and wash basins, ensuring a reliable water supply - a crucial operation in a region where natural springs are scarce. The *cantarelle* were typically positioned along the main elevation of each vaulted module; however, today, these original elements have largely disappeared or been replaced by modern downpipes (Ruggiero & Campagnuolo, 1997).

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6. Transformations over time

Roberto Pane admired how the dwellings in the inland areas of Campania had retained their original architectural features, in sharp contrast to those along the coast, which had been significantly altered by the influence of tourism (Fig. 6). He noted: "*Vaults cover single-storey spaces, arranged side by side around the courtyard of the rural house, enhancing the beauty of a land whose ancient character remains intact, precisely because it is entirely untouched by tourism*" (Pane, 1936, p. 14).

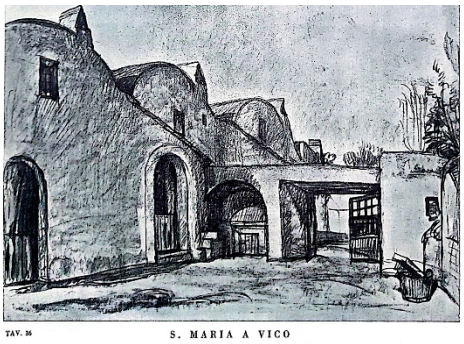

Fig. 6 – *Sketches of barrel-vaulted houses in Santa Maria a Vico* (Pane, 1936).

What Pane could not have anticipated was the radical transformation that these dwellings would soon undergo, driven by evolving housing needs and the demand for functional adaptations. A detailed examination of the current built environment uncovers traces of these changes, enabling us not only to pinpoint the original locations of these houses but also to comprehend the nature and extent of their transformation over the decades. In many instances, the original masonry has been incorporated into newer structures, while the vaults have been either removed, concealed, or modified.
These transformations can be classified based on the degree of alteration to the original building fabric:

1. Dwellings that remain intact but are in a state of decay or abandonment: These structures have largely retained their original form, aside from structural reinforcements - often implemented after seismic events - such as the addition of metal tie rods.
2. Dwellings that preserve the vault but have undergone superficial alterations: While their original structural configuration remains intact, these houses have experienced specific interventions, such as the application of waterproofing layers over the battuto di lapillo or the addition of roof tiles along the vault profile.
3. Row houses that maintain their linear configuration, albeit with the vault extrados sealed or covered.
4. Row houses where individual units have been physically connected, thereby altering the original spatial organization.

Structures that present as a single building entity, frequently incorporating vertical expansions that have either integrated the original vault or resulted in its demolition and replacement with a flat slab (Fig. 7).

Fig. 7 – *Barrel vaults incorporated into the attic of a dwelling* (Author, 2025).

As for the ancillary architectural elements - such as ovens, cisterns, wash basins, and water drainage systems - many have been lost over time. Those that remain extant frequently exhibit a condition of neglect and are no longer in use.

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7. Safeguarding tangible and intangible heritage: intervention guidelines and conclusions

In this context, the greatest risk lies in the irreversible transformation of these dwellings, which could result in the loss of a heritage that is both tangible and cultural. These structures represent a way of life that has fostered a sustainable relationship with the surrounding environment for centuries. The contemporary challenge is to identify compatible recovery strategies - at both territorial and architectural scales - that reconcile current needs with the respect for local specificities. This must be accompanied by the development of long-term conservation strategies that protect the built heritage while adhering to the principles of authenticity and material compatibility.

7.1. Conservation and restoration strategies

As an initial step, it is crucial to remove invasive vegetation, which often causes structural damage and undermines the architectural integrity. Equally important is ensuring the structural stability of masonry walls: prolonged exposure to soil, without adequate waterproofing, can lead to moisture-related issues such as water staining, biological growths, and gradual deterioration of interior surfaces. In such instances, waterproofing the masonry that comes into contact with the ground is essential, with interventions customized to the specific conditions of each structure. The primary mechanisms of structural failure observed in these buildings include masonry crushing, frequently indicated by significant erosion of the mortar. Targeted interventions may include compatible reinforcement techniques, such as repointing joints with lime-based mortars. Vaulted elements may exhibit considerable deflections at the crown, stemming from both ageing and water infiltration. These deformations can be mitigated by inserting appropriate metal tie rods. Regarding roof coverings, two main concerns have been identified: the presence of cracks and the utilization of incompatible waterproofing materials. In the case of cracks, the *lacertino* technique may be implemented, which involves injecting a liquid mixture of lime and sand into the fissures to stabilize the affected areas. For the issue of incompatible waterproofing layers, it is necessary to remove modern anti-mould membranes and restore the original waterproofing function by rehabilitating the underlying *battuto di lapillo* layer.

7.2. Strategies for territorial reuse and enhancement

It is crucial to promote strategies aimed at safeguarding rural building clusters by recognizing them as inseparable components of the cultural landscape. This entails regulating land use in ways that preserve their authenticity and prevent alterations that may compromise their identity value, in alignment with local urban planning instruments (PUC) and overarching regulatory frameworks. In contexts marked by a lack of community gathering spaces - especially in urbanized peripheries - abandoned rural cores could be repurposed as community centres. Such an approach would meet social needs through minimal and respectful interventions that enhance the original spatial configuration of the built environment.

The establishment of multifunctional spaces, achieved through the adaptation of interior environments, would facilitate the reintegration of these structures into collective use, transforming them into venues that reinforce a sense of belonging to the territory (Fig. 8).

Fig. 8 – *Design concept* (Author, 2025).

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In parallel with this approach, there exists the potential to promote local productive and commercial activities within these clusters, such as the sale of local products (e.g., wine, olive oil, honey), which would serve to emphasize the unique assets of the region. Moreover, buildings deemed unsuitable for public, productive, or commercial functions could be restored as private spaces, with any intervention that might alter their specific characteristics subjected to regulatory oversight.

This methodology could also be applied to ancillary elements, such as cisterns, which could be repurposed for rainwater collection and recycling. This demonstrates the feasibility of integrating sustainability with historical memory to address contemporary needs. Similarly, traditional ovens and external structures could be restored to facilitate community events, while outdoor spaces could be revitalized with gardens and urban farms, thereby breathing new life into these sites while maintaining their original identity.

In conclusion, the protection of both tangible and intangible heritage associated with these rural buildings necessitates an integrated approach that harmonizes the preservation of historical identity with contemporary requirements. Only through conscious and sustained engagement can these assets be transmitted to future generations, keeping historical memory alive while strengthening the connection between communities and their land.

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Materials and Components for the Sustainable Retrofitting and Climatic Optimization of Etnean Wineries in Sicily, Italy

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Abstract

The traditional wineries of Mount Etna represent a unique cultural, architectural, and productive heritage, deeply rooted in the region's long winemaking history. However, many of these structures require retrofitting to meet contemporary needs while preserving their historical integrity and environmental significance. An effective approach to the restoration of Etnean wineries should combine innovative and sustainable solutions with traditional techniques, thus fostering a harmonious balance between heritage preservation, energy efficiency, and the reduction of environmental impact. The research focused on the study of several wineries in the Etnean area, identifying recurring typological, technical, constructive, and material invariants that recur across these structures. Based on these findings, compatible interventions on the building envelope were proposed, aiming to improve the indoor hygrothermal performance of wine cellars. These improvements do not only optimize the conditions for wine ageing but also elevate the quality and functionality of indoor spaces. In the current market, marked by a growing demand for high-quality wine, an accurate control of the cellar's climatic conditions is essential for ensuring superior product standards. The proposed interventions incorporate natural materials and components, employing manual or mechanized techniques. Their environmental impacts were evaluated using the Life Cycle Assessment (LCA) methodology to identify the most sustainable retrofit solutions.

Keywords: *vernacular architecture; etnean wineries; sustainable design; life cycle assessment; natural materials*

1. Introduction

Etnean wine, a symbol of Sicilian tradition, originates from the fertile slopes of Mount Etna, where viticulture has been refined over the centuries. The volcanic soil, rich in minerals, and the well-draining substrate (composed by volcanic ash, pumice, and sand) create ideal conditions for vine cultivation, while terracing optimizes the use of Mount Etna's steep slopes. The climate, with significant temperature variations, allows for a slow grape maturation, enhancing its aromas. The Etna wine region is renowned for its DOC wines, produced in accordance with local tradition.

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Vineyards are spread along a "C"-shaped belt around the volcano, with different slopes dedicated to specific types of wine production.

Across the globe, traditional wineries consistently highlight the importance of the relationship between the building envelope and the foundation ground. Many studies confirm that thermal stability, provided by contact with the ground, gives traditional underground wineries a competitive advantage over modern aboveground wineries, which rely on HVAC systems for climate control.

As stated elsewhere (Tinti et al. 2015), from the mid-20th century onward, underground wineries were gradually replaced by single-story aboveground structures equipped with air-conditioning systems for controlling temperature and humidity, which led to increase in management costs and energy consumption.

Some researchers attribute up to half of the total energy required for wine production to the use of HVAC systems for regulating indoor temperatures and humidity levels (Tassinari et al. 2011). It is therefore understandable why so much effort has been put in the wine industry, over the past few years, into decreasing energy consumption.

Historic small and medium farm wineries can offer answers to this issue, due to their production capacity, strong local connections, and efficient thermophysical performance (Cañas Guerrero & Martin Ocaña, 2005). A previous study from the authors (Nocera et al., 2020) analysed the energy retrofitting of a traditional Etnean winery, which was built by using bioclimatic strategies in its design.

On-site simulations and measurements assessed the effectiveness of retrofitting interventions such as the installation of aerogel insulation on basalt masonry walls, of hemp insulation on the roof, and the replacement of windows. The results highlighted the importance of insulating roofs and walls while avoiding modifications to the solid ground floor to maintain optimal temperature and humidity conditions for wine fermentation and ageing.

Today, the growing demand for product quality is combined with an ever-increasing demand for construction quality. The design of wineries faces new needs, in ways that require innovative and sustainable solutions, corresponding to the new market conditions and the diversified use of the production territories. Wine production must ensure safety and quality by integrating advanced technologies while preserving the artisanal characteristics that give each product its unique identity.

In response to evolving demands that require Etna's wine production to maintain particularly high production standards, this study aims at the retrofit of a traditional winery on the eastern side of Etna, which presents typological and constructive features that are typical of the area.

In particular, the study proposes a series of sustainable retrofit strategies for building envelope elements, by using sustainable and low impact materials and components that enhance the thermal performance of the building, while ensuring optimal hygrothermal conditions for wine ageing, without relying on HVAC systems.

These interventions are specifically aimed at adapting the thermal transmittance of wall and roof envelope elements in order to comply with the limits set by the Italian Energy Standard. All the proposed stratigraphies are subsequently evaluated using an LCA approach.

The quantification of the environmental impacts of the various materials and components used in the retrofitting strategy, including those due to transportation, on site construction, maintenance and end of life processes, led to determining which of the various options would ensure the best environmental performance.

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2. Methodology

The methodology approach involves the following steps (see subsections 2.1-2.3).

2.1. Analysis of typological, technical and constructive invariants of traditional Etnean wineries

The typical wineries of the eastern side of Mount Etna are characterised by building traditions that persist today. The Mediterranean climate has influenced the design of rural houses, which utilize natural materials and bioclimatic strategies to limit winter and summer temperatures variations.

The first phase of the analysis concerned the study of the spatial, functional, typological, technical and constructive invariants that characterize traditional Etnean wineries. The most typical features of these wineries (planimetric systems, construction technologies and base materials used) were collected. This analysis was carried out by referring to previous studies (Palumbo, 1991) and to surveys carried out both on site and using Google Earth.

The initial outcome of this investigation phase was the production of a series of fact sheets (Fig. 1) on several traditional Etna wineries. The sheets contain the following information:

- Name of the winery or building
- Location
- Plan and a representative section
- Typological description of the cellar
- Construction techniques and materials used
- Additional notes

Furthermore, the second outcomes of this investigation was the identification of a traditional winery that could act as a zero case to be retrofitted. The elements that characterized the typical winery will be presented in section 3.

2.2 Retrofit hypotheses and thermal envelope design

Based on the technical and constructive information collected in the previous phase, typical stratigraphies were developed for the solid ground floor, as well as for the vertical and roof envelope elements. As previously mentioned the first step toward enhancing the performance of these elements and therefore to improve the expected hygrothermal performance of traditional Etnean wineries, is ensuring compliance with Italian energy regulations.

The Italian standard (D.M. 26 June 2015) determines minimum energy efficiency requirements for building envelope elements, depending on the climate zone. The proposed case, a winery in *Piedimonte Etneo*, is located within climate zone C, which requires the following minimal thermal transmittance values:

- 0.34 W/m^{2}K for exterior walls,
- 0.33 W/m^{2}K for the roof system,
- 0.38 W/m^{2}K for the solid ground floor.

This study proposes several technological retrofits for the envelope elements of wineries to improve the indoor thermal stability and ensure optimal hygrothermal conditions for wine fermentation and ageing, while complying with Italian regulations. In continuity with a previous study by the authors (Nocera et al. 2020), the chosen retrofitting interventions refer only to the vertical and roof elements, leaving the solid ground floor element uninsulated.

For the sake of brevity, only the proposal for the retrofitting of vertical envelope elements is presented below. All the following retrofit scenarios use a first layer of lime and gypsum smoothing coat.

This layer serves to even out the indoor surface of the basalt stone masonry and favours the subsequent application of an insulation layer.

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- STR.01: calcium silicate panels, lime plaster
- STR.02: light earth blocks manufactured on site (with wooden support structure), raw earth plaster
- STR.03: Hemp fibre panel insulation (with wooden support structure), extruded raw earth finishing panels, raw earth coating
- STR.04: Cast-in-place hemp lime mix (with wooden support structure), hemp lime thermal plaster
- STR.05: Cork insulating panel, lime plaster

2.3 LCA analysis of the retrofit strategies

Lastly, the sustainability of retrofitting interventions are confirmed by a life cycle analysis (LCA). This analysis examines the impacts of key material and energy inputs across all life cycle stages: from the extraction and sourcing of raw materials (upstream), through transport, production, construction, installation, and maintenance, to their final disposal or recycling. The LCA was developed in accordance with ISO 14040 and ISO 14044.

The system boundaries include all the materials and processes necessary for the retrofitting of the walls, from cradle to grave. The analysis is referred to a functional unit of $1m^2$ of wall with thermal performance of $U=0.30\ W/m^2K$.

The implementation of this method has enabled the quantification of emissions into the air, water and soil.

The Emission Factors (EFs) for the Carbon Footprint (Global Warming Potential) were assessed using the CML-IA method in SimaPro 9.0.0, based on data from the Ecoinvent 3.6 database. The AWARE method was used to assess the Water Footprint, while the Cumulative Energy Demand (CED) method was used to evaluate the Embodied Energy values.

The analysis is based on several key assumptions. A life cycle of 100 years was assumed for the walls. Emissions associated with the transportation of materials and components were estimated by considering the origin and treatment of the materials in relation to the location of the winery. A distance of 100 km was assumed for sand, fibres, insulation and cladding materials, while earth is assumed to be extracted within a 50 km radius. For assembly and installation, the consumption of materials and energy (electricity and diesel) for processing each component was based on the operations carried out using machinery and equipment. In the case of maintenance, it is assumed that the finishing materials will be replaced every 20 years. Both recycling and landfill disposal are considered as options for end-of-life stage, depending on the nature of the materials, while the emissions related to the transportation (by truck) of materials to a hypothetical waste management facility, located at a distance of 50 km, were also included.

3. Typological, technical and constructive characteristics of Etnean wineries

The wineries of eastern Etna have specific typological and constructive features that have been conditioned by the Mediterranean climate and the availability of local materials. A detailed analysis of Etna's wine cellars has revealed a series of typological, constructive and material invariants that provide a foundation for determining the appropriate intervention strategies.

From a typological point of view, the rural dwellings (locally called *masserie*) of the Etna region can be divided into the following categories (Palumbo, 1991):

- *Single-storey buildings:* consists of simple volumes with transverse walls dividing the spaces and a pitched roof resting on the perimeter walls; in more complex layouts, volumes are arranged around a central courtyard.

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- *Buildings on slope:* structures built on natural elevations, with the main residence on the upper level and the production rooms below. This configuration optimized the flow of must from the pressing area to the cellar and ensured protection.
- *Closed-courtyard buildings:* multi-level structures arranged around a central courtyard designed to provide protection, privacy, animal shelter, and a communal gathering space for agricultural communities.
- *19th-century evolution:* buildings open to the exterior, featuring large windows, balconies, and terraces supported by arcades.

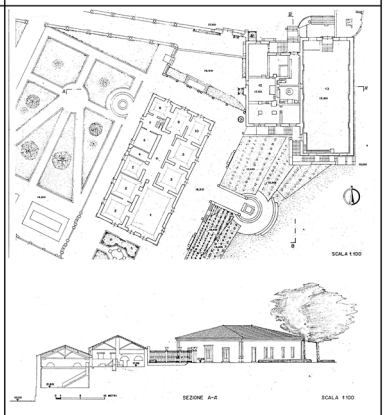
Denominazione	CASA GRASSI A REGIA CORTE
Localizzazione	Piedimonte, Via Sante Puglisi, 8, (CT)
Planimetria	
Descrizione tipologica	Al fabbricato originale si affiancano degli ampliamenti al corpo di fabbrica dedicati alla produzione e conservazione del vino. Il volume situato a Nord-Est del complesso residenziale. Le stanze hanno diversa altezza per facilitare il trasporto del mosto nei vari barili. Dal palmento si accede alla cantina con una scala.
Tecniche costruttive	Le pareti verticali sono costituiti da blocchi di pietra lavica di 60 cm di spessore che rappresentano la parte strutturale dell'edificio. I volumi del palmento e della cantina si trovano a quote altimetriche diverse. Coperturacostituita da capriate e listelli.
Note	Attualmente il fabbricato fa parte di una società agricola.

Fig. 1 – *Example of a factsheet for Casa Grassi winery at Piedimonte Etneo, in the Etnean area* (Sheet by Tushi Artiol, 2025; source Palumbo, 1991).

Traditional masonry building techniques have evolved over time. Initially, irregular blocks of stone were bound together with mortar. Later, stones were roughly shaped and laid with layers of broken bricks to create a more regular structure. Between the 17th and 18th centuries, formwork was introduced, and stone placement improved, resulting in 65-75 cm thick load-bearing walls. Partition walls on the lower floors were similar in thickness to the load-bearing walls in order to resist the thrust of the vaults and ensure the stability of the upper floors; wall thicknesses were reduced on higher floors. On the upper floors, partitions were often constructed using timber framing and reed panels, which provided both lightness and durability. Foundation walls were thicker than aboveground ones, with an average depth of approximately one meter.

Wineries that were built on rocky ground had shallower foundations, more stability and were better protected from moisture; they also had the advantage of occupying areas that could not be cultivated, while the rocky ground provided a naturally paved base for courtyards. Separation from the ground was provided by a crawl space, while the underground rooms contributed to internal hygrothermal regulation.

The floor above the ground level was often built with stone vaults, while the upper floors were constructed with a double-timber-framed floor with beams, joists and planks. Some buildings feature false vaults made of reed structures covered with gypsum plaster.

Timber roofs consisted of rafters aligned parallel to the slope and resting either directly on the edges of the walls or on timber trusses. This main framework bore the weight of beams, that in turn supported vertical wooden slats or planks, on which terracotta tiles were placed.

Openings were kept small to minimize summer overheating.

Materials reflected the availability of local resources. Lava stone, although difficult to work, was widely used for masonry and simple architectural elements, since it was valued for its density and its effectiveness in enhancing indoor comfort by regulating heat flow.

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Limestone from Syracuse, was used for decoration, such as on door frames and other ornamental details.

The choice of flooring materials varied according to the intended function: courtyards were often left with their natural surface, while wine press areas (*palmento*) were paved with lava stone or a mixture of lime, volcanic sand and crushed terracotta (known as *battume*). Interior floors were paved with terracotta tiles, plain and simple in workers' areas, yet elaborately decorated with geometric patterns in the owners' quarters. More modest dwellings used lava stone slabs, which were strong enough to withstand the weight of barrels.

4. Retrofit strategies and thermal properties assessment

Based on the collected information, a prototype winery has been designed, reflecting the representative typological, technical and constructive features of wineries on the eastern slopes of Mount Etna.

The representative winery is located in *Piedimonte Etneo*; it consists of a single-story structure with a height of 6 meters. The load-bearing walls, made of 70 cm-thick squared basalt stone, are coated with lime plaster. The roof features two slopes supported by wooden trusses and covered with terracotta tiles. The floor consists of large stones and soil, a layer of smaller stones with mortar, and a basalt stone slab finish.

For each hypothesized intervention, an assessment of the expected thermal performances was carried out according to the ISO 13786, to comply with D.M. 26 June 2015. Thermal properties of materials were derived from authors' previous works (Dipasquale et al., 2025, Giuffrida et al., 2021). All stratigraphies are homogeneous in terms of thermal performance, as their thermal transmittance equals 0.30 W/m^{2}K. Thicknesses of materials and components used are shown in table 1. Note that the use of natural materials has led to an increase in the insulation thickness, due to their lower thermal performance. This aspect involved a careful study of the implementation phases of the interventions. For each hypothesis, the equipment and machinery used were listed as well as the operational phases for its implementation. This analysis represents a first step towards the life cycle assessment phase.

Table 1 – *Composition of walls after retrofit* (Giuffrida, 2025).

	Layer	t_{tot} [m]	t [m]
STR.01	Lime plaster	0.87	0.03
	Basalt stone masonry		0.70
	Calcium silicate board		0.15
	Lime-gypsum plaster		0.02
STR.02	Lime plaster	1.01	0.03
	Basalt stone masonry		0.70
	Light earth		0.25
	Raw earth render		0.030
STR.03	Lime plaster	0.85	0.03
	Basalt stone masonry		0.70
	Hemp fibre panel		0.10
	Extruded earth panel		0.022
	Raw earth coating		0.002
STR.04	Lime plaster	0.92	0.03
	Basalt stone masonry		0.70
	Lime hemp insulation		0.15
	Lime hemp thermal plaster		0.04
STR.05	Lime plaster	0.87	0.03
	Basalt stone masonry		0.70
	Cork insulation		0.12
	Lime-gypsum plaster		0.02

5. LCA of the retrofit strategies

The table below (see table 2) shows the environmental impacts - Carbon Footprint (CF), Water Footprint (WF), and Embodied Energy (EE) - of the different stratigraphies after retrofit.

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Table 2 – *LCA results* (Giuffrida, 2025).

Wall solution	CF [$kgCO_2eq$]	WF [m^3]	EE [GJ]
STR.01	116.39	3.72	1.32
STR.02	16.80	10.81	0.32
STR.03	31.33	5.26	2.28
STR.04	36.18	5.07	0.99
STR.05	30.71	13.25	2.34

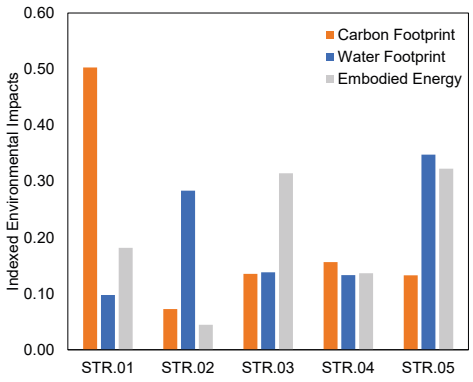

Fig. 2 – *Indexed environmental impacts* (Giuffrida, 2025).

Figure 2 shows the indexed environmental impacts. It is noted that the STR.02, using a light earth mixture as insulating material, has the lowest CF. This is followed by STR.05 and STR.03, respectively, which, despite the use of prefabricated components, employ fewer and more thermally efficient materials. The STR.01 has the greatest CF due to the use of calcium silicate boards.

The Water Footprint (WF) analysis shows that the STR.05 stratigraphy has the greatest WF, followed by the STR.02 (whose WF is mainly due to the use of straw fibres for the light earth mix). Please note that in the case of STR.02, this impact could be lowered by using fibres that are by-products of agricultural supply chains. The STR.01 has the lowest WF.

The Embodied Energy analysis (including both renewable and non-renewable primary energy resources) shows that the STR.05 has the highest embodied energy, followed by STR.03, due to the use of prefabricated insulation panels. The lowest EE belongs to STR.02, which is manufactured on-site as STR.04.

5. Conclusion

Historic buildings for agricultural production represent a valuable architectural heritage that must be preserved and restored in harmony with modern environmental concerns. For traditional wineries on Mount Etna (Sicily, Italy), this involves redesigning the building envelope to enhance the indoor hygrothermal performance, ensuring optimal conditions for wine production and a low environmental impact.

This work presents several intervention strategies on the vertical envelope of a representative traditional Etnean winery. Specifically, five interventions are selected, each using materials of different origins (natural or industrial) and varying manufacturing processes (prefabricated or cast on-site). This approach aims to identify the alternative with the lowest environmental impacts.

The methodology adopted in this study is structured into three main phases. The first phase involved analysing the typological, technical, constructive, and material characteristics that define traditional Etnean wineries. The second phase focused on developing thermal retrofit hypotheses and designing improvements for vertical envelope elements. Lastly, the third phase consisted in assessing the environmental impact of the retrofit strategies through a Life Cycle Assessment (LCA), by evaluating Carbon Footprint (CF), Water Footprint (WF), and Embodied Energy (EE).

The results show that wall stratigraphies using mineral-based prefabricated panels (STR.01) have higher CF compared to bio-based materials as light earth insulation (STR.02), manufactured on site. Moreover, the STR.02 has also the lowest EE. Nonetheless, the light earth stratigraphy has one of the highest WF value, while calcium silicate insulation (STR.01) has the lowest.

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The obtained results highlight the critical role of natural materials in shaping sustainable retrofit strategies. Additionally, they confirm the significance of Life Cycle Assessment as a fundamental tool for promoting more sustainable and regenerative construction approaches.

Future research will focus on validating the efficiency of these interventions through hygrothermal simulations and integrating economic analysis to assess cost-effectiveness. Further exploration of this topic could concern the implementation of real-time monitoring systems and the development of digital twins for continuous performance evaluation and optimization of traditional wine cellars behaviour.

Recovery and sustainability are, today more than ever, two key concepts in the design and revitalization of traditional wineries. The challenge lies in finding the right balance between meeting high performance standards and preserving the historical memory embodied by these architectures.

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Multidimensional Evaluation of the Rehabilitation of Traditional Dwellings: Application to a Protected Dwelling in the Cabanyal-Canyamelar Neighbourhood in Valencia (Spain)

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Abstract

The sustainable rehabilitation of traditional dwellings in historical contexts requires a multidimensional approach that considers both the principles of heritage conservation and the current challenges of environmental, economic, and energy sustainability. This study presents the methodological framework developed within the Re-Habitat research project, aimed at analysing interventions in traditional buildings located in the Valencian region from four fundamental perspectives: intervention criteria, energy efficiency, life cycle assessment (LCA), and real costs. The goal is to develop analytical tools to assess the impact of decisions on construction on heritage conservation and their adaptation to contemporary challenges. To demonstrate the applicability of this methodology, preliminary results are presented from analyses conducted on the restoration of a protected residential building located in the Cabanyal-Canyamelar district of Valencia (Spain). This intervention focuses on dismantling unsuitable elements, restoring carpentry, implementing new installations, and improving finishes using traditional techniques and sustainable materials. The methodology includes the evaluation of intervention techniques, the estimation of energy savings associated with improved habitability, the analysis of environmental impact through LCA, and a cost comparison with industrial options.

