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

HISTORIC SETTLEMENTS

CONSERVATION, REGENERATION AND MANAGEMENT



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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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From Documentation to Strategic Planning: GIS-Based Survey and Assessment of AlUla's Vernacular Wall Paintings

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

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Abstract
The Wall Painting Conservation in Old Town project, commissioned by the Royal Commission for AlUla (RCU) and executed by Opus Conservation, aims to document and study AlUla's vernacular earthen wall paintings. This initiative focuses on using Geospatial Information Systems (GIS) to catalogue over 900 building units and to support the development of a comprehensive conservation framework. Systematic coding assesses conservation priorities, while photogrammetry produces orthographic projections for detailed condition mapping and material analysis. Despite challenges such as collapsed structures, accessibility barriers, and active construction, the team surveyed 912 units, identifying 372 with preserved wall paintings, totalling an estimated 18,000 m² of painted walls. The project now advances to a material analysis phase, employing non-invasive techniques alongside targeted invasive sampling. These investigations will refine preservation strategies, ensuring a sustainable conservation approach that both protects AlUla's rich artistic heritage and contributes to its long-term cultural legacy.

Keywords: *AlUla; Saudi Arabia; wall painting; GIS; photogrammetry; vernacular*

1. Introduction

AlUla's Old Town, nestled in Saudi Arabia's desert landscape, is a remarkable repository of cultural heritage, encompassing vernacular architecture and wall paintings. The standing architecture as seen today dates mainly from the nineteenth century, and the murals, once decorating walls over 900 structures, reflect a blend of artistic expression, community values, and daily life. The abandonment of the town since the middle of the 20th century and subsequent environmental and structural challenges have jeopardized the survival of these invaluable cultural assets. In response, the Royal Commission for AlUla (RCU) launched the "Wall Painting Conservation in Old Town" project in 2023. The initiative is guided by Saudi Arabia's Vision 2030 and aligns with the RCU's "long-term master plan to develop and deliver a sensitive and sustainable transformation of the region". Starting prior to the launch of the current project, significant work on the painting's art historical and cultural context, survey, documentation, assessment and conservation is being undertaken by the RCU (2019 - ongoing). The present initiative aligns with aspects of this wider project to support the existing conservation

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strategies. This paper delves into the project's methodologies, findings, and broader implications for the conservation of the wall paintings at AlUla Old Town.

2. Cultural and Historical Significance

AlUla's wall paintings offer a vivid glimpse into the region's cultural heritage, blending decorative artistry with symbolic motifs. These murals range from geometric designs and floral patterns to figurative depictions of domestic objects. The motifs reveal connections to broader regional artistic traditions while reflecting the unique identity of AlUla's community. However, this study has confirmed the paucity of comprehensive comparative studies in the Gulf. Vernacular domestic wall paintings traditions survive in the region, such as demonstrated by the traditional Al-Qatt paintings in the Al-Asiri region, inscribed in the UNESCO list of intangible heritage (Alsadi, 2022).

The Al-Qatt designs and palette bear some similarities to the designs found at AlUla Old Town, however, while the Al-Qatt painting tradition is connected to the female community (AlHababi, 2012), the wall painting of Old Town testifies traditions linked to wedding rituals (Naseef 1995). As reported by Naseef (1995) the paintings were executed by male friends and family of the marrying couple, as the newlyweds entered their new home. Moreover, the designs found on the wall paintings of Old Town steer away from the abstract quality of the Al-Qatt tradition, with representations of trees, paraphernalia from domestic life and occasionally animals. A progression through time can also be inferred by representations of modern vehicles and electricity. This enhances the site's significance within the broader context of Middle Eastern vernacular architecture. AlUla's murals were not simply decorative elements but rather integral components of a broader cultural narrative that linked architecture, art, and identity (Fig. 1).



Fig. 1 – *A typical wall painting with a geometric band at dado height with a range of objects represented above* (Royal Commission for AlUla, 2025).

3. Methodology

The project components include:

1. Preliminary survey to geolocate all accessible painted units and painted walls within.
2. Preliminary high-level database of motifs, colours and conditions.
3. Rapid assessment and conservation coding to inform conservation priorities.
4. Development of selection criteria for a detailed study of a selection of painted units.
5. Detailed study of a selection of units with invasive and non-invasive scientific analysis.
6. Support to the development of conservation proposals for selected units.

Components 1-4 have been completed and are the focus of this paper. Objectives 5-6 are currently in progress and will build upon items 1-4.

3.1. Scale of the task

The current initiative has sought to build upon and expand the preexisting wall painting data gathered by the RCU and its partners. The goal is to capture data that can support the RCU and other project partners in the ongoing efforts to conserve and manage AlUla Old Town. The initiative's approach was designed to navigate the challenges posed by the ruinous state of parts of the Old Town. The findings indicate that over 1,900 walls contain at least a trace of wall painting. A breakdown of the percentage of the original surface for each painted wall identified is as follows:

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- 457 walls were found to have less than 25% of the original wall surface intact (many with only a trace of colour)
- 524 were assessed to have 25% to 50% of the original surface intact
- 531 were assessed to have 50% to 75% of the surface intact, and
- 349 were assessed to have over 75% of the original surface surviving.

A small number of painted walls could not be given a figure due to access constraints. If only the walls rated to have over 75% of their original surface intact are considered, the total surface area amounts to over 3,000 m^2. This highlights the scale of management and planning required to document and assess the wall paintings, as well as to develop and implement effective conservation strategies and methodologies within Old Town.

3.2. Preliminary mapping and documentation

The methodology for the mapping of wall paintings in AlUla Old Town was designed to align with the existing RCU framework for heritage assets in Old Town and aid the effective and efficient long-term preservation of wall paintings within the broader and more complex framework of the Old Town as a whole. Ekim et al. (2013) have presented similar documentation and conservation planning of earthen architecture settlements in Morocco.

Considering the scale outlined above, the project employed a multifaced approach to capture the distribution, typology, and condition of AlUla's wall paintings. Geospatial Information Systems (GIS) played a central role, mapping the precise locations and characteristics of painted surfaces across 912 structures. Moving zonally through the Old Town, unit to unit and wall to wall, ArcGIS Pro was utilized as the primary software for this study (Fig. 4). Field data collection was conducted using a georeferenced measured plan of the Old Town within the framework already established by the RCU and Heritage Conservation Consulting. Data entry was performed through a combination of ArcGIS Field Maps, which was linked to ArcGIS Online, and manual recording on printed copies. Field Maps was used to map attributes (painted walls) and input attribute table fields such as wall codes, condition scores, colours used and decorative motifs. This hybrid approach ensured uninterrupted data capture, mitigating potential delays caused by hardware limitations and connectivity issues.



Fig. 2 – *View of the OT looking west from the central Al-Sakhra ('The Rock') vantage point* (Royal Commission for AlUla, 2025).



Fig. 3 – *An example of a wall depicting a mosque where over 75% of the original surface is preserved* (Royal Commission for AlUla, 2025).

The survey employed high-resolution photography and photogrammetry. Each painted wall was photographed using Nikon D810 cameras equipped with 18-55mm lenses, supplemented with up to 200mm lenses where necessary. An off-camera speedlight flash, wirelessly triggered, provided controlled lighting. When field-of-view constraints arose due to distance, a set of panoramic images were captured and subsequently merged in Photoshop to produce seamless composite images.

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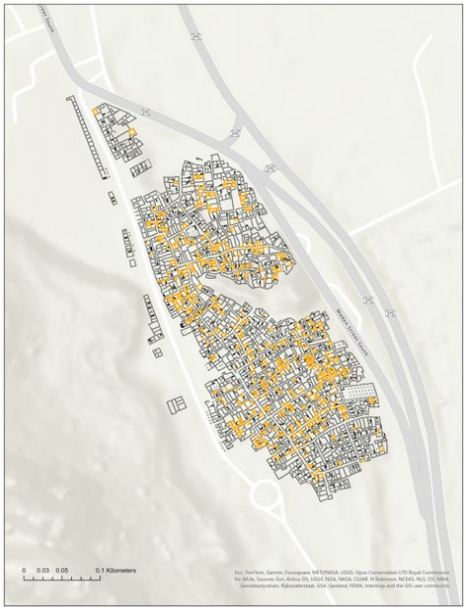


Fig. 4 – *GIS layout showing the distribution of wall paintings in the OT* (Royal Commission for AlUla, 2025).

Additionally, select paintings were documented using Agisoft Metashape, a Structure from Motion (SfM) software. For these models, images were captured with the same Nikon camera equipment, ensuring consistency in data collection. All photographs incorporated internal colour, scale, and location references to facilitate accurate information management and post-processing. A nomenclature system for each unit, room and wall previously established by the RCU was refined and implemented for the specificity of the wall paintings. This created a unique wall code for each painted wall. This approach facilitated the systematic recording of approximately 18,000 m^2 of wall surface over a ten-week period by a team of up to six conservators.

3.3. Rapid condition assessment

In conjunction with the photographic documentation, a systematic coding framework was refined utilising methodologies previously used by the RCU to assess and prioritize conservation needs. This framework evaluated factors such as the extent of decoration, structural condition, and treatment urgency.

The preliminary mapping phase culminated in the creation of a comprehensive database, which serves as an informative resource for ongoing research and conservation planning. This data was also fed into the GIS attribute tables of each wall assessed. Given the historic fabric and state of preservation, the survey encountered several limitations, due to building collapse, blocked access points, and ongoing development. As a result, only fully or partially accessible units could be assessed, while others were classified as "unknown" if no painting was observed and visibility was restricted.

Fig. 5 – *Orthomosaic of Unit 112, ground floor* (Royal Commission for AlUla, 2025).

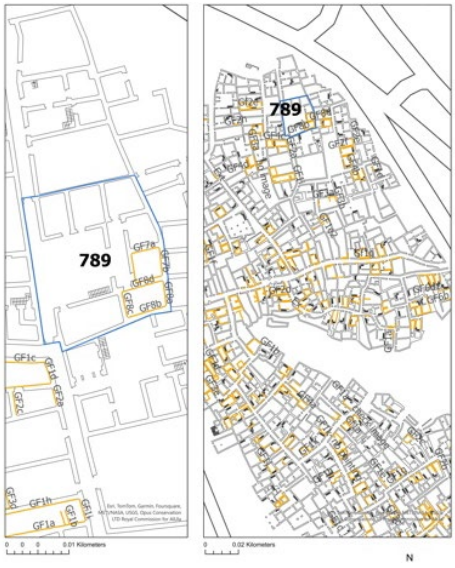


Fig. 6 – *GIS layout detailing the distribution and nomenclature of wall painting in Unit 789* (Royal Commission for AlUla, 2025).

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The assessment methodology was designed to ensure systematic and consistent data collection across Old Town. Each painted wall and unit were geo-located using GIS software, mapped onto base plans, and categorized as painted, unpainted, or unknown. For painted units, decorative motifs, paint layers, structural conditions, and external factors influencing deterioration were recorded.

A rapid condition assessment system was employed to classify paintings based on four key conservation factors:

- Condition;
- Extent of decoration;
- treatment priority, and
- intervention difficulty.

Additionally, a visual impact rating system was introduced to evaluate the completeness and refinement of the paintings of each unit. The surviving painted composition ranges from faint traces of paint to extensively surviving, visually striking compositions.

4. Findings and preliminary results

A total of 912 units were inspected, wall paintings were recorded in 372 of the units, constituting 41% of all units inspected. No wall paintings were recorded for 43% of the units (396 units). Due to collapses and blockages, some units could not be fully inspected. Those constitute 16% (144 units) of the total number of units and are defined as unknowns (no certainty regarding presence or not of painted decoration). Of the units where wall paintings were visually assessed, 67% were fully accessible, 28% were partially accessible and 5% were inaccessible. These numbers are subject to change as the stabilisation and restoration of the Old Town continues and previously inaccessible areas are opened to new discoveries.

4.1. Decorative motifs

The painted motifs found across Old Town's wall paintings encompass a rich variety of decorative and symbolic elements. 82 separate motifs were identified in the preliminary survey with many more that were indiscernible.

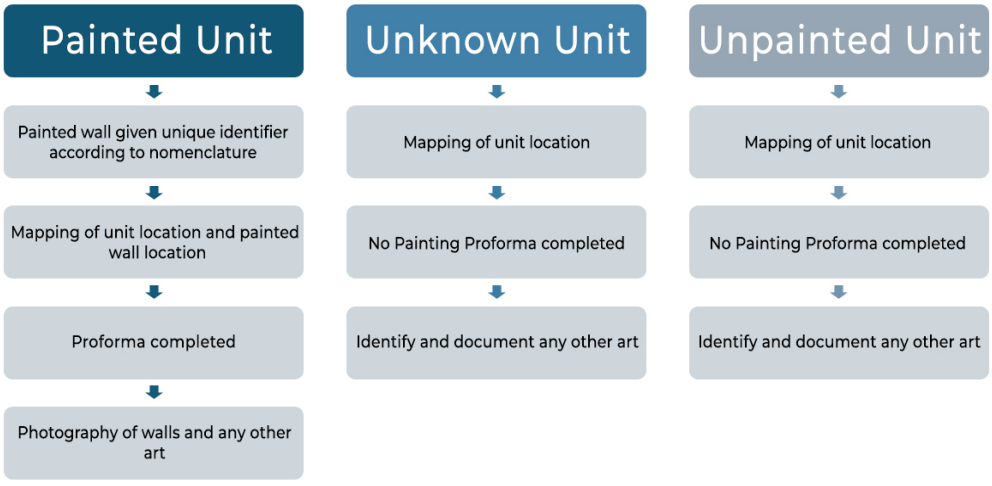


Fig. 7 - *Data collection methodology: different processes were followed depending on the wall painting status of each unit* (Royal Commission for AlUla, 2025).

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Among the most common are geometric designs, often comprising interlocking lines, triangles, rectangles, and squares, occasionally adorned with floral patterns. These motifs typically manifest as horizontal bands at dado height or as borders encircling entrances, niches, or other architectural features. Figurative designs are also widespread, depicting the natural world, including trees, palms and flowers, objects emblematic of domestic life and hospitality, such as coffee and tea paraphernalia, carpets, shishas, incense burners, and clocks. Additionally, depictions of various vehicles, weaponry, and implements add to the diversity of subject matter.

Notably, mosques are given particular attention in how they are depicted, often with more detail than many of the other paintings, underscoring their cultural significance. The abundant presence of a range of tree species reflects the agricultural traditions of the people of Old Town. Arabic inscriptions are another integral component of the wall paintings, appearing in approximately one-third of the units. These inscriptions range from standalone texts to integrated elements within broader compositions, often accompanied by decorative and figurative motifs. Notably, the Saudi Emblem adorns several units, reflecting broader cultural and national themes.

4.2. Painting technology

The technology[1] and quality of the painting varies through the Old Town; however, some general observations can be made. The paint layer is organically bound, applied to a dry substrate, most commonly an earthen plaster, with or without a layer of whitewash as ground. Wooden doors, frames and locks were also painted, seemingly directly onto the wood without the use of a ground.

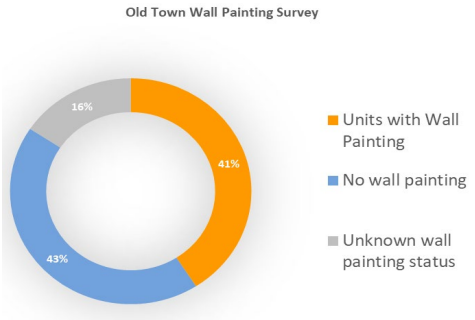


Fig. 8 – *Percentages of surveyed units with surviving wall painting, no wall painting and unknown* (Royal Commission for AlUla, 2025).



Fig. 9 – *Typical motifs of a band of repeating triangles with fans and coffee pots reflecting the importance of hospitality to traditional and contemporary AlUla culture* (Royal Commission for AlUla, 2025).

[1] Characterization of earthen plasters and painting materials is underway.

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4.2.1. Plaster layers

Except for occasional cases where paint was directly applied onto masonry, the predominant substrate for the wall paintings in Old Town is an earthen plaster. As far as could be ascertained, painted schemes are associated with a single application of plaster. Where more than one plaster layer is evident, it is because it is superimposed on an earlier scheme of decoration, indicating reuse, renewal and redecoration of buildings, perhaps as new occupants entered. Often the lower schemes are blackened.

4.2.2. Setting out

While many of the paintings in Old Town are executed free hand without prior organisation, others show a variety of setting out techniques, with various methods used to establish the geometry and layout of compositions. Among these techniques, incisions into the plaster, compass marks and snapped paint lines are commonly observed, serving to delineate boundaries and guide the arrangement of elements within the artwork.

4.2.3. Paint layers

The palette of the paintings today is dominated by red, blue and white. However, this reflects those which have best survived in the harsh local environment – red iron oxide, French ultramarine and calcium whites.

Closer inspection with in-situ microscopy and UV radiation shows that much of the paintings original colour is altered from its original appearance. In what appears to now be similar areas of almost beige paint with little colour, a possibly once greater complexity is evident with a yellow, pink or greenish appearance in UV. In some cases, examining paint which has been protected by its location within a plaster crack or under a superimposed scheme, or looking at a broken edge of paint, shows a very different colour – for instance a beige that was once bright green, or a pink passage that was originally blue. More details about the binder and pigments used and any change or deterioration processes in the Old Town are forthcoming. However, given the evidence from in-situ inspection it seems likely that the original palette of Old Town was much more diverse and vibrant than it appears today.

4.3. Condition assessment

Positioned at the interface between structures and the broader environment, these paintings are highly vulnerable to structural and environmental factors. Collapsed roofs, ceilings, and walls have exposed the paintings to threats such as weathering from rainwater and wind, increased light exposure, as well as fluctuations in humidity and temperature.



Fig. 10 – An example of the detailed setting out of geometric designs using compasses and incised lines (Royal Commission for AlUla, 2025).



Fig. 11 – *Detail of a mosque where the bright blue only survives where it was protected by overlying deposits* (Royal Commission for AlUla, 2025).

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Most of the paint layers are poorly bound, likely exacerbated by adverse environmental conditions, with direct rainfall and water runoff eroding the painted plaster and depositing earth onto the surfaces. Compounding these issues, failures in the water dispersal system in the Old Town have led to increased moisture at the base of walls, contributing to deterioration, including soluble salt deliquescence and crystallization cycles.

5. Broader impacts and future directions

The project advances the academic and practical understanding of vernacular wall paintings in the Gulf region. The preliminary database that builds upon the preceding work by the RCU and partners provides a valuable resource for future research and conservation planning. Moreover, the findings contribute to global heritage management discussions, particularly regarding sustainable preservation in challenging environments.

Looking forward, the project aims to refine and expand understanding and documentation as well as inform continued conservation of this significant collection of wall paintings. The framework established by the RCU and the methodologies and frameworks utilised through this project have the potential to influence conservation practices beyond AlUla, offering insights applicable to similar contexts worldwide.

The work described here is contributing to the RCU's extensive community engagement initiatives that seek to raise awareness of AlUla's heritage among the local, national and international populations.

6. Conclusions

The "Wall Painting Conservation in Old Town" project underscores the critical importance of interdisciplinary collaboration and adaptive strategies in heritage preservation. By documenting and conserving AlUla's vernacular wall paintings, the initiative plays its part in safeguarding a vital aspect of the region's cultural identity and enriches the academic understanding of vernacular art in arid climates.

Through its methodologies and a commitment to sustainability, this project contributes in a small way to the potential of heritage conservation to bridge the past and future, ensuring that the legacy of AlUla's Old Town continues to inspire generations to come.

Acknowledgements

The authors would like to thank all those who have facilitated and supported to this ongoing project. Above all: The Royal Commission for AlUla, His Royal Highness Prince Badr bin Abdullah bin Mohammed bin Farhan AlSaud, Governor of the Royal Commission for AlUla, Abeer AlAkel acting CEO of RCU, all the team in the Culture sector. We are deeply grateful to all those who are working tirelessly to conserve and restore AlUla's Old Town.

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From the Inca Ushnu to the Holy Cross Church: Materialities in the Sacred Landscape of Sahuara, Arica and Parinacota, Chile

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Abstract

The Holy Cross chapel of Sahuara, built in the 19th century in Camarones, Chile, exemplifies a particular case of the coexistence of different building traditions. Located near a 15th-century Inca ushnu, this church reflects historical continuity and deep intercultural dialogue. The selection of local materials for the church reveals insights into its construction. Stone, mud and cactus wood, deeply rooted in the region's pre-Hispanic architecture, were skillfully used by colonial builders to adapt to theesquiña local environment. Stone ensured durability, while mud allowed faster and more adaptable construction, and cactus wood was used both structurally and decoratively, showcasing a profound understanding of local resources. The ushnu, an important Andean ceremonial platform, stands as a silent witness to the Inca presence in the area. Its proximity to the church suggests deliberate placement, where the church's construction on a pre-existing sacred space could have symbolized an effort to Christianize the landscape, imposing a new social order after colonization. The coexistence of the ushnu and the Sahuara church is an example of socio-cultural symbiosis. Both monuments, in a certain sense, engage in a dialogue with each other. The church, with its colonial architecture and Christian symbolism, coexists with the Andean cosmovisión rather than overshadowing it. This is evident in its materials, site selection, and the cultural practices still observed there. The Holy Cross church and the ushnu constitute an exceptional testimony to the complex history of the Arica and Parinacota region. Through the analysis of vernacular materialities and the relationship between both monuments, it is possible to understand how indigenous building traditions were adapted and transformed in the context of the colony and republic. This study invites reflection on the richness and diversity of the materialities and cultures that have inhabited this territory.

Keywords: *Andean temples; ceremonial site; Inca architecture; vernacular construction techniques*

1. Introduction

Sahuara is an Andean village located in the highlands of the Camarones commune, in the Arica and Parinacota region, Chile. It sits at 3,089 meters above sea level and 161 kilometers from the city of Arica, within the ravine bearing the same name, which flows into the Camarones valley. Currently, the village has a semi-permanent population of 14 inhabitants, primarily dedicated to cultivating fruit trees such as tumbo (*Passiflora tripartita*) and prickly pear (*Opuntia ficus-indica*), and to a lesser extent, livestock farming.

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1.1. Inca legacy in the Sahuara *ushnu*

Archaeological records found in the ravine have been key to understanding the area's long human occupation of more than 10,000 years (Ajata, 2015), particularly during the period the Inca Empire. The first archaeological investigations in Sahuara were conducted in the 1970s by Hans Niemeyer and Virgilio Schiappacasse (Schiappacasse et al., 1971). Later, in 2002, the authors published a detailed study of the six sectors that make up the archaeological site, describing its occupation during the Inca and colonial periods.