Keywords: *sustainability; energy efficiency; economic viability; conservation; traditional techniques*

1. Introduction

At a time when the reduction of CO_2 emissions and energy saving are priority objectives at a European level, the rehabilitation of the existing building stock has become particularly important (United Nations Environment Programme, 2023; Von Der Leyen, 2019).

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However, the sustainable rehabilitation of traditional housing in historic contexts poses a challenge which requires a comprehensive approach combining heritage conservation criteria with contemporary demands for energy efficiency, environmental sustainability, and economic viability.

Aiming to ensure the continued use and subsequent conservation of historic dwellings it is necessary to improve energy efficiency and reduce the carbon footprint of the interventions carried out, in a manner also compatible with the conservation of heritage values. There are many studies examining the topic of continuing to use these dwellings (Buyle et al., 2012; Cabeza et al., 2014), but these mostly focus on homes built since the 1950s.

Equally, on the topic of conservation, it cannot be denied that the rehabilitation and conservation of buildings is more sustainable than the demolition of buildings and the subsequent construction of new ones (Carroon, 2010; Ferreira et al., 2015). Once again, the studies carried out to date focus on relatively modern dwellings, and include a very limited number of examples of older heritage buildings.

2. Objectives and methodology

Therefore, the research project "*RE-HABITAT Restauración y rehabilitación sostenible de viviendas tradicionales en contextos históricos*" (Ref. CIAICO/2022/035) seeks to address these challenges by developing a methodological framework in order to assess the impact of decisions relating to construction in the restoration of traditional dwellings. This approach is based on four key axes: heritage intervention criteria, energy efficiency, life cycle analysis (LCA), and the real cost of rehabilitation.

Considering these parameters, this study aims to demonstrate how traditional techniques can offer viable and sustainable solutions for the restoration of dwellings in the Comunitat Valenciana and similar areas. The first phase of this project focused on the collection of general information on interventions in historic dwellings in the Comunitat Valenciana (Fig. 1).

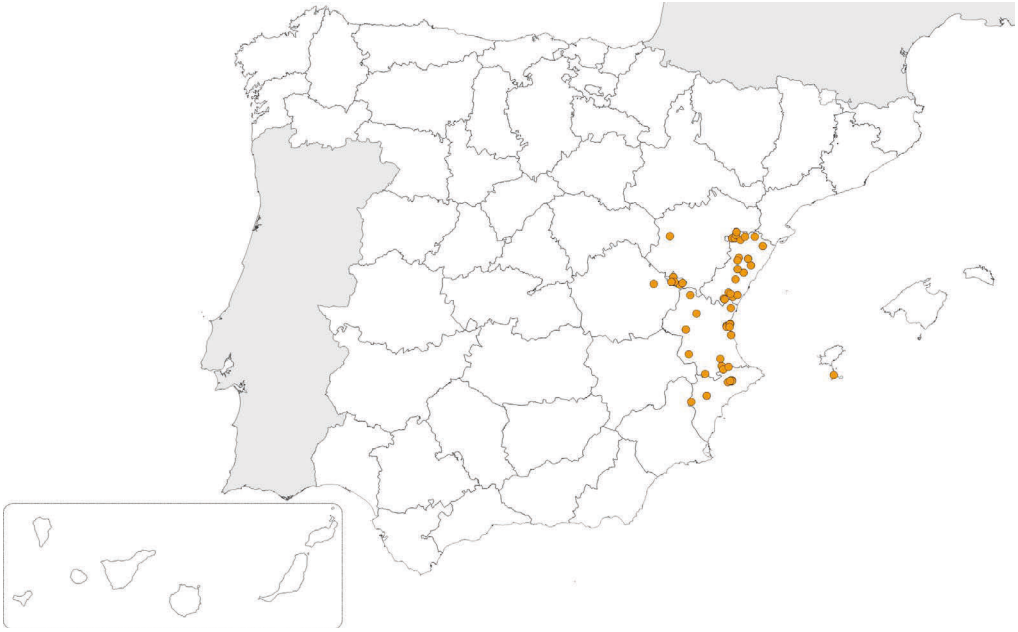

Fig. 1 – *Distribution of case studies from the general selection* (Hueto-Escobar, 2025).

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The study of a total of 84 buildings has allowed conclusions to be drawn in relation to the elements intervened and the solutions used. The second phase consisted in the selection of 8 case studies from the general base in order to carry out a detailed analysis based on the available information and whether the interior of buildings could be accessed.

Detailed analysis contemplates multiple aspects in order to reach conclusions concerning the viability and realistic applicability of interventions. This was done through the evaluation of compliance with criteria, energy efficiency, environmental impact, and real costs.

The third phase presents conclusions extracted from the comparison, as well as drafting guidelines and recommendations to allowing the transfer of knowledge.

This text aims to propose an initial approach to the detailed analysis of one of the buildings selected, a residential building situated in the neighbourhood of Cabanyal - Canyamelar (Valencia). The selection of this specific case study was dictated by the fact that the building and necessary documentation could be accessed, although for security and privacy reasons certain details such as the exact location and total construction budget have been omitted.

The approach to the detailed analysis started with a general description of the building, which was then followed by an assessment of criteria, materials, and techniques used in the intervention in relation to compatibility, energy improvement, life cycle, and real costs.

3. Application to the case study

The building selected for an initial approximation and verification of a detailed analysis methodology is a dwelling located in the neighbourhood of Cabanyal-Canyamelar, in the city of Valencia (Spain).

This intervention was carried out in 2022 in a dwelling built in the 1930s, one of the group of homes developed by Sociedad Pósito de Pescadores “Marina Auxiliante”. The complex is made up of two two-storey linear blocks of buildings with two dwellings per floor.

The dwellings on the ground floor were directly accessed from the street while those on the first floor were reached via a shared central stairwell. The dwelling intervened was on the ground floor, directly accessible from the exterior, with a façade 5.5 m long, a depth of 14 m, and 91 m^2 of built floor area.

The layout prior to the intervention was the traditional layout of entrance, three bedrooms, dining room, kitchen, bathroom and courtyard at the back of the dwelling (Fig. 2).

However, the back courtyard also features a small built volume in industrial brick while the kitchen has an elevated built-in cupboard with metal profiles and wooden boards (Fig. 3).

The intervention carried out in 2022 primarily aimed to improve the thermal comfort of the dwelling, examining the current standards of habitability, salubriousness, energy saving, and accessibility insofar as the heritage protection values allow (Fig. 4).

This building is included within the catalogue of protections of the Special Plan for Cabanyal-Canyamelar, in fiche C-19, which includes the group of dwellings it belongs to. At the same time, it is included amongst several Assets of Local Importance, including *Casa dels Bous* and former spaces for dyeing, *Fábrica de Hielo* and the *Lonja de los Pescadores*.

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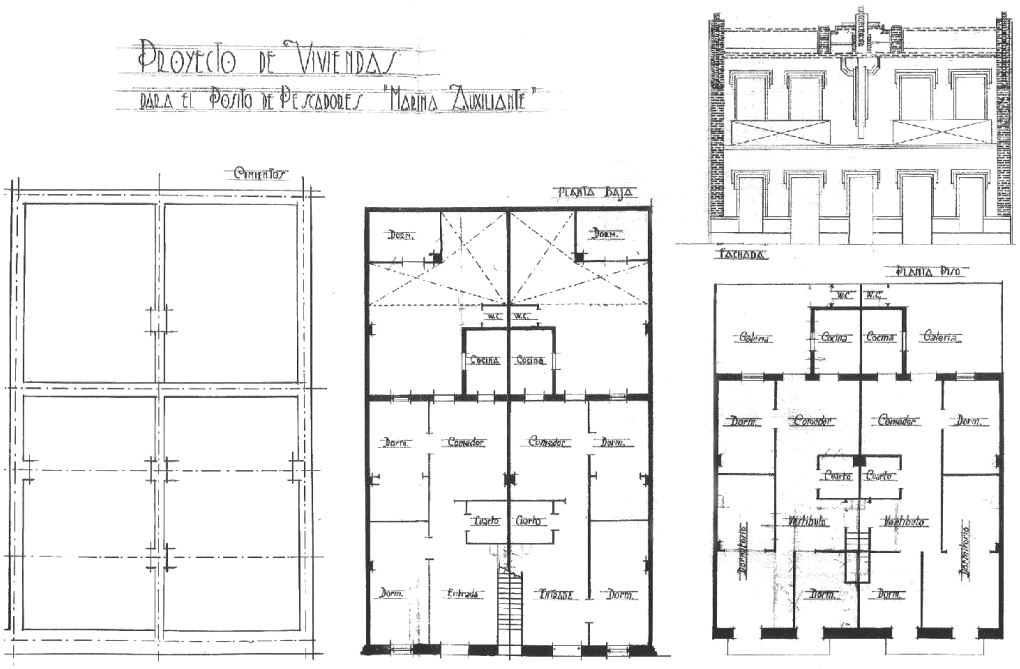

Fig. 2 – *Project for housing of the Sociedad Pósito de Pescadores "Marina Auxiliante", designed by J. Peris Pardo in the 1930s* (Pastor Villa, 2012, p. 377).

This status mostly means that any intervention in the façade must conserve the material and decorative aspects, as well as recovering the original carpentry and ironwork or using similar materials when this is not possible.

3.1. Analysis of interventions

The first step in this intervention is the elimination of unsuitable volumes from the courtyard and kitchen as these did not comply with the basic modern requirements for habitability and salubriousness, nor did they respect the original design of the dwelling (Table 1, I01) (Fig. 4).

In order to improve the ventilation and natural light, as well as thermal and acoustic insulation, this demolition also provided an opportunity to replace the wall between the dwelling and the outer courtyard with a small section of wall with hollow ceramic bricks and a large sliding window in aluminium with a thermal break and double glazing (Table 1, I02) (Fig. 5).

The exterior façade was rendered in lime mortar with a limewash finish (Table 1, I03), conserving the historic decorative mouldings and respecting the local characteristic colour palette.

For interior finishes of walls, the historic tiles known as *arrimaderos* have been conserved. These were a traditional solution characteristic of Valencian architecture, devised to prevent damp stains due to capillarity. The upper section has been rendered in gypsum paste and finished with limewash (Table 1, I04).

Due to the problems of capillarity, following the elimination of the existing concrete floor, ceramic tile flooring was added in a dry layout, allowing water filtration (Table 1, I05).

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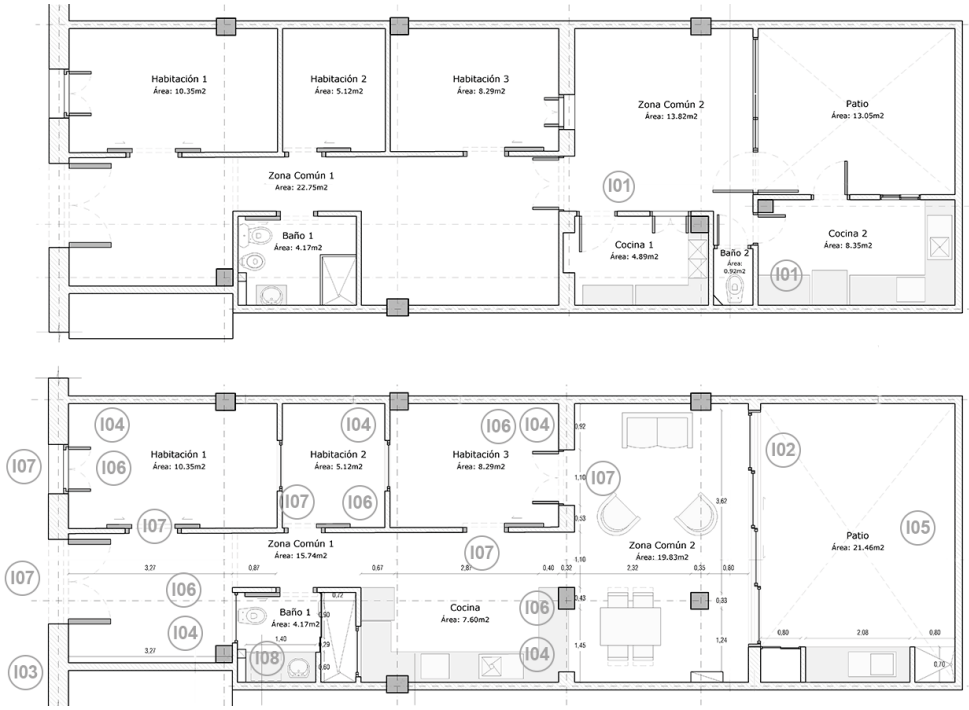

Fig. 3 – *Floorplan of the 2022 intervention project, condition prior to intervention and interventions proposed* (Vegas & Mileto, 2022).

Fig. 4 – *Photographs before and after the intervention* (Vegas & Mileto, 2022).

Unfortunately, interior flooring had to be replaced completely due to capillarity. It was replaced with neutral ceramic tile flooring, helping to unify the indoor spaces (Table 1, I06) (Fig. 5).

The historic wooden carpentry was all conserved (Table 1, I07), except for that eliminated from the courtyard façade and subsequently replaced with the window mentioned above.

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Table 1 – *Assessment of adaptation of interventions to restoration criteria, defined for each intervention: complies ✓, does not comply ✖, non applicable ▪.*

	I01	I02	I03	I04	I05	I06	I07	I08
Conserving authenticity	✓	✖	✓	✓	✖	✖	✓	✓
Minimum intervention	✖	✖	✓	✓	✖	✖	✓	✖
Reversibility	✖	✖	✖	✖	✓	✖	✓	✖
Visual integration	✓	✖	✓	✓	✓	✓	✓	✓
Readability	▪	✖	✓	✓	✓	✓	▪	✓
Material compatibility	▪	✓	✓	✓	✓	✓	✓	✓
Structural compatibility	▪	▪	▪	▪	▪	▪	▪	▪
Functional compatibility	▪	▪	▪	▪	▪	▪	▪	▪
Maintenance and prevention	▪	✓	✓	✓	✓	✓	▪	✓
Durability	▪	✓	✓	✓	✓	✓	▪	✓

Finally, the bathroom, which had been completely replaced without preserving its traditional appearance and had problems with drainage and ventilation, was completely reconstructed using recovered traditional tiles (Table 1, I08).

Thanks to the specific analysis of compliance with restoration criteria (Carbonara, 1997; Vegas & Mileto, 2011), a balance has been sought between conservation and the introduction of certain improvements in habitability, safety, and comfort (Table 1).

In terms of authenticity, the building's general appearance is maintained by conserving original elements such as historic tiles and wooden carpentry, although replacing the wall with a modern window might affect the original perception of the space.

In terms of authenticity, the building's general appearance is maintained by conserving original elements such as historic tiles and wooden carpentry, although replacing the wall with a modern window might affect the original perception of the space. However, this window aims to improve lighting and natural ventilation inside while also providing improved comfort conditions and reducing damp.

The minimum intervention criterion is adhered to as much as possible in decorative elements and render, although unsuitable elements disrupting the original configuration design and with no heritage value of their own were eliminated. This action helps to recover the original reading of the distribution of the dwelling.

As regards reversibility, eliminating the concrete flooring and dry laying of flooring allow earlier solutions to be recovered, although the introduction of the brick wall and aluminium window may be less reversible. Care has been taken with visual integration in both the exterior façade and the interior coatings, using limewash which respected the original palette. The interior flooring which was in dire need of replacement now has a neutral colour and finish, visually homogenizing the space. Mainly using traditional materials and solutions similar to those existing achieves a great degree of compliance with material compatibility. Although structural compatibility is not directly applicable to the interventions carried out, it should be noted that no new loads are added and the original operation is not modified. Equally, since the space remains residential, overall the interventions can be considered to display great functional compatibility.

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Finally, the entire intervention has been devised to facilitate maintenance and to prevent future problems by improving ventilation and insulation conditions, adding a window, replacing floors or using materials such as lime and gypsum which ensure correct hygrothermal behaviour. Therefore, the interventions proposed also comply with the criterion of durability.

3.2. Approximation to life cycle analysis

In order to carry out the life cycle analysis (LCA), an initial inventory of materials, labour, and machinery used during the intervention was completed. This defined both the amount and the distance from the place of origin or production. It should be noted that the complete development of the LCA will provide specific data on the environmental impact of the intervention, allowing a comparison of the intervention and equivalences carried out with industrial materials.

This approximation serves to establish that of the total surfaces intervened during the work, 30.6% corresponds to materials, 59.1% to labour, and 10.4% to machinery. The materials used were divided into major groups. Brick, cement, plastic, metal, varnish, and floor tiles were considered to be industrial materials, while traditional materials included wood, lime, gypsum, recovered tiles, and ceramic brick tiles. It was thus established that the intervention used industrial materials on 22.6% of the surfaces while traditional materials were used on the remaining 77.4%.

3.3. Approximation to energy efficiency improvement

In terms of energy and hygrothermal behaviour of the dwelling, the intervention carried out focused on improving ventilation conditions in order to alleviate indoor damp. The inclusion of insulation material in the main façade was ruled out given the need to preserve the external configuration, decoration, and finishes using lime mortar, while inside, wall tiles or *arrimaderos* were used.

In any case, sensors have been installed to ensure continuous monitoring of indoor, outdoor and surface temperature as well as ambient relative humidity for indoors and outdoors. This will provide an estimation of effective thermal conductivity of an enclosure with no intervention.

3.4. Approximation to cost analysis

According to the preliminary analysis of the costs of the intervention 48.3% of the Budget has been used for labour, followed by 43.4% for materials, and 8.2% for machinery. In turn, 64.9% of the cost of materials was used for traditional materials such as wood, lime, gypsum, ceramic brick tiles, and recovered floor tiles. The remaining 35.1% was spent on industrial materials such as hollow brick and cement.

Furthermore, the initial cost comparison for the restoration of the building versus the construction of a building of similar characteristics shows considerable savings. Taking as reference value the Basic Building Module from the Valencian Institute of Building, set at 720 €/m^2 in the year 2022, the rehabilitation of the dwelling accounts for only 22% of the cost of building a new dwelling with the same surface area. Thus, the cost per unit of the rehabilitation of the dwelling studied falls to 157.90 €/m^2.

4. Conclusions

The rehabilitation of traditional dwellings in historic settings presents a multidimensional challenge which requires the integration of heritage conservation, energy efficiency, environmental sustainability, and economic viability criteria. The research project proposal aims to address this by combining all the aspects mentioned in order to ultimately promote sustainable, respectful, and viable conservation.

The case study analysed in this text confirms restoration as a viable alternative to demolition

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and new construction. As regards the criteria applied, the case study analysed highlights the need to find a balance between conservation and adaptation to the taste, needs, and comfort demands of the owners. In this case, the addition of the window could be considered excessive, but is justified by the improved ventilation and lighting, which will provide better habitability conditions.

Furthermore, this also shows that the rehabilitation and conservation of this type of building is cheaper than constructing a new building, despite the high percentage of the budget allocated to labour. Finally, the economic impact expected is lower as it incorporates a high proportion of traditional materials.

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Passive Heating Strategies and Thermal Characteristics of Vernacular Buildings in Northeastern Portugal: A Case Study of Vernacular Building in the Montesinho Natural Park

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Topic: T1.5. Energy efficiency and sustainable design projects

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Abstract

This study highlights thermal underperformance in key spaces of a vernacular granite masonry building in Portugal, where winter monitoring revealed critically low air temperatures (9.5 °C in the bedroom at 06h30), failing adaptive comfort standards despite passive strategies like thick walls and wood stoves. A localised analysis of external walls and slate roofs evaluates agglomerated cork insulation (5 cm & 10 cm) through simplified thermal calculations. Results show 10 cm cork reduces wall U-values by 82 % (0.387 W/m²·K) and roof U-values by 93 % (0.439 W/m²·K), while 5 cm balances insulation (0.658 W/m²·K) with retained thermal mass. Long-term data correlates inherent passive designs, namely thermal mass from granite walls and shared party walls, with limited buffering capacity during extreme cold, necessitating targeted retrofitting. Despite moderate solar gains and stove heating, the building's thermal inertia proves insufficient without intervention. The findings reveal context-sensitive retrofitting: thicker cork for stable climates, moderate layers for regions requiring thermal mass. By aligning cork insulation with traditional strategies, this approach enhances energy efficiency without compromising heritage integrity, supporting SDG 11. Future work should integrate dynamic simulations to optimise solutions for vernacular architecture.

Keywords: *vernacular architecture; passive heating strategies; thermal performance; energy efficiency; bioclimatic solutions*

1. Introduction

Energy efficiency in buildings remains a critical challenge, particularly in regions with extreme winter climates where heating demands strain both resources and heritage preservation. Vernacular architecture, with its adaptive design principles, offers inherent sustainability, yet

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traditional buildings often struggle to meet modern thermal comfort standards. This study examines a historic granite masonry building in Pinheiro Novo, Montesinho Natural Park (MNP), Portugal.

Long-term monitoring of indoor hygrothermal data, particularly during the coldest periods, revealed persistent thermal discomfort in key living spaces, notably the bedroom (T1), despite passive strategies like thick granite walls and wood stoves. This is attributed partly due to the lack of proper insulation.

To address this, retrofitting with sustainable cork insulation emerges as a potential solution. However, detailed energy simulations exceed the scope of this study and cannot be discussed in detail. Instead, a localised, preliminary feasibility study is proposed for the building envelope components most critical to winter heat loss: the external granite walls and slate gable roof. By evaluating thermal parameters (e.g., resistance, transmittance, and useful thermal mass) under varying cork insulation thicknesses (5 cm and 10 cm), this study highlights trade-offs between insulation efficacy and thermal mass retention. The findings aim to inform retrofitting strategies that balance energy efficiency with the preservation of cultural heritage, aligning with SDG 11 (Sustainable Cities and Communities).

2. Objective

The study aims to improve the passive performance of the case study building by conducting a preliminary evaluation of the effects of insulation on thermal performance of the building envelope elements during heating period.

Long-term monitoring data is analysed to identify key thermal challenges, while a feasibility thermal assessment of the external granite walls and slate roof will quantify the effects of agglomerated cork insulation (5 cm and 10 cm) on thermal resistance (R), transmittance (U), and useful thermal mass (m_{tu}).

Additionally, the monitoring data is correlated with traditional passive strategies, such as thermal mass, and modern insulation techniques. This analysis will contribute to the development of context-sensitive retrofitting approaches that balance energy efficiency with cultural preservation.

3. Methodology

3.1. Data collection and calculations

Field monitoring allowed to collect temperature data, using TESTO 174H sensors, with readings taken at 30-minute intervals over an extended period (almost one year). The sensors are placed in key indoor spaces, including the bedroom (T1), kitchen (T2), and one sensor was placed outdoors (T4), to monitor indoor and outdoor temperature and humidity variations. Since this research is focused on the performance during the heating season, the coldest days during the monitoring period are extracted for detailed analysis.

The theoretical analysis requires the definition of the following thermal parameters: thermal resistance (R), thermal mass (m_t), and thermal transmittance (U). The thermal parameters used in the study are defined in (Briones-Llorente et al., 2020) and calculated using Microsoft Excel. These calculations are based on the thermal properties of granite and slate, as both specified in ITE 50 (Santos & Matias, 2006) and CTE (Instituto Eduardo Torroja de Ciencias de la Construcción con la colaboración de CEPCO y AICIA, 2008), along with the thermal characteristics of cork and the thickness of the insulation layers.

The Portuguese companies that produce cork board insulation in Portugal offer products with similar density and thermal conductivity ranges but do not provide specific heat capacity data. Therefore, the agglomerated cork board sample (Sample F) studied by (Barreca & Fichera, 2016) has been selected as the input reference. The material properties used are as follows:

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- Apparent density: 108.70 kg/m³
- Thermal conductivity: 0.047 W/(m·K)
- Specific heat capacity: *5468 J/(kg·K) (*generalised for simplicity)

3.2. Case study description

The case study building is located in Pinheiro Novo village, MNP (Figs. 1 & 2), and is occupied by a 76-year-old man. The date of construction is unknown but the owner reported that the house was built between 400 and 500 years ago. The building, features thick granite dry masonry walls (80 cm) and a slate gable roof. The upper floor comprises bedrooms, a kitchen, and a toilet, while the lower floor is used primarily for storage and carpentry work (Fig. 3). The building shares walls with adjacent structures on both sides and faces northeast, oriented approximately 30 degrees from north. Passive heating is provided by a wood fire stove located in the kitchen, which also benefits from afternoon solar exposure due to its southwest-facing orientation.

4. Results and discussion

4.1. Temperature monitoring data

The charts display the temperatures recorded during the winter period, presented in two sections (Figs. 4 & 5). The lowest external temperature (T4) during the study period was 0.6°C, recorded on 15th January 2025 (Fig. 6), following the consideration of prior 7 days with consistently low temperatures.

The air temperature in the bedroom (T1) at 06h30 on 15th January 2025 is at 9.5°C, assuming a close approximation to its operative temperature. By 06h30, residual heat from the kitchen (T2) has subsided, aligning T1 and T2 temperatures by 07h00, making 06h30 a valid "coldest" pre-waking benchmark.

In alignment with the adaptive thermal comfort model for naturally ventilated buildings specific to the Portuguese context, as originally established by (Matias, 2010) and later adopted in case studies by (Fernandes et al., 2019), bedroom T1 demonstrates insufficient thermal performance under minimum external temperature conditions, failing to meet established comfort criteria. This deviation is illustrated in (Fig. 7).

Fig. 1 – *Aerial orthophoto of the case study in Pinheiro Novo.*

Fig. 2 – *Front facade of the case study.*

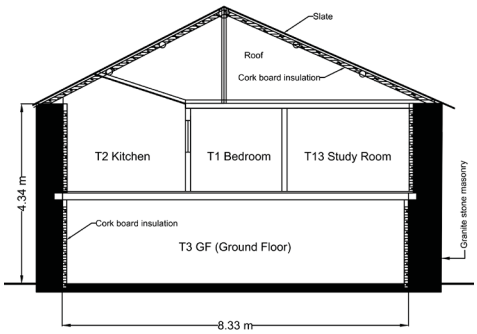

Fig. 3 – *Building section & suggested cork insulation.*

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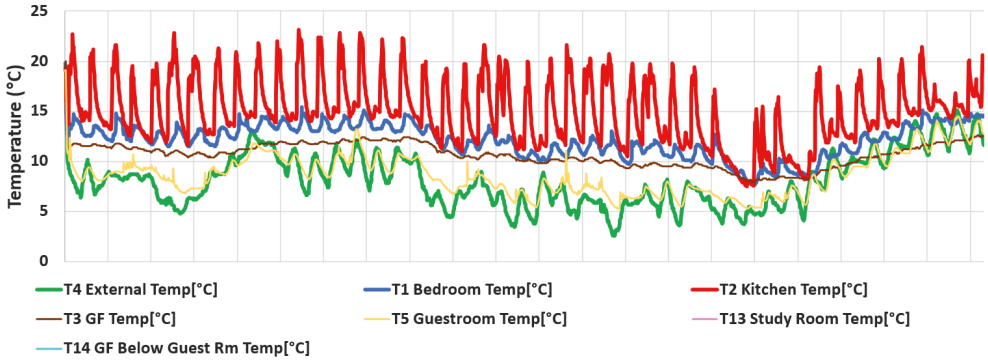

Fig. 4 – *Winter period temperature long-term monitoring in a Pinheiro Novo village case study (1/2).*

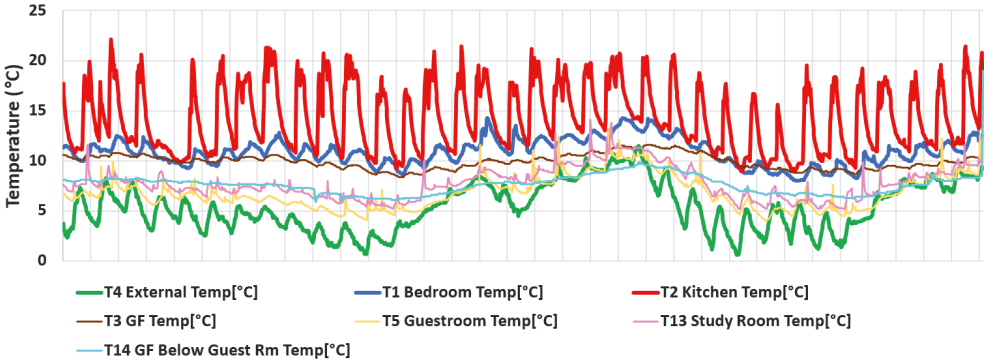

Fig. 5 – *Winter period temperature long-term monitoring in a Pinheiro Novo village case study (2/2).*

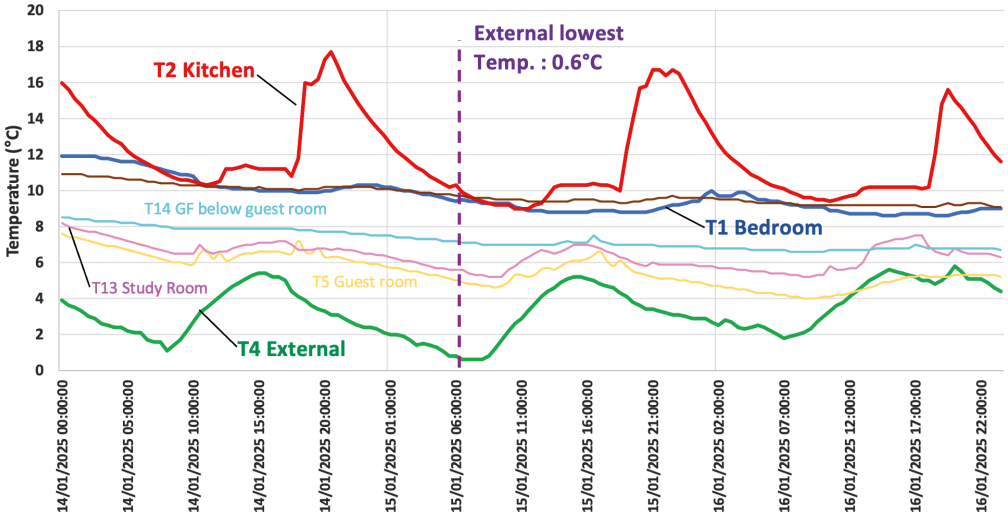

Fig. 6 – *Winter period 14th to 16th January 2025).*

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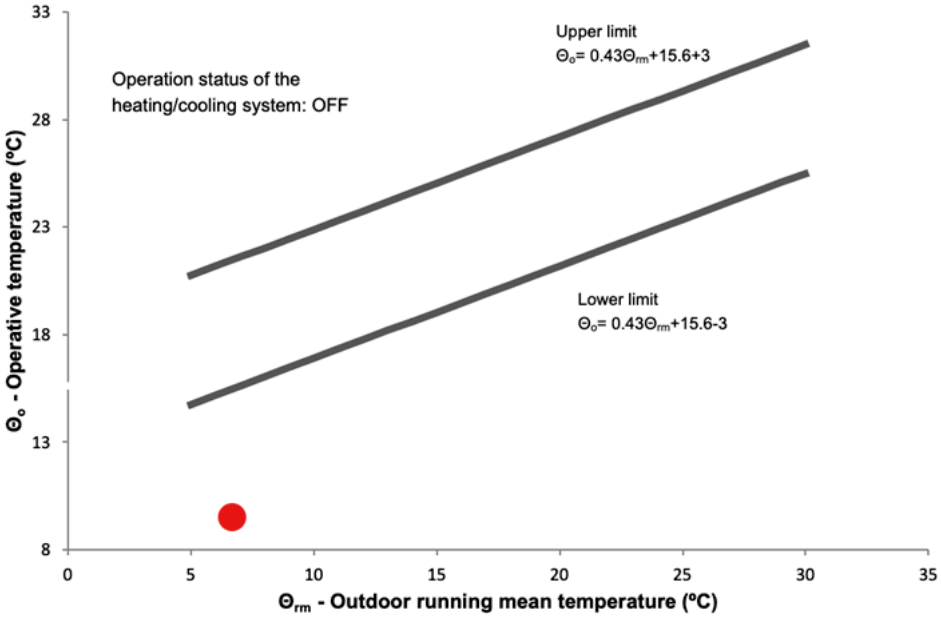

Fig. 7 – *Adaptive comfort chart for bedroom operative temperature (T1) during the lowest external temperature.*

4.2. Thermal characteristics of external walls and slate gable roof

The thermal behaviour of a granite external wall and slate gable roof was analysed under three scenarios: uninsulated, 5 cm internal cork insulation, and 10 cm internal cork insulation. Key metrics include thermal resistance (R), thermal mass (m_t), thermal transmittance (U), and useful thermal mass (m_{tu}).

4.2.1. Key observations (Table 1)

R increased by 233 % (5 cm) and 466 % (10 cm), reducing U by 82.4 % with 10 cm cork.

1. m_{tu} decreased by 78.5 % with 10 cm insulation, highlighting a trade-off between insulation and heat storage capacity.
2. Thermal constant (CTT) rose with insulation thickness, delaying heat penetration.
3. Trade-offs: A 10 cm cork layer offers superior insulation (U = 0.387 W/m²·K) but reduces mt_u % to 8.38 %, potentially limiting temperature regulation in climates requiring heat storage. A 5 cm layer balances insulation (U = 0.658 W/m²·K) and m_{tu} % (12.66 %).

The roof of this vernacular building features an irregular timber framework, reflecting traditional construction methods that utilise locally available materials. Large, roughly hewn beams form the primary support, with secondary wooden members, likely purlins, spanning between them to distribute loads. The slate covering rests on these purlins or battens, ensuring proper spacing. Additional vertical props, placed irregularly, suggest reinforcements against sagging or structural weakening over time.

This organic construction approach, shaped by material availability and on-site adjustments, integrates a timber roof with stone masonry walls, showcasing a vernacular style well-adapted to the local climate.

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Table 1 – *Thermal characteristics of external granite stone masonry wall with agglomerated cork board insulation.*

	R (m2×K/W)	m_t (J/m2×K)	CTT (J/W) = (s)	m_{tu} (J/m²×K)	m_{tu} %	U (W/m²×K)
Current	0.456	2,080,000.000	380,342.857	834,608.15	40.13	2.194
Cork (t = 5 cm)	1.520	2,109,718.580	405,830.379	267,073.78	12.66	0.658
Cork (t = 10 cm)	2.583	2,139,437.160	462,933.411	179,197.22	8.38	0.387

* Thermal Resistance (**R**), Thermal mass (**m_t**), Thermal constant (**CTT**), Useful thermal mass (**m_{tu}**), Useful thermal mass percentage (**m_{tu}** %), Thermal Transmittance (**U**).

Table 2 – *Thermal characteristics of gable slate roof with agglomerated cork board insulation.*

	R (m2×K/W)	m_t (J/m2×K)	CTT (J/W) = (s)	m_{tu} (J/m²×K)	m_{tu} %	U (W/m²×K)
Current	0.149	48,000.000	2,138.182	14,341.46	29.88	6.707
Cork (t = 5 cm)	1.213	77,718.580	19,404.849	15,998.45	20.59	0.824
Cork (t = 10 cm)	2.277	107,437.160	68,287.027	29,993.20	27.92	0.439

* Thermal Resistance (**R**), Thermal mass (**m_t**), Thermal constant (**CTT**), Useful thermal mass (**m_{tu}**), Useful thermal mass percentage (**m_{tu}** %), Thermal Transmittance (**U**).

4.2.2. Key observations (Table 2)

1. R increased by 714 % (5 cm) and 1,428 % (10 cm), lowering U to 0.439 W/m²·K (93.5 % reduction) with 10 cm cork.
2. Unlike walls, m_{tu} increased by 109 % with 10 cm cork, though m_{tu} % fluctuated (29.88 % → 20.59 % → 27.92 %).
3. CTT surged by 3,094 % with 10 cm insulation, enhancing time lag for heat transfer.

Cork insulation significantly improves thermal resistance and reduces heat loss, particularly in roofs (U reduced to 0.439 W/m²·K). External wall lose useful thermal mass with insulation, while roofs gain m_{tu} due to lower initial thermal mass. Optimal insulation thickness depends on climate: 10 cm cork maximises energy efficiency but may underperform in regions requiring thermal mass buffering (e.g., diurnal temperature swings). (Briones-Llorente et al., 2020) observed similar insulation-thermal mass trade-offs in prefabricated blocks, reinforcing these findings.

The selection of internal cork insulation for the granite walls and roof, despite the enhanced thermal mass utilisation of external insulation, prioritises compliance with EU heritage conservation mandates. Under the Energy Performance of Buildings Directive (EPBD) 2018/844/EU (Article 7) and European Standard EN 16883:2017, renovations of culturally significant structures must preserve historical façades and materials, avoiding alterations to external appearances.

External insulation would modify the building's vernacular character, conflicting with these requirements. While internal insulation reduces thermal inertia relatively, it fulfils functionality and technical feasibility without compromising heritage integrity, aligning with the EU's dual emphasis on energy efficiency and cultural preservation.

4.3. Passive heating strategies

This study examines the temperature performance of a traditional masonry building in Pinheiro Novo village, Montesinho Natural Park, Portugal with no insulation on walls and roofs.

The chart (Fig. 6) covers the indoor and outdoor temperature variations between 14th and 16th January 2025 extracted from the long-term monitoring period, with particular focus on key spaces at first floor such as the bedroom (T1), kitchen (T2), and external environment (T4).

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The study aims to understand the thermal behaviour of vernacular architecture in cold climates, especially considering the influence of passive and active heating strategies.

4.3.1. External temperature and building orientation

The presence of neighbouring buildings on both the left and right sides, as well as opposite structures, affects the solar exposure of the case study building. The kitchen (T2) is located at the rear, facing southwest, while the study room (T13) is positioned at the front, oriented northeast. This configuration suggests that solar gains in winter are limited, particularly for T1 since there is no direct solar gain. The southwest-facing kitchen (T2), however, may benefits from afternoon solar exposure contributing to its temperature profile, although it has been discussed that there are relatively less sunny days during winter period (Khei et al., 2024).

4.3.2. Indoor thermal dynamics and wood fire stove influence

The temperature variations in the monitored indoor spaces reflect the impact of both passive heat retention and active heating from the fire stove. The kitchen (T2) exhibits significant temperature fluctuations, particularly during the evening when the stove is ignited between 18h00 and 19h00. Peaks in kitchen (T2) temperature confirm the wood fire stove's contribution to space heating, with a notable increase to approximately 17-18 °C, before gradually cooling down. The bedroom (T1), separated from the fire stove by a 12 cm thick brick wall with cement plaster maintains a more stable temperature profile but slightly benefits indirectly from heat transfer through conduction and radiation from the heated wall.

4.3.3. Ground floor thermal performance

The ground floor (T14), described as having a cave-like structure with a large entrance door but no windows, demonstrates relatively stable but lower temperatures compared to the upper spaces. This is attributed to the thermal inertia of the granite stone ground slab, which moderates temperature fluctuations. The study room (T13), located beside T1, shows a similar thermal trend, though slightly warmer due to indirect heat transfer from adjacent spaces.

4.3.4. Role of building materials and passive thermal strategies

The case study building's thermal performance is significantly influenced by its traditional construction materials. The external granite masonry walls, 80 cm thick, provide substantial thermal mass, slowing heat loss during cold nights and mitigating indoor temperature fluctuations. The shared masonry walls with neighbouring buildings further reduce heat loss, enhancing thermal stability by reducing heat loss through external surfaces. Additionally, the limited window openings, especially on the ground floor contribute to heat retention, making internal heating sources, such as the wood fire stove, crucial during winter.

5. Conclusion

This study addresses the critical challenge of enhancing thermal comfort in historic vernacular buildings while preserving their cultural integrity. Focused on a granite masonry vernacular building in Montesinho Natural Park, Portugal, the analysis reveals persistent thermal inadequacies during extreme winters, particularly in the bedroom (T1), where air temperatures as low as 9.5 °C fall short of adaptive comfort thresholds. Despite passive strategies namely thick granite walls and wood stoves, the building’s lack of modern insulation underscores the need for retrofitting that harmonises energy efficiency with heritage conservation.

By evaluating localised retrofitting of external walls and roofs with agglomerated cork insulation, the study demonstrates that even modest interventions (5 & 10 cm) significantly

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improve thermal resistance (R increased by 233 % & 466 % in walls, 714 % & 1,428 % in roofs) and reduce heat loss (U-values lowered to 0.658 W/m²·K & 0.387 W/m²·K in walls). However, trade-offs emerge: thicker insulation diminishes useful thermal mass (m_{tu}) in walls by up to 78.5 %, potentially undermining their inherent heat-buffering capacity, while roofs gain m_{tu} due to their lower initial thermal inertia. These findings underscore the importance of context-specific solutions, that thicker insulation suits stable cold climates, whereas regions with diurnal swings require balanced m_{tu} retention.

Internal cork insulation aligns with EU heritage mandates by preserving historic façades while meeting energy directives. This study advances SDG 11 by providing a framework for retrofitting vernacular architecture without compromising cultural value. It underscores the importance of integrating modern materials with traditional passive strategies, such as thermal mass and shared party walls, to enhance sustainable thermal comfort.

Future research should explore different bio-based insulation materials with varying thicknesses for roofs and walls to achieve cost-optimal renovations for similar buildings. Additionally, dynamic simulations should assess the impact of renovation scenarios on thermal performance and energy efficiency, while stakeholder engagement will help refine retrofitting protocols to enhance the resilience, efficiency, and liveability of vernacular buildings in a changing climate.

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WEDoVer Strategy for Documenting and Enhancing Vernacular Heritage: a Case Study of the Excavated Wine Cellars in Utiel (Spain)

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Abstract
Conservation of vernacular heritage, documentation and enhancement are related biunivocally. Undoubtedly, heritage conservation is nourished, among other processes, by documentation and has its raison d'être in the enjoyment of both present and future generations. In the field of vernacular heritage, generally unprotected, the risks of incompatible transformation and/or disappearance are evident. Based on this consideration, the WEDoVer strategy aims to document and enhance vernacular heritage through a cooperative experience simultaneously. To test its effectiveness, the plan has been developed in the historic complex of the excavated cellars of Utiel (Valencia-Spain). This heritage preserves the pre-industrial traces of the main activity that characterised the economy of the Valencian hinterland, the artisanal production of wine and its conservation. From the end of the 14th century until the middle of the 19th century, the geological and environmental characteristics were used to guarantee the good quality of the wine, with the habitat around its cultivation and elaboration being its sign of identity. The choice of study area is due to the wide range of circumstances in terms of conservation, architectural typologies, vulnerability, risks, and accessibility. These criteria make it possible to contrast the strategy, improving and redesigning it so that it is adaptable and extrapolated to other vernacular heritage scenarios.

Keywords: *WEDoVer strategy; vernacular heritage; documentation; enhancement; wine cellar; community; historic site; Utiel*

1. Introduction

Enhancing the value of cultural heritage involves identifying and recognising the historical, artistic and social significance, among other factors, of certain assets or spaces that are fundamental to the identity of a social group. This process not only entails conservation but also the implementation of actions that sustainably facilitate its use and enjoyment, ensuring its accessibility, legibility and understanding, and transmission to future generations.

Enhancing its value also implies raising awareness among the local population about the importance of its heritage, which in many cases is at risk of disappearing due to anthropic threats, promoting its conservation and recognition as a legacy of the community's identity.

Two key aspects of the enhancement of cultural heritage are research and documentation. Documentation is considered an integral part of any conservation process and an essential requirement for understanding the cultural

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significance of historic heritage. This principle is reflected in conventions and principles developed from 1930 to the present, emphasising the importance of documentation (Haddad et al., 2021). Documenting not only allows acquiring a specific and detailed knowledge of each unique piece, but also enables the general understanding, through comparison, of the shared common structure, as well as the variations within each typological series (Calduch, 2001).

1.1. What is the WEDoVer strategy?

WEDoVer is the acronym for Workshop for the Enhancement and Documentation of Vernacular Heritage. The WEDoVer strategy aims to achieve two main objectives: to document and enhance the value of vernacular heritage and integrate these actions into a single process. On the one hand, it focuses on discovering, processing, integrating, and recording knowledge related to this heritage. On the other hand, it seeks to reconnect the local community with its heritage through an external perspective and to disseminate this heritage by producing unpublished material. The WEDoVer strategy arises from a shared interest in the conservation of vernacular heritage at the Universitat Politècnica de València, where a group of professors specialising in architectural restoration considers the formative relevance of the *learning-by-doing* method (Anzai & Simon, 1979) which complements theoretical learning with active participation through practical experience.

This strategy has been implemented in two editions: the first in 2022 and the second in 2024. The development format is based on a workshop for university students and graduates in architecture, design, fine arts, conservation and restoration of cultural heritage, which will last for fifteen days. During this period the participants, organised in work teams of 2-3 people, have alternated study, research and case documentation activities with recreational activities that promote knowledge and integration into the local community.

Fig. 1 – *Poster of the 2022 edition workshop.*

To enrich the research process through case documentation, both editions have focused on the same study area: the underground wine cellars of Utiel (Valencia, Spain). Six case studies were explored in the 2022 edition, while three cases were addressed in the 2024 edition. The variation in the number of cases reflects the number of participants (13 in the first edition, from 5 different countries, and 8 in the second edition, from 3 different countries) and the scale of each case.

1.2 Approach to the study case

The excavated cellars of Utiel constitute an identity feature of their natural habitat. They are the earliest evidence of wine production and preservation in domestic settings. The local wine culture has significantly influenced the environment and the social and economic spheres. It shaped the territory through extensive vine cultivation, impacted local demographics, guided urban expansion, influenced the construction of both above-ground and

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underground structures, promoted specialisation and the creation of crafts, encouraged the formation of guilds and cooperatives, and left its mark on the local language, among other aspects.

The subsoil of the urban area of Utiel is home to this historic ensemble of traditional wine cellars, numbering in the hundreds.

Documentarily, their presence is confirmed from the end of the 14th century (Escritura de Venta de Casa Con Bodega En La Villa de Utiel, 1387), with their gradual disuse beginning in the second half of the 19th century, leading to further degradation and, eventually, their burial.

The selection of case studies is based on the following criteria:

- Accessibility is ensured by local community members' involvement in the strategy. Most wine cellars are privately owned, limiting access and requiring trusted local individuals' collaboration.
- State of conservation to select cases that, as far as possible, maintain their original condition without interventions that could distort the understanding of the heritage asset.
- Typological diversity, considering their location either inside or outside the boundaries of the layout of the medieval city wall.

Fig. 2 – *Wine cellar of Rosario and Nicolás. Enmedio Street, 33, Utiel.*

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A scientific approach is adopted for documentation, avoiding a romantic view of the heritage.

1.3 Legislation

The only regulation affecting the heritage ensemble of the excavated wine cellars of Utiel is the *Special Plan and Catalogue of Protected Spaces and Protected Heritage Assets of the Traditional Nucleus of Utiel*. Upon analysing this normative document, the following observations can be made: the intention to incorporate this unique heritage into urban planning instruments and the protection of local heritage, as well as the possible inclusion of these assets within the archaeological monitoring area.

Regarding this last point, it is specified that a preliminary study must include a graphic description of the wine cellars, their construction elements, materials, and contents, as well as photographic documentation.

Additionally, an intervention proposal must be presented to determine whether archaeological excavation or archaeological monitoring is necessary (Plan Especial y Catálogo de Bienes y Espacios Protegidos Del Núcleo Histórico de Utiel, 2014).

2. Objectives

The main objective of the WEDoVer strategy in the two editions conducted has been to document and enhance the value of the set of excavated wine cellars in Utiel.The first objective, documentation, is broken down into the following specific goals:

1. To perform a thorough and detailed visual inspection of the building.
2. To identify the elements that make up the set and contribute meaning to the intended use for which they were designed.
3. To analyse the relationships between elements, evaluating the repetition or diversity of typological solutions
4. To sketch by hand, on-site, using the dihedral system to represent scaled plans and sections that define the geometry of the formal configuration and the inclusion of equipment in each space.
5. To take measurements, horizontal and vertical, triangulating with the first type and establishing relationships between different levels in the second type to formally draft the spaces.
6. To produce an extensive photographic report (orthophotos, detailed photographs, high-resolution videos) that records data on the materiality (construction details, textures, degradation, and pathologies).
7. To reconstruct the on-site sketches through precise architectural and artistic drawings that capture geometry, materiality, degradation, and spatiality, incorporating projected shadows.

The second objective, enhancement, is also broken down into the following specific goals:

1. To organise exhibitions in collaboration with public administrations. First, with a local scope, the results of the research and documentation will be brought to the community; second, with an international scope, the exhibition of results will be integrated into the framework of an international conference.
2. To disseminate the results through publication on an interactive website that provides information on geolocation, produced graphic material, historical information, and virtual tours of the heritage assets documented, among other content.
3. To involve WEDoVer participants in the exhibitions, particularly in the first local exhibition, assigning them the role of exhibition guides.

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3. Methodology

The methodology employed, *learning by doing*, has been implemented through a case-based learning approach. Participants were required to apply their theoretical knowledge to carry out the documentation process, solving problems that only arise when the experience is real (for example, measurement in the absence of Euclidean references, measuring levels in spaces with organic development, and representing complex three-dimensional reality in the two dimensions of paper).

Given the formal complexity of the organic spaces to be documented, principles of flexibility and resilience have been adopted in the on-site documentation process, measurement, and representation of results. In this sense, various methods of measurement and representation have been tested, considering both the spatial complexity of the case study and the knowledge and skills of the participants, who have learned from one another and the mistakes made.

Avoiding strict methodological rigour, the strategy has encouraged the hybrid use of manual tools and electronic devices for planimetric survey work. The results obtained have been evaluated without needing non-contact digital measurement technologies, such as laser scanning or photogrammetry. Manual tools such as drawing boards, graphite pencils of varying hardness, erasers, opaque and tracing paper, measuring tapes, spirit levels, and plumb lines have been used for on-site work. Electronic equipment such as laser measurers, laser levels, smartphone-integrated cameras, and a RICOH THETA S2 spherical camera have also been employed.

For the restitution of the data collected on-site, materials such as high-weight white paper, graphite pencils of varying hardness, coloured pencils, technical pens, and watercolours have been used. With this basic equipment, the WEDoVer strategy has demonstrated that it is possible to obtain high-quality results using accessible, common tools without resorting to costly technologies that are generally economically unsustainable for most (de Dato de Gennaro, 2024), without denying the benefits of digital technology, but acknowledging the value of previous technologies.

The physical presence of participants in the buildings during the sketching and measuring process and their involvement in the graphic restitution at a nearby community venue for two weeks have generated significant interest within the local community. In particular, the community workspace in a public building has remained open and accessible, allowing various groups, such as teachers, local cultural associations, and spontaneous visitors, to observe the graphic restitution process.

4. Results

The application of the WEDoVer strategy to the case study of the historic set of excavated cellars in Utiel across its two editions has provided the following results:

Regarding documentation:

- A total of thirty-two architectural drawing sheets have been created using mechanical graphite pencils of varying thicknesses and hardnesses, which define unique organic spaces. These sheets detail the materials, construction techniques used, observed degradation, and the depth of the spaces through the incorporation of projected shadows.
- Seven watercolours have been painted to artistically express the perception of these unique spaces, with one of them particularly highlighting the intangible process of traditional wine production and preservation.
- Four artistic drawings have been created using coloured pencils, illustrating common degradations observed and studied in the ceramic amphorae. These elements are

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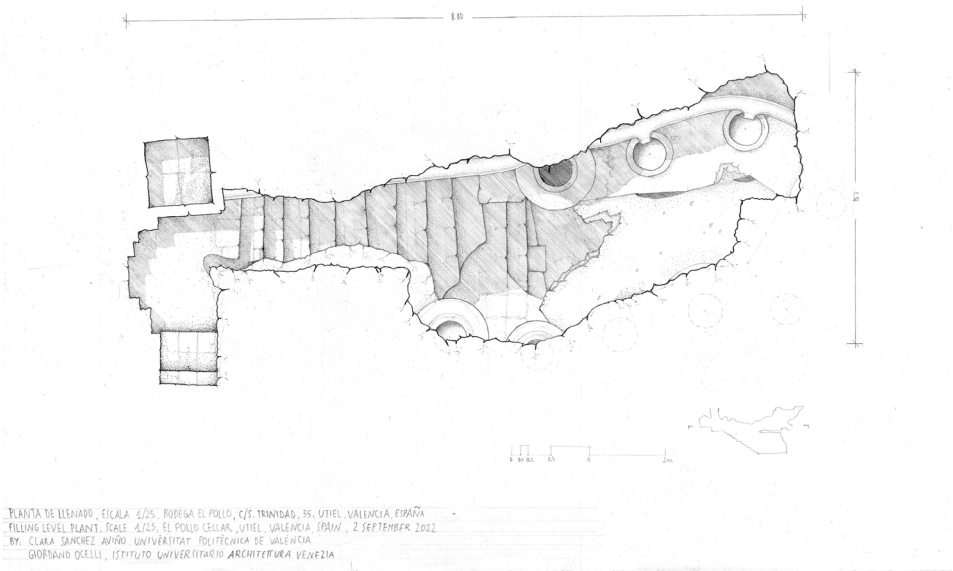

Fig. 3 – *Hand-drawn architectural sheet with graphite pencils, representing a section through the filling level of the "El Pollo" cellar on Trinidad Street, 35* (Sánchez-Aviñó & Ocelli)

significant in these spaces, as their preservation helps date this rich heritage.

- A 20-minute documentary video has been produced, summarising the WEDoVer experience, featuring interviews with participating students, organisers, directors of the strategy, cellar owners, historians, and local community members.
- An interactive website (yet to be published) has been developed, offering access to the generated documentation (drawings and paintings, a virtual tour of each case study) and specific information about each wine cellar (geolocation, historical data).