The sector known as Sahuara 2 (Fig. 1), located on a triangular plateau on the northern slope of the ravine, houses the most significant structure: an *ushnu,* or Inca ceremonial platform, built with stone and mud, oriented from north to south. This complex lies north of the Holy Cross chapel and is surrounded by over thirty predominantly rectangular enclosures, along with circular structures of varying diameters.

The enclosures are generally isolated, although in some cases, two or more units form larger clusters (Schiappacasse & Niemeyer, 2002).

The *ushnu* is in advanced state of decay, with its perimeter walls collapsed and its original trapezoidal shape partially lost. Nevertheless, its floor plan, measuring 23.5 meters in length and 11.2 meters in width, can still be distinguished. Built with stone and earth, it rises 2 meters above ground level and features three staircases on different sides. On its surface, there is a stone calvary and several cylindrical excavations, one of which contained a post-Hispanic burial (Schiappacasse & Niemeyer, 2002). During the imperial expansion, the Incas adapted their colonization strategies based on the function of each settlement within the empire's network. They replicated architectural models from Cusco across conquered provinces (Zori & Urbina, 2014).

One of these structures was the *ushnu*, which, according to ethnohistorical and archaeological studies, served as a platform for ceremonial offerings and astronomical observations.

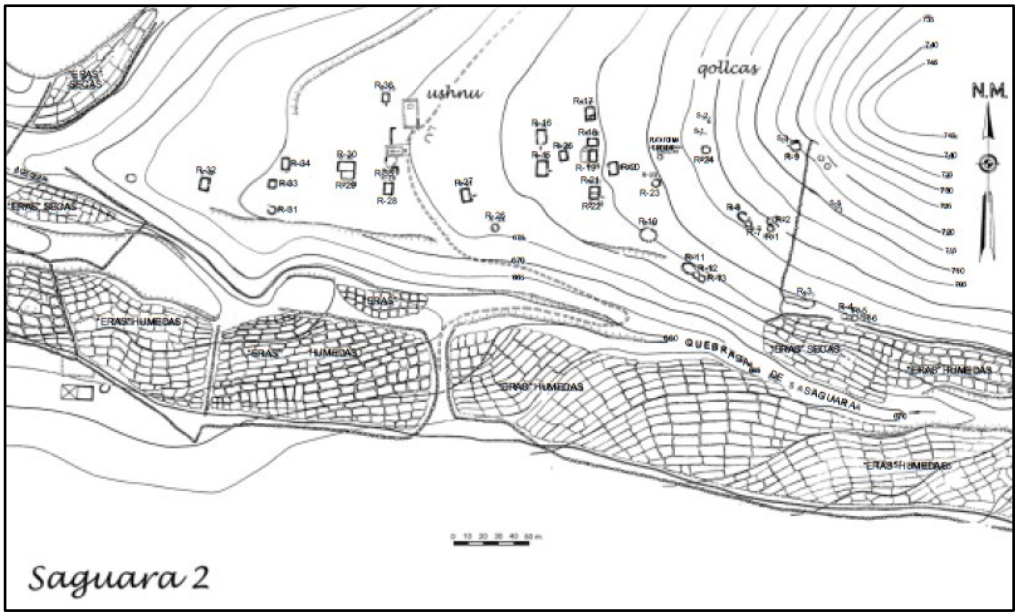


Fig. 1 – *Map of Sahuara 2 sector* (Schiappacasse & Niemeyer, 2002).

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These platforms often featured sophisticated drainage systems designed to absorb sacred liquids, such as *chicha,* a corn-based drink. In provincial contexts, the *ushnu* may have served as a space for political reaffirmation, used by Cusco authorities during administrative visits (Pino, 2010).

These ceremonial centers were interconnected through a complex road network, structured around the *Qhapaq Ñan*, which facilitated the commercial and political control of the territory (Muñoz & Chacama, 2006).

The *ushnu* of Sahuara 2 likely served as a political hub from which administrative decrees and official communications were issued, while also fulfilling a ritual role in the veneration of the sun and the moon. The absence of typical Inca residential structures (*wasi*) and domestic activity remains suggests a strictly ceremonial and administrative use, unlike the nearby Pachica archaeological site, which had a more residential and productive character (Schiappacasse & Niemeyer, 2002).

Therefore, Sahuara was likely a strategic territorial control point, serving as an access gateway to the Surire salt flat and the high-altitude wetlands of the Camarones Valley basin.

1.2. The catholic Church of Holy Cross

The proximity of the *ushnu* to the Holy Cross chapel (Fig. 2) suggests intentionality in selecting the site for Christian worship. Colonial documents do not mention the chapel directly, but they do reference the churches of Esquiña and Pachica, which were indigenous settlements under the doctrine of Codpa, cited as early as 1618. Ethnohistorical analysis reveals that the territories of the Sahuara valley were productively complementary to those of Esquiña, and their population maintained evident kinship networks. The Esquiña temple may have been the main religious center for communities in adjacent and complementary territories during the colonial period (17th-19th centuries). In fact, the Esquiña church still preserves crosses from nearby areas that are no longer inhabited.

Built in the 19th century atop a pre-existing sacred space (Fig. 3), the chapel may have been part of the broader process of Christianizing the landscape and imposing a new social order during postcolonial times. In that century, the Arica region became part of the newly established Peruvian state (1821), initiating a period marked by the promotion of chapel construction to provide religious services to interior Andean communities.

Even after the War of the Pacific (1879), the Peruvian priest Mariano Indacohechea Zeballos continued the restoration and construction of several churches within the Codpa parish until his expulsion in 1910 during Chilean sovereignty (Moreno & Pereira, 2011). These churches followed the Andean Baroque style characteristic of 18th-century ceremonial complexes, often associated with the Potosí Silver Route that passed through the region.

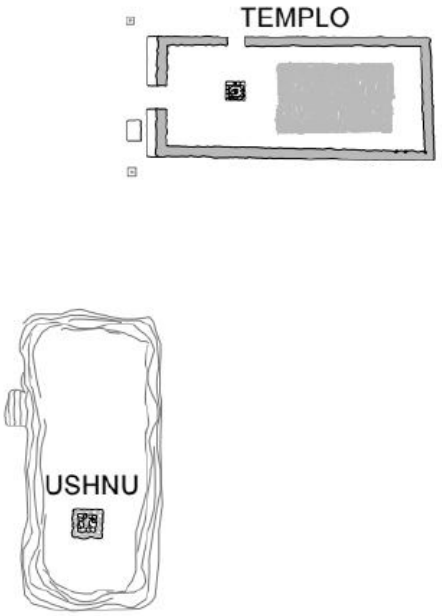


Fig. 2 – *Site plan of the ushnu and the chapel* (Fundación Altiplano Archive, 2019).

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Fig. 3 – *Aerial view of the Inca ceremonial platform.* (Fundación Altiplano Archive, 2018).

The ceremonial complex (Fig. 4), oriented east to west, consists of a rectangular chapel measuring 7.4 meters long by 4 meters wide, enclosed by a perimeter wall topped with pinnacles. In front of the main entrance stands a square-based calvary, crowned with a dome. Inside, the stone altarpiece, designed with three vertical sections and an attic, houses images of wooden crosses. In 2008, the chapel, along with other churches in the commune, was declared a National Historic Monument.

The chapel is dedicated to the Cross of May (*Cruz de Mayo*), a symbol of great importance in Aymara Catholic religiosity, associated with the protection of crops and agricultural labour (Ramírez, 2009). Introduced to the Andes in 1545 by the Archbishop of Lima as part of the evangelization process, its placement near ancient sacred sites was intended to replace indigenous practices with Christian devotion (Galdames et al., 2016). However, evangelization was not a unilateral imposition but rather involved selective appropriation by Andean communities, who reinterpreted its meanings and integrated it into their religious narratives (Arenas et al., 2015). In the Andes, the *Cruz de Mayo* is characterized by the absence of the crucified Christ and its ornamentation with arches, ribbons, clothes, and flowers.

The Sahuara chapel still preserves the traditional roles of *fabriquero* and *alférez*, responsible for the maintenance of the temple and the organization of religious festivities, respectively.

The main celebration is the Feast of the Holy Cross (May 3), during which various rituals known as *costumbres* take place. On the evening of the celebration, devotees ascend to the calvary and bring down the image of the Christ Child to the church. That night, the community gathers in the temple for the *phawa* (offering) and the *chuba* or *chulla* rituals. The main day includes the *gloria*, when a lamb is sacrificed, and the *wilancha*, an offering of a llama to seek permission from the earth. Over the following three days, other traditions such as the *tinka*, *luminaria*, and *ikata* are carried out.

In 2017, concerned about the chapel's deterioration, the Sahuara community sought support from Fundación Altiplano, a partner in the *Programa Puesta en Valor del Patrimonio* (PPVP-Subdere).

In 2019, the foundation implemented a restoration and training project, which also facilitated the documentation and analysis of cultural materials found within the chapel and its surroundings.

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Fig. 4 – *General view of the Holy Cross ceremonial complex* (Authors, 2023).

2. Objectives

This study aims to describe and analyse the adaptation and transformation of local building traditions from the pre-Hispanic period through the Republican era, using the Inca *ushnu* and the Holy Cross chapel of Sahuara as case studies.

By examining the relationship between these two monuments, the research seeks to understand how vernacular materials and construction techniques were reappropriated and redefined within a new cultural and religious context. Additionally, it explores the hypothesis of material continuity within the sacred landscape, focusing on the potential reuse of stones from the *ushnu* in the construction of the chapel.

3. Methodology

This study is based on the analysis of vernacular materials and the relationship between the two documented buildings. It includes a characterization of the traditional construction techniques employed in both the *ushnu* and the chapel, using an interdisciplinary approach that integrates archaeology, history, and architecture. The methodology considers both native and European influences, highlighting the overlap of construction knowledge reflected in the Sahuara chapel.

The research draws on previous archaeological studies, particularly those conducted by Schiappacasse and Niemeyer in 2002, as well as data from the restoration process carried out by Fundación Altiplano in 2019.

4. Results

The analysis of the techniques and materials used in the Holy Cross chapel and the Sahuara *ushnu* reveals the predominant use of local resources deeply rooted in Andean architectural traditions, such as stone, earth, cactus wood, straw, and leather. The study also highlights the adaptation of pre-Hispanic techniques that have persisted in the highlands, incorporating both reused elements from ancient ceremonial structures and construction solutions of European origin.

4.1. Stone walls with mud mortars

The geological study of the area determined that Sahuara is primarily composed of rhyolitic and dacitic stones, formed from the cooling of lava and magma at shallow depths (Gajardo & Pereira, 2016). Basaltic stones and quartz outcrops were also identified.

The constructions in Sahuara 2, primarily built with basaltic stone, exhibit similarities to Cusco-style architecture in their geometric patterns and rectangular forms.

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However, they also display distinctive local features, such as minimal edging of stones and the use of mud mortars, a technique typically absent in Inca dry-stone masonry (Aldunate, 2001). The archaeological walls in Sahuara 2 consist of one or two rows of stones, filled with fine rubble or mud mortar, with wall thicknesses ranging from 0.5 to 0.8 meters.

The core of the *ushnu* is built with porous, white volcanic stones without roughing, while the steps of two of its staircases are made from harder igneous rocks, mainly basalt and granite (Fig. 5).



Fig. 5 – *Detail of the west staircase of the ushnu* (Fundación Altiplano Archive, 2018).

The chapel of the Holy Cross follows similar construction principles, with double-course stone walls 0.45 meters thick, filled with mud mortars and coated with earthen plasters on the interior. During the 2019 restoration, archaeological monitoring allowed the analysis of the mortars and plasters used in the nave, calvary, and perimeter wall. The study revealed an absence of plant fibers in the composition, an element commonly used in other Andean temples in the highlands. Additionally, archaeological material such as late-period and colonial ceramic fragments, pieces of flint and quartz, animal bones, and even a fragment of a 1983 newspaper were discovered, offering valuable insights into the construction history of the temple and its surroundings.

One of the most significant findings relates to the hypothesis of stone reuse from the *ushnu* in the construction of the chapel. Although the analysis suggests that the stones used in the chapel did not originate directly from the *ushnu*, basalt stones of similar size and shape were identified in the perimeter wall. However, it remains uncertain whether these stones were extracted from the ceremonial platform itself or from nearby pre-Hispanic structures, which also feature undressed basalt masonry with irregular forms. What can be confirmed is that some of the stones in the perimeter wall were originated from Inca structures, reinforcing the practice of material reuse during colonial and republican periods.

4.2. Cactus and straw roofing

The chapel's roof structure (Fig. 6) follows a collar beam system built with candelabra cactus wood (*Euphorbia ingens*), a solution rooted in the Mudejar tradition introduced by the Spanish and adapted in Andean temples using local and imported timbers. In the chapel, the cactus trusses are joined with leather ties and rest directly on the walls without any upper wall reinforcement, a common feature in Andean vernacular architecture.

During archaeological monitoring, llama leather ties were found, some of which had been replaced in previous interventions.

Above the wooden structure there is a hollow cane (*Phragmites australis*) ceiling, likely sourced from the Codpa Valley, laid in an orthogonal pattern for greater stability. On top of this, the roof was assembled with a layer of reed mat (*Schoenoplectus californicus*) from highland lagoons and wetlands, followed by an outer layer of *paja brava* (*Stipa ichu*), a native grass from the high-altitude Andean plains known for its insulating and weather-resistant properties.

Given that some of these materials are not found in Sahuara's immediate surroundings, it is likely they were brought from Parcohaylla in the highlands, where Sahuara's inhabitants maintained livestock herds and, until recently, engaged in strong commercial and productive ties with nearby communities.

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Fig. 6 – *Interior view of the Holy Cross chapel* (Fundación Altiplano Archive, 2018).

5. Conclusions

The *ushnu* of Sahuara and the Holy Cross chapel stand as exceptional testimonies to the complex historical processes that have shaped the Camarones commune. Their coexistence illustrates the superimposition and transformation of construction traditions, where pre-Hispanic techniques and materials were adapted and reinterpreted within new colonial and republican contexts. The proximity of the 16th-century Inca *ushnu* to the 19th-century chapel suggests a deliberate spatial and symbolic continuity, reflecting a dialogue between cultures in which indigenous construction practices were integrated into the structures imposed by colonial authorities.

The analysis of vernacular materials in both monuments highlights the persistent use of local materials, such as stone, earth, cactus wood, straw, and leather, rooted in Andean architectural traditions. The selection of these materials reflects not only their environmental availability but also the transmission and resilience of local construction knowledge. The study further reveals the complex interactions between different ecological zones, as evidenced by materials sourced from distant areas, and the historical networks of trade and cultural exchange that linked Sahuara to the highlands.

The Holy Cross chapel, while adapting the architectural influence of colonial styles, coexists with the Andean worldview, as evidenced in its construction techniques, spatial organization, and cultural practices that continue to be celebrated there. Rituals such as the Feast of the Holy Cross and the traditional roles of *fabriquero* and *alférez* exemplify the blending of Catholic and Andean spiritualties, where Christian symbols are reinterpreted through indigenous cultural frameworks.

The archaeological work conducted during the "Restoration and Training Program for the Holy Cross Chapel of Sahuara" in 2019 has expanded our understanding of the site, providing new insights into the chronology, materiality, and history of its constructions. The findings underscore the need for further research to refine our understanding of the architectural evolution of this and other Andean temples in the Arica and Parinacota region, contributing to a broader comprehension of their role within the sacred Andean landscape.

This study invites reflection on the richness and diversity of materials and construction practices that have shaped this territory over centuries. It emphasizes the importance of viewing Andean vernacular architecture not merely as a response to environmental conditions but as a manifestation of cultural resilience and the continuity of ancestral building knowledge.

Acknowledgements

We dedicate this article to the community of Sahuara, whose faith and deep connection to their land have preserved the memory of their territory

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and traditions over time. We also extend our gratitude to the team at Fundación Altiplano, whose dedication and perseverance made the restoration of the Holy Cross chapel possible, fostering the integration of local knowledge and strengthening the bond between cultural heritage and the community.

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Stereotomy and Composition in Maya Architecture: The Medial Moulding at the Palace of the Governor at Uxmal (Yucatán, México)

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Abstract

The medial moulding is a defining architectural element in monumental Maya architecture, serving compositional, structural, and constructive functions. This study examines its stereotomy, craftsmanship, and architectural role in the Palace of the Governor at Uxmal (Yucatán, México), a prime example of Late Puuc architecture. By tracing its evolution across Puuc substyles, the research explores its transformation from simple rectangular forms to complex multi-member arrangements. Based on in-situ documentation—combining direct visual inspection with digital techniques—and supported by bibliographic sources, the study identifies and classifies the masonry pieces comprising the medial moulding, analysing their geometry, standardisation, and contribution to architectural composition. The findings reveal a high degree of precision and specialisation in the carving process, demonstrating the builders' capacity for the seamless integration of architectural components. The study ultimately underscores the medial moulding's significance as both an aesthetic and structural unifying element.

Keywords: *stereotomy; Puuc architecture; Maya architecture; construction engineering; stonework; Uxmal*

1. Introduction

Façade composition in monumental ancient Maya architecture exhibits certain invariable features. Buildings typically have a tripartite elevation consisting of: (1) a plinth or platform that serves as a base either on the ground or atop a substructure; (2) a lower wall that defines the layout of the interior spaces; and (3) an upper wall that corresponds externally to the roof covering the inner chambers, usually stone vaults (Muñoz Cosme, 2006) (Fig. 1).



Fig. 1 – *Classic Puuc-style façades in the ancient Maya city of Uxmal* (Gilabert-Sansalvador, 2017).

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This façade composition is emphasised by two linear mouldings, a medial and an upper one, that encircle the entire building, framing the upper panel —commonly referred to as the frieze, since it concentrates most of the decorative elements, whether in stucco reliefs or carved stone mosaics (Gendrop, 1997).

The upper moulding is located at the top of the frieze, acting as the building's crowning perimeter element. The medial moulding is placed projecting atop the lower walls, serving as a transition piece between the lower wall and the frieze, and creating a characteristic shadow line that makes the medial moulding the most dominant horizontal feature on the façade.

However, this element does not serve only compositional and aesthetic functions; it also has constructive and structural roles: it directs rainwater away from the façade and protects the doorways' lintels, supports the weight of the frieze decorations, and facilitates the junction between different construction phases.

Although there are constructive and stylistic variations depending on the geographical region and the building's chronology, this medial moulding is an omnipresent element in monumental Maya architecture.

In Petén-style architecture, medial mouldings are typically formed by a projecting course of well-carved prismatic stones (Quintana Samayoa, 2013). In the Usumacinta region, particularly in Palenque Classic architecture, sloped friezes and angular medial mouldings are characteristic, formed by overlapping horizontal slabs with profiled edges (Fig. 2).

In the architecture of northern Yucatán, mouldings are constructed using several courses of well-dressed stone pieces, incorporating decorative elements or forming specific details, such as the characteristic "loop motif" of Classic Puuc architecture (Fig. 3). This moulding consists of three carved stone pieces that form a symmetrical vertical section: two bevelled apron-type pieces—one positioned above as a *reverse apron-type*, and the other below as an *apron-type*—and a central narrow rectangular piece, known as the *listel*. This arrangement is often interpreted as a stylised representation of bindings or ties in vegetal or textile elements (Gendrop, 1997).



Fig. 2 – *Sloped frieze and medial moulding in the Palace of Palenque, featuring overlapping horizontal slabs* (Gilabert-Sansalvador, 2015).



Fig. 3 – *Loop motif in the medial moulding and cornice of the House of the Turtles at Uxmal* (Gilabert-Sansalvador, 2017).

2. Medial moulding in Puuc architecture

The characteristics of the architecture in the Puuc region stem from the masterful stonemasonry techniques of its builders, who developed a construction system based on walls and vaults formed by a resistant concrete core and an outer

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layer of carved limestone (Gilabert-Sansalvador, 2021). Their expertise in stone cutting enabled them to develop the technique of carved stone mosaics, which they used to create the characteristic compositions with repetitive motifs in façade friezes, framed by medial and cornice mouldings that are, to all intents and purposes, universally present in these buildings (Pollock, 1980). Particularly in Classic Puuc architecture, these mouldings take on such distinctive forms that they become defining elements of this architectural style (Ringle et al., 2021).

Puuc buildings have been classified by styles and defined chronological periods (Pollock, 1980; Andrews, 1995), which makes them an excellent field of study for analysing the long-term evolution of medial moulding.

George Andrews' detailed characterisation (1986, 1995) reveals the significant transformation of the medial moulding in Puuc architecture. Over time, it became more sophisticated, incorporating a greater number of specialised pieces and introducing apron-type elements to form the distinctive loop motif that defines this architectural style.

In the *Early Oxkintok* style (dated *ca.* 550-610), medial mouldings were typically large, single-member rectangular elements. In buildings attributed to the *Proto-Puuc* phase (*ca.* 610-670), these mouldings became slightly more refined, generally comprising one to three rectangular pieces with moderately well-dressed outer faces, while the lower courses extended deeply into the wall core.

During the *Early Puuc* period (*ca.* 670-770), medial mouldings evolved into slightly bevelled elements that projected approximately 8 to 10 cm beyond the lower walls.

A marked evolution can be observed in *Classic Puuc* architecture (*ca.* 770-1050), where medial mouldings were crafted from finely cut, highly specialised stones. These mouldings typically incorporate the three fundamental elements of the loop motif: two apron-type members and a central narrow rectangular *listel*. Additionally, in many cases, interleaved rows of supplementary stone elements feature decorative motifs, such as colonnettes—characteristic of the Colonette substyle (a)— or geometric patterns typical of the Mosaic substyle (b), including *guilloche* and zigzag designs (Fig. 4).

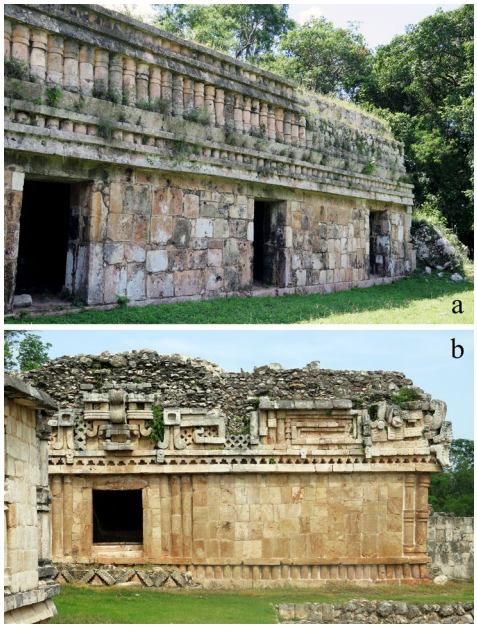


Fig. 4 – *Colonette substyle façade of Structure 5 at Chacmultún (a) and Mosaic substyle façade of the Palace of Labná (b)* (Gilabert-Sansalvador, 2017).