Fig. 4 – *QR code for accessing the virtual tour of the Rosario and Nicolás cellar at Enmedio Street, 33, Utiel.*

Regarding enhancement:

- Two local exhibitions have been organised and inaugurated at the conclusion of the WEDoVer experience. One thousand two hundred visitors over two weeks in each exhibition have demonstrated the positive impact of the action. The local community has been able to recognise their heritage, and they have been pleasantly surprised to see how outsiders appreciate and value their heritage. This has sparked an interest in preserving their cellars, which still lie beneath the streets of Utiel's urban centre.
- One exhibition was held at the Heritage 2022 international conference.
- Site visits to the case studies have been organised as complementary activities during international conferences, such as Heritage 2022.
- The experience has been locally disseminated through radio interviews, with student participation.

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- Articles have been published in local and international journals.

It is important to note that the results of both editions have undergone an enriching expressive evolution, reflecting the participants' diverse educational backgrounds. In the first edition, all participants were trained in design and architecture. In contrast, in the second edition, in addition to students with the aforementioned training, there were participants with backgrounds in Fine Arts and Conservation and Restoration of Cultural Heritage.

Regarding the experience itself, participants, in addition to receiving specific training, worked on and enhanced transversal skills such as social commitment, creativity and innovation, teamwork and leadership, effective communication, as well as responsibility and decision-making.

5. Conclusions

The tactile perception of the documented heritage emphasises the vulnerability of traditional architecture and reinforces awareness about the need for its conservation. The WEDoVer experience has highlighted the fragility of vernacular heritage in Utiel, demonstrating that the loss of heritage value in the excavated cellars is caused by anthropogenic factors, from incompatible transformations of these structures to their burial. This situation is further exacerbated by the disconnect between the current population—both local and immigrant—with the local history. Therefore, there is an urgent need to redouble efforts to document and enhance the value of traditional heritage.

Regarding regulations, the initial intent to preserve the excavated cellars of Utiel requires thorough documentation and detailed cataloguing that allows for differentiation of conservation statuses, protection levels, and permissible types of intervention. Additionally, it is essential to create and establish comprehensive protection mechanisms for the entire site, along with economic support measures that promote safeguarding this heritage from a social perspective.

In the contemporary context of technological advancements, it is concluded that it is essential to reflect on the coexistence of traditional methods and non-contact technological innovations in the processes of documentation and enhancement.

The traditional documentation process, which involves physical proximity to the heritage site, allows for an immersive experience that facilitates contemplation, reflection, and transformation of the person documenting it. This approach ensures deep learning through knowledge integration, fostering an appreciation and respect for cultural identity. Sensory perception allows for a connection between the object and the body, providing a deeper understanding of it, such as its scale. Touching, listening, smelling, and observing the study environment facilitates memorising tactile information—something digital tools (such as laser scanning or photogrammetry) cannot replicate. It can be concluded that both tactile and intellectual understanding are essential for proper conservation planning. Therefore, traditional and innovative technologies should complement and reinforce each other’s benefits.

Regarding enhancement, it is necessary to acknowledge that the manual representation of results helps bridge generational gaps and creates an expressive connection with the local community. The community can observe how others with different cognitive profiles perceive and value their heritage in an exercise of awareness and sensitisation (Pejkovic, 2021). At the same time, it is important to consider the advantages of innovative technologies in addressing various limitations (physical, legal, etc.), which may hinder direct engagement with the heritage, providing alternatives such as augmented or virtual reality. On one hand, there is physical reality with its virtues and limitations,

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and on the other, digital reality. The synergy between both realities offers a range of benefits, overcoming the inherent limitations of each and creating an enriched and enhanced experience for the user (de Dato de Gennaro, 2024).

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Bourbon Industrial Architecture and Territory: the Recovery of the Vanvitellian Mills in Valle di Maddaloni (Italy)

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Abstract
The Vanvitellian Mills of Valle, included in the UNESCO network of Caserta, a strategic site in southern Italy, are an extraordinary example of industrial architecture. Once the productive heart of the Kingdom of the Bourbons and now in a state of abandonment, these architectures represent an opportunity to rethink the relationship between history and territorial development. Commissioned by Ferdinando IV of Borbone and built between 1793 and 1800 by Carlo Vanvitelli, the complex consists of an upper mill, a lower mill and the church of San Carlo. Its strategic position allowed it to exploit the power of the water of the Carolino River through a system of indirect transmission milling. With its production and support functions, the complex was a self-sufficient microcosm, indispensable in a rural and isolated context. The paper, based on work carried out as part of a degree dissertation, proposes an integrated restoration and redevelopment project that can restore the complex's dignity as a key cultural asset through its reintegration into the social and cultural fabric of the area. Through a detailed cognitive investigation, it was possible to understand the strategic importance of the mills within the hydraulic system of the Acquedotto Carolino, Luigi Vanvitelli's engineering masterpiece. The operational phase, a combination of surveys and diagnostic studies, has made it possible to identify construction techniques, significant disturbances and surface degradation. Starting from a project idea that networks the area's Bourbon industrial architecture, strategies are foreshadowed to start a process of valorisation of the complex. The Mills will be linked to nature trails, UNESCO World Heritage sites and other Bourbon architecture, and reintegrated into a new cultural cycle-pedestrian route through the Tifatini Mountains. The paper therefore analyses the methodological approach and design perspectives that can create the conditions for re-thinking the relationship between history, community and sustainability.

Keywords: *Bourbon heritage; industrial restoration; cultural redevelopment*

1. Introduction

In the context of the Reggia di Caserta and its network of UNESCO heritage sites, the Mulini della Valle complex represents a significant example of 18th century industrial architecture, now in a state of ruin. Designed by Carlo Vanvitelli and commissioned by the Bourbon crown, these mills exploited the water of the Acquedotto Carolino, an extraordinary infrastructure conceived by Luigi Vanvitelli in 1762 to convey water, along a 37-kilometre

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route, from the Taburno springs to feed the hydraulic system of the Royal Palace (Fig. 1). The aqueduct, with its imposing Bridges of the Valley, is a grandiose work inspired by Roman models, an integral part of the economic and political plan initiated by Charles of Bourbon and continued by his son Ferdinand IV, aimed at rationally exploiting the Kingdom's water resources.

Within this system, the network of royal mills was designed to exploit the hydraulic energy generated by the lowering of the water level along the Carolinian aqueduct. These mills, which functioned as real industrial plants, were structured in such a way as to exploit water energy to drive the milling mechanisms: two large, superimposed stone wheels, one fixed at the bottom and one movable at the top, set in motion by the driving wheel through an axle, allowed the grinding of grain.

This thesis research arises from the need to recount not only the grandeur and monumental works of a historical period or population but also the everyday transformations of a territory, shaped by small social events and local practices. The province of Caserta, historically known as "Terra di Lavoro," bears witness to a past of productive activity through its Bourbon industrial structures, which deserve preservation and enhancement. The Mills of Valle serve as a significant example, representing an essential chapter in the history of labor and technical ingenuity of the time.

The proposed project for the recovery of the Mills of Valle is based on an in-depth understanding of their history, construction evolution, and materials, as well as an analysis of their current state of conservation. This knowledge serves as the foundation for defining restoration methodologies aligned with Vanvitellian architecture and enhancement strategies compatible with contemporary needs.

The project seeks to rethink the relationship between historical identity, community, and sustainability by integrating heritage conservation with an inclusive and territorially integrated development model.

The case of the Vanvitellian Mills of the Valle is proposed as a model of how the restoration and enhancement of historical industrial heritage can strengthen the connection between architectural history, landscape values, and local communities.

The core idea of the project is to create a cultural network linking the Bourbon industrial architectures in the region, initiating a sustainable enhancement process. The ultimate goal is to restore the complex for broader public use, offering new opportunities in cultural, educational, and tourism sectors, thereby situating it within a broader framework of rediscovery and promotion of the region's historical-industrial heritage.

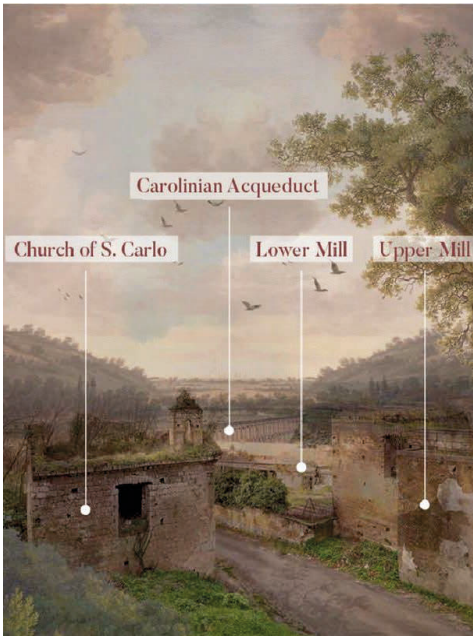

Fig. 1 – *The Mills of Valle complex and the relationship with the Carolinian aqueduct* (Staiano & Paradiso, 2024).

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2. Knowledge for restoration

2.1 Historical analysis

The Mills of Valle, built from 1793 by orders of Ferdinand IV and designed by Carlo Vanvitelli, are located at a point where the aqueduct exhibits the greatest elevation drop along its entire route. This location allowed for the creation of a highly efficient milling system.Royal documents have provided valuable information on the functional composition of the mills and the operational techniques employed. The complex utilizes a 19-meter drop to activate a hydraulic milling system, using water energy to operate the millstones through a vertical wheel mechanism. The organization of the complex reflected an advanced concept of industrial architecture for the time. The mills included spaces for milling, storage, housing, an inn, and cisterns, forming a self-sufficient microcosm (Fig. 2).

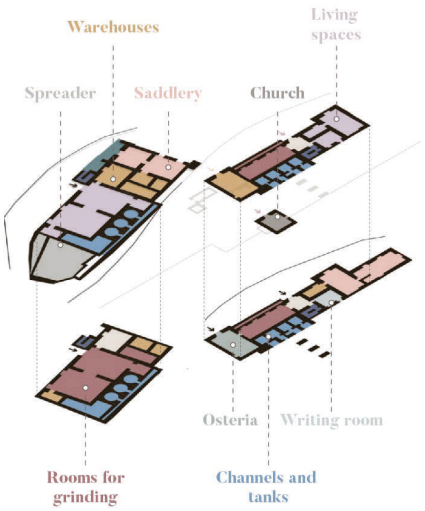

Fig. 2 – *The functional organisation of the complex* (Staiano & Paradiso, 2024).

From a technical standpoint, the Mills of Valle featured an advanced system of "indirect transmission." This mechanism, which drove the millstone's rotation, consisted of two distinct rotating elements: a large gear wheel known as the "*lubecchio*" and a smaller cylindrical wheel called the "*rocchetto*", equipped with evenly spaced pegs around its perimeter. The *rocchetto's* axis housed the rotating millstone shaft. This configuration optimized the use of available hydraulic energy, ensuring continuous and reliable operation.

In 1798, the site's strategic location and the availability of water power led to the construction of the Royal Ironworks adjacent to the mills. Powered by the aqueduct, the ironworks became one of the most productive metallurgical facilities in the Kingdom of Naples. To complete this structure, in 1800, the Church of San Carlo was built to serve the spiritual needs of the workers living and working on-site. However, the political context of the time, marked by the revolutionary uprisings of 1799 and subsequent instability, influenced the fate of these production complexes. In 1822, the ironworks were converted into a three-millstone milling facility based on the design of architect Antonio De Simone, while the church underwent modifications to address humidity issues and accommodate the growing local community's needs. Today, the Mills of Valle represent a significant example of industrial archaeology. Their restoration is not only a matter of architectural conservation but also an opportunity to rethink the relationship between history, community, and sustainability, presenting a crucial challenge for the region.

2.2 Investigations on the structure

The restoration of the Mills of Valle complex has been planned through a structured methodological approach, including material surveys, degradation assessments, and structural failure analyses (Fig. 3). The study of the structure involved the integration of various diagnostic methodologies to obtain a detailed picture of its conservation state, identifying degradation phenomena and structural vulnerabilities. The analysis of construction and material characteristics was fundamental in understanding the historical stratification of the

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buildings and planning interventions compatible with their original nature.

The first phase involved a material survey, crucial for understanding the construction and technological aspects of the complex. Through direct surveys and drone-based aerial photogrammetry, the characteristics of the materials and construction techniques were documented. The upper mill is characterized by roughly hewn tuff blocks arranged in irregular courses, a typical solution in Bourbon rural constructions, while the Church of San Carlo features walls in regular courses, with more refined finishes and details reflecting the Neoclassical style. Of particular interest is the canal bridge, a functional element for directing water towards the milling system. The structure, built of tuff masonry, still preserves significant portions of its original hydraulic plaster coating, a fundamental aspect for understanding the waterproofing techniques used during the Bourbon period. The discovery of these traces has deepened the understanding of historical construction solutions, contributing to a more precise reconstruction of the mill's hydraulic system.

Great attention was given to documenting the vernacular construction techniques present in the complex. The church's vaulted structure, built with natural stone blocks, represents a significant example. Additionally, the discovery of terracotta roof tile fragments suggests that both the upper mill and the church were originally covered with wooden trusses and a tile roof. The analysis of traces on the masonry confirmed the presence of wooden trusses, compatible with the historical construction period. The study of the mill's flooring remains has identified the use of terracotta bricks laid on a mortar bed, a typical technique of Bourbon-era industrial structures. The meticulous documentation of these elements has reinforced awareness of the historical and technical significance of the complex, providing essential data for the planning of conservation interventions.

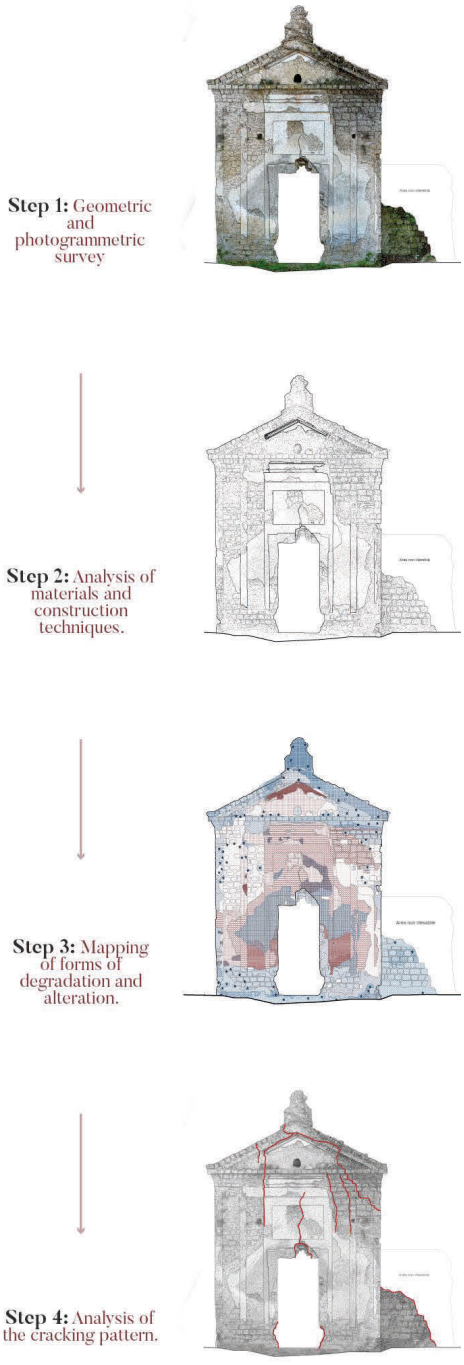

Fig. 3 – *The method* (Staiano & Paradiso, 2024).

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The next phase involved mapping degradation and alteration patterns. This diagnostic phase is crucial to identifying surface and structural degradation phenomena, determining not only their effects but also their causes.

This approach ensures that restoration techniques are selected based on compatibility with original materials, allowing for minimally invasive interventions.

For the Mills of Valle complex, the analysis of degradation and alterations was conducted according to UNI 11182 standard for "Natural and Artificial Stone Materials," identifying phenomena such as plaster loss, black crust formation, and invasive vegetation growth, which, exacerbated by a complete lack of maintenance, threaten the stability of the masonry.

Structural analysis revealed several issues related to the building's stability, with particular attention to three main collapse mechanisms. The opening of the masonry box was observed in the western section of the upper mill and in the perimeter walls of the church, caused by the loss of interlocking masonry at the corners and the thrust of the vaults. Masonry crushing, due to increased static loads and material degradation, was detected in various parts of the complex, requiring targeted reinforcement interventions. Finally, the vaults were found to be particularly vulnerable, showing evident signs of structural failure caused by water infiltration, loss of voussoirs, and pressure exerted by invasive vegetation.

The investigative phase confirmed the necessity of a tailored intervention plan that includes specific actions for each type of detected degradation. The systematic collection of data and subsequent graphic processing of the information have enabled the development of a restoration strategy focused on the long-term conservation and protection of masonry and structural surfaces. Future interventions must take into account the critical issues that emerged during the analysis phase, ensuring a rigorous methodological approach that respects the original materials.

3. Strategies for restoration and enhancement

3.1 Proposals for restoration interventions

The proposed interventions for the conservation of the Mills of Valle complex are based on the fundamental principles of contemporary restoration, ensuring material compatibility, reversibility of operations, and minimal intervention, while respecting the historical and structural authenticity of the building.

The principle of compatibility guides the selection of materials and techniques, prioritizing solutions consistent with the building's original characteristics. For instance, masonry should be treated with lime-based materials, ensuring perfect integration with the preexisting structure and improving resistance to atmospheric agents without altering breathability. Similarly, for structural consolidation, carbon fiber bars and stainless-steel tie rods with reversible anchors could be employed, avoiding interference with traditional construction techniques.

Reversibility is an essential principle aimed at allowing future removals or modifications without compromising the original structures. In this regard, consolidation interventions should be designed to be dismantled and non-invasive. For example, metal tie rods must be anchored in a way that allows for their removal without causing damage, and grout injections should be performed in a controlled manner to avoid irreversible alterations to the masonry structure.

The principle of minimal intervention serves as a guiding criterion in restoration operations, limiting interventions to elements that are truly compromised and minimizing the impact on original structures. The removal of black crusts and invasive vegetation, for instance, should be

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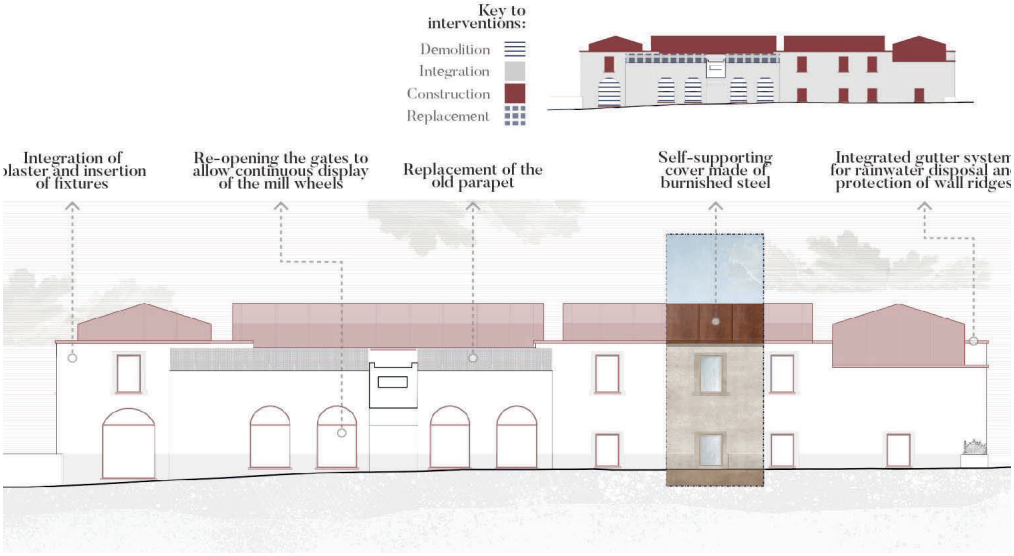

Fig. 4 – *The new facade on Viale dei Borbone of the Upper Mill* (Staiano & Paradiso, 2024).

carried out using manual and non-aggressive mechanical techniques, while masonry stabilization should involve localized interventions, avoiding extensive replacements and preserving material unity.

The authenticity of the complex must be safeguarded through the use of materials and techniques compatible with local construction traditions. In the case of more severe damages in the Mills of Valle complex, traditional restoration methods such as "*twist and sew*" masonry repair could be applied. This technique involves replacing damaged elements with materials similar in type and workmanship, maintaining stylistic and material consistency.

To prevent future forms of degradation, an interdisciplinary approach can be adopted to improve rainwater management, reducing rising damp. The implementation of appropriate drainage and surface protection solutions can ensure long-term durability of the interventions, contributing to the conservation and enhancement of the entire complex while defining economically sustainable restoration strategies over time.

3.2 Enhancement perspectives

The valorization of the Mills of Valle complex goes beyond architectural restoration, the final outcome (Fig. 4), expanding into a cultural and social project aimed at reintegrating this extraordinary example of industrial archaeology into the living fabric of the region. Structural restoration and material conservation are only the first steps towards a broader objective: to transform the site into a meeting point between the past and future, capable of attracting visitors, scholars and local communities. The historical importance of the complex, which tells a story of technical innovation and economic development under the Kingdom of Naples, makes it a symbol of resilience and adaptability.

Through an integrated approach combining history, innovation and sustainability, the complex can become a strategic node in the network of heritage sites in the Caserta area, offering new economic and cultural opportunities for the region.

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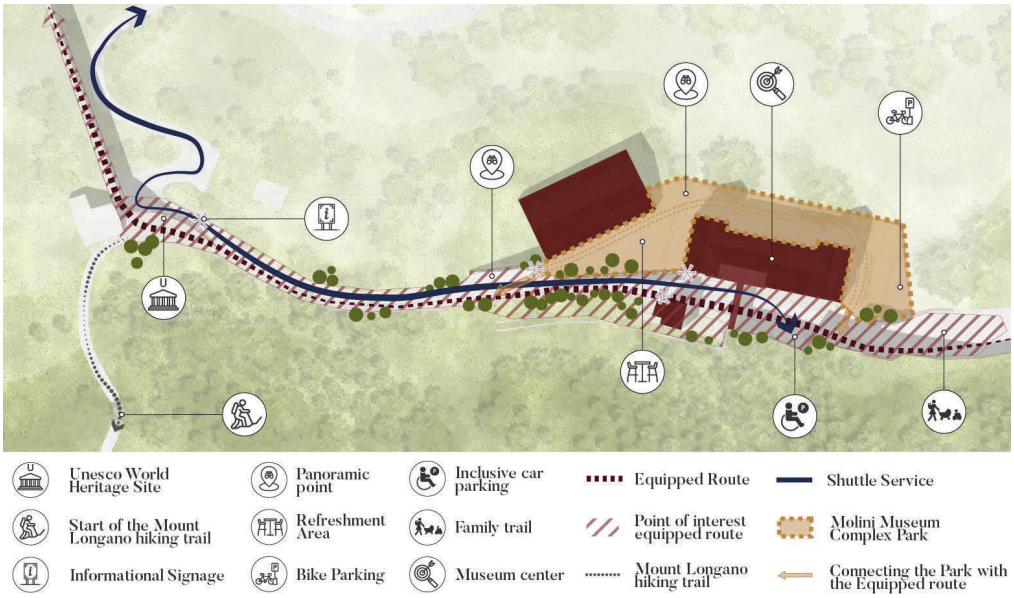

Fig. 5 – *The masterplan design goal of the new "Carolino Linear Park"* (Staiano & Paradiso, 2024).

The creation of tourist, educational and production itineraries within the mills provides an immersive experience that tells not only the history of the site but also the socio-economic and technological context of the Bourbon period. It also offers the opportunity to promote a new vision of cultural heritage as an educational and identity resource for future generations.

One of the main strategies for enhancing the complex is the "Carolino Linear Park" project, (Fig. 5), a network of cycling and pedestrian paths connecting Caserta's major UNESCO heritage sites. This green corridor not only facilitates access to the mills but also promotes slow and sustainable tourism, combining cultural heritage discovery with environmental conservation. The creation of viewpoints and rest areas along the route enriches visitors experience, providing spaces for landscape contemplation and historical reflection.

The bridges and valleys crossed by the route represent an opportunity to enhance the surrounding landscape, adding an aesthetic and environmental dimension to the project. Furthermore, the presence of informational panels and multimedia supports ensures an educational and inclusive experience, suitable for visitors of all ages. The park aims to be a place where nature and history intersect, fostering an experience that stimulates both emotional and intellectual engagement.

At the heart of the Carolino Linear Park route, the Valley Bridges lead directly to its historic mills, which, under a new vision, are repurposed into an innovative, well-equipped, and well-connected productive museum.

The creation of a multifunctional museum hub, integrated with the surrounding territory, not only enhances cultural heritage but also fosters broader reflections on the role of culture as a driver of local development (Fig. 6).

By adopting modern technologies for site access and conservation, such as tactile maps, augmented reality devices, and accessible routes, an inclusive and participatory heritage experience is ensured.

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Fig. 6 – *The mill on show. An exhibition that goes beyond the room* (Staiano & Paradiso, 2024).

The introduction of cultural activities, such as courses and seminars, not only increases the attractiveness of the complex but also fosters the establishment of collaboration networks at national and international levels, strengthening the cultural identity of the region.

4. Conclusions

Ultimately, the recovery and enhancement of the Mulini della Valle complex represent a unique opportunity to rediscover and celebrate Caserta's cultural heritage while promoting an integrated and sustainable development model that looks to the future without forgetting the region's historical roots.

This holistic approach, which unites conservation, innovation, and participation, ensures not only the protection of the site but also its full integration into the cultural and social life of the community. The project as a whole offers a concrete vision of how heritage enhancement can become a catalyst for the cultural, social, and economic regeneration of an entire area, setting an exemplary model for success

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Re-envisioning Rural Heritage as a Resource for Regeneration: The Case of Abandoned Farmhouses in Northern Italy

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Topic: T3.2. Intervention and regeneration projects

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Abstract
The rural landscape, formerly a dynamic center of agrarian life, currently confronts a multitude of challenges, encompassing depopulation, economic regression, and the deterioration of its built heritage. This article investigates how abandoned rural heritage can be repurposed to create new opportunities for rural communities. The North Oglio Park region in northern Italy serves as a case study, featuring numerous historic farmhouses and agricultural estates—along the Oglio tributary. Largely abandoned and deteriorating, these structures exemplify the area's neglected heritage. This research documents their current condition and explores their potential for local regeneration. To inform revitalization strategies, the study analyzes successful heritage reuse projects from related rural areas, considering factors like location, community engagement, financial resources, and sustainable maintenance. Drawing from these insights, the research develops a set of evaluation criteria to assess the potential for adaptive reuse of these rural structures. Initial reuse ideas and scenarios are presented, such as new agricultural ventures, agritourism centers, communal hubs, and educational or cultural institutions. By reimagining these structures, the research aims to redefine their role in sustainable regeneration and contribute to the broader discussion on the future of rural heritage and its potential to revitalize rural communities and cultural landscapes through adaptive reuse. With thoughtful planning, sustainable strategies, and active community involvement, these abandoned farmhouses could become valuable assets, driving economic growth, enhancing social cohesion, and preserving rural heritage.

Keywords: *rural heritage; abandoned farmhouses; evaluation criteria; adaptive reuse; regeneration*

1. Introduction

The rural environment, once a vibrant landscape of agricultural activity, now faces significant challenges, including depopulation, economic decline, and the degradation of rural heritage. With the modernization of agriculture, many property owners have struggled to manage large rural estates, often abandoning or neglecting them in favor of urban migration. As a result, rural buildings have been left unused or went through significant alterations to meet new needs.

Preserving rural buildings, especially barns and farmhouses, presents particular challenges, as these structures often lack modern infrastructure such as electricity, water, and sewage systems and require substantial investment for conservation and restoration works. Moreover,

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their original use, such as housing livestock, may have resulted in persistent odours that require mitigation, while neglect may have led to structural deterioration and collapses, further complicating rehabilitation efforts. Furthermore, rural heritage, mainly privately owned, depends on stakeholders' priorities for its future, which may overlook its cultural or architectural value. Despite these challenges, historic rural estates still exhibit outstanding geomorphology, microclimate, and landscape qualities (Torreggiani & Tassinari, 2012).

The focus of this research is on abandoned "cascine" (hereafter farmhouses) located along the North Oglio Park in Lombardy (Fig. 1).

> It is a type of agricultural settlement frequent in the Po Valley. It generally consists of a rectangular courtyard, enclosed by sheds and two main buildings (one of which serves as a dwelling for people, the other as a stable and haystack). This form of dwelling, different from the usual type of isolated dwelling, has its origins in the need for deep ploughing for cultivation or for cattle breeding, which in turn led to the existence of various buildings intended to shelter agricultural tools and livestock (Italian Encyclopedia, 1931).

These large structures, usually a few kilometres from inhabited centres, had stables, barns, granaries, and dairies around a courtyard (Fig. 2, 3). Larger farmhouses had multiple courtyards and housed several peasant families, varying by farm size. They thrived in the 18th–19th centuries but have declined since the early 20th century due to depopulation and agricultural modernization. Since the 1950s, industrialization and the repurposing of farmhouses in Italy have transformed the function and rural character of numerous sites (Torreggiani & Tassinari, 2012).

Currently, there is growing interest in revitalizing rural areas through initiatives such as ecotourism and innovative agricultural practices, particularly among young people and local communities. Inspiring stories of young people returning to rural landscapes to foster business growth and drive sustainable development can be found in the "Stories of Young Businesses" within the "ReStartApp" and "ReStartAlp" projects by the Edoardo Garrone Foundation in Italy.

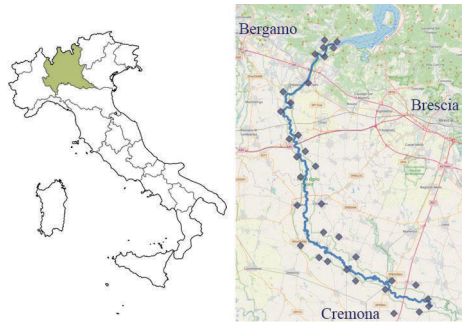

Fig. 1 – *Diagrammatic map of Italy highlighting Lombardy (left), with a zoomed-in map of the study area (right). The Oglio tributary is marked in light blue, and the visited municipalities with blue diamond shapes* (Psoma, 2025).

Fig. 2 – *Courtyard and surrounding structures of Cascina Grottanuova, Bordolano, Cremona, Italy* (Psoma, 2024).

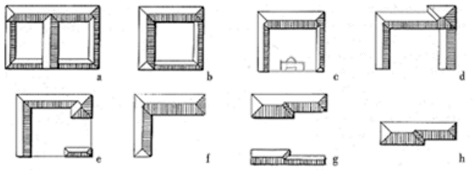

Fig. 3 – *Plan Typologies of Rural Buildings in Brescia, Italy* (Paoletti & Fappani, 2015).

Following the introduction, Section 2 outlines the research objectives, while Section 3 describes the methodology used. Section 4 presents selected examples of adaptive reuse projects involving rural heritage, relating them to this research.

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Section 5 introduces the study area, explores existing adaptation examples for farmhouses, and provides the list of evaluation criteria developed in this study. Section 6 discusses adaptive reuse strategies and scenarios, and the final Section 7 presents the conclusion.

2. Objectives

This research explores the potential of repurposing abandoned farmhouses to foster regeneration prospects for rural communities. It aims to identify strategies for preserving and sustainably managing these buildings, contributing to a unified framework that integrates heritage preservation with economic and social revitalization. The study focuses on the North Oglio Park area, in Lombardy, specifically examining the farmhouses as indicators of economic, technical, social, and visual changes in rural regions. To assess the adaptation and regeneration potential of these buildings, the research develops a set of evaluation criteria that can be applied to other rural structures in comparable contexts.

3. Methodology

This research adopts a structured approach to assess the adaptive reuse potential of the farmhouses. Initially, a bibliographic review was conducted to explore literature on adaptive reuse and regeneration practices. This was followed by the identification of successful adaptive reuse projects and examples related to rural heritage, which helped inform the research by highlighting key values, evaluation criteria, and success factors. The second phase involved site visits to the farmhouses in the study area. These visits allowed for a direct assessment of the buildings' current condition and context. A photographic archive was created to document the farmhouses, providing a visual record for analysis. In the third phase, a Farmhouse Index Card was created for each farmhouse to document key architectural, functional, and typological aspects. The fourth phase involved identifying several farmhouses that had already been adapted. These steps, along with the previous analysis, helped develop preliminary evaluation criteria for assessing the potential for adaptive reuse of each farmhouse. These criteria are based on factors such as structural integrity, location, accessibility, stakeholder interest, community needs, and others. The final part of the research explored initial ideas for adaptation strategies and re-use scenarios for the farmhouses.

4. Adaptive reuse of rural heritage and regeneration projects

Adaptive reuse, defined as “the process of reusing a building or structure to give it new life through a new function,” offers sustainable, cultural, economic, and placemaking benefits (ODASA, 2014). Economically, it creates jobs, attracts investment, boosts tourism, and revitalizes local businesses (Gravagnuolo et al., 2017). Socially, it fosters community engagement, and enhances safety and services (Gravagnuolo et al., 2017). Environmentally, it reduces raw material use, lowers energy consumption, cuts waste and emissions, and supports sustainability by retaining embodied energy (Gravagnuolo et al., 2017).

Moreover, adaptive reuse preserves cultural values while promoting sustainability, optimizing resources, and generating benefits such as local investment and community integration, ultimately enhancing heritage value with lasting social and economic impact (Gravagnuolo et al., 2017). Reused heritage buildings, often considered “second-hand,” can support mixed functions shared by various users (Gravagnuolo et al., 2017). Ensuring long-term adaptability is also crucial, enabling buildings to evolve with future needs (Gravagnuolo et al., 2017). Furthermore, adaptive reuse solutions must align with stakeholders' needs and preferences, as highlighted by Sardaro et al. (2021) in their study on the conservation of historical rural buildings in Apulia. For further insights on adaptive reuse success factors, refer

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to the literature review by Fatameh Vafaie et al. (2023). This research builds on these arguments and advocates for the adaptive reuse of rural heritage to drive positive rural transformations and local regeneration.

4.1. Projects on rural heritage with positive outcomes in the Italian context

This section examines three projects that offer key insights for our research on community engagement, participatory planning, and integrating environmental, cultural, and economic aspects in rural regeneration.

First, the "RURITAGE" project, funded by the EU's Horizon 2020 program, focused on rural regeneration through heritage-led strategies, applying participatory models to rural contexts. By leveraging cultural and natural heritage, the project introduced a new model for regeneration using co-design and community-driven approaches (Conticelli et al., 2021). Central to this was the creation of "Rural Heritage Hubs" in 19 territories (including hubs in Italy), combining physical spaces and local networks to foster collaboration (Conticelli et al., 2021). Coordinators managed the hubs, ensuring engagement through activities, discussions, workshops, classes, and cultural events that promoted social integration and long-term participation (Conticelli et al., 2021). The project engaged with more than 3,500 citizens, trained hundreds in resilience practices, restored 39 buildings, improved walking and cycling routes, and organized cultural events. Beyond these outcomes, RURITAGE evolved into a broader model for sustainable development, showing how coordinated efforts can drive transformative change (Conticelli et al., 2021).

The next initiative is the "AttivAree" program, launched by the Cariplo Foundation in 2016 as an innovative effort to revitalize Italy's rural heritage and address the challenges faced by its fragile territories (Scala, 2020). This program aimed to finance projects that enhance and conserve cultural and natural identity, restore landscapes to boost the attractiveness of these areas, and safeguard cultural heritage threatened by neglect and degradation (Scala, 2020). AttivAree promoted social, cultural, and economic regeneration through participatory approaches, sustainable development, and strengthened urban-rural connections. Flagship sub-projects such as the "Resilient Valleys" led by the Mountain Community of Trompia Valley and Sabbia Valley focused on advancing multifunctional farming, and harmonizing heritage preservation with modern needs (Cariplo Foundation, n.d.). The program transformed rural areas into innovative hubs by promoting community involvement, ecological sustainability, and connection with urban centers.

The third initiative, from the Local Action Group Oglio Po (GAL), promoted sustainable rural development in the area between the Oglio and Po rivers as part of the 2014-2020 Local Development Plan. Supported by the European Agricultural Fund for Rural Development and Lombardy's Rural Development Programme, it fostered innovation, preserved local identity, and enhanced cultural and natural heritage. Two key GAL projects for rural regeneration include: a. "LANDsARE," a project that viewed landscapes as complex systems, promoting sustainable tourism, heritage preservation, and innovative management, and b. "Destinazioni Rurali," a project that enhanced rural tourism through stakeholder collaboration, youth engagement, and strategic communication.

Together these projects show the potential of rural areas as sustainable, innovative spaces that celebrate heritage and promote collaboration. The approaches of RURITAGE, AttivAree, LANDsARE, and Destinazioni Rurali offer useful models for adaptive reuse, sustainable tourism and community-led revitalization. Though the projects have ended, they provide key insights for shaping a long-term rural heritage regeneration strategy.

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4.2. Successful adaptation projects of rural buildings

This section presents three adaptive reuse projects that showcase different approaches to regenerating rural heritage, and provide valuable insights for guiding potential reuse scenarios and long-term management strategies.

The first example is "Holidays in Buildings of Historic Importance," a Swiss initiative launched in 2005 by the Swiss Heritage Society. It restores at-risk historic buildings, converting them into holiday accommodations. An online portal allows users to search for buildings by architectural style, including farmhouses, promoting their preservation (Holidays in Historic Buildings Foundation, n.d.).

The "Rebecco Farm" project is another significant example, which involved restoring two abandoned buildings for collaborative use as part of the Resilient Valleys initiative mention in the previous section (Scala, 2020). The project focused on restoration, landscape regeneration, and creation of a participatory management model. The restored site now includes a B&B, an educational farm with local food production workshops, and a student meeting area. It combines sustainable tourism with community-driven development and was developed in collaboration with the heritage authorities to preserve historical integrity of the building, while adapting the site for future needs (Scala, 2020).

Lastly, a large barn in Riom, Switzerland, was transformed into the Winter Theater of Origen, a cultural venue for the Origen Festival. Awarded the Wakker Prize in 2018, the project preserved the barn's unique atmosphere while converting it into a flexible theater space. The adaptation successfully balances historical preservation with modern functionality (Constructive Alps, n.d.; Gasser, Derungs Architects, 2018).

Despite their diverse uses and locations, these projects share key elements relevant to our research, demonstrating how community involvement, funding, sustainable rural hospitality, creativity and innovation can drive heritage regeneration and transform rural buildings into multifunctional spaces with lasting social and economic benefits.

5. Adaptation opportunities for the farmhouses in the North Oglio Park

The North Oglio Park spans 14,170 hectares across the Lombardy region, covering parts of the provinces of Bergamo, Brescia, and Cremona, and includes 34 municipalities. The Park is centered around the Oglio tributary, which flows from Lake Iseo near Sarnico. Since Roman times, the river has served as a boundary between Brescia and Cremona. Castles, fortresses, walled villages, and manor houses, built later, dot the riverbanks, reflecting centuries of territorial disputes. Among the communities and historic centers of each municipality, a vast agricultural plain stretch, with farmhouses located on the outskirts of the municipalities, often in close proximity with the Oglio tributary. The tributary provided irrigation for agricultural activities and water for livestock raised in the barns.

The research systematically catalogued the farmhouses, compiling index cards with their architectural and functional characteristics (Fig. 4). While sharing similarities, some features vary based on location, depending on proximity to Lake Iseo or the plains.

The study classified the farmhouses by plan typology (courtyard, single building, enclosed courtyard, or other), condition (inhabited, abandoned, semi-abandoned, or transformed), and usage (residential, agricultural, mixed, or other). The architectural assessment considers the number of floors (single-story, two-story, or multi-story) and the scale of the complex (small, medium-sized, or large). Site visits revealed that some farmhouses have been converted into agrotourism lodgings or residences, many remain in use as farmhouses, and others are abandoned.

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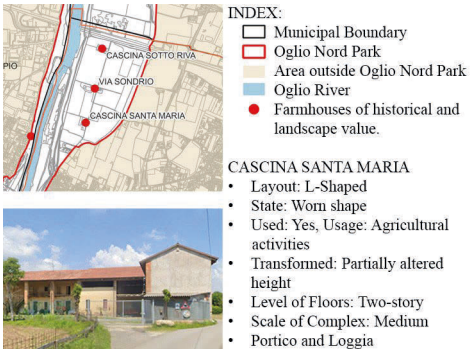

Fig. 4 – *Example of a Farmhouse Index Card with a map, photo, and description* (Psoma, 2025). Map created by the "Variante generale al Piano Territoriale di Coordinamento (PTC) del Parco Regionale Oglio Nord" Project Team.

The focus was to identify cases where farmhouses were revitalized through new activities. Only a few met this criterion, including Cascina Cà Del Lupo in Palazzolo (Fig. 5) near Lake Iseo, transformed into an agritourist facility, a common model in Italy that combines temporary tourist accommodations with active farms and agricultural activities. The farmhouse functions as an agrotourism facility, with a working farm and horse-riding activities. The complex is well-maintained and restored, featuring a two-story "U"-shaped layout around a courtyard. It is a medium-sized complex with features such as a "portico" and "loggia." Located just 5 minutes from the historic centre and 1 minute from the main road, it is easily accessible by car. This example shows that farmhouses can be transformed into active small businesses, blending farming with new, profitable uses.

Fig. 5 – *Cascina Cà Del Lupo, Palazzolo, Brescia, Italy* (Cascina Cà Del Lupo, 2024).

5.1. Evaluation criteria for adaptive reuse

Based on catalogued farmhouses, reuse examples, and adaptive reuse success factors from Section 4, the research developed an initial evaluation criteria list. This list provides a baseline for developing a multicriteria evaluation and serves as a qualitative tool to guide future projects in selecting farmhouses with revitalization potential. Moreover, it can help establish guidelines for the sustainable adaptive reuse of rural buildings in similar contexts, as explored by Musso & Franco (2014). Evaluation criteria list:

1. Location and Accessibility: Proximity to infrastructure, Accessibility to the historic centre, Local facilities, Natural surroundings;
2. Building Condition and Restoration Feasibility: Structural integrity, Level of decay, Feasibility of integrating technological systems, Energy efficiency potential;
3. Typology and Usability: Size, layout, and functionality of spaces, Adaptability for new uses, Utilization of outdoor areas;
4. Stakeholder and Community Involvement: Stakeholder and investor preferences, Local community preferences and needs;
5. Energy, Resources, and Sustainability: Proximity to energy, water, and communication networks, Availability of renewable energy sources and waste management system;
6. Environmental and Cultural Impact: Preservation of heritage, Contribution to the local ecosystem and biodiversity, Opportunities for sustainable tourism, education, or cultural activities;
7. Economic and Regulatory Feasibility: Cost-benefit analysis for restoration (short- and long-term), Availability of incentives, Compliance with heritage conservation policies and local planning regulations;

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8. Flexibility and Future Resilience: Adaptability for evolving needs or multifunctional uses, Integration of climate-friendly solutions and sustainable design;

6. Discussion

This research puts forth the vital role of community participation in adaptive reuse, alongside evaluating criteria and challenges. It also aims to show that engaging locals in planning and implementation ensures projects reflect their preferences and needs. Additionally, demonstrated that the repurposing of farmhouses in North Oglio Park can serve as a model for driving local rural regeneration and advancing ongoing projects and efforts.

The research progressed by formulating two strategies for the adaptive reuse of farmhouses, applicable at both large and small scales, each offering functional ideas that could inspire further discussion and investigation. A large-scale approach envisions creating a network of farmhouses along the Oglio tributary, each reimagined to accommodate new uses. Aligned with the existing bicycle routes within the park, selected farmhouses could function as "stopping points" offering short-term accommodation, outdoor activities, small events, and artisanal workshops. This would form an interconnected system of productive agrotourism destinations, where visitors engage with local culture, traditions, and the rural landscape, promoting sustainable ecotourism.

In contrast, the small-scale strategy focuses on the individual adaptation of farmhouses based on local community needs for communal, educational, or cultural spaces. These buildings could be repurposed for use by young people interested in cultivating land, raising animals, or sharing agricultural responsibilities. They might host weekend farmers' markets, serve as cultural hubs for artists, or provide gathering spaces for community groups, particularly for vulnerable populations who lack access to their own facilities. Such spaces would foster collaborative projects, workshops, and educational programs, taking place both indoors and outdoors.

These are initial concepts that require further analysis and evaluation. A multi-criterion, multi-stakeholder approach, grounded in criteria focused on the circular and sustainable reuse of cultural heritage, could provide valuable insights into the best adaptive reuse scenarios by considering the needs of owners, users, and broader social dynamics (Gravagnuolo et al., 2017).

7. Conclusions

This research was conducted for a specific study area, focusing on one type of rural building. However, its findings are applicable to other rural areas with similar geographic and socio-economic characteristics. The reuse of abandoned or neglected farmhouses is a valuable strategy for rural regeneration, as it not only helps revitalize communities but also preserves rural heritage. Adaptive reuse appears to be the most viable and sustainable solution for these structures, allowing them to retain their connection to the rural landscape, outdoor activities, and architectural identity, even when their original agricultural function is lost. Future research could explore a detailed proposal for a specific farmhouse and its adaptive reuse, analyzing the spatial requirements of a new program within the existing structure. This would help assess user needs, necessary adaptations to contemporary demands, and practical aspects of restoration, and reuse. Additionally, a multi-criteria evaluation of different adaptive reuse scenarios could provide further valuable insights.

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Disclaimer

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The Risks to Vernacular Architecture Associated with Depopulation in the Valencian Community, Spain

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Abstract
Depopulation is the most widespread demographic phenomenon in Spain. In addition, the areas affected by depopulation hold the greatest proportion of vernacular architecture in the country, and this may in turn lead to a risk for conservation. This research identifies the risks presented by depopulation for conservation of vernacular architecture, which can be classified into three categories: sociocultural risks; physical and material risks; and risks in the management of vernacular architecture. The methodology used follows a two-fold bibliographical review of articles and books. Texts on demographics, culture and society were analysed, paying particular attention to mentions of architecture and housing, while a review of studies on vernacular architecture and heritage focused on aspects relating to depopulation, migration, and cultural loss. Based on these results, a methodology was developed to analyse the level of risk to vernacular architecture in areas with population loss. To do this, the risks identified in the bibliographical review were transformed into quantifiable vulnerability factors. A methodology was created to analyse the level of risk of vernacular architecture by vulnerability factor. This methodology has been contrasted and perfected in 180 municipalities affected by depopulation in the Comunidad Valenciana, for possible application in other similar contexts, both in Spain and abroad.

Keywords: *vernacular architecture; depopulation, risks; methodology; vulnerability factors*

1. Introduction

The demographic paradox in which we currently live allows us to speak of global overpopulation, with major migratory movements, and limited resources. In contrast, there is another much more immediate reality which seems to contradict this: 55% of the land in Spain holds only 6% of the country's population living in municipalities with less than 2000 inhabitants. These also account for 72% of the municipalities in the country (Instituto Nacional de Estadística, 2023; Ministerio de Agricultura, 2009). According to data from the Spanish Statistical Office, in 2001 there were 981 municipalities with under 101 inhabitants. At present, there are 1,374 municipalities with under 101 inhabitants. This constitutes an increase in 20 years of 393 municipalities seriously affected by

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depopulation. This clear continuity of the process of readjustment of demographic figures in the systems of population nuclei prompts several reflections and suggests devising an approach dealing with the loss of construction know-how due to the loss of intergenerational transmission and the lack of maintenance and conservation of the traditional architecture linked to these places.

Fig. 1 – *Calle de la Cuesta. Puebla de San Miguel*. (sup. Guillamon, 1974). (inf. Tortajada, 2022).

Vernacular architecture is one of the richest and most diverse categories of cultural assets in the field of heritage. This fact makes it more accessible to all citizens, but also means that it is under the greatest threat. In addition, population loss is the most widespread demographic phenomenon in Spain, affecting over half the country. Based on these two factors, most vernacular architecture is located in the territories affected by population loss (Méndez Juez, 2019), so that threats associated with this phenomenon may constitute a risk to the conservation of these assets. This leads to vernacular constructions – mostly characterized by their traditional uses – losing their original function. This, in turn, has led to their abandonment, progressive destruction, and modification in order to adapt them to new needs.

In Spain, the rural exodus which began at the start of the last century led to the displacement of millions of people over several decades, causing a major cultural crisis. When they left their villages, the inhabitants took with them centuries of knowledge, techniques, beliefs, crafts, and values. Some of these elements have evolved and been preserved until now. However, others only exist in the memory of a few citizens who remember those traditional societies.

2. Methodology

2.1. Bibliographical review

This study examines two subjects which have been widely studied in recent decades: population loss and vernacular architecture. However, it is unusual for both themes to appear combined in the scientific literature or in political or social debate. Against this backdrop, the study begins by establishing the state-of-the-art to form the theoretical basis of the research. This bibliographical review has covered as much context as possible in order to establish a full state-of-the-art. The chronology for the literature analysed begins in the late 19th century, while the section on geography starts with the evolution of vernacular architecture and the social risks associated with population loss on an international scale, before moving on to a more specific in-depth investigation of the situation in Spain. The literature analysed includes legislation, charters, and national and international recommendations to address the political perspective, and books, articles, and specialized journals to cover the professional and scientific contexts.

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2.2. Vulnerability factors

The theoretical framework has enabled the definition of the risks posed by depopulation to vernacular architecture and the transformation of these risks into vulnerability factors used to analyse and compare the level of risk to architecture in the affected municipalities. The risks identified through the literature review have been grouped into three categories: physical and material risks, sociocultural risks, and management risks. These risks were then translated into quantifiable and comparable factors, forming the basis of a methodology that can be extrapolated to other territories. This analytical methodology was applied to a selection of case studies, enabling a quantitative assessment of the risk level to vernacular architecture in these municipalities. Based on the results, it was possible to estimate the urgency with which action must be taken to halt the loss of vernacular architecture and, if possible, to reverse the threats posed by the identified vulnerability factors.

2.3. Case studies

The selection of case studies required data on the municipalities to be cross-referenced and incorporated, based on two main sources of information on population loss in the Comunidad Valenciana. The first of these is the Valencian Antidepopulation Agenda (Agenda Avant) (Generalitat Valenciana, 2023), made up of a total of 172 municipalities, recipients of the Municipal Cooperation Fund for the fight against Depopulation. The other is the Valencia Institute of Statistics (IVE), which analyses the risk of population loss according to demographic population loss indicators (Institut Valencià d'Estadística, 2022). This data source identifies a total of 173 municipalities at moderate, high, or very high risk of population loss in the Comunidad Valenciana. As both sources apply different criteria in establishing the risk of population loss, municipalities affected by Agenda AVANT and IVE are not an exact match. Combining both sources of information has yielded 180 municipalities at risk of population loss. The analysis methodology has been applied to these in order to ascertain the level of risk to vernacular architecture according to the vulnerability factors created.

3. Definition of risks associated with population loss

Population loss has had a profound impact on rural society, and for most of its inhabitants this has meant the end of traditional life. This phenomenon has brought about a radical transformation in the dynamics of rural communities, with significant repercussions for their social, economic, and cultural structure (Collantes & Pinilla, 2019). Whenever social or intellectual changes such as inventions, phenomena and beliefs are recorded, new needs arise which threaten the continuity of the group (Malinowski, 1970; Sánchez Zamora et al., 2016). This could lead to the transmission of cultural tradition being interrupted and the society beginning to lose its local identity.

In the age of globalization, the largest powers and systems threaten the survival of traditional societies, dominating and redefining entire cultural systems. Large-scale industrial expansion, combined with the advances in science, technology, and revalorization of capital converge towards a single system (Habermas, 1968; Moholy-Nagy, 1957). This process breaks the configuration of, and often destroys, societies based on cultural tradition (Rucabado, 1917), which are now seen as opposing this growing rationalization (Lopes Ferreira, 2014).

The irreversible loss of traditional culture entails the disappearance of the identity of a given place, construction techniques, and systems using local materials, functions and uses of buildings, rooms and urban spaces, of the landscapes adapted to ways of life, as well as the transmission and organization systems (Fernández Balbuena, 1922; Torres Balbás, 1918). Preserving the

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architectural culture of a place requires willingness and understanding. By simply respecting and protecting (Chevallier & Chiva, 1996) what exists in every place it is possible to reach a profound understanding of their culture. To do this, municipalities must be guaranteed the necessary structural capacity to provide the relevant services (budgetary, economic, urbanistic, educational, technical, environmental, etc.). Equally, suitable urban planning should promote the virtues and value the assets of individual municipalities. This urban planning must regulate the characteristics of local traditional constructions, including dispositions on the material nature, relevant actions, and forms of construction (García-Moreno Rodríguez, 2019). However, the real situation in these municipalities is quite different. Economic and technical incapacity prevents suitable instruments from being drawn up in their own territory, and these are eventually produced outside the municipality in question (Fernández Criado, 1983; García-Moreno Rodríguez, 2019).

Population loss and development must be articulated jointly, based on human, social and relational capital, setting aside strategies that are based solely on material, human and economic growth. Guaranteeing effective management requires culture to be a transversal element guaranteeing a social dimension to these policies (Sáez Pérez, 2019). Society must recognize the values and threats to its heritage, thus promoting actions for the conservation and preservation of constructive culture. Society, therefore, requires greater awareness in order to become a participant in everything related to its cultural heritage (Cristini et al., 2022; Dipasquale et al., 2023; Fathy, 1973), so that, above all, ignorance may cease to be a risk to heritage (Medina Rosales, 2020). “Knowledge for understanding, understanding for valuing, valuing for caring, caring for preserving, preserving for transmitting” (Ministerio de Educación Cultura y Deporte, 2015).