The *Late Uxmal* style (*ca*. 1000-1050), primarily exemplified in the ancient Maya city of Uxmal (Yucatán), represents the final, most elaborate phase of Puuc architecture. This period is distinguished by monumental buildings featuring highly refined masonry and intricate sculptural decoration. Medial mouldings in this style were typically large, adopting either a three-member configuration with apron-type elements at the top and bottom or a four-member arrangement incorporating colonnettes near the base. These mouldings were often further embellished with sculptural decorations at the corners, all executed to an exceptional degree of stone refinement.

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3. Objectives and methodology

The Palace of the Governor at Uxmal (Yucatán, Mexico) is the focal point of this research. Based on comprehensive in-situ documentation (Muñoz Cosme & Vidal Lorenzo, 2020), which combined direct visual inspection with digital techniques such as photogrammetry and laser scanning, and supported by extensive bibliographic sources and geometric analysis, this study undertakes a detailed examination of the stereotomy of the pieces forming the medial moulding, with the aim of assessing their shape, geometry, and constructive functions.

4. Case study: Palace of the Governor

Widely recognised as one of the finest examples of the Late Uxmal style (Andrews, 1995; Kowalski, 1987), the Palace of the Governor consists of three buildings linked by two transversal vaults, all resting on four monumental platforms (Fig. 5) (Kowalski, 1987). Beneath the third platform lies an earlier structure from the Early Classic period, constructed at least 200 years before the palace (Huchim Herrera & Toscano Hernández, 2021).

4.1. Medial moulding in the Palace of the Governor

The palace follows the characteristic tripartite façade composition, consisting of five architectural elements, including the medial moulding (Rosado-Torres, 2018; Rosado-Torres et al., 2021). This moulding is present on both the buildings and the transverse vaults (Fig. 6), with variations in the stereotomy of the masonry pieces to suit the structure's configuration. Positioned above the perimeter walls, the moulding measures 65–70 cm in height and consists of three components: two bevelled apron-type members and a central listel, forming the characteristic loop motif. At each corner of the buildings, sculpted snake heads with open jaws are set at a 45-degree angle to the façade at the listel level (Fig. 7).



Fig. 5 – *Main façade of the Governor's Palace at Uxmal, facing east, featuring three buildings and two transverse vaults* (Gilabert-Sansalvador, 2017).



Fig. 6 – *South transverse vault, east side, at the Governor's Palace, connecting the South and Central Buildings* (Rosado-Torres, 2015).

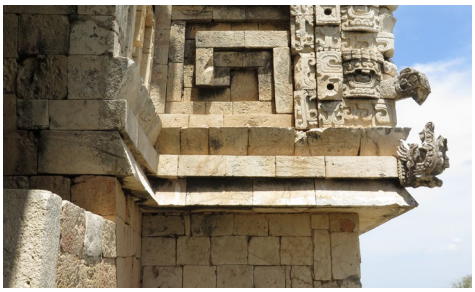


Fig. 7 – *Detail of the medial moulding, showing the nine standard pieces and the sculpted element inserted at the corner* (Rosado-Torres, 2015).

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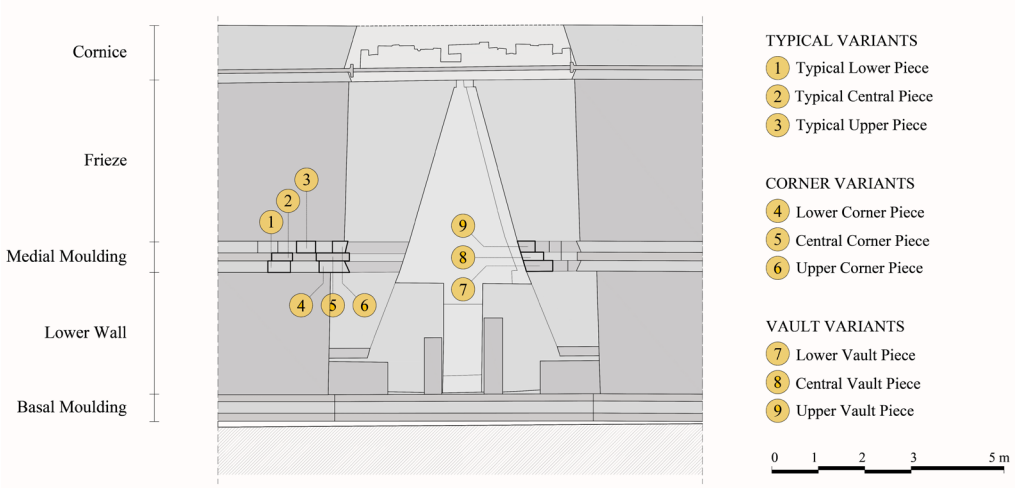


Fig. 8 – *Schema of the South Transverse Vault on the East Façade of the Palace of the Governor: Identification of standard masonry pieces in the medial moulding* (Rosado-Torres, 2025).

4.2. Stereotomy of standard masonry pieces

Beyond the sculpted elements, the medial moulding of the Palace of the Governor consists of nine standard masonry pieces: three standard units, three corner variants, and three vault-specific variants (Fig. 8).

4.2.1. North, central, and south buildings

The *Typical Lower Piece* (1) has a finely carved visible face, featuring an apron-type bevelled edge set at an angle of 65 degrees to the horizontal plane. Its plan is nearly rectangular, except for its rounded tenon embedded in the wall, which is only roughly hewn. Its lower bed is only partially visible (30-40 cm), but it is still finely carved. The typical dimensions of the piece are approximately 80 cm in length, 25 cm in height, and a variable width.

The *Typical Central Piece*, or listel (2), has a rectangular plan, except for its rounded tenon. It features a finely carved rectangular visible face. Although the lower and upper beds are barely visible, they are also finely carved. The typical dimensions of the piece are 40 cm in depth, 18 cm in height, and variable width, with 54 cm being the standard.

The *Typical Upper Piece* (3) has a finely carved visible face, featuring a reverse apron-type bevelled edge set at an angle of *ca.* 110 degrees relative to the inferior horizontal plane. Its plan is slightly trapezoidal, with a roughly hewn, rounded tenon embedded in the wall. The typical dimensions of the piece are approximately 45 cm in length, 24 cm in height, and a variable width, usually around 39 cm.

The *Lower Corner Piece* (4) is the largest masonry piece in the medial moulding, with average dimensions of 86 cm in length, 25 cm in height, and 65 cm in width. This piece features two apron-type bevelled faces, with both visible edges set at an angle of approximately 65 degrees to the horizontal plane. Although the two visible faces appear perpendicular, the angle between them varies slightly, ranging from 86° to 93°, depending on their position in the building.

This variation corresponds to the geometry of the Palace itself: the junctions between its perimeter walls form angles that range from 89° to 94°, rather than being true right angles (Kowalski, 1987, p. 90; Rosado-Torres, 2018, p. 59). Consequently, the Lower Corner Pieces, which follow the alignment of these walls, exhibit non-

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perpendicular visible faces, adapting to the building's overall layout through subtle but precise angular adjustments.

The *Central Corner Piece* (5) is a variation of the typical listel. It features a finely carved rectangular face, and its plan is shaped as an acute trapezoid to ensure the proper insertion of the sculptural element's tenon into the wall. The piece measures 18 cm in height, with a length ranging from 22 cm to 59 cm, the standard being 54 cm.

The *Upper Corner Piece* (6) features two reverse apron-type bevelled faces, with both visible edges set at an angle of *ca*. 110 degrees to the inferior horizontal plane. Its plan is triangular, with a roughly hewn, rounded tenon embedded in the wall. The average dimensions of the piece are 37 cm in length, 24 cm in height, and 42 cm in width.

4.2.2. Transverse vaults

The transverse vaults incorporate very specialised corner moulding pieces, the most complex in terms of stereotomy. Unlike the corner pieces of the building, these vault pieces are carved at different angles on each face. The face of the main façade, with the loop motif, defines the characteristic profile of the medial moulding, while the side face is carved to match the angle of the transverse vault (Fig. 9).

The *Lower Vault Piece* (7) is the largest of the three, measuring approximately 60 cm per side and 25 cm in height. Its main elevation forms an inverted rectangular trapezoid, while the side elevation forms a rectangular trapezoid, both finely carved. Both faces are bevelled: the main elevation has an apron-type bevel set at an angle of 66 degrees to the horizontal plane, and the side elevation features a reverse apron-type bevel set at an angle of 115 degrees to the horizontal plane.

The *Central Vault Piece* (8) measures approximately 50 cm per side and 18 cm in height, with two finely carved surfaces. Its main elevation forms an inverted rectangular trapezoid, while the side elevation is rectangular. The side face is bevelled to follow the vault's angle, set at 108 degrees.

The *Upper Vault Piece* (9) measures approximately 40 cm per side and 24 cm in height. Both elevations form an inverted rectangular trapezoid, finely carved, with a reverse apron-type bevel: 108 degrees on the main elevation and 120 degrees on the side elevation.

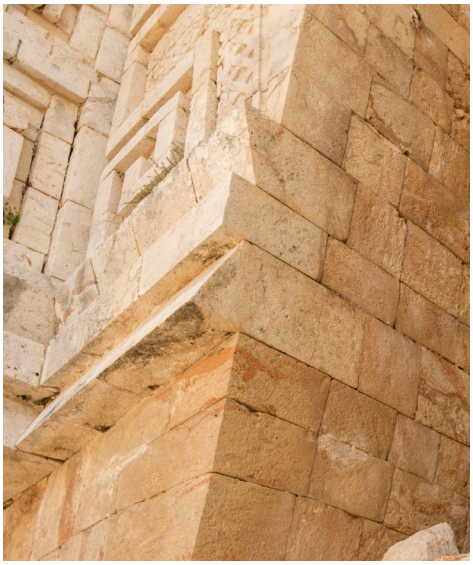


Fig. 9 – *Detail of the medial moulding in the transverse vault, showing the three vault variants* (Rosado-Torres, 2018).

4.3. Craftsmanship

The masonry pieces forming the medial moulding of the Palace of the Governor, made from Yucatec limestone (Alonzo Salomón & Espinosa Graham, 2003), exhibit sharply defined edges and finely dressed visible surfaces. The precision of the carving is so refined that the joints between pieces are barely perceptible, demonstrating exceptional craftsmanship. This level of finish is characteristic of the Puuc architectural tradition, particularly in its late phase.

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The partially and non-visible surfaces, including the lower bed, upper bed, and sides, display a semi-finished surface with less overall refinement. Closer to the façade, these surfaces are finely worked, with a smooth, polished finish, while closer to the tenon, they are more coarsely carved and sometimes left unpolished.

Although carved with less precision, these surfaces were nevertheless shaped carefully to ensure proper fit and alignment with adjacent pieces, facilitating their seamless integration into the architectural element (Fig. 10).



Fig. 10 – *Side view of a typical upper and central piece, illustrating the variation in the quality of the carved surface* (Rosado-Torres, 2018).

5. Discussion and conclusions

The medial moulding of the Palace of the Governor at Uxmal serves not only a structural function—supporting and distributing the weight of the intricate frieze over the lower walls—but also directs rainwater runoff by protruding 30 to 40 cm beyond the walls.

Additionally, the moulding serves as an integrative element, unifying the entire palace. It runs along the full façade, seamlessly connecting the buildings with the recessed transversal vaults. This compositional continuity is achieved through a stone mosaic system composed of nine specialised masonry pieces in the case of the Governor's Palace, which are classified into three types: typical, corner, and vault variants.

Typical pieces, with one visible face, can be adjusted using wedges, while corner pieces, which have two visible faces, are less adjustable. Vault pieces, however, demand exceptional precision to align with both the vault's inclination and the moulding profile, leaving minimal room for adjustment.

This progression in the complexity of the masonry pieces underscores the precision required in their fabrication, with the margin for mistake diminishing as the pieces become more specialised.

The mosaic technique employed in the Palace of the Governor, shared by many other Classic Puuc buildings, is based on the typification and standardisation of stone pieces. This approach enabled Puuc builders to deconstruct the medial moulding into multiple parts, offering endless combinations of pieces (such as apron-type, listels, colonnettes) akin to a puzzle.

These combinations resulted in a variety of medial moulding compositions, all of which adhered to a consistent logic, preserving the moulding's defining identity and ensuring its integral role in the Puuc architectural style.

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Restoration Project of Vernacular Architecture. A Case Study: Consolidation-Underpinning Works and Post-Control of Deformations in the Church Juslibol (Zaragoza, Spain)

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Abstract

At the request of the Archdiocese of Zaragoza, a study of the situation of the Parish Church dedicated to the Assumption of Our Lady (18th century) in Juslibol (Zaragoza, Spain) has been carried out since 2011. This church has been suffering for many years from deformation and settlement issues caused by a combination of particularly unfavorable factors, such as poor soil quality, its location on a sloped hillside, and leakage from a sewer system that has accelerated soil dissolution and subsidence beneath the foundations. To address the differential movements of the hillside affecting the building, a containment and underpinning solution has been implemented through a micropile wall, reaching depths of up to 24 meters, applied to the foundation of the church's south wall. This wall includes anchors embedded in firm ground and the rocky substrate, which were to be executed in a second phase. The primary goal of these works was to stop and contain the differential movements the building has experienced. The works were completed in February and March 2020. To monitor the effectiveness of the containment and underpinning measures, a study using terrestrial laser scanning technology is being carried out. This method provides a large amount of data, highly valuable for the rehabilitation and protection of urban environments with significant historical and architectural value. The main objective of this type of analysis has been to obtain a detailed topography of the studied area and to conduct a comparison between different surveys, thus identifying differential movements over a specified period. More than four years later, the results show a reduction in the differential movements and deformations (cracks in the walls) affecting the church.

Keywords: *church of Juslibol; underpinning; micropiles; deformations; settlements; laser-scanner control*

1. Introduction

The purpose of this article is to describe the work that has been carried out and the apparent results that can be seen almost five years after its completion. The main objective of the work carried out was to stop and/or contain the differential movements of the church building. To this end, a piloted retaining wall was designed and calculated in and under the south wall facade of the building.

However, the problem raised does not only concern the church building. One aspect that has not been sufficiently addressed is the situation of the cracks identified in the church in relation to

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those in the immediate surroundings. From the diagram of the fissures identified, it is possible to make a lateral correlation of them, obtaining an upward system, towards the upper part of the slope, in successive outflow arcs, which give meaning to the idea of a descending flow, which fits well with the morphology of the cone or dejection fan of the primitive gully. The approximate axis of this old drainage channel corresponds to the current layout of Church Street.

In conclusion, it can be said that the problem affecting the church, in terms of the movements it is currently experiencing, has its origins in a much wider area, which includes at least part of the slope corresponding to the old cone of depression of the ravine located at the very top of the hill.

The process covers a large area of the hillside and affects the church, the square and the houses that remain in the immediate vicinity, within the cone of depression in which they are located, which has been "flowing" slowly and for a long time. Specifically, the houses located in the Church Street and in the odd numbers of the Principal Square, at least between numbers 41 and 51.

2. Building description

The church is a single space with an elliptical floor plan, with a rectangular atrium and presbytery at the chancel and base, and side chapels of low relative depth between the walls to house altars. The whole is inscribed in a parallelepiped from which rise the tower and the drum of the elliptical dome.

The building has a height of 20-21 metres (at the roof) and up to 28 metres (the tower) and is located halfway up the slope, with its main façade facing the Church Street and Principal Square (Fig. 1). The base is at an altitude of 212 metres (a.s.l.), between 10 and 12 metres above the lower banks of the Ebro River.

3. Description of pathologies

As can be seen in Fig. 2, the floor of the church has been subject to a general uplift over the last few years, which has resulted in severe fracturing of the floor slab. As a result of this upward movement, the floor has split systematically at less than one metre from the wall (about 1.80 metres from the wall in relation to the side



Fig. 1 – *Aerial view of the area.*

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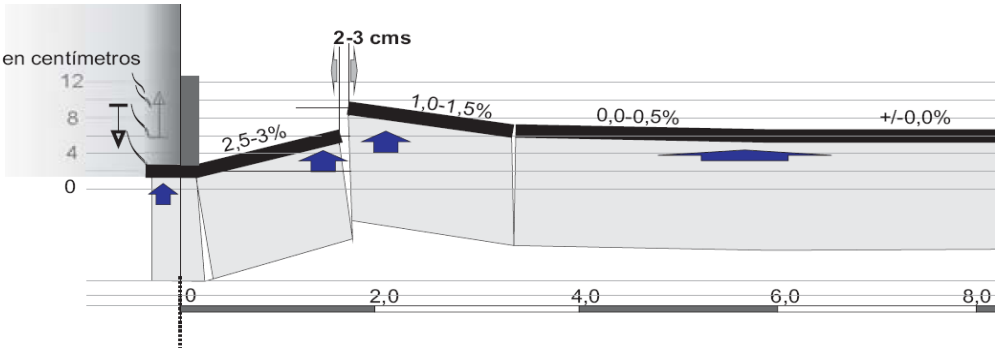


Fig. 2 – *Schematic profile of deformations and fractures in the pavement - floor of the Church.*

chapels). As can be seen in the figures below, the fractured slab sections adjacent to the walls show very pronounced relative uplift, with measured slopes of up to 5%. And although the central area appears to be horizontal, deformations of between 0.5 and 1% slope are also measured in the opposite direction, towards the centre of the slab. Systematically, an increase is recorded that forms an eyebrow or step of 2-3 cm in height and another 2-3 cm of lateral opening, as shown in Figure 2 below. In the measurements carried out in 2018, an increase of the crack in the horizontal direction of between 1.0 and 20 cm was recorded.

Of all the hypotheses put forward since research began, the one that makes the most sense in terms of the relative position of the cracks and their evolution over time is the one that attributes the main cause to a process related to the growth of expansive salts. These are most probably related to the cement injections made when the church was underpinned by get-grouting.

The reflection of this system of cracks in the floor affects the walls of the church. The relative opening stresses recorded in the floor are transmitted to the rest of the building. The following correlation profile (Fig. 3) shows the cracks affecting the church and its surroundings. Numbers. 3, 4 and 5 project towards the interior of the church and exert this differential relative opening movement.

4. Analysis of the pathologies

From the analysis of the various pathologies and defects observed, it can be concluded that the problem is caused by differential movements of the ground, with an essentially horizontal component, due to a combination of several factors:

1. The location of the building on a site with very poor geological and geotechnical characteristics: loose colluvial soil with a clayey gypsum composition.
2. Located in the middle of the slope, in a position with a relatively steep relative slope.
3. Problems of water infiltration into the ground from a sewerage network with sizing problems and frequent breaks.

The following figure (Fig. 4) shows a cross section of the church, with arrows indicating the relative displacements that can be deduced from the morphology and openings of cracks and fissures.

The part of the building facing the slope (on the left of the drawing) shows more moderate displacements than the part facing the lower part of the slope, where the recorded openings are much larger.

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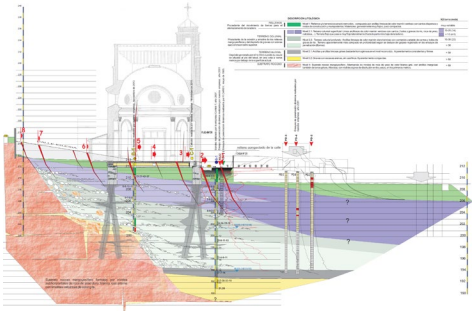


Fig. 3 – *Geotechnical correlation profile of all available data.*

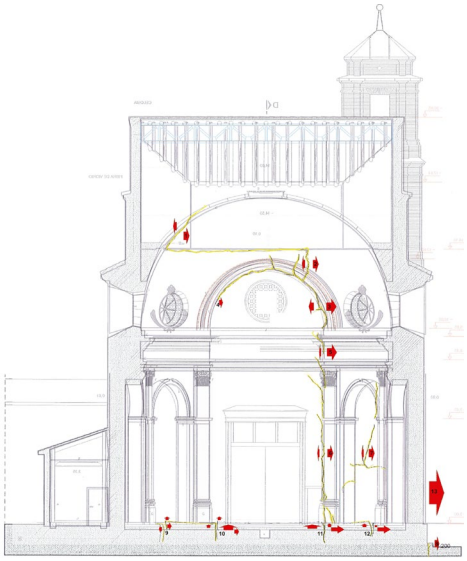


Fig. 4 – *Schematic profile of the main cracks and fissures in the interior of the church. The position and magnitude of the arrows indicate the apparent movement of the detected deformation.*

On the basis of the observations made, the following conclusions can be drawn:

1. The cracks and fissures have a typology compatible with mainly horizontal relative displacements between the lateral (longitudinal) walls in an apparent direction towards the bottom of the slope. They do not indicate movements due to differential settlement on the vertical.
2. These movements are most likely caused by hydrostatic thrusts of underground water infiltrating the slope. According to the geological-geotechnical model, these thrusts have been caused by infiltration, mainly from a very defective drainage network. The inertia of the process, even after partial repair of the network, maintains the dynamics of the stresses and has created a trend that does not seem to stop.
3. The phenomenon of the rising of the floor of the church seems to have a different origin. It is probably related to the growth of expansive salts under the floor. All around the interior perimeter, coinciding with the injection of grout during the underpinning work carried out in 1997.
4. The two processes are most likely related and complementary:
   - The configuration of the ground, which is very loose in the lower part of the slope, favours the process of deformation of the colluvial soil itself towards the south, towards the river plain. The cracks that affect the whole area, after their lateral correlation, begin to be recorded from the upper part of the slope (High Street), so this is not an isolated effect concentrated on the church building. Traction cracks can also be seen on the southern wall of the church itself.
   - The apparent expansion process that causes the sill of the church to rise may also act laterally, promoting shear that helps to 'open' the cracks in the transverse direction of the building. However, no such stress system is recorded in the longitudinal direction.

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5. Actions and instrumentation adopted

5.1. Actions adopted

The measures adopted were as follows:

1. Underpinning foundations with micropiles.
2. Inside the church, work was carried out to repair the floor slab.
3. Restoration of external urbanisation.

5.2. Monitoring performed

Within the control systems for differential movements and deformations of the building, once the measurements have been taken, different methods have been used to obtain differential data and measurements (Fig. 5).

Specifically:

1. Relative distances between different points inside the church. Measurements of convergences (in this case divergences) between points at the entrance, just below the choir, in the middle of the nave and at the altar.
2. On the railing of the choir. In the fitting of the thick rail of the balustrade that has separated from one of its supports (the one on the right). The first measurements date from 2014.
3. In the cracks and access fissures from the floor of the church. According to the traditional method of placing plaster cores.