Fig. 2 – *Repairs to rammed earth wall using cement mortar. Forcall.* (Tortajada, 2022)

Once the risks detected by researchers, scholars, and politicians were identified, a classification was drawn up. Risks detected in heritage management include the lack of coherent urbanistic regulations which respect vernacular architecture, lack of protection and recognition of this type of construction, and the need for authorities to promote technical and economic solutions for the conservation of vernacular architecture. Physical and material risks include a series of threats caused by population loss: abandonment and progressive ruin, the disappearance of traditional techniques, the poor condition of rural housing, poor practice and introduction of unsuitable materials (fig. 2 & fig. 3), and lack of awareness and value on the part of owners and younger generations. The sociocultural risks address the fact that population loss constitutes a lack of intergenerational transmission of the culture of a given place, resulting in a loss of traditional knowledge, techniques, uses, and beliefs. In most cases, the younger generations who have

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remained in contact with the place of origin have not continued family traditions or traditional ways of life. This entails different needs in vernacular dwellings, which must be adapted to the new ways of life of their occupants, risking these changes not respecting traditional techniques and materials.

4. Vulnerability factors

The definition of risks following all three categories has resulted in vulnerability factors which can then be used to analyse the level of risk to vernacular architecture in municipalities affected by population loss. Management risks have evolved into the following management vulnerability factors: the technical personnel for individual municipalities in the field of architecture and urbanism; current urban planning and heritage protection systems; and the application for grants and subsidies for the conservation of vernacular architecture and the cultural assets for each case study. Physical risks have evolved into physical vulnerability factors which include the state of conservation, type of dwelling use, and number of vernacular dwellings conserved within it, taking as reference the data from the decade prior to the start of the process of population loss. Finally, sociocultural risks have developed into two specific sociocultural vulnerability factors: demographic evolution and type of population.

Fig. 3 – *Repairs to masonry wall with industrial blocks. Penáguila* (Tortajada, 2024).

Vulnerability factors, in themselves, speak volumes of the current condition of vernacular architecture. However, as these are very different categories (sociocultural, physical and management), the risk level between the different factors is hard to compare. Furthermore, each vulnerability factor is shown in a different measure (number of dwellings, percentages, years, type of planning, etc.).

Obtaining a common risk level for all vulnerability factors requires the prior establishment of a transversal analysis system for the different factors, enabling a comparison of the level of risk to which vernacular architecture is subject depending on the individual vulnerability factors and case studies.

The study of each vulnerability factor has made it possible to establish their individual risk to the conservation of vernacular architecture, and has been weighted to calculate a risk level depending on the importance of the risk. In order to establish a common grading for the individual vulnerability factors, a scale has been defined spanning the levels of null to critical, associated with a scale value of 1 to 4.

By assigning these values to the individual factors and case studies, a points table was defined for use in determining the risk level of the individual case studies.

The sum of the value assigned to the individual factors yields a total risk value per case study, where the lowest corresponds to the lowest vulnerability of vernacular architecture, while the highest corresponds to case studies less able to preserve their vernacular architecture.

In order to facilitate the understanding of data, the creation of maps representing the level of risk of vernacular architecture of the individual case studies has been proposed, using a Geographic Information System (GIS).

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5. Results

Figure 4 shows the analysis results for the vulnerability factors of vernacular architecture of the territories affected by population loss. The first three maps show the risk level for each municipality according to the different categories, while the last one presents the total risk levels after adding up sociocultural, physical, and management risks. In terms of sociocultural risks, the municipalities which saw the highest percentage of loss of census population are those where seasonal population is the greatest threat to vernacular architecture.

However, the opposite is true in terms of the physical risks to vernacular architecture. In this case, the greatest threat to architecture is found in the municipalities which have lost the lowest percentage of population during the process. Finally, the risk to vernacular architecture linked to management vulnerability factors is lower in the municipalities with an average loss of population, and greater both in municipalities which have experienced a high loss of population and in those which have kept practically the same number of inhabitants.

Throughout this study, other results have been obtained in relation to the risks to vernacular architecture in territories affected by population loss. Most notably, these include the disappearance of 41% of all the vernacular dwellings in existence in 1950 (Tortajada Montalvá et al., 2024); the complete absence of protection for vernacular architecture in 63% of case studies; and the representativity of vernacular architecture, only 39% compared to the total of modern dwellings. In addition, 10% of those preserved are abandoned and in a poor state of conservation (Tortajada Montalvá, 2024).

6. Conclusion

This research highlights the extensive cultural loss observed in the municipalities affected by a loss of population, which has led to the disappearance of numerous examples of vernacular architecture. Equally, the architecture which has been preserved until the present day is under threat from sociocultural factors, such as the loss of attached value from inhabitants; physical factors, due to improper actions and the abandonment of this heritage; and management

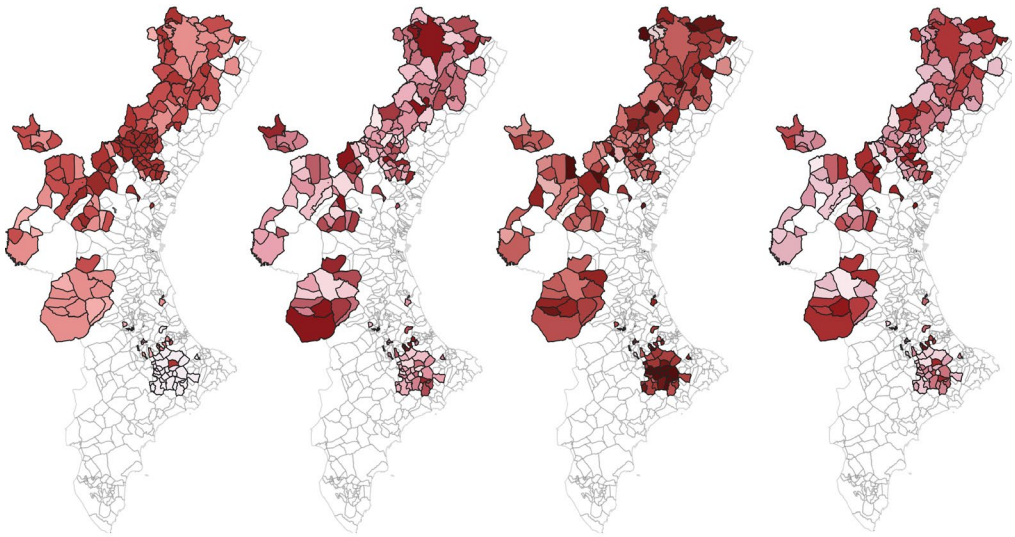

Fig. 4 – *Level of risk of vernacular architecture according to vulnerability factors* (Tortajada, 2024).

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factors, linked to the lack of specialist technical personnel and the lack of protection for vernacular architecture in urbanistic plans.

With the ultimate aim of reversing this situation, it becomes necessary to revalorize this heritage in all its dimensions (technical, social, economic, and environmental), and include all the stakeholders influencing its conservation (owners, inhabitants, administration workers, developers, architects, and tourists) so that ignorance ceases to pose a risk to vernacular architecture.

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Beyond the Surface: Neo-Vernacular Architecture in Sweden and Denmark's Contemporary Landscape

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Abstract
In Scandinavian architecture, the neo-vernacular movement has gained ground as a means of sustainable building design. Hence, the objective of this paper is to investigate Danish and Swedish neo-vernacular in order to examine whether these building approaches are mimicry or reflect genuine alignment with the core values of traditional vernacular. To achieve this, the paper presents a literature review on neo-vernacular architecture and a case study comprising a Danish and a Swedish neo-vernacular dwelling. Main findings include the Scandinavian neo-vernacular as a complex field that holds different approaches to building and overall, shows a significant trend to integrate traditional vernacular with modern design and sustainability principles.

Keywords: *neo-vernacular architecture; contemporary vernacular; Scandinavian architecture; sustainability in architecture; cultural authenticity; Danish and Swedish architecture*

1. Introduction

Within the last decades, many studies have shown that vernacular materials and techniques can contribute to sustainability in the built environment. Consequently, neo-vernacular architecture denotes a design approach that aims to reinterpret and adapt traditional building styles and techniques to contemporary needs and contexts (Vellinga, 2013).

In Scandinavia, the neo-vernacular movement has gained traction to preserve the region's rich vernacular heritage and promote sustainable design practices. The neo-vernacular approach thus comprises several Danish and Swedish building types from residential to institutional.

The Danish neo-vernacular includes both *folk* and *academic* examples. Many buildings in eco-villages (e.g. Dyssekilde, Andelssamfundet in Hjortshøj and Friland) are inspired by low-carbon building and vernacular architecture. Among the *academic* architecture, there are many renowned examples. For instance, The Modern Seaweed House by Vandkunsten Architects (2013) interprets the traditional Læsø vernacular buildings with seaweed roofing. Studielandsbyen (*Study Village*, 2017) is the development of a vernacular farm into student accommodation through the addition of new buildings designed by architects Lenschow and Pihlmann. House of Nature (2021) at Silkeborg Højskole by ReVærk Architects is built of wood and takes its inspirational sources in the historic post-and-plank-construction. At Fyn, VERNA

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Architects have designed a common house (2023) in cooperation with the local community that focuses on reuse and flexible constructions.

Sweden has also embraced the neo-vernacular approach in which architects and designers explore ways to integrate traditional building techniques and aesthetics into contemporary projects. This often features elements such as pitched roofs, exposed timber framing, and the use of local, natural materials. Examples includes eco-villages such as Baskemölla Ekoby and Unterstenshöjden. Among the *academic* examples is Library House (2022) designed by Fria Folket Architects to accommodate work spaces and a book collection. At Rörbäck Forest Retreat (2020), Gipp Architecture has added two new buildings to an old Halland Farm. The new buildings are definitely contemporary, though shape and materials resemble the old farm buildings. Villa Glasmästar (2023) designed by KFA Architects exemplifies sustainability with biogenic materials and avoidance of chemicals. Traditional red Falu paint on the exterior reflects a vernacular Swedish aesthetic.

2. Objective and methods

The neo-vernacular movement sparks discussions on the essence of such approaches and calls for critical exploration. Consequently, the objective of this paper is to examine the diverse interpretations of *neo-vernacular* in Scandinavian architecture and investigate the extent to which it reflects a genuine alignment with the environmental, cultural, and social imperatives associated with traditional design.

The first part of the paper establishes the theoretical and analytical frame of the study. In doing so, it explores understandings of neo-vernacular architecture and looks into key elements of traditional Swedish and Danish vernacular through literature reviews, since this knowledge is crucial in the discussion on the possible alignment between traditional and neo-vernacular. The second part of the paper presents a case study for the purpose of exploring neo-vernacular in the built environment. Findings of the case study and the analytical frame inform the discussion, followed by results and conclusion.

Applied methods comprise literature reviews and case study research. For temporal reasons, the literature reviews are not comprehensive. Concerning the exploration of neo-vernacular, the aim is to throw light on this ambiguous notion for which reason diversity among the sources is emphasized. Case study research is chosen, as this method is well-suited to produce in-depth information on a phenomenon (the essence of Scandinavian neo-vernacular) through the investigation of a small number of dense cases (neo-vernacular buildings). The selection strategy aims to maximize information from a few, dense cases (Flyvbjerg, 2006; Yin, 2014). Lastly, the following criteria are reflected in the choice of the two selected cases: 1) Each case must be Scandinavian neo-vernacular, confer to the overall objective of the study, 2) each case must be unique to the other regarding its national context (Danish or Swedish), 3) Each case must be a single-family house for reasons of comparability. Single-family housing is well represented among neo-vernacular architecture, and it also holds extensive relevance in Scandinavian architecture, since these houses are among the most popular types of dwellings. Hence, the chosen cases are Hahn Lavsen's own house (Agger, Denmark) and Rundbalshuset (Kassjö, Umeå, Sweden).

Sources comprise of literature on vernacular and contemporary architecture, research methods and other relevant material. Concerning the case study, sources encompass interviews, right of access to documents, site visits, empirical studies, literature, drawings, photos and videos in order to get critical insights into the motivations and challenges of the design process. For reasons of temporality and extent, the study is delimited to Danish and Swedish neo-vernacular, though the authors acknowledge that such buildings are found all over Scandinavia.

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3. Theoretical and analytical framework

3.1. Neo-vernacular

The term vernacular architecture is complex, comprising both historic, rural heritage and on-going building processes (Vellinga, 2013). (Maudlin, 2010) broadens the definition further as *the other* comprising everything but canonical architecture. This study concurs with the multifarious nature of vernacular architecture and applies Paul Oliver's predominant definition as a guideline. According to (Oliver, 2006), vernacular architecture is the common people's buildings. They are built by the owner (possibly together with the community) in accordance with traditional building practice. Hence, the building design is influenced by local conditions such as climate, landscape and materials as well as the buildings reflect the culture and economy of their residents.

Likewise, the notion of *neo-vernacular* (also new vernacular or contemporary vernacular) is intricate. (Zographaki, 1986) sees neo-vernacular as a deliberate reproduction of traditional buildings into contemporary forms. (Turkušić, 2011) develops on neo-vernacular from a heritage perspective and defines it as modern interpretations of vernacular architecture, meaning that it takes its inspirational sources in vernacular heritage and applies current technology and aesthetics. According to (Vellinga, 2013), neo-vernacular architecture refers to a contemporary movement that draws inspiration from traditional building and local materials while integrating modern technology, aesthetics and sustainable practices. It emerged as a response to the globalization and homogenization of architectural styles and is often seen as a counterpoint, emphasizing the importance of local identity, environmental responsiveness, and community engagement in the design process.

The neo-vernacular movement has gained significant attention in recent decades as a means of preserving cultural heritage and promoting sustainable development. For instance, (Zhao & Greenop, 2019) introduce the concepts of *neo-vernacular* and *semi-vernacular* architecture as approaches to vernacular village conservation in China. It critiques the neo-vernacular style for prioritizing aesthetics over community needs and highlights the semi-vernacular method for its focus on social sustainability and community engagement. In his extensive literature review, (Pardo, 2023) examines current research trends and challenges in preserving vernacular architecture in the context of globalization. This study emphasizes the environmental benefits of traditional materials and the challenges posed by globalization, loss of craftsmanship, and changing societal needs.

The review also identified a number of papers in which the growing focus on sustainability is reflected. For instance, (Chahanjiri et al., 2014) highlight the connection between sustainability and vernacular architecture. Thus, their understanding of neo-vernacular comprises responsible use of resources, blending traditional and new construction and harmony with the context. (Tiwari & Vij, 2024) explore the integration of neo-vernacular elements in traditional Indian temples and how to balance tradition and innovation.

3.2. Characteristics of Danish and Swedish vernacular architecture

Danish vernacular architecture is strongly connected to cultural and geographic conditions, particularly the temperate climate and the extensively cultivated landscape. The majority of the vernacular heritage is half-timbered, a building technique developed from the Middle Ages onwards. Regional differences such as available timber resources are reflected in the diverse types of load-bearing structures and timber joints. West Schleswig was influenced by Frisian culture, which is why brick-building

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gained ground here in the early 18th century and then spread along the Danish West Coast. In Southern Jutland, a few post-and-plank-constructions are preserved. Distinctive features of Danish vernacular architecture are the rectangular layout called *længehuset* (prospectively the *longhouse*), steep roofs (pitched or half-hipped) and facades with a rhythmic design due to the half-timbering. Main materials are wood (timber, boards), earth (infills, adobes, bricks etcetera), thatch (reed, straw), mortar and stone, usually from the local area. Reuse of building materials and components were common in vernacular building practice and so was thrift (Stoklund, 1969; Eybye, 2024).

Swedish vernacular architecture is deeply influenced by the country's diverse climate, geography, and cultural heritage, spanning from the northern Sami regions to the southern earthen buildings. In the north, the traditional Sami dwellings called *goahti* are constructed from timber and turf, designed to provide warmth and protection against the harsh Arctic climate. These structures reflect a close relationship with nature and materials sourced from the surrounding environment. Moving southwards, the architecture transitions to a mix of wooden cottages and farmhouses, notably *stugor* and *torp*, often built with timber from the vast forests. The southern regions, particularly in places like Skåne, showcase earthen constructions such as *skånelänga*, where thick clay walls provide insulation in contrast to the colder northern climate. Throughout the country, timber plays a significant role in vernacular architecture, with its use in everything from homes to barns, ensuring the structures are both functional and adapted to their environment (Bronner, 2004; Björck et al., 2021).

3.3. Summary

Though the literature review is not exhaustive, it indicates lack of theory on neo-vernacular. Focus on sustainability has increased in line with the general development, and contemporary is crucial in neo-vernacular. Relatedly, current construction in Scandinavia is subject to strict legislation (energy consumption, daylight, spatial conditions and insulation to name a few) that inevitably adds modernity. Consequently, the analytical frame defines contemporary as 1) design, construction and technology, and 2) sustainability. Since this study explores whether Scandinavian neo-vernacular truly aligns with traditional vernacular, the analysis also includes 3) elements from traditional vernacular such as adaptation to site, design and materials.

4. Case studies

4.1. Hahn Lavsen's house, Agger, Denmark

In 2018, architects Caroline Hahn and Ebbe Lavsen purchased an old *højremshus* (aisle-truss house) from 1827 in the village of Agger. Aisle-truss houses are the vernacular architecture of Northern Jutland, and the building design and choice of materials are closely connected to the scarce resources and harsh climate conditions by the West Coast. Next to the old house, Hahn and Lavsen have built a new, single-family house from 2019 to 2022 (Fig. 1). Preliminary to the construction process, the architects investigated the design principles of their old aisle-truss house as basis of the new house (Munk, 2023).

4.1.1. Design, construction and technology

The house is designed as two longhouses in a T-shape form with a pitched roof and it is 126 m^2. The scale is adapted to the old aisle-truss house and similarly, the fenestration resembles the old house with larger openings to the south and few, small openings to the north. Despite this, the house is clearly contemporary. Concerning materials, the walls are built of Ytong energy+ blocks, the roofing is made of tarred pinewood planks, the windows are of pinewood and produced in a local factory. Floor tiles are laid in sand for future disassembly and insulation materials are natural, comprising shells and wood fibre (Jensen, 2022).

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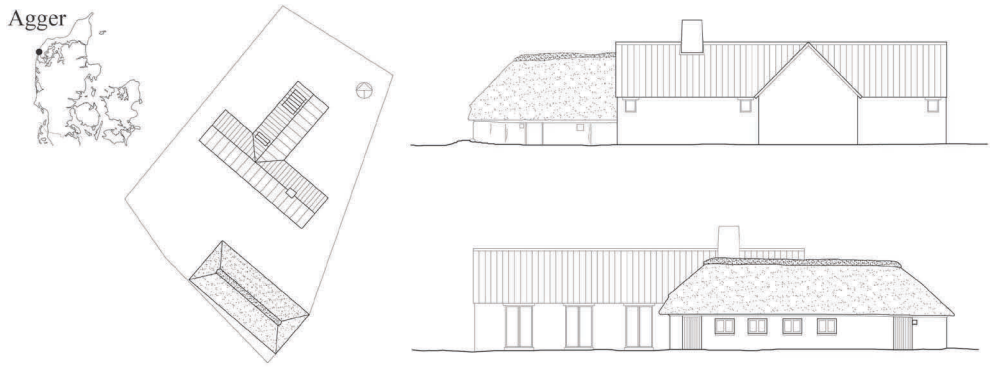

Fig. 1 – *The Hahn Lavsen house. The houses are orientated according to the strong, prevalent wind from the north-west. North and south elevations. Scale and fenestration of the new house aligns with the old house. Drawings are based on (Thisted Kommune, 2025)* (Eybye, 2025).

4.1.2. Sustainability

The house is energy labelled *A2015* (Thisted Kommune, 2025) and thus, is a Net Zero Energy Building (NZEB). The main energy source is district heating which is considered a relatively green energy source. The aim was to avoid concrete, and Hahn explains that they have chosen *"few, honest materials with a long lifetime"* (Jensen, 2022). For instance, the Ytong energy+ blocks were selected due to their cradle-to-cradle certification. Leftover wood from the construction has been used to build the front door and interior elements. The kitchen is built of reused oakwood. (Jensen, 2022; Munk, 2023).

4.1.3. Elements from traditional vernacular

The orientation, shape, design and fenestration of the house refers to traditional vernacular. Hahn relates that the components of the vernacular materials (i.e. wood, sand, lime and clay) also are the main components in their choice of materials. The architects wanted affinity between the two buildings in regard to materials and scale, just as the preconditions of Agger are the same as 200 years ago (Jensen, 2022). The house is owner-built to a large extent which was common in the traditional vernacular and highly unusual in present Danish construction. Hence, building costs are relatively low. Lastly, Hahn and Lavsen state that the building process was about learning, not getting finished quickly (Jensen, 2022).

4.2. Rundbalshuset, Kassjö, Sweden

Rundbalshuset (The Round Bale House) is a single-family house (Fig. 2) located in Kassjö, northern Sweden and it is built from 2017 to 2021 by Laura and Erik Vidje. Their aim was to incorporate circular design principles in the building, reduce the environmental impact and to build in accordance with local climate. In this area, temperatures can range from-30°C in winter to over 30°C in summer (Elva Hållbara, 2025).

4.2.1. Design, construction and technology

The house has a distinctive, round shape, since this form is most efficient in regard to energy and materials. The primary materials are straw bales and clay, as the 70-centimeter-thick walls consist of wooden studs filled with tightly pressed straw bales, which are then plastered with clay. This combination provides excellent insulation. Other materials are laminated timber and bricks. Windows are large and along with the shape and detailing, the house is indisputably contemporary (Elva Hållbara, 2025).

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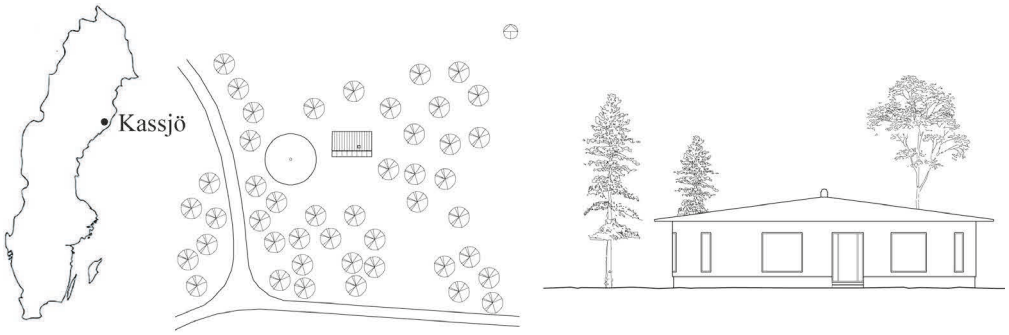

Fig. 2 – *The Rundbalshuset. Site plan with the dwelling and guest house. South elevation with main entrance. Drawings are based on (Elva Hållbara, 2025)* (Eybye & Dabaieh, 2025).

4.2.2. Sustainability

The house comprises a number of sustainable features. The primary materials are chosen for their low environmental footprint and local availability. Likewise, more materials are reused such as the kitchen cabinets and furniture. The house is labelled *Energy Class A* and it has its own solar cells and solar collectors to produce renewable energy and thus, minimize reliance on the electricity grid. Moreover, an innovative shower system recirculates hot water, requiring only five litres per use. Greywater is treated on-site through infiltration, and composting toilets manage waste sustainably. Lastly, Laura and Erik Vidje promote sustainable building through workshops (Elva Hållbara, 2025).

4.2.3. Elements from traditional vernacular

Following vernacular construction principles, the house is built from a limited number of local materials. These are also found among the traditional vernacular buildings. The low roof pitch and wide eave are characteristic of local vernacular architecture, and the latter protects both earthen and wooden buildings. The house is built by the owners to a large extent and on a modest budget. Self-building is a principal feature in vernacular architecture and uncommon in the current Swedish construction sector. Finally, the plot is laid out to vegetable garden with a view to produce as much of their own food as possible (Elva Hållbara, 2025).

5. Discussion

The objective of this study is to examine the diverse interpretations of *neo-vernacular* in Scandinavian architecture and investigate the extent to which it reflects a genuine alignment with the environmental, cultural, and social imperatives associated with traditional design. Therefore, the paper presented a literature review and a case study. Though not exhaustive, the review highlighted the lack of deep theory on neo-vernacular architecture. It is likely that more literature sources had supported this finding. The case studies comprised a Danish and a Swedish single-family house. Clearly, more cases had most likely added to the findings, yet this was not possible for reasons of time and extent. Hence, it can be argued that limited knowledge on this complex matter can be deduced from two cases. However, according to (Flyvbjerg, 2006), generalisation is often possible from a single case and moreover, case studies are highly useful to scientific development, for instance through their thick descriptions. In this paper, the case studies produced crucial data.

The two cases were examined in regard to the developed, analytical frame. First subject concerned design, construction and technology. Both houses have an indisputably contemporary design (e.g. shape and fenestration) and they apply modern technology in regard to energy.

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The design of the Hahn Lavsen house is closely affiliated with the vernacular aisle-truss house, whereas Rundbalshuset has a strong emphasis on passive systems and renewable energy sources.

Regarding sustainability, both houses comprises more aspects of sustainability. These include energy and choice of materials issued from vernacular architecture (biogenic, natural, reused or locally sourced). The climate by the West Coast is harsh for which reason the materials of the Hahn Lavsen house also are chosen with an emphasis on durability. The Rundbalshuset has a low carbon footprint, as it is mainly built of locally sourced straw and clay and furthermore, it is self-sufficient in terms of energy production.

Vernacular elements can be seen in both houses. This includes a small palette of (local) materials, self-building on a modest budget and the construction process emphasizing learning and hands-on experience. The Hahn Lavsen house is developed from the vernacular aisle-truss house and thus, it inserts itself in the tradition of the neo-vernacular as a preservation approach. The Rundbalshuset applies vernacular methods as well as eco-building (straw bale houses).

Initially, the Hahn Lavsen house appeared as a beautiful house that possibly was vernacular mimicry. Scrutiny shows, however, that the building aligns with vernacular principles and is neo-vernacular. Similarly, the Rundbalshuset aligns with vernacular principles and is neo-vernacular. With the strong intentions of renewable energy and low-carbon materials, this house arguably represents another branch within neo-vernacular that affiliates with eco-building.

5.1. Results

The study of neo-vernacular architecture in Scandinavia reveals a significant trend towards integrating traditional building practices with modern design and sustainability. Through the review and the case studies, it is evident that neo-vernacular architecture in Denmark and Sweden is characterized by a deliberate emphasis on local materials and construction techniques, which blend harmoniously with modern technology and aesthetics. The two cases are thus exemplars of this architectural movement. The Hahn Lavsen house commits to neo-vernacular principles through its design and construction methods, while the Rundbalshuset shows innovative eco-building techniques. Both structures underscore the importance of durability and sustainability, reflecting a broader trend towards environmentally conscious design in response to stricter building regulations and climate change imperatives. The findings suggest that while contemporary designs incorporate modern elements, they maintain a strong connection to traditional vernacular architecture, thereby raising pertinent questions about authenticity and the essence of neo-vernacular approaches.

6. Conclusion

The exploration of neo-vernacular architecture in Scandinavia underscores its potential as a viable paradigm for sustainable and culturally resonant building practices. By integrating traditional architectural values with modern technological advancements, neo-vernacular architecture offers a compelling framework for addressing contemporary challenges such as climate change and resource scarcity. The case studies of the Hahn Lavsen house and the Rundbalshuset illustrate the movement's capacity to prioritize local adaptation, architectural quality, and sustainability. These examples highlight the complexity and potential of neo-vernacular architecture to redefine single-family housing in Scandinavia.