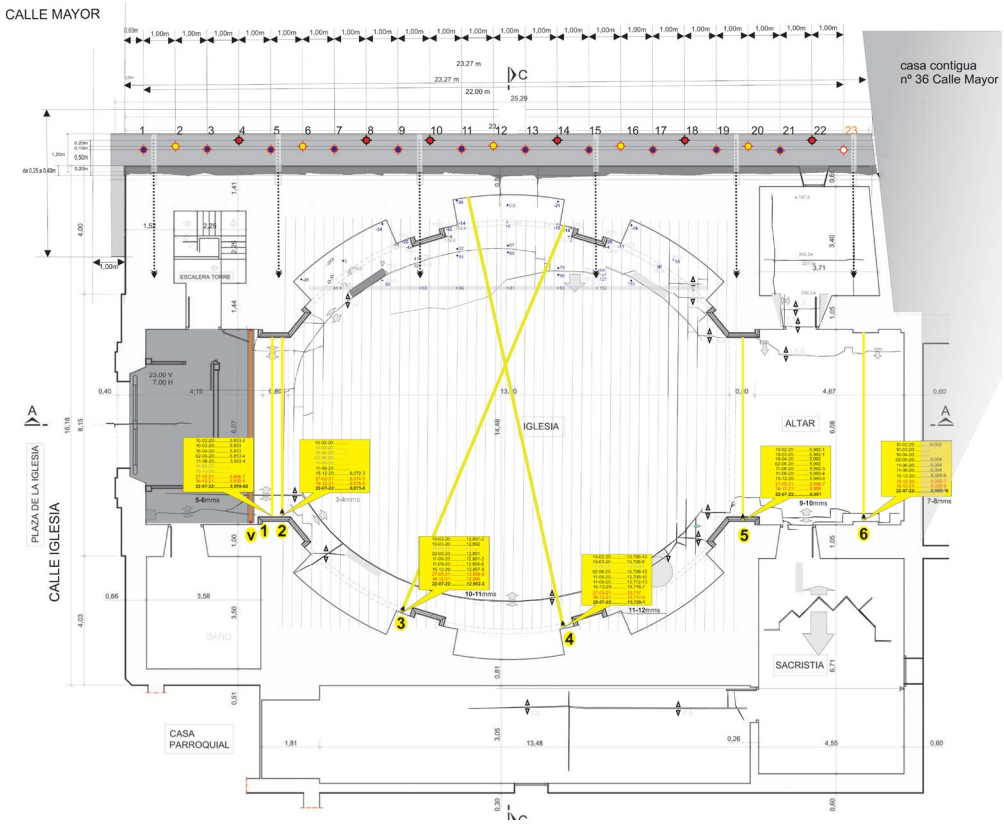


Fig. 5 – *Plan view of the measurements taken inside the church.*

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Table 1 – *Table of data on relative distances within the Church taken over the last 4.9 years*.

	nº	Data collection date	Days passed to origin	Days from previous date	P1	Δ P1	P2	Δ P2	P3	Δ P3	P4	Δ P4	P5	Δ P5	P6	ΔP6
Period 1	1	10/02/2020	0		5,853				12,891		13,709		5,991		6,002	
	2	10/03/2020	30	30	5,853	-			12,891	-	13,709	-	5,991	-	6,002	-
	3	16/04/2020	46	16	5,853	-			12,891	-	13,709	-	5,992	0,001	6,003	0,001
	4	02/06/2020	112	66	5,853	-			12,892	0,001	13,710	0,001	5,992	0,001	6,004	0,002
	5	11/06/2020	121	9	5,853	-			12,892	0,001	13,710	0,001	5,993	0,002	6,004	0,002
	6	11/09/2020	211	90	5,854	0,001			12,895	0,004	13,712	0,003	5,994	0,003	6,004	0,002
	7	15/12/2020	305	94	5,855	0,002	6,072		12,898	0,006	13,716	0,007	5,995	0,004	6,005	0,003
Period 2	8	27/05/2021	467	162	5,857	0,004	6,074	0,002	12,899	0,008	13,717	0,008	5,997	0,006	6,007	0,005
	9	16/12/2021	667	200	5,858	0,005	6,075	0,003	12,900	0,009	13,718	0,009	5,999	0,008	6,009	0,007
	10	17/11/2022	997	330	5,859	0,006	6,076	0,004	12,902	0,011	13,720	0,011	6,001	0,010	6,010	0,008
	11	10/05/2023	1171	174		0,008	6,077	0,005	12,905	0,014	13,721	0,012	6,005	0,014	6,012	0,010
	12	30/01/2024	1424	253	5,863	0,010	6,079	0,007	12,908	0,017	13,721	0,012	6,009	0,018	6,014	0,012
	13	24/09/2024	1661	237	5,863	0,010	6,080	0,008	12,909	0,018	13,722	0,012	6,011	0,020	6,015	0,013
	14	31/01/2025	1791	130	5,864	0,011	6,090	0,010	12,910	0,019	13,723	0,012	6,012	0,021	6,016	0,014
			4,9 years													

Travel speed (mms/year)	15/12/2021	**Period 1**	**7,42**	4,79	0,00	9,57	9,57	7,18	5,98
	17/11/2022		**2,46**	2,11	2,11	2,64	2,11	3,16	2,64
	30/01/2024	**Period 2**	**2,47**	2,05	1,79	2,82	1,28	5,47	2,31
			2,90	2,81	5,62	2,81	0,56	2,81	2,81
	31/01/2025		**2,21**	1,83	2,04	2,65	1,06	3,46	2,24

A PLR 30 laser surface and volume meter with a 2cm backlit display was used to measure the relative distances between various points inside the church. The connectivity function allows the measured and calculated values to be transferred via Bluetooth to a Bosch application. It measures distances of up to 30 metres with an accuracy of 1-2 mm and a continuous measurement function.

Up to 6 distances were taken from 10 February 2020, coinciding with the end of the consolidation and underpinning work on the south wall of the exterior of the church.

The following table (Table 1) shows: the days elapsed, and the measurements taken for each of the six (6) observation points. The starting points are marked on the wall on which the meter rests. At the opposite end, the laser point for the first measurement was marked.

All subsequent measurements were taken with special care to ensure that the two positions coincided. For each measurement, a series of at least 5 measurements was taken and the average of the three most similar measurements was recorded.

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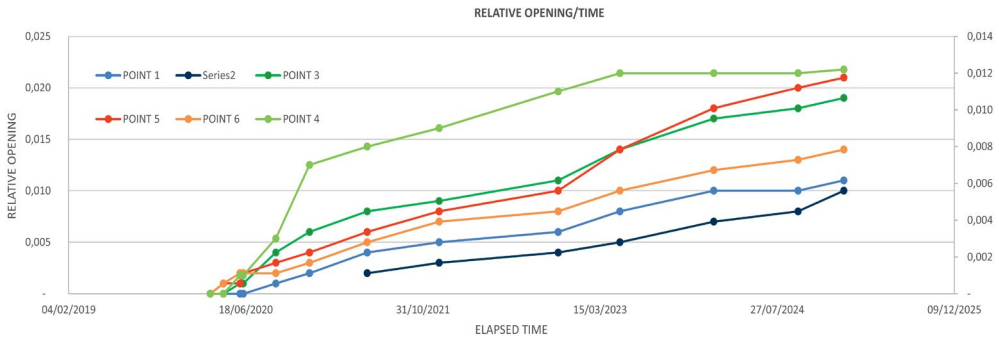


Fig. 6 – *Graph of data on relative distances within the Church taken over the last 4.9 years.*

The result is shown in Table 1. It shows the increase in relative distances and the apparent opening velocity, which has varied between 2 and 9 mm/year.

This relative displacement velocity has varied depending on the time considered. In a first-time interval of the order of 305 days, the velocity was of the order of 7.42 mm/year and became about 2.46 mm/year in the last period of 692 days (Fig. 6).

6. Conclusions

The main conclusion can be summarised in the fact that the containment and replacement work of the church building of Juslibol are proving to be effective. The differential movements that had been occurring and seriously affecting its structural stability have begun to decrease and it can be assumed that they are tending to stop. The readings from the auscultation systems carried out in recent years indicate this.

However:

1. It is necessary to act on the road, especially on the corner of the tower, to discover the situation of the drainage system and the contribution of the sub-valve from the upper part of the slope, and thus to study solutions for the stabilisation-consolidation of the slope.
2. It is highly desirable to continue observations and control measurements of the movements to confirm the apparent trend. At least of the differential movements from inside the Temple by means of laser measurements.
3. The above-mentioned differential movements have caused very visible damage, resulting in the detachment of debris and cracks in the walls and roof. There are significant cracks in the chancel arch and the prefabricated segmental dome, installed during the last restoration (1997), has shifted several centimeters. The vertical cracks in the walls, also in the altar after the demolition of the adjoining house, cause problems of detachment from the eaves and allow leaks into the interior of the church.
4. Once the demolition of the house attached to the church has been completed (already done) and the sacristy on the left (in ruins) has also been demolished, this part of the building needs to be properly renovated and consolidated.

Acknowledgements

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The Venice and its Lagoon UNESCO site (Italy): Cultural Heritage and Climate Change

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Abstract

The contribution illustrates the outcomes of the research "Deepening the Impacts of Climate Change on Venice's Monumental Heritage". This activity was carried out to integrate the various studies conducted in recent years by the Iuav University of Venice, the outcomes of the CORILA Venezia2021 research and the general aspects of the Venice Climate Change Adaptation Plan, as well as in coordination with the contents of the UNESCO, ICOMOS International and Europa Nostra documents and with other national (PNIEC, PNAC, PTE) and EU documents. The analysis of impacts and risks to cultural heritage is provided both with regard to the effects of gradual changes in climatic parameters (temperature, precipitation, relative humidity, etc.) and with regard to possible damages caused by extreme events (floods, heavy rain, prolonged drought periods). The effects considered to be potentially more damaging were associated with risks/threats for macro morphological/typological categories of cultural assets identified in the existing cultural heritage, also considering the effects of activating the MOSE system. The analytical campaigns also involved several Iuav laboratories such as Lama, FisTec and Geomatics CIRCE. The conclusion of the research saw the elaboration of a series of actions to prevent and mitigate the effects of climate change, calibrated taking into account the characteristics of the assets belonging to the different macro-categories identified, and referable to both the punctual intervention and the preventive conservation plan, aimed at increasing specific resilience. The proposed actions are aimed at guaranteeing not only the effectiveness of the solutions, but also the material and formal compatibility of the different expressions of historic lagoon buildings.

Keywords: *Venice; cultural heritage; climate change; risk; intervention*

1. Introduction

This paper presents the findings of the "Detailed Study of the Impacts of Climate Change on the Monumental Heritage of Venice" begun in 2023 (Trovò et al., 2024; Trovò, 2024; Trovò, 2023). As early research on the city of Venice and its lagoon demonstrated (Saetta et al., 2020; Berto et al., 2022), the impacts of climate change—variations in environmental parameters (rainfall, humidity, temperature), rising sea levels, and the increase of extreme weather events—pose a new threat to the conservation of cultural heritage. The importance of understanding and addressing the impact of these changes on cultural heritage conservation arises from the fact many losses are irreversible and have significant consequences in

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terms of the intangible heritage linked to questions of identity and belonging.

The study began with an elaboration of the main risks of Climate Change on Cultural Heritage delineated by UNESCO in 2007 (UNESCO, 2007) and proceeded by identifying specific indicators ETCDI - Extreme Climate and Weather Indicators (EPA, 2025) to show the change, variation, and projection of current climate change impacts in relation to future scenarios. These threats were then distinguished as direct or indirect. The former are climatic conditions that act tangibly on materials, compromising their physical integrity. They can be further distinguished as gradual (variations in environmental parameters) or sudden (extreme weather events). The indirect effects are aggravating factors that can result from the sum or interaction of direct threats (prolonged draught phenomena that can increase the risk of fire) or dynamics that affect not so much the materials as the intangible aspects of the asset, such as the loss of the historical-cultural context, the alteration of the original use, or changing collective perceptions of heritage value.

The research[1], which was coordinated with educational experiences (Gobbi et al., 2024), examined data on temperature, precipitation, and extreme weather events for the Veneto region by analyzing projections developed by ARPAV (the Veneto regional agency for environmental prevention and protection) and considering different emissive scenarios. The Venice lagoon was then examined in its specificity and its historical and recent anthropic transformation, and attention finally focused on the historical city.

2. The approach to the Venetian context: from macro-category to case study

Even though the historical city of Venice is exceptional from an architectural point of view, it is still an extremely significant case study. Every major conservation issue is concentrated here, heightened by the city's extreme environmental conditions and the vulnerability of its historical building fabric. The study investigated the possible actions (from monitoring to specific direct interventions) that can be implemented to strengthen the resilience of the city's built heritage in relation to future risk scenarios. Analyzing the solidity of Venice's built heritage required a morpho-typological macro-categorization through which the specificities of the built environment's vulnerabilities could be examined, prompting an initial distinction between buildings (churches, bell towers, residential/commercial structures, theaters, etc.) and open spaces.

Subdivision into macro-categories makes it possible to identify the risk of climate impacts on the urban scale. It also permits shortlisting specific actions for identified classes and evaluating and comparing assets of classes with similar characteristics. This process made it possible to identify specific building characteristics, such as the materials used and recurring construction nodes, establishing the basis for analyzing the behavior of these elements in relation to certain climatic impacts. In this sense, the risk assessment process begins with in-depth analysis of the intrinsic qualities and proceeds by assessing the various vulnerabilities with respect to the direct threats on the built environment in a given location.

[1] *Approfondimento degli impatti dei cambiamenti climatici sul patrimonio monumentale di Venezia (Detailed Study on the Impacts of Climate Change on the Monumental Heritage of Venice)*, City of Venice, Regional Development and Sustainable City, Director Architect D. Gerotto; Environmental Assessment and Reclamation, Manager Dr. M. Gattolin - Università Iuav di Venezia, Dipartimento di Culture del Progetto Professor F. Trovò (coordination), Professor G. Bruschi (co-coordination), Architect E. Gobbi (research assistant).

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3. Threats & risks for the built environment

A total of 805 buildings were included in this study. Intrinsic factors such as construction and connotative features, the state of conservation, and the extent of restrictions were assessed for each building. Extrinsic factors were then evaluated in relation to location. The specific factors included exposure to sunlight, rain, and wind and average sea level rise. The use of multipliers, which were differentiated on the basis of the building's construction and materials, made it possible to account for vulnerability and resilience on the basis of different climatic factors (higher scores corresponded to greater risk). The first risk indicator was the asset's historical designation[2], after which its maintenance and conservation status were taken into consideration[3].

To assess the asset's exposure in relation to the threats' intensity, the building stock was divided into three categories based on urban location. Buildings located in marginal areas (Fig. 1) that are considered to have greater exposure to the action of winds (bora and sirocco, in particular), rain, and other storm surges were grouped together. Buildings with water frontage (Fig. 2) whose facing walls are threatened by phenomena of water absorption and wave motion came next and, finally, the properties scattered throughout the urban fabric that are considered to be more protected from direct extreme calamitous events.

The impact of sun or shade (Fig. 3) compromises materials in different ways (thermal shocks or the proliferation of biological colonization), which is why multiplicative values were associated to sunlight and shade based on existing materials and their exposure, while rainfall and strong winds can have a greater impact on particularly high buildings, such as bell towers or churches.

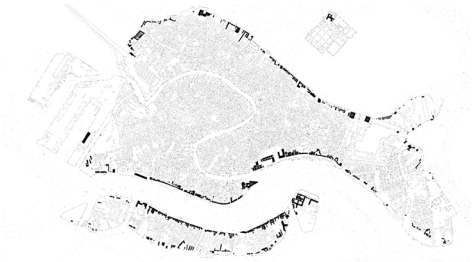


Fig. 1 – *Buildings located in marginal areas* (Elaborated by Enrico Gobbi as part of the activity "Detailed Study of the Impacts of Climate Change on the Monumental Heritage of Venice", 2024).

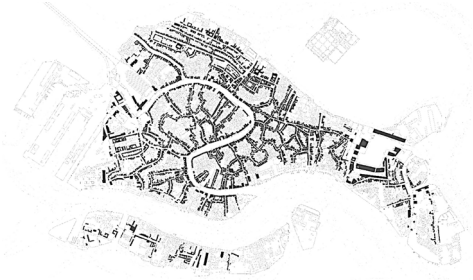


Fig. 2 – *Buildings with water frontage* (Elaborated by Enrico Gobbi as part of the activity "Detailed Study of the Impacts of Climate Change on the Monumental Heritage of Venice", 2024).



Fig. 3 – *Identification of areas with minimum sunshine 0-4 h and macro-areas subject to Bora and Scirocco winds* (Elaborated by Enrico Gobbi as part of the activity "Detailed Study of the Impacts of Climate Change on the Monumental Heritage of Venice", 2024).

[2] Buildings that are protected by historic preservation provisions were considered higher risk than those that are unregulated.

[3] Properties that are abandoned were considered higher risk than those characterized by recent interventions.

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In the case of Venice, in particular, it was also necessary to assess vulnerability to the average sea level rise and to assess phenomena of high tides, making use of the altimetry elevations of the Digital Terrain Models (DTM) of the Metropolitan City of Venice integrated with RAMSES data[4].

Managing the digital models in a GIS environment made it possible to combine each different building weight with the identification of different critical flooding levels, thereby identifying the vulnerability of the building stock with respect to different scenarios of average sea level rise. The mitigation of the average sea level rise through the activation of the MOSE system, as well as its effectiveness in future scenarios (2030, 2050, 2100), was taken into account in calibrating the risk scores.

4. Threats and risks for open spaces

With respect to open spaces, the study assessed a total of 566 case studies, including 125 stone-paved squares, 68 gardens, 55 bridges, and 72 wellheads. Open spaces are mainly affected by intense intermittent phenomena, such as winds and heavy rainfall, in which the presence of trees or discontinuous elements increases the risk in relation the safety of people and the adjacent properties.



Fig. 4 – *Palazzo Minotto in Dorsoduro sstiere* (Trovò, 2020).

[4] The RAMSES project (*Rilievo altimetrico, modellazione spaziale e scansione3D* [Altimetric surveying, spatial modeling, and 3D scanning]) was promoted by the City of Venice and implemented by Insula spa beginning in 2011.

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Fig. 5 – *Campo San Lorenzo with the church of the same name in the background* (Cappelletti, 2024).

The same methodology used the built environment was used to assess the areas' exposure to sunlight and shade taking into account the surface type. Green areas or permeable surfaces conditions that favor the mitigation of heat waves or water drainage in the event of heavy rainfall—scored better. Wind action was considered in the presence of trees that risked falling. The previously developed digital model was also used to assess the critical elevations for scenarios of average sea level rise for open space.

5. Actions to prevent and counteract

To develop the basis for a flexible programmed conservation plan it was necessary to identify three case studies (Figs. 4-6), each one of which represents a macro-category and specific urban and environmental conditions.

Each case is an example for developing a modus operandi that can be adapted to other contexts in the city, with the goal of establishing a systematic monitoring practice as well as protective measures and/or interventions for cultural heritage that can be extended to other situations. Through an urban scale analysis, this methodology permits the preventive identification of risks and vulnerabilities, making it possible to define targeted measures. The three case studies —a palazzo, a church with a bell tower, and an open space— provide a sufficiently complete framework for developing a methodological approach to planned conservation.

For each case study, it was possible to identify the major building nodes by location, materials, and vulnerability in relation to specific threats correlated to the particular exposure (Bruschi 2020a; Bruschi 2020b).

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A shortlist of conservation measures, divided into the major areas of intervention (cleaning, consolidation, integration, protection, and so forth), was identified for each node, made up of specific materials with precise localizations. The measures to prevent and counteract the effects of climate change can then consist of a series of specific interventions to be carried out in the short term to ensure a sufficient level of resistance to known threats, as well as the preparation of programmed conservation plan aimed at increasing resilience over time as threats and their intensity change. The previously identified and "weighted" vulnerabilities and risks determine the frequency of monitoring and, where appropriate, timely interventions making it possible to limit the loss of material and increase the components' resilience level.



Fig. 6 – *Santa Maria Assunta dei Gesuiti church* (Trovò, 2021).

6. Conclusions

In a situation in which the variation of predictive data can even significantly alter risk scenarios, the ideal strategy—in a relevant context such as Venice—should consider defining a preventive programmed conservation plan. Alternating monitoring and maintenance measures provides an effective methodology for defending cultural heritage from climatic threats, especially if these actions are integrated into municipal regulations such as master plans and building codes. This proposal stands in contrast with one-time restoration interventions, which are more costly and by their very nature often incapable of adapting to the behavior of cultural heritage in face of rapidly changing climate threats. Digitalizing the collected information in GIS provides an indispensable basis for timely queries regarding an individual building or a single risk factor but must also be continuously updated as scenarios and risks evolve. This research, which focused on historical buildings characterized by traditional materials distinguished by intrinsic resilience, could be further developed for twentieth-century buildings characterized by innovative building materials and construction techniques of poor durability and at even greater risk in extreme weather conditions.

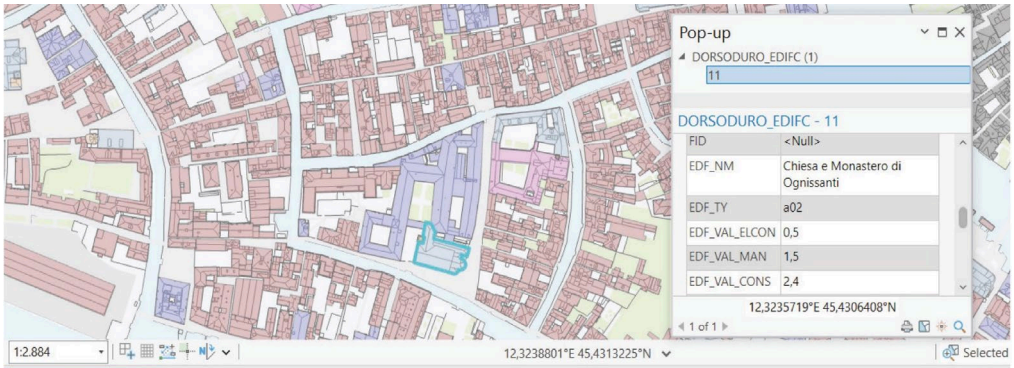
Fundings

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810	Palazzo Soranzo	a01	0	1,7	2,4	2,2	3	1	1,5	1,5	1	1
811	Chiesa di San Barnaba	a02	0,5	1	2,2	2,2	3	2	1,5	<Null>	2,5	2,5
812	Campanile della Chiesa...	a03	0,5	1,5	2,4	2,2	3	1	1,5	1,5	2,5	2,5
813	Palazzo Barbarigo Marc...	a01	0,5	1,5	2,2	2,2	3	1	1,5	1,5	1,5	1,5
814	Palazzo Bollani	a01	0,5	1	2,2	2,2	3	1	1,5	1,5	1	1
815	Chiesa di Santi Vito e M...	a02	0,5	1,5	2,2	2,2	3	2	1,5	1,5	1,5	1,5
816	Chiesa di San Giorgio	a02	0,5	1,5	2,2	0	3	2	1,5	1,5	1,5	1,5

Fig. 7 – *Gathers georeferenced and punctual data for the individual building unit in order to define specific interventions with respect to the vulnerability conditions to which the asset is subjected*. (Elaborated by E. Gobbi as part of the activity "Detailed Study of the Impacts of Climate Change on the Monumental Heritage of Venice", 2024).