As the movement continues to evolve, it will be crucial to further investigate the balance between authenticity and innovation, ensuring that neo-vernacular architecture remains a dynamic and relevant approach in the architectural landscape.

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Integrating Traditional Mechanisms in the *Escalà* HDU at the Solar Decathlon Europe 21/22 (Valencia, Spain / Wuppertal, Germany)

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Topic: T4.2. Traditional sustainability mechanisms applied to contemporary architecture

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Abstract

Throughout the 20th century, architects turned to vernacular architecture to mitigate the impact of industrialization and preserve traditional cultures. Its adaptability and environmental integration offer valuable insights for addressing contemporary challenges, especially climate change. The building sector, a major energy consumer and CO_2 emitter, can benefit from integrating traditional architectural principles with modern innovations to promote sustainability. This study investigates the application of these principles through the Escalà project by the Azalea UPV team, which participated in the Solar Decathlon Europe 21/22. The project integrates traditional Valencian architectural mechanisms, such as the escalà, to improve energy performance and adapt to local climatic conditions. Using locally sourced materials, passive cooling and heating systems, and renewable energy, the project showcases how vernacular solutions can be adapted to modern building needs. The Escalà project's success, including winning first prize in innovation and two third-place prizes, highlights the importance of incorporating vernacular systems into contemporary architecture to achieve more sustainable and efficient models. Furthermore, the project's public exhibitions in Valencia and at the Solar Decathlon promoted the reinterpretation of traditional systems and emphasized their international relevance, particularly by demonstrating compliance with Passivhaus standards. This research underscores the value of combining traditional knowledge with contemporary innovations to create sustainable, energy-efficient housing solutions for the future.

Keywords: *vernacular architecture; Solar Decathlon Europe; traditional mechanisms; valorisation; enhancement; reinterpretation*

1. Introduction

Currently, globalization has led to an apparent homogenization in the identification of problems, the application of techniques, and the use of scientific methods, giving them a seemingly universal character. However, factors such as climate, geography, topography, cultural identity, and numerous region-specific aspects must be taken into account to develop solutions that are effectively adapted to each unique context (Le Corbusier, 1930).

Throughout the 20th century, several architects, concerned about the impact of growing industrialization and the threat to the survival of

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traditional cultures, focused their research on studying vernacular architecture. Their aim was to identify and analyse the practical and technical solutions that these traditional constructions could offer to contemporary architecture (Alexander, 1979; Hitchcock, 1963; Moholy-Nagy, 1957; Rudofsky, 1964). This reappraisal not only acknowledges their cultural significance but also recognizes the quality and environmental adaptability that define these spaces. As a result, vernacular architecture emerges as a valuable source of knowledge for addressing contemporary challenges, underscoring its importance in the education of today's architects (Goldfinger, 1969; Rapoport, 1969).

Over the first decades of the 21st century, climate change has become a central global concern. Research has focused on identifying the factors that accelerate this phenomenon, developing strategies to mitigate its effects, and adapting to emerging challenges. These three areas of study have far-reaching implications across all sectors of society, with the building and construction industry playing a particularly crucial role, as it is one of the largest consumers of energy and a major emitter of CO_2 (United Nations Environment Programme, 2022). In this context, the recognized values of vernacular architecture serve as an invaluable source of knowledge for addressing climate change challenges in the building sector, encompassing its causes, mitigation strategies, and adaptation measures.

Architect Hassan Fathy argues that tradition is not necessarily synonymous with obsolescence or stagnation, nor does modernity inherently guarantee progress or improvement (Fathy, 1973). The widespread availability of modern technology and artificial means to optimize climatic conditions has led to the loss of traditional knowledge. As a result, many industrialized countries have embraced excessive use of machinery, unsustainable energy management, and the production of polluting synthetic materials. This has had detrimental effects on the environment and has further increased dependence on non-renewable energy sources (Fathy, 1986; Krier, 2009; Taylor, 1997).

This trend accelerates the depletion of natural resources and increases polluting emissions, underscoring the urgent need to reconsider the architectural, technical, and technological solutions developed over generations to adapt to local climatic conditions. In the pursuit of sustainability, traditional architecture stands out as a valuable reference, offering a wealth of accumulated knowledge on efficient material use, natural thermal regulation, and environmental integration. Advancing toward a more sustainable architectural approach requires the revival and application of vernacular architectural principles (Sánchez-Montañés Macías, 2007), combining them with contemporary innovations to achieve a balance between tradition and modernity.

2. Solar Decathlon Europe 21/22

Fig. 1 – *Solar campus. Solar Decathlon 21/22. Wuppertal, Germany* (SDE, 2022).

The Solar Decathlon, established in 2002 by the U.S. Department of Energy, is the leading international student competition for regenerative habitat. Today, the ten contests that form the foundation of the Solar Decathlon competition, challenge students to design and construct high-performance low-carbon buildings that actively mitigate climate change while enhancing quality of life through improved affordability, resilience, and energy efficiency (Solar Decathlon Europe, n.d.).

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The main objectives of the competition are to educate the next generation of architects and engineers and to inspire the public by raising awareness about resource efficiency and the importance of achieving a carbon-neutral energy supply for buildings. To achieve this, the competition promotes the integration of solar systems into building designs and the optimization of environmental energy, encouraging the construction of 'net-zero energy solar buildings' as well as 'net-positive energy buildings' that are connected to the electricity grid (Voss et al., 2023). To achieve this, the teams were required to build a House Demonstrating Unit (HDU) that would offset its energy demand. In doing so, the contestants sought to generate their own energy while simultaneously minimizing the energy demand of the houses as much as possible.

Azalea UPV is a university team participating in the *Generación Espontánea* program at the Universitat Politècnica de València (UPV). The team is a multidisciplinary group composed of more than forty UPV students and researchers, with the goal of creating a project for the 2021/22 edition of the Solar Decathlon Europe. Over the course of two years, the team developed a project aimed at addressing environmental, social, and economic challenges in a specific urban context by constructing sustainable, energy-efficient housing. From this theoretical project, the demonstrator (HDU) was created, which became part of the competition—a dwelling focused on efficient design and the use of low-impact materials for the environment (Fernández Forcada et al., 2023).

3. El Cabanyal

Azalea UPV takes Valencian tradition and culture as its starting point. Through technology and innovation, a proposal is developed that seeks to harmoniously combine past and future. This is how *Escalà* was born, a project designed by and for the residents of the neighbourhood of El Cabanyal, which provides ingenious solutions for the regeneration and activation of its urban heritage, and which can serve as a reference for other neighbourhoods and cities.

Escalà proposes a joint response to the different problems of the neighbourhood, including the large number of vacant lots, a consequence of the urban instability of recent decades. The team has devised a construction solution with minimal environmental impact that takes advantage of the Mediterranean climate, introducing passive measures and the production of renewable energies in the community. In addition, reused and locally sourced materials are introduced, thus promoting the circularity of the proposal and reducing its carbon footprint.

The proposal contributes to fostering the social cohesion of the neighbourhood through a cooperative of scattered houses at affordable prices with a large presence of common spaces and services. In addition, it is committed to recovering street life, reducing the presence of private vehicles and promoting sustainable mobility to connect the neighbourhood with the city.

Based on the essential features of traditional Mediterranean architecture, the proposed typology arises from the livelihoods, customs of its inhabitants and climatic conditions as a response to basic needs.

Fig. 2 – *Process of replacing barracas and the escalà in the Cabanyal* (Barberá Masip, 1871).

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El Cabanyal is a residential neighbourhood, originally a fishing village, whose particular grid pattern derives from the previous alignments of the *barracas* and the *escalà*. This space of 1.36 m was shared between two *barracas* (the vernacular popular dwelling typology) and was used for the maintenance of the roof and ventilation (Fig. 2).

In the transition of the *barracas* to the current modernist typology of El Cabanyal, the distribution of the property of the *escalà* marked the evolution of the urban fabric, maintaining similar plot dimensions throughout the neighbourhood. The current plots range from 6 m to 8 m and a depth of 12 m to 20 m, allows for greater scalability of the project in the neighbourhood; the same construction model and housing typology can be adapted to the neighbourhood's subdivision and developed on the current vacant lots.

4. A reinterpreted tradition

The *escalà* is incorporated into the project as the main character of the proposal. Located on the north party wall, it acts as a thermal cushion to improve the building's energy performance. The continuous passage of air favours the cooling of the dwellings located to the east and also increases cross ventilation through the courtyard for the dwellings located to the west. It also contributes to improving the climate conditions at the urban level by favouring the passage of the sea breeze between the streets of the neighbourhood. It is also established as a vertical communication nucleus and a space where vegetation is integrated and allows natural light to enter the interior of the dwelling. In addition, on the ground floor level of the *escalà*, there is a space reserved for bicycle parking in order to encourage sustainable mobility among the residents.

Thanks to its height of 10 metres, the thermal draught of the *escalà* can be used in summer to extract the hot air from the house during the day where the wind speed is less than 2 m/s. In winter, the *escalà* takes advantage of winter solar radiation to improve indoor thermal conditions through the thermal gain system which is part of the forced ventilation system.

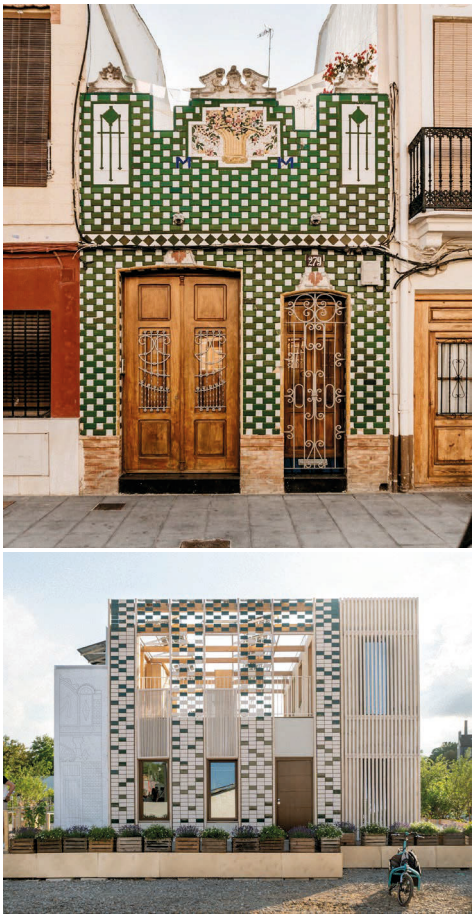

Fig. 3 – *sup. Modernist Cabanyal dwelling. inf. Escalà project* (Azalea UPV, 2022).

A typological and material study of all the facades in the neighbourhood led to the final solution, a façade that combines the tradition of the traditional glazed ceramic pieces of El Cabanyal, with an industrialised system: Flexbrick, which allows the facade to be fitted in a simple way and facilitates its maintenance and dismantling. In addition, it is important to emphasise that the composition of openings

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typical of the neighbourhood's buildings has been maintained and a combination of pieces and colors has been chosen, with the colour green taking centre stage (Fig. 3).

On the East and West facades there are openings in a similar proportion to the openings in the traditional architecture of the neighbourhood.

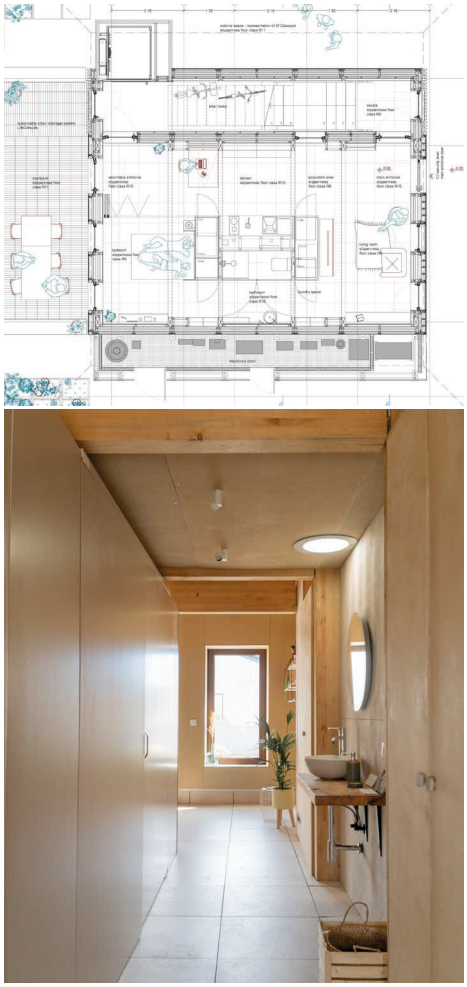

Fig. 4 – *(sup) Escalà house plan. (inf.) Circular multi-purpose corridor promoting natural ventilation*. (Azalea UPV, 2022).

This allows for increased natural light and exterior views, thus increasing people's well-being. In addition, the circular house plan (Fig. 4), together with the openings exactly positioned in opposite façades, facilitated the natural east-west ventilation inside the dwelling. This mechanism reduces the energy required to condition the interior, just as traditional Cabanyal buildings used to do to take advantage of sea breeze ventilation.

These openings are fitted with a retractable awning, which is an adaptation of traditional Valencian shutters. This system was chosen because it reduces the direct entry of solar radiation on the hottest days while allowing indirect light and natural ventilation into the dwelling. On the main facade, the shading system consists of a mobile device that arises from the same construction system as the entire facade, allowing it to be architecturally integrated.

In an attempt to reinterpret the traditional materials used in the early construction of *El* Cabanyal and its tradition with ceramic materials, the flooring is made with ceramic tiles, in order to continue the history of the neighbourhood.

Rice straw is another traditional material reused in the project. The enclosure system is based on a lightweight framework of wooden slats and OSB panels, which have the same rice-straw insulation on the inside that was used as a roofing material in the *barracas* (Fig. 5). The combination of a highly insulated envelope and the thermal inertia of a ceramic material reduces the heating requirements of the house by passively releasing heat and preventing it from escaping from the envelope, reinterpreting the passive conditioning mechanisms of the *barracas*.

In order to reduce the energy consumption of the air renewal system required by the building regulations the team reinvents the vernacular air catchers by combining them with a solar chimney. The *Caloret* System, a prototype designed by Azalea UPV, is implemented within the thermal gain ventilation system, which allows

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the house to be heated in a passive mode in winter and to be cooled with a natural air flow in summer. The *Caloret* System is integrated into the southern edge of the *escalà* and runs the entire length of the volume. The materials used in its production consist of a reinterpretation of natural materials: adobe (for its great energy capacity), wood (for its structure) and natural ventilation. As a result, a visually and functionally integrated solution is achieved that does not interfere into the overall perception of the terrace space since the surface seen from it is made of ETFE, a transparent polymeric membrane (Fig. 6).

Fig. 5 – *Rice-straw filled modules process of creation* (Azalea UPV, 2022).

Fig. 6 – *Caloret system creation process. The first images correspond to the experiments and measurements of the adobe. The last image is the terrace with the caloret located on the left side of it* (Azalea UPV, 2022).

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Finally, the back of the house symbolically represents the courtyard, typical of the traditional Valencian typology and one of the common spaces of the co-living proposal. It is a space that allows the relationship with the exterior, the incorporation of greenery and contributes to improving the thermal comfort of the house by facilitating cross-ventilation. Figure 7 shows the draining paving system made out of ceramic tiles from the region that are in stock (LifeCersuds). Thanks to this system, it is possible to collect rainwater to irrigate the vegetation and to respond to the occasional flooding that occurs in the neighbourhood. This mechanism reduces the energy required to condition the interior, as the traditional Cabanyal buildings did to take advantage of sea breeze ventilation.

Fig. 7 – *sup. LifeCersuds terrace pavement. inf. Escalà rear façade* (Azalea UPV, 2022).

5. Conclusion

This university research project focuses on the reinterpretation and revival of certain traditional mechanisms from Valencian architecture, which played a key role in the team winning the first prize in innovation at SDE 21/22, as well as two third prizes in the categories of architecture and engineering & construction. These awards highlight the significance of integrating vernacular systems into contemporary design, demonstrating that modern architecture must prioritize the adaptation and optimization of traditional vernacular systems to achieve a more sustainable and efficient model.

Finally, it is worth noting that despite the limitations of the university project (Davis et al., 2025) during its public exhibition, the project was presented to the members of the 16 international teams, as well as to the 140,000 visitors of the SDE, including 1,000 primary school children who attended with their schools. Additionally, during the project's presentation in Valencia, the doors were opened to UPV students and faculty, as well as to public and private companies that collaborated with *Escalà*. This has not only allowed for the reinterpretation of traditional systems used throughout the neighbourhood since its early days but also provided an opportunity to enhance their value at an international level by demonstrating their compliance with the Passivhaus Institute standard, while at the same time transmitting them to future generations, ensuring they do not fade into oblivion.

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Sustaining Traditions, Preserving Forests: Adaptation of Vernacular Woodworking in Rural Japan

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Abstract

Traditional architectural craftsmanship in Japan faces significant challenges due to modernization and industrialization. While most single-family homes now rely on post-and-beam construction with pre-cut joinery and metal connectors, some small carpentry firms continue to uphold traditional hand-carving techniques. This study examines Firm S, a carpentry firm in Shiga Prefecture, investigating how it preserves these woodworking traditions while adapting to contemporary needs. Through participant observation in construction projects, this study identifies key adaptations in three main structural components—walls, roofs, and foundations—when compared to the vernacular farmhouses of the region. Interviews with local practitioners were conducted to understand the reasons behind these adaptations, as well as their motivations for preserving woodworking traditions. In newly constructed wooden houses, cedar board walls, gable roofs with metal panels, and reinforced concrete foundations have largely replaced the mud walls, tiled roofs, and stone foundations of vernacular houses. Key factors driving these adaptations include legal restrictions, time and cost efficiency, and aesthetic preferences. Firm S sees these structural adaptations as necessary compromises to sustain woodworking traditions—particularly hand-carving techniques—while remaining competitive. More importantly, the firm addresses two major challenges in Japan: the short lifespan of contemporary wooden houses and unsustainable forestry practices. Traditional wooden houses can last for centuries thanks to hand-carving techniques that enable the replacement of damaged structural components and the customization of joints to accommodate timber's natural shrinkage. By promoting longevity in wooden houses, Firm S seeks to balance timber consumption with forest regeneration. Efforts are also made by exclusively using locally sourced lumber and participating in reforestation activities. For Firm S, preserving woodworking traditions is more than a technical decision of architectural authenticity—it is a moral and ecological responsibility of fostering a symbiotic human-nature relationship. By doing so, the firm not only preserves traditional craftsmanship but also advocates for a more ecologically responsible approach to contemporary construction.

Keywords: *vernacular architecture; craftsmanship; woodworking; cultural heritage; adaptation*

1. Introduction

Traditional architectural craftsmanship faces significant challenges to its survival amid modernization and industrialization. In Japan, it is further threatened by an aging population and rural-to-urban migration.

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Whereas craftspeople in industrialized societies tend to primarily focus on the conservation of historical buildings, traditional woodworking is still applied for contemporary construction projects in Japan.

1.1. Woodworking Traditions in Japan

Japanese traditional post-and-beam construction is referred to as *dento-koho* in Japanese. Following the 1891 Nobi Earthquake, experts in Japan have been devoted to strengthening the earthquake resistance of *dento-koho*. This led to the development of the so-called conventional post-and-beam construction method known as *zairai-koho* (Clancey, 2006; Nishizawa, 2018). In essence, *zairai-koho* is the result of experts' efforts to formalize *dento-koho* and ensure its quality control with a top-down approach.

In 2008, about 75% single-family houses in Japan were built with post-and-beam construction. However, the majority of these houses employed pre-cut joinery techniques (Hirano, 2010). While some scholars regard *zairai-koho* as a continuation of *dento-koho* (Clancey, 2021; Eastin & Roos, 2010), this paper emphasizes their fundamental structural differences and classifies them as two distinct construction systems.

Although relatively rare, traditional hand-carving techniques are still applied in some construction projects. A small carpentry firm in Shiga Prefecture serves as an example. By comparing its contemporary building practices with vernacular farmhouses in the same region, this study examines the adaptations made by local practitioners and the reasons behind these adaptations.

1.2. Research objective

Discussions on craftsmanship preservation have long been dominated by expert perspectives. This study aims to enrich the discourse by highlighting how local practitioners perceive and preserve woodworking traditions in Japan.

1.3. Methodology

Qualitative field surveys were conducted to collect data and can be divided into two periods: December 2019 to June 2021, and May to October 2024. The study scope in the first period focused on vernacular farmhouses, while the second period on contemporary construction. This included two architectural internships at the carpentry firm, totaling about six months. During the internships, the author acted as a participant observer, meaning the primary role was to collect research data, and the group being studied was aware of the author's observation activities (Kawulich, 2005). For the analysis of vernacular farmhouses, methodologies included measurement surveys of farmhouses and interviews with local residents and senior carpenters. For contemporary construction, participant observation was applied by engaging in the design process of construction projects. This involved technical drawing and 3D modelling of wooden structures. Additionally, observations at construction sites and both non-structured and semi-structured interviews were conducted, mainly with architect Mr. M and master carpenter Mr. U.

2. Introduction of the Carpentry Firm S

The carpentry firm (hereafter, Firm S) is situated in a rural region in Shiga Prefecture, nestled between the Hira Mountain Range to the west and Lake Biwa to the east (Fig. 1). Historically, local residents supported themselves mainly through agricultural activities, and harvested lumber from their own forests to build houses.

2.1. Practitioners

Firm S was founded by a local carpenter in 1958 and passed down to his son, Mr. M, in 1998. Mr. M (male, 50s) is an architect who graduated from Chiba University near Tokyo. After working for Atelier ZO for several years, where he embraced the concept of environmental design, he returned to his home, took over the family business and collaborated with local carpenters.

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Fig. 1 – *Location of Firm S* (Author, 2025).

Currently, Firm S employs nine carpenters, expanding to 20 through subcontracting when needed. One of Mr. M's key partners is master carpenter Mr. U (male, 30s), who now serves as the Representative Director of Firm S. Raised in a nearby village surrounded by dense forests, Mr. U began his apprenticeship at 15 and has been practicing traditional house carpentry in the region for about 15 years.

The close architect-carpenter collaboration defines Firm S's specialty, as introduced in Section 2.3.

2.2. Operations

In the past, master carpenters often supervised both design and construction, acting as architects, structural engineers, and builders. Yet these roles are more specialized in modern practices. In the context of Firm S, Mr. M mainly handles architectural and structural design, while Mr. U focuses on construction, on-site carpentry supervision, and project management.

Overall, Firm S offers a comprehensive service encompassing wood harvesting, processing, design, to construction.

2.3. As a *Komuten* in Japan

Firm S is classified as a *komuten* in Japan, in contrast to large home builders with extensive nationwide sales networks. Despite its rising variety in recent decades, *komuten* typically refers to small, local-based, and family-run construction firms. These companies normally build a limited number of houses each year. Firm S, for instance, constructs around 10 houses annually. However, Firm S differs from a typical *komuten* in several ways. While an increasing number of *komuten* have adopted mechanized mortising machines for efficiency and prefer imported lumber for its lower cost (Clancey, 2021), Firm S insists on using locally sourced timber and hand-carving techniques. At the same time, unlike more conservative *komuten* that strictly adhere to tradition, Firm S incorporates structural adaptations and offers services at reasonable prices, making them accessible to nearby residents with average incomes.

3. Structural Adaptations

Timber frames of a vernacular farmhouse can be categorized into three components—foundation, wall, and roof truss (Fig. 2). Adaptations made in each component are explained accordingly.

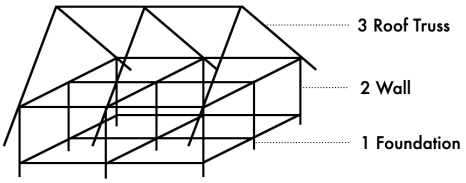

Fig. 2 – *Simplified scheme* (Author, 2025).

3.1. Foundation

In the practices of Firm S, reinforced concrete (RC) foundations are predominantly used, replacing traditional stone foundations (Fig. 3). Historically, pillars were placed directly on base stones without any fixation. These base stones, typically naturally rounded stones sourced from nearby rivers or streams, required the foot of each pillar to be carefully cut and shaped to fit their irregular contours.

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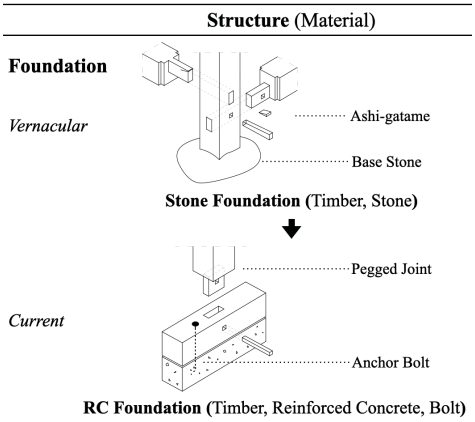

Fig. 3 – *Changes of foundation* (Author, 2025)

A framework of floor beams was then attached to the pillars and extended around the building using sophisticated joinery techniques, known as *ashi-gatame* in Japanese. In contrast, RC foundations are now widely adopted. Floor beams are placed directly on the RC foundation, which provides a level base and connects all pillars using pegged mortise-and-tenon joints. Additionally, preliminary ground surveys are mandatory to ensure adequate earthquake resistance by assessing soil conditions and preventing liquefaction. For the same reason, anchor bolts are used to secure the wood frames to the foundation. Notably, foundation is the only structure where the use of metal connectors is compulsory.

3.2. Wall

Firm S primarily adopts timber board walls, also known as *itakura* (a form of Japanese log construction) for wall structures, replacing the traditional wattle-and-daub construction (Fig. 4). The traditional Japanese wattle-and-daub wall, often referred to as mud wall or straw-clay wall, comprises a tied lattice of split bamboo serving as the structural frame (wattle), with a heavy mixture of mud and straw plastered on both sides (daub). The plaster is applied in several layers, typically finished with a fine sand texture. However, some farmhouses featured mud walls with a bold, rough texture.

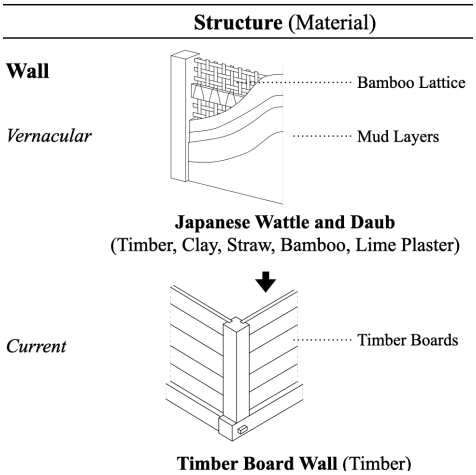

Fig. 4 – *Changes of wall structures* (Author, 2025).

Today, mud walls are rarely employed. Instead, timber board walls (*itakura*) have become the standard wall system in new constructions. This system consists of precut tongue-and-groove boards installed between the pillars and can be constructed using only timber (most commonly cedar) and insulation materials. Still, lime plaster can be applied as an exterior finish upon client request.