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A 'String Figure' Perspective on Heritage Sites - Examining a Village, a Fishing Harbour and a Former Railway Area in Denmark

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Abstract

This paper will take its departure from research conducted by the author at Aarhus School of Architecture concerning the Danish heritage category 'cultural environments'. This heritage category concerns heritage sites and incorporates both buildings, structures and landscapes. In other words; 'cultural environments' are built wholes. The research has focused on how to manage these sites in a sustainable manner and this has led to new insights into the connection between the intangible and tangible aspects. The paper will be based on this research, but further the discussion and reflection through the so-called 'string figures' described by professor Donna Haraway (2016). The paper will analyze three Danish heritage sites; a small village in the countryside, an historic fishing harbor in a small town and a former railway area in the city centre and pair these places with the 'string figure' perspective as a method to deepen our understanding of the places. The connections between the different physical elements, natural elements, people and more-than-humans can provide a new understanding of what is important to care for within the historical site. Furthermore, the theory behind the 'string figures' outlines an approach to a more detailed narrative of the site which elaborates on the historical relevance and the deep meanings that the site contains. This way of understanding the many layered historical sites creates a direction for how to manage and care for the sites in the future. The historical buildings do not stand alone, and their cultural, historical relevance is often interconnected with the natural surroundings, along with plants and animals, and the people that have cared for the buildings through history and today. Donna Haraway's 'string figures' show the importance of the connections, and not the isolated objects or buildings, which can create a new understanding of our heritage sites.

Keywords: *heritage; Haraway; ecology; connections; methods; management*

1. Introduction

The paper will analyze three different historical sites by mapping the tangible and intangible components as well as the dynamic and static aspects of the sites. However, the analysis will not focus on these aspects and components as isolated entities, but rather the connections they form. This is investigated through professor Donna Haraway's, so-called, "string figures" (Haraway, 2016). The three sites are selected on the basis of an extensive research work conducted at Aarhus School of Architecture from 2015-2022 where over 2300 *cultural environments* in Denmark have been mapped and described (Morgen et al., 2025). The term

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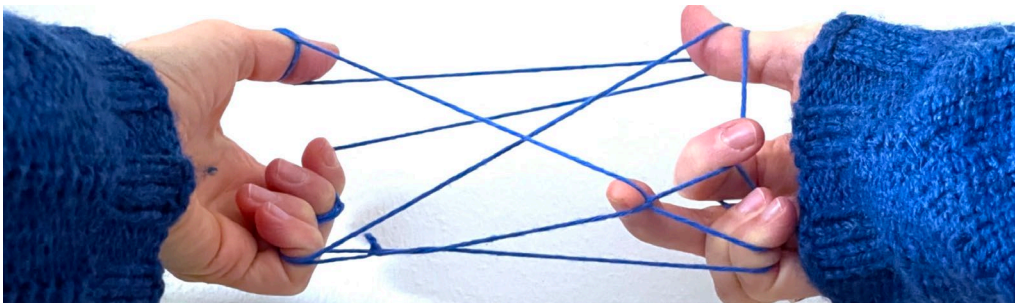


Fig. 1 – *Picture of the string figure game or "cat's cradle" performed by the author* (Kirkegaard, 2025).

cultural environments are a Danish planning category where a collection of buildings, built structures and the landscape, in unison, conveys a cultural, historical narrative. Within the official Danish management of cultural environments, the following description is used to evaluate whether a site is a cultural environment: The site should be *"*a built whole where significant aspects of the societal development can be experienced*"* (Skov- og Naturstyrelsen, 1999, p. 7). Cultural environments are a heritage category that both can comprise urban areas and in rural areas. The three sites, this paper will describe, are: A small village in the countryside, called Alling, an old fishing harbor, called Ebeltoft Fishing Harbor and a former railway area, called Godsbanen, in the city centre of Aarhus. Ebeltoft Fishing Harbor, Alling and Godsbanen has been the subject of investigation in the research project *Sustainable Cultural Environments* (2022-2026) (Kirkegaard et al., 2025) and the Ph.D. thesis *Transformation of Cultural Environments* (2017-2021) (Kirkegaard 2021) at Aarhus School of Architecture.

2. String Figures

The American professor emerita Donna Haraway describes a practice in her book *Staying With the Trouble – Making Kin in the Chthulucene* from 2016 by two letters: "SF". The "SF" stands for "science fiction", "speculative fabulation", "string figures", "speculative feminism", "science fact" and "so far". This "SF"-practice is an attempt to approach our world through modesty, mixed methods and an acknowledgement of the world's complexities (Haraway, 2016, p. 10). Donna Haraway works within and in-between different disciplines, such as art, philosophy, science and biology. One could argue that her work is a part of the new ecological discourse, along with Bruno Latour and Anna Tsing, among other scholars. Some of Haraway's references in her theory are to the English mathematician and philosopher Alfred North Whitehead whose theory, e.g. *Adventures of ideas* from 1933, has been a base for ecological theory. Whitehead argues that relevant things in nature are the outcome of their interconnections and this interconnectedness shows us how everything has internal relations to other things (Whitehead, 1933, p. 201). A string figure can also be called "cat's cradle" and is a string game you play with your hands (Fig. 1). It is something that kids can play, but it has also been a means of telling stories within native communities. The string runs from finger to finger in a pattern that forms a "picture" or a story. In the string game the string is passed to another participant in the game. When given to another participant the string figure changes and so the story will change.

Haraway uses the *string figure* as an analogy for the connections between what she calls "critters": microbes, plants, animals, machines, humans, and nonhumans. Within the *string figure* the "critters" are an analogy for the fingers, so the string is the connector between the fingers, or the, so-called, "critters".

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To exemplify this view: The farmer is a critter, his cow is a critter and his field is a critter and these three critters are interconnected in the *string figure* by strings forming a pattern or a "figure". Haraway describes how: "String figures can be played by many, on all sort of limbs" and she continues; "as long as the rhythm of accepting and giving is sustained" (Haraway, 2016, p. 10). Haraway explains that sometimes you drop a sting and other times you form something that was not there before. In the following description, I will describe three cultural environments through this *string figure* perspective by mapping the sites' different "critters": people, nature, and buildings, and span connections between them as a means to nuance the narrative of the cultural environment and form directions for future developments.

3. Three *string figure* heritage cases

3.1. Introducing Ebeltoft Fishing Harbor through the *string figure* perspective

I will describe Ebeltoft Fishing Harbor (Figs. 2 & 3) through the lens of the *string figure* perspective. I have concluded that the cultural environment has seven, so-called, critters: 1) *The Buildings*, 2) *The Urban Layout*, 3) *The Leisure Associations*, 4) *The Businesses*, 5) *The fish*, 6) *The sea* and 7) *The visitors*. The critters are a mixture of physical objects, animals, nature, people and activities (that are tied to associations or businesses and thus consists of both objects and people). Another researcher could point to other critters or an even larger array of critters, but as Haraway states: "It matters what thoughts thing thoughts" (Haraway, 2016, p. 35) and in this case I am forming the *string figure* as an urban planner and researcher in cultural environments. Thus, the narrative, that the *string figure* will form, will be different if another person is creating it. However, the relevance of the *string figure* lies within its ability to shed light on connections within the environment which may be hidden or underrepresented when managing the site in a planning and heritage context.



Fig. 2 – *Picture of one of the sheds at Ebeltoft Fishing Harbor, Denmark* (Kirkegaard, 2019).



Fig. 3 – *Ebeltoft Fishing Harbor has a 125-year-old fishing association and one industrial fishing boat left. The picture shows the fishing boat at Ebeltoft Fishing Harbor, Denmark* (Kirkegaard, 2019).

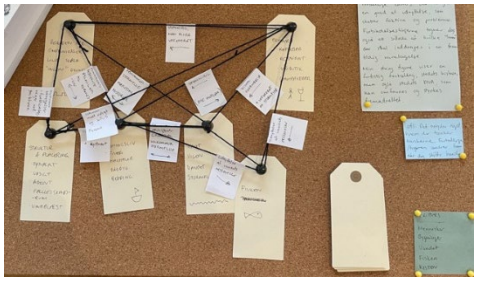


Fig. 4 – *Example of a string figure analysis with strings, connections, and critters, needles with notes stating the critter* (Kirkegaard, 2025).

The connections at Ebeltoft Fishing Harbor are many (around 20 connections) and some of these connections seem symbiotic and others expresses an exploitation (Fig. 4). The fishing harbor has historically been a place of trade and fishing. The fishing industry has been, and is still, in decline and currently the harbor holds one fishing company with one boat. Besides the one fishing boat, the harbor has been a place for leisure

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activities concerning boats and fishing, but recently new businesses have moved into vacant buildings. These businesses are: A wine shop, an Italian delicatesse shop, a glass art shop, a champagne bar, a café, a restaurant and a furniture store (Kirkegaard 2021, pp. 232). I have noted these businesses as one overarching critter called "The Businesses" in my diagram and this critter forms a connection to the following other critters: 1) The Buildings, 2) The Urban Layout, 5) The Fish, 6) The Sea and 7) The Visitors.

The Businesses are connected to *The Urban Layout* by their presence in the shared, public space with furniture, people and activities in the course of a day, week and year. *The Businesses* and *The Urban Layout* form a connection that is important for the identity of the heritage site and has consequences for the space left for the maritime leisure associations and it strongly impacts what type of visitors that are visiting the site. After I conducted interviews and observed the site during approximately two years (Kirkegaard, 2021) it became clear that within the public space there was a conflict between *The Businesses* and *The Leisure Associations*, which felt pressured by the unspoken guidelines formed during the years of inhabiting the space and due to the physical spaciousness of the shared space. The *string figure* does not form a connection between *The Leisure Associations* and *The Businesses* since there are none. However, for future sustainable management a connection between those two could result in less social friction at the site. In other words, a more symbiotic connection between the two could help sustain *The Leisure Associations* which is pressured by the forces of *The Businesses*. It is important to note that *The Leisure Associations* is "doing" the intangible heritage, such as fishing and boat repair. This intangible, but site-specific, heritage carried out by *The Leisure Associations* is often overlooked in planning and heritage management and easily destroyed by a lack of understanding of which other aspects and forces that impacts it.

The focus on the *connections,* both those that show a symbiotic relationship and connections that are lacking or resulting in a less harmonious environment between people, structures, the layout, buildings, nature and/or animals, are one of the abilities of the *string figure* perspective. The *string figure* analysis for Ebeltoft Fishing Harbor also sheds light on three other connections that is worth paying attention to: Firstly, the connections between *The Fish* and *The Businesses*, secondly the connection between *The Fish* and *The Sea,* and thirdly the connection between *The Fish* and *The Leisure Associations*. *The Fish* covers the underwater animals as a whole; molluscs, clams, porpoise, cod, and all other sea creatures that are a part of the Danish marine life ecosystem within Ebeltoft Vig.

The three connections to *The Fish* demonstrates exploitation (by some of *The Businesses* and *The Leisure Associations*), dependence (*The Fish's* dependence of *The Sea* along with its water quality and the manmade disturbances happening within the sea), and support (the support given to *The Fish* by some of *The Leisure Associations* by the acts of improving the viability for *The Fish* through underwater habitation places, egg tumblers and fry aquariums at land). The critter that I have dubbed *The Fish's* connections in the *string figure* underlines its role for the cultural environment both in terms of its historical role, its present role and future role. *The Fish* has been of vital economic importance to the fishing harbor, a healthy food source for the people buying it and has also been vital for the community, culture and activities at the harbor. However, in the future management of the heritage site the exploitation of *The Fish* should shift to a more sustainable "interaction" or, as the *string figure* expresses, more symbiotic connection, to ensure an end of the exploitation of *The Fish* and replace it with another type of "interaction". Today, *The Fish* also provides an experience, atmosphere and identity to the heritage site which could be kept alive through experience-based interactions not resulting in a near extinction of parts of *The Fish*.

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3.2. Understanding the village Alling through one significant *string figure* connection

The critters for Alling (Fig. 5 and 6) are noted as: 1) *The Residents*, 2) *The Layout Within The Village*, 3) *The Surrounding Landscape* and 4) *The Buildings*. The village is an old, so-called, "*stjerneudstykning*" which can be translated into "star-shaped allotment plots". In the late 1700 Denmark underwent a large structural reform resulting in changes in the way we cultivated the soil and the ownership of the fields. Before the reform many small villages shared the land and cultivated the soil where it was best suited for the different purposes. To better the individual peasant's right to land most of Denmark was divided into fields with one farm allocated to one piece of land. This resulted in many farming communities being dissolved because the farms were moved out to each piece of land for efficiency purposes. Alling is one of the few villages where the farms remained in a cluster which sustained their community even though their shared land, surrounding the village, was divided into individually owned fields. When viewing the village on a map the farms and small houses are gathered in a cluster surrounded by fields that "shines" (like a star) in lines out from the village. While also visible when visiting the town (Fig. 6), the cadastral division today still reflects the former "starshaped allotment plots" (Fig. 7).

I will focus on the connection between the two critters *The Residents* and *The Surrounding Landscape* which is a connection that has been of vital importance for the local community through the last centuries. Through the years most of the family-owned farms in the village have been transformed into regular family homes and the fields has been rented to large farming companies. The Residents of Alling's current connection to the landscape is thus mainly through recreational walks on designated pathways alongside the fields.



Fig. 5 – *Picture of the village of Alling, Denmark* (Kirkegaard, 2024).



Fig. 6 – *Picture of fields surrounding the village of Alling, Denmark* (Kirkegaard, 2025).



Fig. 7 – *The illustration shows an orthophoto of Alling from 2024. The red lines are the current cadastral division and they are almost true to the division of land made in 1782*. (Plan- og Landdistriktsstyrelsen, 2024).

In 2024 a group of residents formed an association with the aim of transforming one of the fields surrounding the village into a wild nature reserve. They contacted one of the owners which donated his field to the project. The rewilding project strives to benefit biodiversity, but also form a voluntary co-creation project for the residents of Alling. Four yearly meetings have been planned in the village's community house and the residents of Alling are invited to become ambassadors for the future plants and

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animals inside the rewilding zone. For example, one resident could become responsible for a type of flower by counting and monitoring it and another resident could keep an eye out for the emergence of some rare insects (Kirkegaard, 2025). In other words, the rewilding project strives to form a new interaction with the landscape. An interaction that is not merely spectacle by recreational walks, but an active interaction similar to the active interaction that previously existed between the village farms and the fields. However, this new interaction is intended to benefit the natural balance of nature and not merely exploit it.

The *string figure* connection, that I have enhanced, between *The Residents* and *The Surrounding Landscape,* represents a connection that, historically, has been of vital importance for the village’s livelihood and sense of community. It is a great part of the narrative and DNA of the village. By reforming the connection into a new symbiotic connection, the village is reviving a part of its identity and supporting the community feeling through the collective rewilding project. Thus, the connection between *The Residents* and *The Surrounding Landscape* represents an important understanding of the situatedness within the landscape and the collective interaction with the soil and the plants – both today, in the past and its role in the future.

3.3. The unfortunate development of the heritage site *Godsbanen*

Godsbanen, as it is called, is a former freight rail area near the city centre of Aarhus (Aarhus Kommune 2013, pp. 220–223). It was an industrial working zone for the Danish state lines (DSB), but in 2000 DSB vacate the area and the municipality buys the northern part of the area. Due to the financial crisis in 2008 development plans came into a standstill. The area was fenced off and consisted of a wide, open space with gravel, a few bushes and trees, train tracks and a few vacant buildings and containers.

Around 2009 a creative group of young people were allowed by the municipality to occupy some of the buildings with the aim to create a small cultural centre. After a couple of years, the creative group, called Bureau Detours, managed to create a space for alternative exhibitions and events, and Godsbanen became an alternative offer for young people of Aarhus to express themselves. Eventually, small business start-ups and creative initiatives gathered at the site, in the containers, or inside the buildings (Figs. 8 & 9). The activities at the site were gathered under one association called “Institute for X”. To this day Institute for X still exists and foster several start-ups, creative groups and functions as a creative community.



Fig. 8 – *Picture of one of the former railway tracks surrounded by colourful sheds/containers inhabited by the creative association Institute for X, Godsbanen, Aarhus, Denmark* (Kirkegaard, 2022).



Fig. 9 – *Picture of one of the historical, railway buildings inhabited by Institute for X, Godsbanen, Aarhus, Denmark* (Kirkegaard, 2022).

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A contrasting difference between 2009 and now is the surrounding site to Institute for X. In 2009 the creative environment was left undisturbed at the vast industrial site. They could use the materials found at the site and they were allowed to use many of the vacant buildings. The landscape surrounding them was an open space with train tracks stretching into the horizon. As one of the members of Institute for X described it:"It was like a dream space where you could see to the end of the world*"* (Kirkegaard et al., 2021).

The Godsbanen is located in the former river valley which makes the space uniquely flat and open in the otherwise dense and hilly town of Aarhus. Today Institute for X only has a small area and a few buildings to "be creative" within. The site is otherwise (2025) more or less packed with new developments (Fig. 10): Apartment blocks, a parking garage and office buildings. Aarhus School of Architecture moved into a new building at the site in 2021. The municipality transformed one of the historical buildings into a 'Culture House' with concert hall, work spaces and event spaces in 2012 (Fig. 11). When analysing the historical, urban site of Godsbanen through the *string figure* perspective I can divide the site into the following nine critters: 1) *The Former River Valley*, 2) *The Insects And Plants*, 3) *The Municipality's 'Culture House'*, 4) *The New Developments*, 5) *The Historical Buildings*, 6) *Institute for X*, 7) *Residents and Employees/Students*, 8) *Guests* and 9) *Platform 7* (which is a safe space for homeless people). These categories represents both people at the site, the buildings and the landscape.

The former river valley has a surprisingly rich plant and insect life which has a high level of biodiversity, but a lot of it has been destroyed by the new developments. *The New Development* is, in the *string figure* analysis, not connected to *The Former River Valley* or *The Insects And Plants*. Likewise, *The New Development*, is not connected to *The Historical Buildings* or made with respect to the historical urban site as a whole.

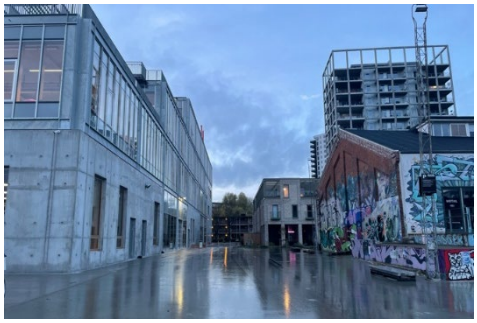


Fig. 10 – *Picture of a part of the heritage site Godsbanen where concrete pavement has replaced the former gravel and train tracks. New buildings are sourrounding the hertage buildings which is seen in the right side of the picture with red bricks and graffiti. Godsbanen, Aarhus, Denmark* (Kirkegaard, 2022).

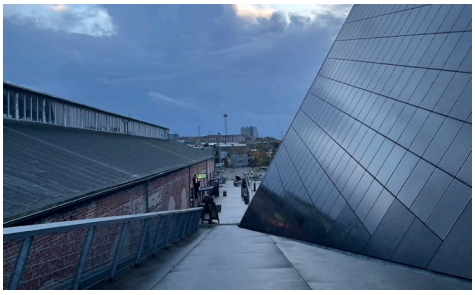


Fig. 11 – *Picture of the Municipality's 'Culture House'. A transformed historical building now in use as a cultural centre with concert hall, work spaces and event spaces. Godsbanen, Aarhus, Denmark* (Kirkegaard, 2022).

Some of the new developments have demolished historical buildings, removed historical train tracks and significant biodiversity. Furthermore, the site's historical relevance could be found in the vastness and openness of the area which today, with the new constructions, has been densified and lost.

The creative group, Institute for X, has, in contrast to *The New Development*, managed to transform the historical buildings and left spots for biodiversity to flourish with the mantra of not cutting any (of the few) trees or bushes down. Together with the municipality owned 'Culture House', which is located in two former industrial buildings, the Institute for X is the only other

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actor at the site that preserves some of the heritage characters. This is placing *Institute for X* with many positive connections within the *string figure.*

Institute for X has, unintentionally, become one of the only actors that preserves the existing buildings, nature, train tracks, etc. The spirit of the initiative Institute for X is an ad hoc, slow development within the existing, given “frames” (buildings, materials, landscape). The new developments demolishes both heritage and landscape and has formed no connections in the *string figure* perspective. In contrast the connections Institute for X has formed to the sites critters exemplifies a sensitive, site-specific development with regards to Aarhus’ collective railway history.

4. Conclusions

The *string figure* perspectives that I have used to analyze and describe the three heritage sites of this paper are a subjective method. The findings would be different if another researcher with a different professional background mapped the critters and the connections. However, the perspectives emphasize the need for a more detailed understanding and management of the heritage sites and the intertwined and essential connections.

Donna Haraway describes how *string figures* are like “stories; they propose and enact patterns for participants to inhabit, somehow, on a vulnerable and wounded earth” (Haraway, 2016, p. 10). At the three sites the *string figure* perspective illustrates how the connections that are formed and the connections that are lacking indicate where the site is experiencing faults. Haraway describes how she is not interested in restoration, but in the more modest possibility of merely “getting on together” (Haraway, 2016, p. 10). At both Godsbanen, Alling and Ebeltoft Fishing Harbor there are connections between critters that could be optimized towards a more balanced relationship. For example, how would the site of Godsbanen have been developed if the new development had considered “getting on together” with the insects and plants and the historical buildings?

Haraway sees an urgency for us to consider the world as an interconnected web spun between microbes, plants, animals, humans, machines, things, nonhumans, etc. and this view is also relevant in relation to heritage sites which often represent deep, historic, many-layered places with complex connections that both form the heritage site’s narrative today and direction for future management. By using the *string figure* perspective, it is possible to shed light on hitherto undetected or under-prioritized connections that could help form a more sustainable future.

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Aesthetic Qualities and Fragments of History in the Tiburtine Landscape (Italy). Places of the 'Sacred' and Ancient Itineraries

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Abstract
The study concerned the Tiburtine territory of eastern Lazio, and in particular the area of the pass between the valleys crossed by the rivers Empiglione and Giovenzano, the two left tributaries of the Aniene. The geomorphological aspect of a territory, a natural quality, can activate a visual attraction capable of arousing the genesis of 'added values' (symbolic, religious ...) in some environmental contexts, charging them with further qualities that, absorbed into the culture, contribute to the aesthetic experience that takes place in them. Starting from these considerations, those peculiarities that have contributed in history to the characterization of the landscape context around the area under study were identified. Through ancient sources, material traces, the perception of places, the relationships between natural elements and anthropic traces, two ancient routes of particular importance have been identified, one on the ridge and the other halfway up the eastern slope of the Prenestini Mountains overlooking the Giovenzano valley, which have contributed to the definition of the peculiarities of the contemporary landscape, for conservation but also as support for a possible cultural enhancement, inherent in the project.

Keywords: *landscape; territory; ancient itineraries; conservation*

1. Introduction

The area under study is located in eastern Lazio, in the Tivoli area, at the meeting point between the valleys of the Empiglione and Giovenzano rivers, the two tributaries of the Aniene before Tivoli. This area (Figs. 1 & 2) has been the crossroads of transhumance routes since prehistoric times along the east-west axes (attributable to the route of the current Via Empolitana) and north-south, from the upper Aniene valley to today's Palestrina (Sciarretta, 2013); this latter route partly coincides with the *Praeneste-Treblis-Carsulis* route indicated in the *Tabula Peutingeriana*, the ancient map in which the main public communication routes of the Roman Empire are represented (Mari, 1993; Mari, 2021; Scotoni, 2008).

Even after the Roman conquest of the territory east of Tivoli, the pass between the aforementioned valleys, the so-called Passo della Fortuna, maintained a strategic role for road control, at least until the 15th-16th century (Montanari, 2025).

In fact, there are numerous traces of structures dating back to the time span between the pre-Roman era and the late medieval period still present in the territory.

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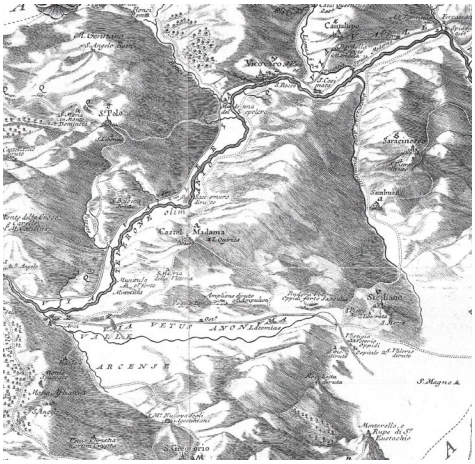


Fig. 1 – *Diocesi Agri Tiburtini Topographia, detail* (Diego de Revillas, 1739).

The importance of this geographical position is also demonstrated by the discovery in 1948, near the same pass, of the remains of the ancient *Trebula Suffenas*, the location remembered by the Latin poet Marcus Valerius Martialis (*Epigrammaton*, V, 71), a Roman municipality at least since the 1st century BC, which extends along the eastern slope of Monte Spina Santa, a massif of the Prenestini mountain chain (Sciarretta, 1974; Id. 2013). Recent studies and morphological analyses of the territory around the Passo della Fortuna suggest that the archaic *oppidum* (active from the 5th-4th century BC), abandoned after the Roman conquest, must have arisen on the height of the hill facing the slope on which the Trebulan archaeological site develops, in the place where the current town of Ciciliano is located (Mari, 2023; Id., 2015), divided into two contiguous plateaus at about 600 meters above sea level. From this position, in fact, there is a wide view of both the Empiglione and Giovenzano valleys; furthermore, the polygonal substructures of the steep access road that starts from the pass and climbs up to the top of the hill are evident, in addition to the wall traces of the terraces attributable to fortified enclosures along the slope (Mari, 2024).

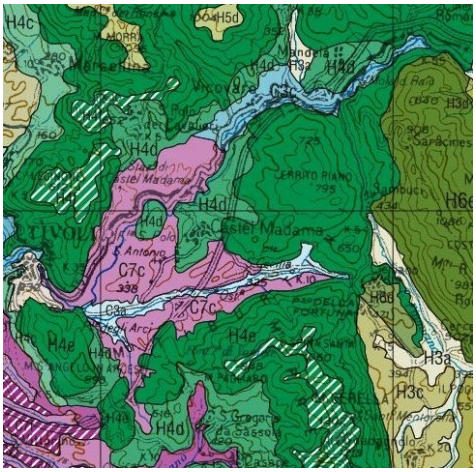


Fig. 2 – *Pedology of the Empiglione and Giovenzano valleys, detail* (Carta dei suoli del Lazio, 2019).

2. Characteristics of the territory and landscape

The mountain system that overlooks the Giovenzano valley, in front of the twin hill on which the town of Ciciliano stands and which delimits its south-western visual horizon, is the eastern side of the Prenestini Mountains. This mountain range, with a north-south orientation between the Aniene and Sacco basins, constitutes part of the Lazio pre-Apennines. From a geomorphological point of view, its walls are formed by alternating calcareous-marly and limestone (*Carta dei suoli del Lazio*, 2019), with a slope from very steep to steep, the lower part of the slopes is mainly made up of sandstone-clayey layers partially covered by groundwater debris, while the valley bottoms are made up of fluvial-alluvial sediments (Fig. 2). The low degree of soil permeability, due to the marls, guarantees a dense surface hydrography. The effect of this abundance of water is evident from the lush vegetation.

The peaks reach high altitudes, although lower than the neighboring mountain ranges of eastern Lazio: Mount Spina Santa, the northern head of the Prenestini, reaches 1060 meters above sea level, Guadagnolo, at the opposite end of the

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ridge, is at 1218 meters above sea level. The petrographic composition of the soils on the eastern slope of the Prenestini Mountains - consisting of alternating calcareous layers and marly layers - in which various springs emerge, has determined on the one hand the torrential character of the watercourses (precisely due to the presence of marls) and on the other the formation of rocky calcareous emergencies. Today these are largely hidden by the rich spontaneous vegetation, but are documented in photographic images from the end of the last century.

The geomorphological aspect of a territory can activate a visual attraction, at least initially linked only to the natural qualities, for those elements that characterize the landscape; interest that in past eras has favored the genesis of added values, such as symbolic, spiritual, religious, historical of some environmental contexts, charging them with further qualities that, absorbed into the culture of those same places, contribute to the aesthetic experience that takes place in them. Among these undoubtedly falls the rocky spur of Mentorella, which emerges from the profile of Mount Guadagnolo, southern offshoot of the Prenestini mountains, on the eastern side to define its profile. On the limestone cliff overlooking the Giovenzano valley, at over a thousand meters above sea level, stands the Sanctuary of the Madonna Madre delle Grazie, one of the oldest Marian sanctuaries in Europe. Its foundation dates back to the legend of Sant'Eustachio, a Roman tribune (1st-2nd century AD). The place is also linked to the figure of San Benedetto da Norcia, who retired here to live as a hermit before going to Subiaco (Cascioli, 1901).

From the Passo della Fortuna, and from the archaeological site of *Trebula Suffenas*, a wide view opens up over the Giovenzano valley, bordered to the east by the Prenestine ridge that ends with the peak of Mentorella (Fig. 4). Along

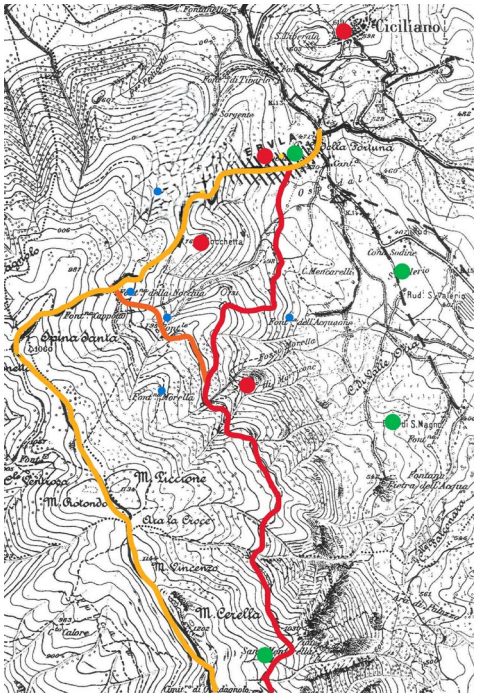


Fig. 3 – *The itineraries from Passo della Fortuna to Mentorella* (Montanari, 2025, on cartography by Sciarretta, 2013).

this line, two isolated spurs (today largely covered by thick woodland) protrude just above the half-coast of the slope at a 'visually' intermediate distance along the Passo della Fortuna-Mentorella visual axis. On these rocky outcrops, starting from the 10th century and at later times, two defensive structures were built that can be placed in the broader program of control and defense of the Giovenzano valley, carried out in the context of the territorial disputes between the Subiaco Abbey and the Diocese of Tivoli (Montanari, 2025). These military structures are the Rocca d'Elci (Travaini, 1979; Annoscia, 2012) built on a limestone outcrop at an altitude of 761 metres above sea level, in close relation with the underlying rural settlement of *Civitas Noe*, mentioned in the *Regesto della Chiesa di Tivoli* in the year 978 (Bruzza 1880), which probably occupied the ancient structures of *Trebula*

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Suffenas (Minorenti, 2014), and the *Castrum Morellae* located at approximately 700 metres above sea level on a hill characterised by three very rugged rocky buttresses, 'i tre murruni' in the local dialect (Sciarretta, 1997). From the remains of the fortified structures organized on several terraces, today in ruins, it was possible to ascertain how in both cases there was technical care in following the morphology and the differences in altitude of the land in the construction of the structures themselves. The construction wisdom in the grafting between the outcropping rocks and the stone walls, which characterizes the wall facings, making them appear as the natural extension of the rocky spurs, belongs to a long-standing tradition.

In the area under study, in fact, examples can be found starting from the pre-Roman era – such as the enclosures of the terraces along the slopes of the Ciciliano hill, mentioned above, and the road substructure works on the eastern side of Roccasecca - as well as the structures of the fortification on outcropping rocky banks of Ciciliano itself, but also around the area of the Passo della Fortuna. In this tradition, the 'factual' memory handed down over the centuries is the fruit of experience that becomes 'knowledge' and defines a taste, a doing (not only mechanical) also aimed at the search for aesthetic qualities.

The rocky outcrops on the eastern side of the Prenestini, along the visual finish line from Passo to Mentorella, therefore constitute a characterizing element of the territory from a naturalistic, geomorphological, but also historical and cultural point of view.

The architectural emergencies that connect with them amplify their distinctive character and document the process of transformation of the landscape, favoring a reading in a diachronic sense.



Fig. 4 – *View of the Giovenzano valley from one of the terraces of the archaeological site of Trebula Suffenas. On the right, the eastern slope of the Prenestini Mountains with Mentorella* (Montanari, 2024).

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Fig. 5 – *First section of the 'pilgrims' path' after the Passo della Fortuna. On the right the eastern slope of the Prenestini mountains and the peak of Mentorella, on the left the Giovenzano valley* (Private collection, mid-20th century).

The distinctive character of the places also appears in the *Diocesis Agri Tiburtini Topographia*, the map of the Aniene valley drawn up by Diego de Revillas in 1739 (Fig. 1). This is the first scientific territorial representation recorded with the triangulation system. In this 'graphic mediation' of perceived reality, the topographer, in addition to the geographical position of the natural elements and the anthropic transformations of the territory, also reports those qualities inherent in the places themselves, which contribute to characterizing the landscape, such as the Passo della Fortuna-Mentorella direction.

3. The itineraries from Passo della Fortuna to Mentorella

The Fortuna pass, located at about 480 meters above sea level, is delimited by the western side of the Ciciliano hill and the eastern side of Mount Spina Santa, a northern offshoot of the Prenestini. At this point the Via Empolitana, coming from the Empiglione valley, at the end of a steep climb enters the southern stretch of the Giovenzano valley, and then continues downhill towards the wide flat area between the Prenestini and the Ruffi mountains.

The toponym Passo della Fortuna, with which the site is still identified, could derive from the presence in ancient times of a temple dedicated to the goddess Fortuna, as several scholars hypothesize (Ceccarelli & Marroni, 2011), or from the fact that the road that exited the pass, in a southerly direction, led to the sanctuary of *Fortuna Primigenia* of *Praeneste* (Sciarretta, 2013).

From a geomorphological point of view, the pass, in addition to being a place of transit, is also characterized as a privileged rest area along the route. At the highest point, on the eastern side of the road, there is a structure with clear signs of transformation, now in ruins. In the past it must have served as a support for travellers and

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pilgrims. The site is in fact also called *Ostaria* or *Hostaria* and it is likely that in ancient times the area was occupied by a post station, later adapted to an inn during the Middle Ages (Minorenti, 2014).

In front of the *Ostaria*, on the opposite side of the road, there is a large flat area in which there is a fountain with a drinking trough. In this area, in recent times, a restaurant structure has been built (to testify to the permanence of the hospitality character of the place). Along the plateau, also on the left side, there are the church of Santa Maria Maddalena and the *Hospitale*.

These structures, commonly believed to be from the 15th century (Persili, 1995; Minorenti, 2014), show evident transformations that can be dated to later periods, up to the most recent interventions of the second half of the 20th century. However, a careful observation suggests that their construction is much older, at least as far as the original layout is concerned. It can be assumed that the church and the hospital - not built at the same time - had, from the very beginning (certainly the hospital), the function of 'support structures' and assistance for pilgrims heading towards the medieval hermitage of Mentorella. The main routes that connected the Passo della Fortuna to Mentorella, still partially recognisable, were already two in ancient times: the road called Cerretana, which adapts to the natural roughness and runs halfway up the eastern slope of Palestrina; the road called San Giovanni, which at the height of the archaeological site of *Trebula Suffenas*, went up Mount Spina Santa to reach the ridge of the Prenestini mountains, a very ancient route.

4. Conclusions. Landscape perception: aesthetic identity of places

The ancient road “so-called Cerretana” (Fig. 3, red itinaray), essentially coincides with the ‘hiking’ route of the ‘pilgrims’ path’. The latter, however, to meet the modern needs of tourism sensitive to the naturalistic-cultural peculiarities of the territory, includes a series of branches along the route that allow you to admire particularly characteristic sites, such as springs, streams, but also rich in history such as the ruins of the fortified systems mentioned above. Privileged panoramic points are also indicated from which to contemplate the underlying Giovenzano valley.

The Via Cerretana begins on the left, just before the archaeological site of *Trebula Suffenas* the route runs downhill and runs along the bottom of the valley on the Prenestino side (Fig. 5) where, across an ancient bridge (Minorenti, 2014), it passes the ‘Fosso della Mola della Rocchetta’, the stream fed by high altitude springs (the tourist route at this point indicates an off-piste to admire a very suggestive karst waterfall and, at a much higher altitude, the remains of the Rocca d’Elci). The ancient itinerary continues uphill following the roughness of the terrain until it reaches the half-coast near a spring, the Fonte della Morella, a sacred place for popular tradition. At this point there is also the confluence of a path that comes from the Spina Santa side (Fig. 3, orange itinerary), which branches off from the itinerary called San Giovanni, which will be discussed later, at an altitude of over 800 meters above sea level, in correspondence with another important source (which was decisive for the development of the settlements downstream). It is possible to hypothesize that the column "*que stat su fonte ilicis iuxta viam deinde in montem qui vocatur vulturella*", or the boundary stone, as it could be understood (or even the milestone, but further investigation would be needed), near the '*fonte ilicis*' along the road to Mentorella, which is referred to in the Diploma of Otto I (*Regesto Sublacense*, document of 11 January 967), was to be found, halfway up the hill, near the confluence of the two paths. The two itineraries meet at the height of Fonte Morella which in ancient times was called Fonte d’Elci (Minorenti, 2014), a name which also extended to the surrounding area (Montanari, 2025).

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Here the historical-naturalistic itinerary suggests an alternative path to admire some karst waterfalls and the ruins of the *Castrum Morellae*. The ancient route continues halfway up the hill and, climbing in altitude, before reaching the Sanctuary of Mentorella, it crosses wooded areas, grazing areas and finally dirt plains used in the past for threshing wheat, where, legend has it, the conversion of Sant'Eustachio apparently took place (Minorenti, 2014).

The itinerary called San Giovanni (Fig. 4, yellow itinerary) takes its name from the abbey church of the same name that during the Middle Ages occupied some structures of the ancient Trebula, in an area not far from the Fosso della Mola, downstream from Rocca d'Elci and near the settlement of Civitas Noe. The church is mentioned in the Privilege of John XVIII with which the properties of the Abbey of Subiaco are confirmed (*Regesto Sublacense*, document X, 21 July 1005). Its construction could therefore be placed within the context of the agrarian reorganization and control of the territory started by the Subiaco Monastery between the 10th and 13th centuries (Montanari, 2025).

The ancient route approaches with steep hairpin bends the isolated promontory on which the ruins of the Rocca d'Elci (the *Rocchetta*) stand. In the area of the fortified structure a large stone block from Trebula was found (Sciarretta, 1997). This suggests that the route was intended to ensure the transport of materials by pack animals. Continuing uphill, after the spring from which the route that runs halfway up the hill branches off, the path must have continued to the summit of Spina Santa and from there continue along the ridge to Monte Piccione (1130 m), Monte Cerello (1202 m) until reaching Mentorella (coinciding with the Spina Santa-Guadagnolo naturalistic-cultural tourist itinerary). The ancient stretch of the Passo della Fortuna-Spina Santa is now cut in several places by a new forest road built in the last century (passable up to the high-altitude fountain), which has caused the loss of the 'sense of continuity' of the original route. This must have been part of an older transhumance route that connected the Empolitana valley to the Prenestine area via ridge paths.

The visual relationship between the Passo della Fortuna and the rocky spur of Mentorella, along the axis defined by the eastern slope of the Prenestine mountains, as has been possible to observe, has always activated in the populations that in the various historical periods have occupied the area around the pass, or that have passed through it, a process of recognition of the same as distinctive 'places' of the landscape. They have therefore assumed an identity value (specific to 'those places' that participate in the definition of 'that landscape'), in which spirituality and the sense of the sacred (first pagan and then Christian), have always coexisted with tangible and natural elements; in a subtle bond that blends immateriality and materiality and that persists, albeit varied, even in contemporary experience. It will then be a question of formulating protection programs and possible intervention proposals, aimed at respecting the balance achieved between the different factors that contribute to the perception of the landscape.

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Analysis and Strategies for the Conservation and Enhancement of Abandoned Villages in Southern Italy: The Case of *Castrum Vayrani*

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Abstract

The present study investigates the fortified village of Vairano Patenora - also known as Castrum Vayrani - in the northwestern province of Caserta, near Naples. This site is integral to the historic network of fortifications established in the Campania region of southern Italy during the 8th and 9th centuries A.D., located between the Casilina Road and the Volturno River. Over time, the strategic significance of these settlements has diminished, contributing to depopulation and a pronounced state of decay. This research examined the intricate aggregation system of the urban fabric within Castrum Vayrani, focusing on the diverse building typologies that compose it and their spatial arrangement in the territory's orography. Particular emphasis is placed on significant architectural elements within the historic settlement, including the Norman castle, the Swabian Church of San Tommaso, the entrance portals, and the Angevin towers positioned along the defensive walls. Utilising innovative analytical tools and previously unpublished documentation from local archives, this study investigated the historical, formal, functional, technological, and material aspects of these buildings. Attention is also directed towards the traditional construction techniques prominent in the area, such as "irregular masonry with periodic layers" constructed from local limestone. Finally, the research elucidates potential causes of structural instability and degradation, aiming to propose best practices for the restoration of this cultural heritage. The approach seeks to harmonize opportunities for reuse with the preservation of both material and intangible values, drawing inspiration from recent successful revitalization projects in comparable Italian villages. The objective of this paper is to draw attention to an exemplary case of an abandoned historic settlement, thereby enhancing the understanding of its historical, urban, and architectural significance. Furthermore, it aims to define potential intervention strategies for the effective conservation and enhancement of this uniquely significant heritage.

Keywords: *abandoned villages; fortified architecture; local limestone; restoration; Castrum Vayrani*

1. Introduction

The province of Caserta in the Campania region of Italy is notable for its intricate network of fortified villages, including *Castrum Vayrani*, which is the focus of this examination. These settlements emerged on the summits of the local mountains and hills during the Early Middle Ages, driven by a process aimed at fortification. This phenomenon primarily arose in response to security concerns and public health issues. Initially, the indigenous populations inhabited

the marshy valley regions, which were not only unhealthy but also vulnerable to Saracen incursions. The earliest iterations of these fortified villages comprised merely a perimeter wall, which was later enhanced with defensive features such as towers and castles to improve active defence measures. Among these historical sites, the fortified village of Vairano Patenora assumes a significant strategic position. Located atop Piesco Hill within the eponymous municipality, it overlooks the Volturno River plain and lies between Matese Regional Park, Roccamonfina Regional Park, and the Monte Maggiore mountain range. Thus, the village is situated in a landscape rich in historical, cultural, environmental, and scenic attributes, further enhancing its multifaceted heritage. A process of depopulation has affected many villages in the surrounding area, leading to the present-day state of the historic centre of Vairano, which is characterised by notable abandonment and decay. This deterioration can be attributed to several interconnected factors: challenging topographical accessibility, a lack of essential services and commercial activities, the complexity of adapting the urban structure to modern requirements, and the village's isolation from major economic hubs (Colletta, 2010). Consequently, these critical issues have adversely affected the conservation state of the built heritage, with many structures now reduced to ruins overtaken by vegetation.

2. Methodology

The study involved an analysis of documentary sources and the collection of in-situ data through direct observation of the village's structures and a comprehensive survey campaign. Given the intricate planimetric and volumetric configuration of the village in question, an integrated survey approach was adopted. Reality-based data acquisition tools were utilized, including a 3D laser scanner and a drone equipped with a camera. The drone was particularly valuable for capturing areas of the built environment that were inaccessible to the laser scanner, as well as for documenting the roofing systems of the buildings. This combined methodology leveraged the strengths and high performance of each technique, resulting in the creation of a detailed 3D model. From this model, various graphic representations were developed, facilitating a thorough analysis of the village, its architecture, and the associated construction systems. Ultimately, all data collected during the study were carefully evaluated to identify specific actions and strategies intended for the conservation and enhancement of this historic urban settlement.