3.3. Roof

The roof structures of vernacular farmhouses can be categorized into two main types: brace truss for thatched roofs and Japanese roof truss for tiled roofs. While the brace truss has fallen out of use with the decline of thatched roofs, the Japanese roof truss continues to be employed by Firm S in contemporary construction (Fig. 5).

The brace truss is one of the oldest roof structures, consisting of diagonal braces supported by transverse beams and eave purlins. Bamboo battens and rafters were further tied to these braces to support thatching materials such as wheat and rice straw. Reeds were rarely used in this region due to their relatively high cost. In contrast, the Japanese roof truss incorporates purlins and vertical posts to support rafters and battens. Sophisticated joints are used to connect pillars with transverse beams and eave purlins.

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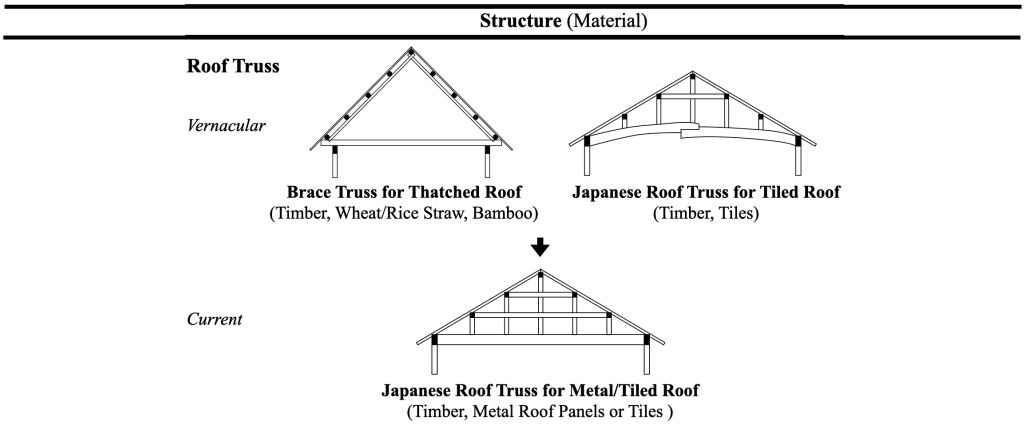

Fig. 5 – *Changes of Roof Structures* (Author, 2025)

In general, Japanese roof trusses have undergone minimal changes over time, and similar joints are still employed in new construction. However, there are three notable differences in their contemporary application:

1. Material Shift: There is a reduced use of round logs and an increased use of square timber for transverse beams.
2. Roof Materials: Light metal roof panels are increasingly replacing traditional tiles.
3. Simplified Roof Forms: Simple roof designs, such as gable roofs, have become predominant, replacing the more complex hip-and-gable and hipped roofs that were once common.

4. Reasons for Structural Adaptations

In short, the reasons for making these structural adaptations can be attributed to three main aspects: legal restrictions, time and cost efficiency, and aesthetic preferences. However, changes made in each structural component result from different legal, economical, and aesthetical considerations (Table 1).

4.1 Legal restrictions

Legal restrictions can be observed in the changes made to foundations and wall structures. As briefly mentioned in Section 1.1, *zairai-koho*—a conventional construction method developed by experts—employs diagonal bracing and metal connectors, significantly distinguishing it from wood building traditions (*dento-koho*). *Zairai-koho* aligns with prescriptive building codes that emphasize strengthening the rigidity of structures to resist earthquakes, whereas *dento-koto* relies on its high deformation capacity to dissipate seismic energy. Thus, new building projects that aim to employ authentic traditional post-and-beam structures with stone foundations and mud walls necessitate specific structural calculations to comply with performance-based regulations. While feasible, this process entails additional time and costs.

Table 1 - Reasons for structural adaptations (Author, 2025).

	Legal Restrictions	Time - Cost Efficiency	Aesthetic Preferences
Foundation	O	O	-
Wall	O	O	-
Roof	-	O	O

Note: "O" stands for affirmation.

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To address these regulatory requirements, Firm S employs prescriptive RC foundations and adopts timber board walls. Whereas the construction of RC foundations strictly follows building codes, timber board walls (*itakura*) offer a practical alternative that allows carpenters to construct timber frames using handcrafted joints, eliminating the need for diagonal bracing or metal connectors.

Itakura is a construction method derived from traditional warehouses, such as those seen at Ise Shrine. It was adapted to modern construction in 2005 by researchers in vernacular architecture at Tsukuba University. The key advantage of *itakura* is its ability to meet legal standards as a "rigid" structure due to its sufficient initial stiffness. At the same time, unlike *zairai-koho*, *itakura* retains a degree of deformation capacity during earthquakes. This combination of stiffness and flexibility makes *itakura* a legally recognized alternative that remains compatible with traditional carpentry techniques. As a result, carpenters can readily acquaint themselves with the system, viewing it as a continuation of traditional practices rather than a modern construction method.

4.2 Time and cost efficiency

As Firm S remains committed to using hand-carving techniques, improving construction efficiency in other aspects has become crucial. This emphasis on efficiency is evident across all three structural components.

In general, there has been an increasing use of squared logs in roof truss, which simplify the creation of joinery and facilitate the installation of interior components, such as partition walls. Similarly, RC foundations also require less complex joints and eliminate the need to carve pillar feet to fit irregular stone foundations.

Additionally, the timber boards used for wall structures are dried and prefabricated in advance, significantly reducing the material and labor costs associated with plastering mud walls and shortening construction timelines. While hand-carving joinery still takes months of processing and preparation, assembling an *itakura* frame requires only about two days of on-site construction. As a result, a new house built by Firm S can remain competitively priced compared to prefabricated houses constructed by large home builders.

4.3 Aesthetic preferences

Changes driven by aesthetic preferences are most evident in roof structures. In the past, due to limited material and economic resources, vernacular farmhouses often had similar appearances, with roof forms serving as a key indicator of a family's social and economic status. As a result, hip-and-gable and hipped roof forms, which required sophisticated joints, were favored by residents.

However, these roof forms are now rarely used in new constructions. Beyond the constraints of construction budget, the simplicity of gable roofs is increasingly appreciated for their aesthetic appeal. This preference is further reinforced by the growing use of metal roof panels, which are characterized by straight and clean roof lines.

5. Motivations For Preserving Woodworking Traditions

From the perspective of Firm S, structural adaptations are necessary compromises to protect the core of traditions—the sophisticated hand-carving techniques of carpenters and, more importantly, a traditional value system that prioritizes a symbiotic human-nature relationship. Their efforts are particularly significant in addressing two major challenges in modern Japan.

The first challenge stems from the so-called scrap-and-build approach in the Japanese housing market. Japanese building codes require only a minimum 30-year durability for new houses. This policy was originally intended to support rapid housing reconstruction after World

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War II, but it has led to a market where houses depreciate quickly and are rarely maintained for long-term use (Eastin & Roos, 2010).

However, traditional wooden houses can last for centuries if properly maintained. Traditional farmhouses are designed for easy maintenance—timber frames remain exposed on both sides after wall completion, allowing quick identification of decay. When deterioration is detected, carpenters can replace the damaged structural components using handcrafted joints and the process is known as *netsugi* (Fig. 6). Additionally, hand-carving is considered essential for customizing joints to accommodate the distinct shrinkage movement of each timber piece, contributing to the long-term durability of wooden houses.

To this day, Firm S remains dedicated to building houses that endure for centuries, emphasizing the significance of longevity as it aligns with the natural lifecycle of wood. Since quality timber takes decades or even centuries to mature, constructing houses that last for generations helps to achieve a sustainable balance between timber consumption and forest regeneration.

The second challenge concerns forest management. Before World War II, Japanese forests were abundant with oak, maple, and various broadleaf trees and evergreens. After the war, government policies promoted the replacement of these natural forests with commercially valuable species like Japanese cedar and cypress. However, this strategy ultimately failed both ecologically and economically. Ecologically, the superabundance of cedars has prevented sunlight from reaching the forest floor, threatening the growth of small- to medium-sized plants and offering little food or protection for wild animals. Economically, the value of cedar forests declined as the government began the imports of inexpensive foreign timber in 1964, leading to a significant reduction in the domestic forestry workforce. Low revenues demotivated the forest owners from engaging in proper forest management. Consequently, forest management is practiced with an emphasis on immediate profitability instead of sustainability (Fuchigami et al., 2016).

Through its material selection and construction methods, Firm S aims to mitigate these issues and contribute to sustainable forest management. By utilizing locally sourced cedar board walls, they maximize the use of abundant yet underutilized cedar resources. Additionally, they engage in reforestation efforts to restore healthier forests. Firm S also views traditions like visiting local forests and selecting suitable trees with clients as essential practices to be upheld in contemporary construction. This not only ensures the quality of the materials used but also fosters a deeper connection between clients and nature. By addressing both the longevity of wooden houses and the sustainability of forestry resources, Firm S ensures that traditional woodworking remains a viable and meaningful practice in contemporary Japan.

Fig. 6 – *Replacing a rotten footing* (Author, 2025).

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6. Discussion

This study shows that Firm S adapts traditional woodworking techniques by modifying foundations, walls, and roofs to meet current building requirements. A key point is the difference between *zairai-koho* and *itakura*. Early engineers favored rigid wooden structures with metal connectors, leading to the development of *zairai-koho*. This approach reduced the applicability of traditional joinery, as proper assessment methods to verify its seismic resilience were not available. Later, with advances in engineering and computer technology, *itakura* emerged. It recognizes the seismic performance of traditional joinery as well as facilitates the use of domestic timber resources, aligning with the key concerns of carpentry firms like Firm S. Although a detailed technical comparison is beyond the scope of this paper, the evolution from *zairai-koho* to *itakura* highlights that expert-driven innovations must incorporate the practical and cultural values of local practitioners.

7. Conclusion

By examining how and why Firm S integrates traditional woodworking into contemporary construction, this study explains local practitioners' perspectives in perceiving and preserving building traditions. In response to legal restrictions, time and cost efficiency, and evolving aesthetic preferences, newly constructed wooden houses commonly feature cedar board walls, gable roofs with metal panels, and RC foundations, replacing the mud walls, tiled roofs, and stone foundations typical of vernacular houses. These adaptations allow Firm S to implement traditional hand-carving techniques while maintaining market competitiveness. For Firm S, preserving woodworking traditions is not merely a technical decision focused on architectural authenticity; it is a moral and ecological responsibility that fosters a symbiotic relationship between human habitation and the natural environment. In doing so, the firm not only preserves traditional craftsmanship but also advocates for a more ecologically responsible approach to contemporary construction.

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The Knowledge Production of Ecovillages and the Issues With Contemporary Regenerative Architecture

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Abstract
In January 2024 MOMA NYC featured a large exhibition entitled Emerging Ecologies: Architecture and the Rise of Environmentalism. The exhibition displayed architecture works from the 1970's and the motivation was that their ideas and technologies, while perhaps forgotten, actually held a promise. An important element left out from the exhibition was the work of self-made ecovillages. The aesthetics of self-built ecovillages in earthen and strawbale technologies, have to a large extent been rejected by architectural canons. While architects, engineers and building codes have turned down their applicability due to aesthetic reasons and difficulty in technical assessment, these built experiments still stand soundly and have been carefully maintained by their inhabitants. In the light of the current ecological crises which values and lessons can be learned from +20-year-old ecovillages? This paper examines two cases, a self-built house in an ecovillage and a contemporary regenerative centre designed by architects. The two examples present the difference in ideas and values of what regenerative can mean and do, and to whom.

Keywords**:** *sufficiency; regenerative design; ecological vernacular; ecovillages; architectural history and theory*

1. Introduction

Ecovillages share deep roots with both the Arts and Crafts and the picturesque movements, reflecting a broader historical lineage of resistance to industrialization and a desire to harmonize human habitation with nature. The Arts and Crafts Movement, emerging in the late 19th century as a reaction to the dehumanizing effects of mass production, emphasized craftsmanship, the use of local materials, and a return to traditional building techniques, drawing on the realm of vernacular architecture. These are values closely aligned with the self-built, biogenic architecture seen in many ecovillages. Just as Arts and Crafts advocates like William Morris sought to integrate beauty, utility, and social reform into design, ecovillages often prioritize hand-crafted homes, regenerative materials, and participatory construction processes that empower inhabitants and foster community bonds.

The picturesque movement, with its focus on irregularity, organic forms, and the blending of built environments into natural landscapes, also resonates with ecovillage aesthetics. Rather than adhering to strict architectural formalism,

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ecovillages often adopt asymmetry, curving lines, and the use of raw, unprocessed materials — creating a sense of place that appears "grown" rather than imposed. This connection to the picturesque reflects a shared philosophy: that architecture should work with, rather than against, nature.

While these historical movements and their influential ideas offer a rich and meaningful foundation for ecovillage design, they are often overlooked in contemporary architectural practices focused on regenerative design. While ecovillages constitute a valuable exemplary catalogue of practices and solutions, today, the vision of building in harmony with nature, using sustainable materials, and creating low-tech, energy–efficient homes is just as often associated with a different spatial language that still praises modernist principles of order, cleanliness and straightness. Furthermore, unlike the low-budget work and economic principles that surround ecovillages formation, new regenerative architecture today often requires a high level of investment. The high cost of labour-intensive craftsmanship, the expense of locally sourced materials, and the need for specialized expertise to design and construct buildings that respond to the local climate and environment can create significant financial barriers for architecture. Lastly, an unspoken stigma surrounding the aesthetics of ecovillages within the architectural community often hinders meaningful knowledge exchange between the two spheres.

One of the persons that wrote extensively on regenerative design and founded the Centre for Regenerative Studies in California in 1976 is John Tillman Lyle. He differentiated "development as a matter of economics" from development as the design of a "new ecosystem" were "its structure, function, and spatial distribution of activities determines its effects in terms of both resource use and environmental quality" (Lyle, 1994, pp. 19-25).

Lastly, is important to note that the study draws on Daniel Maudlin's definition of vernacular architecture as "the 'architectural language of the people'" (Maudlin, 2010, p. 13), thus applying a wide understanding of the concept. According to Maudlin, "Vernacular architecture studies can be an inclusive and continuous field of study that can incorporate any number of methodologies and perspectives and which may include such buildings as traditional, regional, anonymous, everyday, modern and contemporary." (Maudlin, 2010, p. 13). Relatedly, ecovillage buildings are examples of 20th century Danish vernacular architecture (Eybye, 2024, p. 500).

2. Objective and methods

This paper examines one house in a Danish ecovillage and one project that was built under regenerative, contemporary ideals. By bringing these two cases together, the objective of this study is to showcase the architectural dichotomies and differences that exist when the 'regenerative' is constructed and owned from different perspectives and by different constituencies.

Methods applied is case study research. Sources comprise literature, site visits, empirical studies, interviews and other relevant material to get critical insights into the aims and visions of the building design. Furthermore, the study draws on theory and history of architecture such as the Arts and Craft Movement, the picturesque, vernacular architecture, regenerative architecture and sustainability.

3. Two regenerative practices in the same landscape – balancing inclusion and elitism

3.1. A house in Hjortshøj

Hjortshøj is a cooperative ecovillage hosting more than 300 people in eight housing groups. It is located 15 km north–east of Aarhus and was founded in 1986, although the first group of inhabitants moved in in 1992.

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The aim of the ecovillage was and still is to build a local community with an organic social cohesion and thus, one which can test for new environmental initiatives and new forms of social collaborations providing economic freedom for many. Most materials were chosen in relation to the climatic function they needed to respond to, including solar orientation, thermal comfort and natural ventilation. The irregular expression of the built works can be understood through the theoretical framework of the Picturesque, which sustained that architecture should feel like nature, much more irregular and diverse than Renaissance geometric articulations (Hussey, 1967/2020). The climatic exchange between inside and outside in Hjortshøj is much more varied and consists of far more 'participants' than in the modernist sealed glass building with mechanical climate controls (Bjerregaard, 2005).

Not only are associative references to the local farmhouse incorporated in relation to the site, but the area is characterized by actual elements from a traditional farming culture: willow grove (for fuel), small artificial mounds for storing vegetables, and roads and paths that are unpaved and contribute to the fostering of biodiversity. By its very nature, the 'self-grown' should not just be seen as a strategy in a figurative sense, as we know it from the architectural theory of the picturesque, but in Hjortshøj it has a consequence that reveals a great variety and wealth of possibilities. The dissemination lack of unifying and holistic wit contained in buildings from the heyday of the picturesque in the 18th and early 19th centuries and in the later Arts & Crafts movement, is an aspect that also characterizes ecovillages like Hjortshøj.

The Arts and Crafts Movement radicalized how to understand material properties. In the work of Gertrude Jekyll for example, materials almost took on an independent 'personality'. (Watkin, 1982). Building materials in general, were not just from the local brickwork production, but made from clay from the building site itself. Within this ideology, buildings had to be built according to local climate and should be freed from symmetrical cannons. Windows, chimneys and eaves would be designed according to the specific needs and location, an extremely situated positioning of the work to be done (Ruskin, 1925).

Through one of the self-built houses in Hjortshøj, this paper discusses the knowledge production that has been gestating in the context of ecovillages. The house was built in 1993, a time when very few architects - and certainly not the big studios - were working with low-tech, ecological technologies. At first glance, there is a similarity in terms of expression and content to the self-build projects of the temporary hippie-camps of 1968 (e.g. Thylejren) and the more established low-rise movement (e.g. Vandkunsten) (Hoff, 1977). But a significant difference is that the ecological traits, understood as anti-industrialism, anti-technical and anti-scientific have been taken a step further. Instead of burning fossil fuels, the focus was on renewable energy, created in the simplest and most low-tech way possible. The choice of building techniques and materials also carefully consider how to build in a way that is as respectful of nature as possible.

The house is located on a windswept hilltop overlooking the Bay of Aarhus. It is oriented towards the south with a one-sided roof slope to the north. A large facade area is then created to the south and a small one to the north. The house is constructed with thick rammed clay walls as load-bearing elements. It is a semi-detached house for two families. The rammed clay walls support the vertical partition and the beams of the roof, whose massive timbers can be seen in the ceilings on the inside, as would have been devised by Arts and Crafts architects.

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Fig. 1 – *Trompe wall* (Eybye, 2024).

The clay walls stand on a ground plinth of conventional design consisting of cast concrete. The clay walls are exposed in the interior, creating a beautiful surface where the small stone particles of the earth sparkle in the slightly rough and matte earth-colored surface. The floors are made of wood. On the outside of the clay walls, there is a thick layer of paper insulation laid in a heavily dimensioned wooden structure (the builders call it 'half–timbering'). The insulation and 'trusses' are clad with wood on the outside.

The timber cladding begins at the first floor, which in picturesque and Arts and Crafts theories is a strategy to achieve a feeling that the house has 'grown out of the ground like a tree', clay and stone on the ground and timber structures 'growing' up high.

At the center of the lower floor on the south façade, an arch evokes the form of traditional Nubian clay architecture, leaving the earthen wall visibly expressed on the exterior.

Fig. 2 – *Hjortshøj street* (Jensen, 2024).

In this way, the clay wall is exposed in the exterior (Fig. 1). The large opening created by the arch is glass-covered, with heavy mullions. In general, the building's window sections have strong wooden mullions, and thus do not pay homage to glass as a material in its own right, with its science- connotations, but instead adhere to John Soanes strategies of 'hiding' the glass. (Giedion, 1997) (Soane 1815), but can also be understood as a reference to the vernacular mullioned window.

The composting toilets and installations for rainwater collection - the water is led to a central tank for the area - are located behind the north facade of the center section. The composting toilets and rainwater form an important nuance between inside and outside and are slightly 'closer' to nature than the living rooms in the clay squares, whose character of being more 'inside' than the middle section is emphasized by the fact that the wood-burning stove and chimneys are located adjacent to them.

It can be said that the house uses the repertoire of the Romantic architectural program in a somewhat random way: the exposed structures in the interior, the self-grown appearance, the variation in building techniques, the division into a more enclosed part around a wood-burning stove and a more exterior part with a terrace, the mud-composting toilets, the rainwater

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installations, etc. The house is really rich and nuanced in the indoor-outdoor relationships with climate as there is no vapor barrier and the clay wall's storage of heat and cold gives it a special dimension in terms of cooperating with the natural climate.

The house has been built as if it has grown from its site - literally through the local clay and figuratively through its weathered expression. It is both foreign to and typical of the place. The house does not live up to the formal modernist rules of minimalist architecture. Neither does not live up to the ideals of either Leon Batttista Alberti or Ludwig Mies van der Rohe. However, it could have been built by one of the English eccentrics who made up the pioneer class of the picturesque.

As a whole, the area is interesting, with its dense, curving village streets (always cobbled, unfortified), its residential greenhouse streets, its barns, sheds and animal husbandry, farming - and not least its string of picturesque follies and chateaus (self-build villas) (Fig. 2). One can come to love this variety in the context of a picturesque landscape with solid roots in Romanticism - a romantic garden. If a Giedionic, main stream modernist architect had planned the design and the connection between the public housing and the individual houses, the transition would not have been so dramatic and the contrasts not so sharp. There would probably have been a more rational pathway and a clearer delineation of which zones could be used for chickens and which for beetroots etc. But this would have moved this housing area away from the picturesque tradition. In that tradition it was exactly a special pleasure for the owner of a romantic park with a picturesque house if the cattle grazed by the Gothic terrace door. On the other hand, an architect who was more architecturally trained in the history and theory of the values of Romanticism could have achieved something better than what the Hjortshøj Cooperative Society looks like today.

If it really had been built by an architect familiar with the architectural theory and form-repertoire of the Romantic picturesque, 'random' trees would long ago have been planted in carefully selected locations, with the planting playing as important a role as the buildings, probably be placed as dramatically, unexpectedly and randomly as everything else.

3.2. A regenerative centre in Hedeskov

The project Hedeskov Centre for Regenerative Practice was finished in 2024. It was designed by architecture practice Djernes & Bell and funded privately and with help from Realdania. The project will be monitored by Aalborg University BUILD AAU. Other collaborators include Local Work Studio, Institut for Agroøkologi AU, SoilValues, Skovskolen KU, Kalø Økologiske Landbrugsskole and Dinesen. The project seeks to demonstrate the importance and values of working with nature in the built environment. Strangely, the project is very close to Hjortshøj and to Friland, another ecovillage with more than 20 years of experience in regenerative practices. Sadly, neither the clients nor the architects approached neither of the two communities. Instead, Hedeskov was a collaborative effort between the architects and their clients—owners of a fertility clinic in Aarhus with a longstanding interest in farming—who, in 1978, purchased 180 hectares of land in Rønde.

The project is the transformation of an old school with an explicit aim of showcasing regenerative architecture. Unlike the aesthetic language found in ecovillages, the well-ordered piece of architecture displays details that were tastefully crafted, earth and wood floors perfectly aligned and well made, natural and locally sourced clay finishes on walls and natural stones. The clients proudly express to have worked with the best Danish craftsmen. Even a British expert on clay finishes was hired to teach other Danish workers particular techniques at the construction site. While the school needed a new roof, many of the original wood and brick components were reused

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Fig. 3 – *Meeting room at the Hedeskov Centre* (Dehlin, 2024).

in various parts of the design. The project consists mostly of meeting rooms (Fig. 3) and some office space as well as a residency apartment with a double bed and a very generous kitchen. There is an adjacent building connected with the Centre that is the daughter's new private house with some exquisitely made earth floors done by Lasse Koefoed Nielsen. The project cost over 10 million Danish kroner (approximately 135,000 euros).

3.3. Comparative analysis

Unlike the house in Hjortshøj, Hedeskov does not experiment with indoor-outdoor possibilities, neither tries to test new ideas for the discipline of architecture. Lacking a clear theoretical framework, the project primarily aims to replicate the functions of a typical bourgeois building—albeit using natural materials. The high cost of its execution shows the big disconnect with market flows and also the privileged position to have the solvency to still afford it. Unlike the low budget economical exemplar found in ecovillages, Hedeskov while projecting itself as forward thinking, it shows the issues that are stake when the regenerative architecture does not dare to be experimental or nurtured by ambitious ideas of worldmaking.

4. Discussion: The ecological class

These recent types of projects in Denmark begin to show the power and importance of what Bruno Latour and Nikolaj Schultz have called 'the ecological class' (Latour and Schultz, 2023). But unlike the sociologists would want to define it, these projects also show that the ecological class is often still very much connected with the definition of social class.

Expert in regenerative design, Chrisna du Plessis explains that during the 1960's and in face with the 1970's energy crises, there was a strong self-sufficient leftist global movement in the West *"*based on locally available, renewable resources and appropriate, small-scale technology as a conscious attempt to limit both consumption and development*."* (du Plessis, 2012, p. 12). She explains that these efforts, however, while appropriate for small-scale rural and peri-urban contexts, were seen as impractical for application at an urban scale and the realities of urban growth. On the other hand, the romantic approach to traditional agrarian practices and the hostility to urban civilization, modernization and industrialization has also been a subject of eco-fascist positions. While regenerative architecture represents an important shift in how we think about building and environmental stewardship, its implementation is hindered by practical, economic, and regulatory challenges. To make it more widespread, there needs to be increased support in the form of subsidies, clear regulations, and the development of affordable technologies. Ensuring that regenerative architecture is accessible to all communities—not just the wealthy—is crucial for achieving both ecological and social equity. Not without regulatory struggles, ecovillages like Friland or Andelssamfundet Hjortshøj among others in Denmark have been practicing forms of regenerative constructions for many years now but these communities' work is often seen as peripheral and outside architectural expectations.

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Nikolaj Schultz claims that "instead of opposing ecology and economy, we will have to face, theorize, and organize these in the same breath" (Schultz, 2020, p. 308). It seems that in order not to oppose the two, architects must think in forms of innovation, care and development that can be implemented at meaningful and impactful scales. A wealthy client can spend all they want in making the most beautiful project, as shown in the Hedeskov example, but what does it do to a society, to an ecology, to the planet? Philosopher Slavoj Zizek suggest that "All these things can — hopefully — be achieved only through strong and obligatory international cooperation, social control and regulation of agriculture and industry, changes in our basic eating habits (less beef), global health care, etc." (Zizek, 2024). He argues that a "representative political democracy alone will not be sufficient for this task" and that "a much stronger executive power capable of enforcing long-term commitments will have to be combined with local self-organizations of people, as well as with a strong international body capable of overriding the will of dissenting nations" (Zizek, 2024).

5. Findings and conclusion

This paper focused on investigating different values and ideas of regenerative architecture. For the purpose of illustration, the paper presented two cases. The Hjortshøj house is grown from is site, permeated with respect of nature, and built on a low budget. Moreover, the house features a number of (architectural) experiments. In contrast, the Hedeskov Centre is an expensive transformation that draws on regenerative principles, yet with a focus on visual delight and with little will to experiment and challenge. Consequently, the cases highlight the dichotomies and differences within regenerative architecture and thus, show the alignment between the ecological class and social class.

Let us hope that some of the future projects carried out by the elitist communities at Hedeskov, as well as in other regenerative centres emerging in the country can begin to address and implement solutions and alternatives to some of these larger mass-involved questions and issues. A suggestion could be to study the self-built + 20-year-old ecovillages, proven to provide financial freedom, liveability and low environmental impact. However, without picking the low hanging fruit of operating more consciously in the architectural strategies of The Picturesque and Arts and Crafts Movement.

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