3. Urban characteristics of *Castrum Vayrani*

The historic village of Vairano Patenora (Fig. 1) is situated along the southwestern slope of a hill, characterised by an elevation change of approximately 60 meters. This natural topography has been skillfully adapted through the development of a complex network of buildings and roads, resulting in a harmonious integration with the site's orography.



Fig. 1 – *The fortified village of Vairano Patenora* (Author, 2024).

3.1. The road system

The urban layout of the village features several main thoroughfares that run longitudinally, interconnected by a network of secondary pathways. This road system is marked by a limited number of open spaces and includes a series of staircases and stepped pathways that enable access across significant elevation changes.

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Every surface is paved with local limestone, the same stone that naturally surfaces in some areas, highlighting the geological characteristics of the landscape upon which the entire settlement is established (Panarello, 2001).

3.2. The building aggregation system

The village's construction is predominantly characterized by residential structures complemented by corresponding open spaces and a singular religious edifice: the Church of *San Tommaso*. The urban layout emerges from a complex system of building aggregation, examined through comprehensive architectural surveys, within which the following typologies can be discerned:

- Isolated buildings, featuring three or four free-standing sides, positioned either near the defensive walls or within the village core;
- Aggregated buildings, comprising multiple structures erected at different times and arranged in continuity without distinct separation;
- Structures integrated into the defensive walls, a variant of aggregated buildings that incorporate sections of the fortified perimeter and/or towers into their design. This category includes various facets of the *intramoenia* ecclesiastical complex;
- Merged building clusters, where several aggregated structures have been unified through residential units that feature integrated passageways.

3.2.1. Residential units

Each building cluster comprises multiple residential units, which can be categorized into four distinct typologies based on their spatial and functional characteristics:

- Basic unit, a dwelling characterized by one free front and three shared sides, typically spread across two or more levels connected by an internal staircase;
- Unit with a courtyard, similar to the basic unit, though featuring an attached open space;
- Unit with a workshop/storage area, a residence with one or more independent ground-floor rooms, historically utilized for tool storage, livestock shelter, or small commercial activities. The living quarters are situated on the upper floors and accessed via an external staircase;
- Unit with a passageway, similar to the basic unit, except for the incorporation of an overhanging volume on the first floor, which facilitates connections between two building clusters.

These typological residential units, when intertwined over time, define the village's complex building aggregation system, which emerged through a gradual and discontinuous growth process.

3.2.2. The *San Tommaso* ecclesiastical complex

The San Tommaso religious complex, which dates back to the 13th century, consists of several structures, including the church, sacristy, bell tower, and oratory, all of which have undergone numerous modifications over the centuries. The church features a single nave covered by a lunette barrel vault, with a hemispherical dome positioned above the presbytery. The western facade includes a small enclosed entrance atrium, while the main gabled front is characterized by a pointed-arch portal flanked by two lateral windows. Additionally, on the northern side of the church, there is a semi-basement sacristy and a private courtyard, with its perimeter wall accommodating the significant elevation difference between the church and the higher street level. On the southern side, a secondary entrance and the bell tower are located, with a partially barrel-vaulted passageway traversing its base. This bell tower serves as a connection between the church and the oratory - a two-story structure perpendicular to the church - which incorporates one of the towers originally part of the defensive walls.

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4. The fortified architectures of *Castrum Vayrani*

4.1. The city walls, towers and urban gates

Castrum Vayrani is encircled by a city wall that follows an almost elliptical shape, with a major axis measuring approximately 220 meters and a minor axis of about 100 meters. This impressive wall circuit has been remarkably preserved, although it has been integrated into various buildings that have altered its overall appearance. The city wall serves as the original and sole defensive structure established during the Lombard era when the *castrum* was founded. Over the centuries, it has undergone numerous formal and functional transformations. The first significant alteration took place during the Norman period with the construction of the castle, which interrupted the continuity of the walls on the northeast side. Later, during the Angevin period, fourteen battlemented towers featuring sloping bases, either cylindrical or semi-cylindrical, were added along the circuit. These watchtowers were later modified during the Aragonese period to meet new defensive requirements, as their previous design rendered them vulnerable to the artillery (bombards) introduced at that time. Finally, from the 17th century onwards, the turreted wall lost its geopolitical and defensive significance, gradually becoming part of the new constructions that extended against it. There are three urban gates within the walls:

- *Porta Oliva*, which provides access from the southeastern side of the village, is characterized by a full arch carved into the sloping base of one of the watchtowers;
- *Porta di Mezzo*, situated on the southeastern side, features a distinctive double lowered arch;
- *Porta Castello*, the entrance from the northeastern side, features a full-arched portal located next to the bastion leading to the castle.

4.2. The castle

The castle of Vairano Patenora is situated at the apex of a hill, reaching an elevation of 254 meters above sea level, and occupies a position that is peripheral to the settlement below (Fig. 2). This spatial organisation, alongside historical analyses, indicates that its construction occurred after the establishment of the *castrum*. The castle was built around the mid-12th century, during the Norman fortification period led by the Altavilla dynasty. The original design of the castle featured a trapezoidal courtyard accompanied by three quadrangular towers at its corners (Pistilli, 2003). Over the centuries, the fortress has experienced numerous transformations, shaped by evolving defensive and offensive military strategies, corresponding to various historical epochs and dynastic rulers, thus contributing to its complex architectural narrative. During the Angevin period, significant modifications were executed, including the addition of a fourth tower, as well as enhancements to the existing towers, which were augmented in height, converted into cylindrical forms, and equipped with battlements featuring sloping bases. Such modifications were instrumental in facilitating both flanking and plunging defensive capabilities, while the frontal defence was managed via the patrol walkway atop the crenellated walls (Panarello, 2001). With the rise of the Aragonese dynasty in the late 15th century, reinforcement efforts commenced, particularly concerning the curtain walls, which were subjected to masonry jacketing. This technique involved the juxtaposition of two layers: an inner layer maintaining consistent thickness throughout its height, and an external layer characterized by a pronounced sloping base. Furthermore, the four corner towers, previously part of the village's fortification circuit, underwent significant reduction (Scialla, 1969; Santoro, 1979; Santoro, 1982). Notable alterations can also be discerned in the facades, where Norman-era pointed arches were sealed, and expansive squared windows - typical of the

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Fig. 2 – *Transversal section of the village of Vairano Patenora* (Author, 2024).

15th century - were introduced in previously solid sections of the walls. Additionally, this phase saw the construction of a substantial pentagonal bastion adjacent to the castle's entrance hall. In the 17th century, the castle transitioned into a noble residence under the stewardship of Baron Mormile. This period is marked by the final significant modifications before the structure began to experience gradual abandonment in the 19th century.

A literary account from 1660, titled "Description of Vairano".[1], delineates the spatial and functional characteristics of the castle's rooms, which are now only partially identifiable due to structural collapses, particularly affecting the upper floors. According to this source, the castle's residential complex was organized over four distinct levels:

- A basement utilized as either a prison or a cistern, situated solely at the base of the corner towers;
- A ground floor, aligning with the trapezoidal courtyard, containing numerous vaulted service rooms;
- A first floor, identified as the noble level - accessible via an external staircase - featuring the main hall, a chapel, and a series of ancillary rooms;
- A final level, comprising a walkway that connected the upper portions of the towers.

This configuration necessitated the introduction of windows, particularly on the ground floor, which had previously been omitted for defensive reasons.

5. Materials and techniques of the local building culture

The architectural characteristics of the village under scrutiny exhibit a pronounced influence from the geo-lithological attributes of the surrounding region, featuring limestone rock

[1] This description is contained in a document kept at the General Archive of Simancas, Valladolid (Spain), f. 57-140.

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outcrops, which provide a consistent supply of this essential building material. Limestone was utilized not only in constructing the walls for fortified, civil, and religious edifices within the site but also for the vaulted surfaces that exclusively envelop the various levels of the towers and the ground-floor spaces of the fortress. The construction technique employed in the fabrication of these walls is identified as irregular masonry courses, a method that enjoys widespread application throughout the province of Caserta, where the fortified village is situated. This technique, referred to as "irregular masonry with periodic layers", is characterized by a facade composed of a succession of distinguishable horizontal masonry layers, each demarcated by pairs of contiguous bedding joints - thicker linear layers of mortar (Fig. 3). The construction of these masonry layers occurred at different stages to promote appropriate settling of the wall section under construction. Notably, this specific masonry arrangement employs irregular limestone stones of varying dimensions, where the volume of the stones diminishes as the elevation of each construction phase and the wall itself increases. These stones are positioned in a staggered format, devoid of any systematic alignment; rather, they are organized to maximize contact between their surfaces. This pattern similarly applies to the stone components present within the core of the wall. Consequently, the wall's construction adheres to a "three-dimensional" methodology, wherein the inner and outer facings, as well as the core, are developed concurrently. The material and technological properties of the masonry examined indicate the existence of numerous voids in the limestone, which are predominantly filled with fragments of brick. Notably, the masonry associated specifically with the fortified structures within the village features so-called "scaffold holes", as independent scaffolding was often impractical. These holes, which can be characterized by either square or circular cross-sections, facilitate the anchoring of scaffolding to the construction in progress and assist with subsequent maintenance or repair efforts concerning the curtain walls. For defensive considerations, these holes were only left exposed from heights ranging between 3 to 4.5 meters above the ground. Within the fortifications under analysis, these openings do not exhibit a uniform distribution across the wall but adhere to an irregular arrangement, signifying the construction of the wall in non-isometric sections (D'Aprile, 2001). This particular masonry technique has persisted through various historical epochs that have influenced the development of the village, reflecting a remarkable continuity over time attributed to its stability, cost-effectiveness, and expedited execution. Additionally, another stone material utilized within the edifices of the village of Vairano Patenora is grey tuff, or *ignimbrite campana*, which is sourced from the nearby volcanic region of Roccamonfina. This material is primarily employed for the creation of mouldings and frames surrounding the doors and windows of residential structures. In the context of the fortifications, it is also incorporated in the construction of various architectural elements, such as *redondone* (arched stone brackets) and *beccatelli* (stone corbels), as well as openings for drawbridges and gun slits.



Fig. 3 – *The coursed masonry of the castle* (Author, 2024).

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6. Analysis of the conservation status of the village's architecture

Following an exhaustive historical and critical examination, alongside a comprehensive material survey of the village's architectural edifices, the primary issues regarding deterioration and degradation were meticulously analyzed. This investigation revealed that approximately 15% of the village, which encompasses the castle and several towers within the defensive wall, is in a state of ruin. These structures are notably characterized by the absence of roofing and, in certain instances, even the floor slabs, resulting in multiple cases of structural collapse due to overturning or crushing, combined with the proliferation of invasive vegetation within their confines. Furthermore, around 35% of the built heritage - limited to the residential buildings within the same construction complex - has been categorized as being in poor condition, largely attributable to recent abandonment or infrequent utilization. In such cases, the neglect arising from insufficient maintenance has caused widespread deterioration and issues about humidity. In contrast, a mere 15% of the buildings, situated on the eastern side of the walls, remain in satisfactory condition, as these structures are actively inhabited. The previously mentioned group of buildings, except those categorized as ruinous, has undergone significant transformations - both concerning installations and structural flooring - which have been almost entirely supplanted by non-traditional building methods. Within these structures, one can observe floor slabs dating from the previous century, composed of steel beams and large tiles, alongside newer reinforced concrete floors that have replaced the historically significant wooden floors and roofs. Such modifications have resulted in a partial alteration of the village's historical architecture, undertaken in an attempt to adapt to contemporary residential and performance standards, often executed without appropriate sensitivity to the original architectural context.

7. Strategies for the conservation and enhancement of the village

The complex analysis conducted in Vairano Patenora has elucidated the principal characteristics, challenges, and potentialities intrinsic to both the built heritage and the surrounding territorial context. Informed by this analysis, a strategic intervention framework can be established aimed at the conservation and enhancement of the village, employing a multi-scale methodology. This methodology would encompass the integration of the *castrum* with its surrounding landscape, alongside the urban and architectural restoration of the village itself. The initial phase of this intervention should focus on harnessing the diverse potentials of the landscape surrounding the village, establishing it as a connective element linking various regional parks and the multitude of cultural landmarks situated within these areas. Such an effort necessitates the strategic planning of a comprehensive network of intermodal nodes and pathways. Concurrent with these landscape initiatives, an urban regeneration strategy for the settlement should be undertaken, drawing inspiration from recent projects such as the village of Torri Superiore in Liguria. This regeneration process should encompass the development of essential primary and secondary infrastructures, enhancements to access roads and local public transport systems, and the introduction of a mixed-use program aimed at functional diversity. These actions must be harmonized with the site's specific characteristics. The submitted program should incorporate various land uses, including residential zones, accommodation facilities, local commercial and artisanal enterprises, public spaces, and areas designated for institutions and associations. These strategic interventions are anticipated to not only stimulate economic and tourism growth but, crucially, facilitate the reinstatement of a permanent resident population. This revitalization would stimulate a renewed sense of belonging, akin to the transformations observed in Casertavecchia during the 1960s

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following the urban restoration initiatives led by Roberto Pane and Ezio De Felice (Picone et al., 2020; Serraglio, 2020). Additionally, a salient consideration in the recovery of such villages and their built environment is the significant reduction in resource consumption, waste generation, and land use, which would promote sustainable urban development in alignment with contemporary national and European directives.

These objectives necessitate careful architectural restoration of the historical edifices under consideration, through interventions evaluated on a case-by-case basis that emphasize consolidation, compliance with regulatory standards, and accessibility improvements. Each intervention must adhere to the prevailing restoration best practices for built heritage, respecting foundational principles such as minimum intervention, reversibility, compatibility, and the distinguishability of new additions. Ultimately, the diverse actions proposed could be executed through collaborative efforts involving public entities, businesses, associations, and private stakeholders, facilitated by initiatives akin to those currently promoted under the "National Villages Plan" of the PNRR[2].

In light of these proposals and observations - which hold applicability to analogous contexts such as *Castrum Vayrani* - it is posited that these historic urban settlements have the potential to evolve into new hubs for their surrounding territories. They serve not only as custodians of a millennia-old heritage but also as facilitators of numerous avenues for development - economic, social, and cultural - benefiting local communities.

Future avenues for research may explore how the deliberate implementation of new digital technologies within the realms of restoration, management, and promotion of cultural heritage can augment the appeal of these abandoned historical settlements. Such advancements could pave the way for gradual and stable regeneration processes grounded in sustainability and a profound respect for local particularities.

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[2] This plan, funded by PNRR resources, is structured into four lines of intervention as defined by Ministerial Decree No. 112 of March 18, 2022.

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Analysis of Rural Settlement in the Czech Republic: A Case Study of Dolní Kounice

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Abstract
The study of settlement development, its components, and activities within rural space is one of the basic objectives of the Association for the Renewal of the Village and the Small Town (SOVAMM). This Association was founded in 1990 as a network of professionals and enthusiasts of vernacular architecture. The results of this research are summarized in a recent publication offering an overview of village and field pattern development, including a systematic analysis of farmstead and field plot modules. A key resource for this analysis is the Franciscan (also known as the 'Stable') Cadastre from the second quarter of the 19th century, alongside other historical sources. This paper also outlines the evolution of methodological approaches rural settlement studies, tracing their development from the beginnings in the 19th century. It presents the current analysis method used to examine the evolution of the spatial structure of rural settlement and illustrates its application in heritage preservation and spatial planning using the example of the small South Moravian market town of Dolní Kounice.

Keywords: *rural settlement; village structure; field pattern; Stable Cadastre*

1. Evolution of Methodological Approaches

Settlement history occupies a distinctive position among historical disciplines, much like the history of architecture. For a long time, little attention was paid to the development of "ordinary" building types and constructions, as well as rural settlements in the historic Czech lands. Until the mid-20th century, these topics generally attracted little academic interest.

The earliest attempts to study settlement development can be found in local historical journals, usually in an ethnographic context, in the late 19th century. From the interwar period, we should mention the historian J. V. Šimák's 1938 treatise on medieval colonisation in the Czech lands – the first large-scale work to address the structure of villages and their field patterns (Šimák, 1938). In terms of settlement geography, relevant works include those of F. Říkovský (Říkovský, 1939), J. Pohl (Pohl, 1935), and post-World War II studies by Z. Láznička. Láznička's publication *Types of Rural Settlements in Moravia* (Láznička, 1946) is particularly significant, as it, also addresses the development of field pattern and the potential for their gradual transformation from older systems to more advanced configurations within the same cadastral unit. In the post-war period, the work of architect Otakar Máčel stands out for both its broad conceptual scope and detailed analysis. His publication *Basic Problems of Urban Structure*

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of Villages in Bohemia and Moravia (Máčel, 1954) emphasizes the importance of the relationship – and even the unity – between village and field patterns. In Máčel's later publications, co-authored with Jaroslav Vajdiš who contributed the chapter on the Slovácko region, the analysis of village structures is underpinned by knowledge of traditional rural architecture (Máčel & Vajdiš, 1958). From the 1950s to the 1990s, a number of editions of older cadastres were published. These include the *Berní rula* [Subsidy Roll] for Bohemia, the *Lánový rejstřík* [Land Plot Register] for Moravia and the Theresian Cadastre), all of which are crucial for understanding village development from a long-term perspective (Doskočil, 1953–1954; Chalupa et al., 1964, 1966; Burdová, P. et al., 1970; Matějek, 1981, 1983, 1984, 1994). Inventories of modern-era villages were also compiled and were summarized in a separate edition by Josef Křivka (Křivka, 1978). Finally, since the 1970s, several key publications emerged from the first systematic archaeological research on extinct medieval villages. These include *Svídna* by Zdeněk Smetánka and Pfaffenschlag by Vladimír Nekuda (Nekuda, 1975; Smetánka, 1988).

Research on rural settlements has naturally progressed across all scientific areas since the 1970s. Due to space limitation, we cannot examine these developments in detail here. Instead, we will briefly mention the activities of our association, SOVAMM (Association for the Renewal of the Village and the Small Town), and its members. An attempt to classify primarily mediaeval types of village structures was published by Jan Pešta, author of the multi-volume *Encyclopaedia of Czech Villages* (Pešta, 2000, 2003–2011). Karel Kuča, author of the *Encyclopaedia of Cities, Towns and Market Towns in Bohemia, Moravia and Silesia* (Kuča, 1996–2011), also developed a detailed classification of village structures for the *Landscape Atlas of the Czech Republic* (Makovčin et al., 2010). The results of previous long-term research are summarized in a recent publication by Jiří Škabrada, which provides an overview of the development of villages and field patterns (Škabrada, 2022). This research draws primarily – though not exclusively – on maps from the Franciscan (also known as the 'Stable') Cadastre from the second quarter of the 19th century. For this purpose, the research uses (in addition to other sources) mainly maps of the Franciscan (also known as the 'Stable') Cadastre from the second quarter of the 19th century. A key methodological issue is the informative value of the Franciscan cadastre maps themselves. This is repeatedly critically examined based on a number of particular situations, always with the help of confrontation with other historical data. In general, two approaches are applied to the basic analysis of the development of village and field structures: a progression from simpler to more complex forms and a possible reverse process influenced by natural conditions.

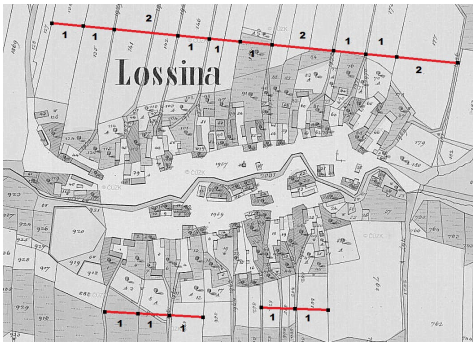


Fig. 1 – *Village of Losiná near Pilsen, founded in 1327 – an example of module identification (52 Prague ells) on the Imperial Obligatory Imprint of the Stable Cadastre from 1838* (Škabrada, 2022).

A new contribution of the publication is the systematic analysis of the modules of farmstead and field plots, as recorded on the maps of the Franciscan Cadastre, and the identification of measurements and their multiples used in the past. The basic module was the Prague ell (0,592 m), from which the Bohemian *Landseil* (literally "land rope") – measuring 42 ells and, from 1541, 52 Prague ells – was derived (Fig. 1). This

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measurement was replaced in 1875 by the Austrian fathom (1,89 m). Additionally, the analyses of archaeological site situations, specifically the extinct mediaeval villages of Pfaffenschlag near Slavonice (Fig. 2) and Svídna in the Slánsko region, proved to be both interesting and insightful.

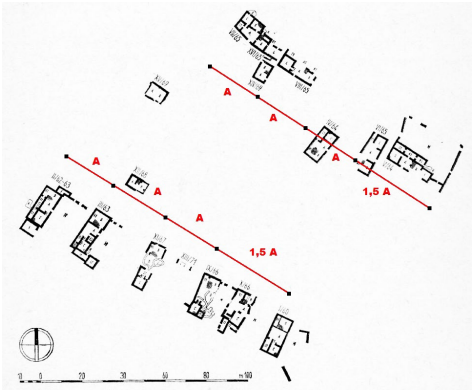


Fig. 2 – *Ground plan of the extinct mediaeval village of Pfaffenschlag near Slavonice (based on V. Nekuda, 1975, p. 39), with indicated plolt modules* (Škabrada, 2022).

2. Basic Types of Village and Field Patterns

The classification of village and field pattern types is not standardised in professional terminology. In this paper, we follow the typology proposed by Jiří Škabrada, including its chronological order. He identifies the following types:

1. **Rural settlement situations with Romanesque churches**, where - if supplemented by archaeological findings - we can at least trace the principles for the locating the villages in relation to terrain, cardinal points, and water source.
2. **Radial arrangement –** the oldest regular form of village and fields patterns appearing from the second half of the 12th century. These villages, typically small and consisting only of a few farmsteads, were characterised by a simple, direct connection between the farmstead and its arable land. The larger patterns of this type were probably formed only at the time when the emphyteutic system emerged – from about the mid-13th century onward.
3. **Villages founded on emphyteutic principles**, featuring regular arrangement of farmsteads and fields designed as equal units. The equal rights and obligations of the settlers were intended to be matched by equal conditions. These include, in particular:

- Valley linear villages (údolní lánové vsi): settlements formed in a long line along a watercourse, with parallel strips of land (historically called lán in Czech and Hufe in German) laid out roughly perpendicular to the watercourse. A single-row variant of this pattern occurs as a result of terrain constraints, and it is typically located on edges of broad valleys.
- Street villages: based on a similar principle, these structures continue a slightly older tradition of small-town and urban-type settlements. Many so-called market villages probably already adopted a street-type arrangement at the end of the early medieval period.
- Short single-row or two-row villages: ideal, fully homogeneous arrangements with strips of arable fields divided into sections. The main sections were located directly behind the rows of farmsteads, while other sections were distributed throughout the entire cadastre. This layout ensured not only equal land area for each farmer but also comparable land quality.
- Villages with a village green: villages organised around a regularly shaped rectangular or square green, again with sectioned strips of arable fields. This system probably reached its peak during the first half of the 14th century, when the largest villages of this type emerged.

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- Mixed forms: combinations of the above types.

4. **Village foundations of the modern period:** the first major wave of village establishment and transformation in this period is associated with the aftermath of the Thirty Years' War; the second wave followed the agrarian reforms of the 18th and 19th centuries, the aim of which was a more efficient use of manorial land. Modern village structures are often versions of proven layouts from earlier periods, typically on a smaller scale and featuring modular arrangements of repeated structural units, often documented in surviving plans. In addition to the types we know from previous periods, we can distinguish:

- Clearings ("*paseky*"): villages laid out through the parcelling of cleared forest areas, creating a mosaic-like system covering areas of former forest. These villages, typically founded in higher-lying hilly areas, represent the final stage of agricultural colonisation.
- Transformations of abolished demesne farms.

3. Case Study: Dolní Kounice

The comprehensive analysis method used to examine the evolution of rural settlement spatial structure – as well as proposals for its preservation and spatial regulation – can be illustrates by the example of a small market town Dolní Kounice, located in the Brno-Country District of the South Moravian Region. The town is situated in the dramatic landscape of the deep Jihlava River valley. It is known for its Gothic-Renaissance château and the ruins of the Premonstratensian monastery *Rosa Coeli* with the Church of the Virgin Mary. Dolní Kounice has preserved its historic structure, including the older mediaeval part on the right bank of the river, which encompasses the monastery, the chateau, the town itself with its market square (developer from the original village in 14th century), and the former Jewish ghetto.

On the left bank lies the suburb of Závodí, which developed from the 16th century onwards along existing roads and a newly created axis leading to the dominant Baroque pilgrimage chapel of St. Anthony of Padua. The rest of the cadastre is composed of segmented strips of vineyards and fields.



Fig. 3 – *Dolní Kounice, view across the Jihlava River at the site of the old ford leading to Farní Street.* (Syrová, 2024).

The appearance of the town was significantly affected by the devastating flood of 1862, which also devastated the parish church, originally located on the riverbank at the ford (Fig. 3). The new church was subsequently built on the site of the former town hall and burgher houses, positioned along the axis of the square. Several insensitive interventions into the city's structure took place in the 1960s–1980s, including the demolition of the Upper Gate, the construction of a cultural centre on the site of the former hospital near the bridge, and the building of a bus terminal that required the partial demolition of the Jewish ghetto was demolished, etc.

Despite these interventions, the value of the preserved building stock, the urban structure, and the settlement's integration into the landscape still prevail.

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3.1. Basic sources for standard analysis and their use

The written sources are summarized by Karel Kuča in the relevant chapter on Dolní Kounice in his *Encyclopaedia of Cities, Towns and Market Towns in Bohemia, Moravia and Silesia* (Kuča, 1996, p.714–719).

For the standard analysis that we routinely carry out for the purposes of spatial planning, we can use a number of commonly available map sources (most of which have gradually been digitised and made available online since 2008).

In the case of Dolní Kounice:

1. First Military Survey (1764–1768 and 1780–1783, rectified)

This survey was based on the Müller's maps from 1716–1720, which were rescaled to a larger scale of 1:28,800.

Officers of the Military Topographic Service rode through the country on horseback and mapped the terrain using the "a la vue" method – that is, they simply observed the terrain visually and estimated distances.

The survey was not based on a net of precisely defined triangulation points. For this reason, the survey results were less accurate.

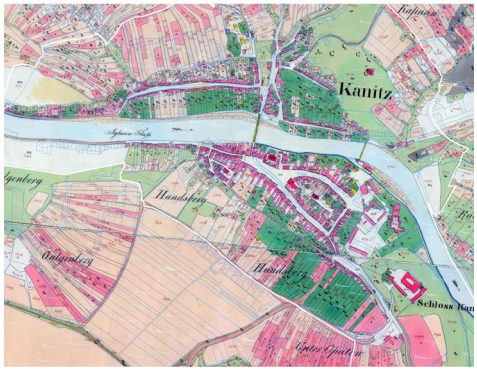


Fig. 4 – *Dolní Kounice, georeferenced Imperial Obligatory Imprints of the Stable Cadastre from 1826.* (Central Archive of Surveying and Cadastre, Prague).

2. Franciscan (also known as the 'Stable') Cadastre

These maps were created between 1826 and 1843; the maps of Dolní Kounice come from 1826, and for this reason, they capture the situation prior to the 1862 flood (Fig. 4). Cadastral maps were drawn up for each village at a standard scale of 1:2880, where one Viennese inch on the map represented 40 Viennese fathoms on the ground. Larger-scale maps were prepared for town and village centres.

Indication Sketches were derived from the preliminary original maps. An Indication Sketch was a portable, coloured map used to record changes as they occurred. The map displayed the names of landowners, house numbers, types of agricultural products, and the quality of each field. Objects were differentiated by colour – fields were shown in ochre, gardens in dark green, water in blue, fire-risk buildings in yellow, and fire-resistant buildings in pink, etc. In addition to the number allotments, a plot protocol was created – this register listed all fields, buildings, and their owners. On the basis of the plot protocol other written documents were created, particularly the main book of possessions (Besitzstands-Hauptbuch), which later replaced the land registers.

Descriptive numbers are an important piece of information on the sketches. House numbering was enacted during the reign of Maria Theresa in February 1770, with most municipalities carrying it out between autumn 1770 and 1771. Its closed series, in combination with later assigned numbers, allows us to identify buildings existing at the time of numbering and trace the later gradual development of the settlement.

- Original maps are precisely hand-drawn and coloured maps, with lithographic copies produced after completion. One of the printed copies was preserved as the so-called Obligatory Imprint. Other copies of the original maps were used to chart changes (a

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revision / Reambulation was ordered in 1869). The originals therefore provide us with information about the later development of the settlement and cultural landscape.

- Imperial Obligatory Imprints were originally intended for archiving in the Central Archive of the Cadastre of Lands in Vienna. Following the formation of the Czechoslovak Republic, they were transferred to Prague as part of the separation of archives. In contrast to the so-called Original Maps of the Stable Cadastre, the Obligatory Imprints document the original state of the landscape, without showing later changes.

3. Second Military Survey (1836–1852)

In contrast to the First Military Survey, the Second Military Survey was based on triangulation net and also on the cadastral maps of the Stable Cadastre at a scale of 1: 2 880, resulting in much higher precision. In addition to larger-scale maps (1: 28, 800), general (1: 288, 000) and special (1: 144,000) maps were produced.

4. Third Military Survey

- The Topographic Sections of the Third Military Survey at a scale of 1:25,000 originate from the Third Austrian Military Mapping. The maps were published between 1872 and 1953 in the Austro-Hungarian Empire and later in Czechoslovakia and other successor states. The territorial extent of this series significantly exceeds boundaries of today's Czech Republic.
- Special Maps 1:75,000 from the Third Military Survey, originally produced as part of the Third Austrian Military Mapping. These maps were published between 1875 and 1952 in the Austro-Hungarian Empire and later in Czechoslovakia and other successor states.

5. Maps of the former land cadastre (1931–1956)
6. Maps of the Registry of Real Estates 1: 2,880 from the 1960s and 1980s.
7. Historical aerial photographs of the Czech Republic 1937–1996
8. Archive Orthophoto of the Czech Republic produced since 1996
9. ZABAGED® - Altimetry

- DMP 1G. Digital Surface Model of the Czech Republic of the 1st generation (DMP 1G). The model represents a depiction of the territory, including buildings and vegetation cover, in the form of an irregular network (TIN).
- DMR, DMT 5G. Digital Terrain Model of the Czech Republic of the 5th generation (DMR 5G)



Fig. 5 – *Comparison of the current state with the state captured by the Stable Cadastre, identification of extinct objects.* (Syrová, 2024, Obligatory Imprints of the Stable Cadastre from 1826, and ortophoto, Central Archive of Surveying and Cadastre, Prague).

The georeferencing of historical maps has not yet been completed for the entire territory. The first set should be the originals of the Stable Cadastre. Therefore, for a certain portion of the maps, manual georeferencing remains necessary. The above-mentioned archive maps, along with digital models of the terrain and surface, make it possible to identify extinct parts of structures and to assess the effects of orientation to cardinal points and terrain configuration in comparison to the present state.

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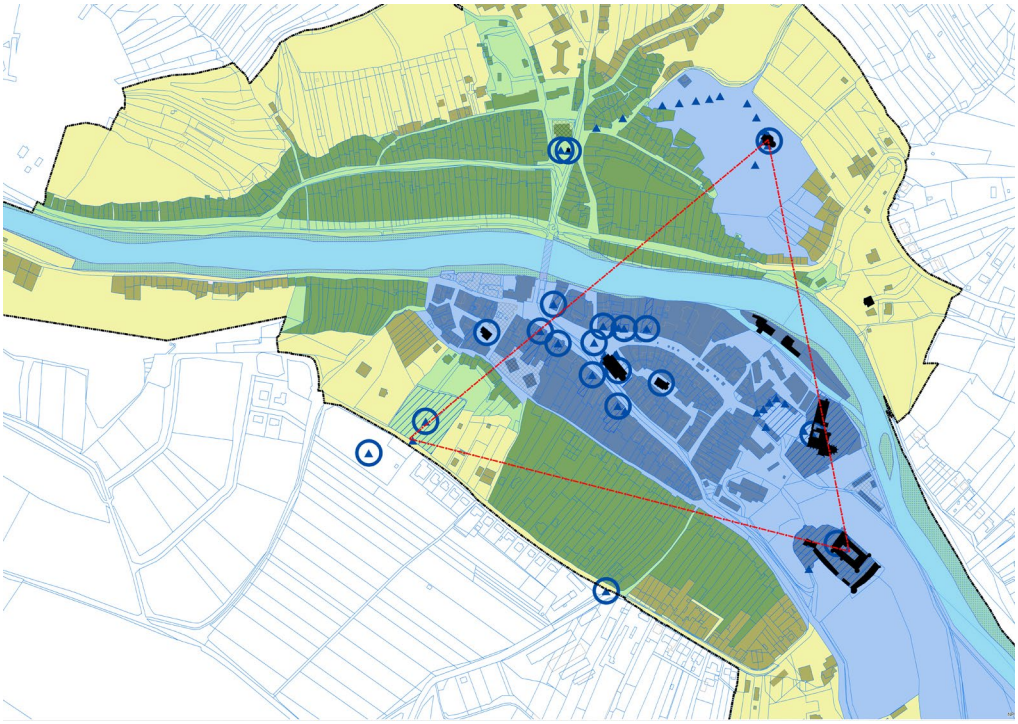


Fig. 6 – *Dolní Kounice, map of the designated conservation area with the basic classification of urban blocks and spaces into three categories - A – parts determining the character of the zone (blue), B complementary parts (green), C – related parts (yellow); visual landmarks (black) and axes (red); protected cultural monuments are marked with dots (blue triangles and circles)* (Syrová, 2024).

In the case of Dolní Kounice, this allows us to identify visual landmarks and axes, historical communication axes (particularly the north-south communication with the old ford across the Jihlava River) (Fig. 3 and 5), earth quarries, etc.

Naturally, the comparative analysis of these sources must be supplemented by field research. The fieldwork will include photographic documentation and, where possible, a survey of building interiors.

3.2. Results of the Survey

The results of the survey are summarised in three or four maps – with graphical analysis of the periods of construction, architectural value, conservation policy, and comparative analysis of the Stable Cadastre.

For settlements designated as a conservation area, this is a basic classification of urban blocks and spaces into three categories, which follows a methodology used since the 1980s (Vošahlík, 1981).

These categories (A – parts determining the character of the zone, B – complementary parts, C – related parts) together with the identified defects are the basis for establishing basic regulatory principles (Fig. 6).

4. Conclusions

The analysis of rural settlement structures is an important basis for spatial planning and heritage conservation. Old maps, in the case of the Czech Republic and other countries of the former Austro-Hungarian Monarchy mainly maps of the

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Stable Cadastre, are irreplaceable in combination with completely modern sources such as the Digital Surface and Terrain Model for the study of village and field patterns. A great advantage of the last decades is their easy availability. We have tried to demonstrate their use here both in a comprehensive study of rural settlement throughout the Czech Republic and in selected examples from Dolní Kounice.

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Circular Villages and Field Systems on a Large Estate of Teplá Abbey in the Czech Republic - Land Arrangement, Settlement Pattern, Surveying and Metrological Analysis

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Topic: T3.1. Studies of historic urban and rural areas

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Abstract

This article deals with the spatial land arrangement and settlement pattern of historic rural areas, based on geometrical analysis of built-up areas and field systems. The sites were evaluated through the lens of medieval agricultural colonization and land tenure, incorporating local and imported settlement rights - emphyteusis. The quest for a method based on land surveyors' use of a knotted cord is followed by an interest in cadastre border delineations, field systems, and village patterns. This benefits from historical land registers and cadastres. Within regional planning, they can be used for urban regeneration, especially in partially abandoned rural areas affected by the disruption of patterns.

Keywords: *land arrangement; settlement pattern; emphyteusis; urban regeneration; surveying; metrology*

1. Introduction

The feudal system based on the fief relations was the bearer of religious, social, and economic changes during the High Middle Ages. This meant a fundamental transformation of the settlement structure, village pattern, and land arrangement in the later Lands of the Bohemian Crown.

This concerned not only existing settlements within areas already settled in prehistoric times and the Early Middle Ages, but mainly newly founded ones in places less suitable for agriculture, i.e., an undulating landscape with higher heights above mean sea level (AMSL). This "Great Colonization", as it is called now, was Germanic in our case mainly (Šimák, 1938).

The first foreign settlers appeared in the western borderlands at the beginning of the 13th century. The German toponyms have been recorded here since then, albeit Slavic ones preceded them far beyond the present border. Colonists from present-day Bavaria (incl. regions of Franconia) were coming over Egerland to the then deep forested areas at the foothills of the Upper Palatine Forest. From present-day Saxony (incl. Margravate of Meissen) to the areas at the foothills of the Ore Mountains on the other side of the Slavkov Forest, likewise. However, the reality was much more intricate at that time.

1.1. Settlement right

New settlers were settled according to the local rights at first. This usually happened with the consent of the ecclesiastical or secular nobility.

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Fig. 1 – *The Tepla Town and the Tepla Abbey (1193 FWR, ~ 660 m AMSL) below it* (Military Topographic Service, 1764-1768 and 1780-1783, rect., 1st Military Survey, Bohemia, map sheet no. 118, scale 1: 28 800)..

The sub-contractor employment began to be applied later as a medieval novelty. The locator was responsible for the landowner for locating, clearing, surveying, and apportioning land among peasants. Home, alias Bohemian rights, were superseded by foreign rights, known as German, emphyteusis, etc. Legal conditions are recorded from the beginning of the 13th century, in the case of the Premonstratensians in Bohemia as well (in Moravia even earlier). Town rights or privileges must be mentioned in this context, namely, Magdeburg rights affected by the north German *Sachsenspiegel* (literally Saxon Mirror) and Nuremberg rights derived from the latter south German *Schwabenspiegel* (Swabian Mirror) (Kapras, 1935).

1.2. Terminology

Besides the nucleated villages, fundamental changes also occurred in the surrounding landscape as a result of farming. This was often based on vast, long, narrow fields demarcated directly behind the homesteads as the toft and croft pattern. One such field strip was called *lán* in Czech, i.e., as the unit of measurement which replaced the previous *popluží* in Czech, i.e., ploughland or hide. The word *lán* probably also appeared in connection with the economic changes in the 13th century, when a mintage was introduced, and levies started to be paid apart from previous in-kind levies and unpaid unfree work. The individual tracks of fields were arranged parallel or radial, and non-arable land (e.g., meadows, wood) could also be included under this term. It might be as well one large area of the field or several smaller areas of the given sum. The relationship between this shape of field and emphyteusis is not always bidirectional (Žemlička, 2023). Sometimes, the large fields were not measured out at all, or they could have been parceled out later at other times.

Table 1 – *Terminology* (Cernansky, 2025).

English/Czech	German	Latin
fief	Lehn, Lehen	feudum
/ léno		beneficium
field	Feld, Flur,	ager, agros
/ pole, role	Acker	campus
large field,	Hufe, Hube	mansus
hide / lán	Hueb	laneus
peasant,	Landwirt	agricola
farmer	Ackermann	colonus
/ rolník, sedlák	Bauersmann	

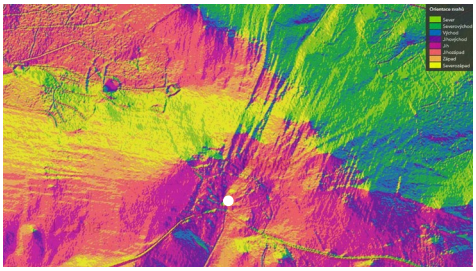


Fig. 2 – *Beranov village under an elevation (1233 FWR, 725 m AMSL) with a radial pattern around a spring, warm/cold colours, i.e., south/north slope* (Land Survey Office, DTM 5G, https://ags.cuzk.cz/av).

2. Methodology

The methodological approach is based on three varied methods, each with advantages, disadvantages, and limits. However, all the methods are dependent on the extracted sources, whether from in-depth historical research or archaeological excavation.

2.1. Graphical modular analysis (GMA)

The standard analysis is based on the assumed or indirectly confirmed existence of a surveying module and its recurrence in the same or related

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size. This metrological/geometrical analysis is usually carried out with the help of historical maps inter alia (Pešková, 2016; Škabrada, 2022). The extraordinary import pertains to historical cadastres, namely Terezian, Joseph II, and Stable Cadastre. The latter, dating back to the 1st half of the 19th century, is important for its maps supply a diagonal scale that allows geometric analysis at a detailed measuring scale. The weak points are already generally known (Klír, 2008).

2.2. Historical sources research (HSR)

Besides broadly written sources of various ages, the erstwhile fiscal assessments are mainly used for this. It has long been known that land tenure was connected with dimensions, especially the width of the plot measured in the front or back (Sheppard, 1966). The essential import belongs to historical deeds, urbarium, and land registers, particularly *Berní rula* (BR, 1654), i.e., a list of tax duties in the Kingdom of Bohemia. Earlier or later seigneurial and peasantry land registrations are an irreplaceable source of knowledge, known as the *Emphyteutisches Kaufkontraktenbuch, Grundbuch, Verkauften* in German, i.e., books with tenancy agreement also incorporating some Latin phrases, e.g., *emphyteusis ipso facto*.

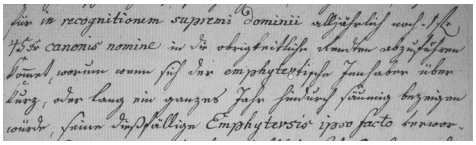


Fig. 3 – *Seigneurial land registration, No. 1, 1784-1829* (State Regional Archive, Pilsen, Sign. Teplá 43a, K1).

2.3. Cosine quantogram analysis (CQA)

This up-to-date analysis is based on the unknown module, in which case statistics are employed to find the collective unit. This analysis has already been implemented in studies dedicated to early medieval Anglo-Saxon settlements, etc. The basis is also the measurement of dimensions of the plots/parcels of land, this time necessarily in real numbers and not only in ratios. The disadvantage is the small number of accurately obtained dimensions eliminated by the procedure of mathematical statistics, e.g., the bootstrap in part. The result is a graph of the cosine quantum function with maxima representing the collective units, i.e., measurement, present in the given data set. (Legut-Pintal & Kubicka, 2021).

3. Theoretical basis

Analyses of rectangular settlement patterns have predominated over radial ones up to now. The result of these is often a rope-length "graticule" as a grid of perpendicular lines on a small-scale map similar to centuriation in former areas of the Roman Empire. Compared to this, analyses of the radial arrangements are generally less frequent, with exceptions. That applies to the so-called *Rundling, Runddorf* in Wendland, the Polabian Slavs region in Lower Saxony (Meibeyer, 2005).

3.1. Metrology and surveying

An ell was one of the most important units of length measurement, originally understood as an ancient cubit. Its length varied in the case of lands, but also market towns or domains. It was fixed by a dimensional gauge, i.e., standard. The Prague ell was a base of measurement system established for the Kingdom of Bohemia in 1268 during the reign of Ottokar II, possibly following the Magna Carta (1215). An iron standard of ell-wand was at Old Town Hall in Prague and was also walled into the portal of the New Town Hall later, where the etalon has remained until now. A rope was another important unit, derived from the ell and based on the knotted cord analogous to the ancient *schoenus*.

Table 2 – *Conversion of basic unit* (Cernansky, 2025).

Bohemian	Metric	Roman
1 Prague ell	59.14 cm*	2 feet/pedes

and other towns, Cheb (65.85 cm) * as likely as not

Most of the Old Bohemian units of measurement were replaced, as well as obsolete Austrian units (introduced in Bohemia in 1765), by the metric system adopted by law in 1871 and introduced in 1876 in Cisleithania, a part of Austria-Hungary.

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The obsolete English units of measurement, which evolved as a combination of the Roman and Anglo-Saxon systems, were replaced by the Imperial system of units later (Wedell, 2010).

Table 3 – *Unit of length measurement* (Cernansky, 2025).

Bohemian	German	English
loket	Öln, Elle	ell
sáh of Vienna	Klafter	fathom
provazec	Seil	rope

... finger, palm, span, foot, fathom, chain, mile, etc.

Table 4 – *Unit of area measurement* (author's c., 2025).

Bohemian	German	English
lán	Lahn	lan
jitro, korec,	Morgen,	Morgen,
akr, měřice,	Joch, Acker	Acre
hon, strych	*(iugerum, strichones in Latin, ...)*	

3.2. Figures and numeral system

Knowledge of the numerical systems is also very important. The duodecimal numeral system was often used compared to the decimal one. This system, known as base twelve, was related to a monetary system and units of time. Although it may not be obvious now, it has advantages: divisibility (by 2, 3, 4, and 6), multiplication, and formulation of fractions, as 12 is a superior composite number. Different units and systems complicate the identification of the medieval surveying system in a way. Multiples of ells are an example because the rope was derived from them. In the duodecimal system, the multiple of the numbers 5 and 10 (marked as A or turned 2) is written this way because it is four times the base twelve plus two units, i.e., 42 = 4 x 12 + 2 = 48 + 2 = 50. Other frequent modules are 24 (i.e., 2x12+4=28 in decimal), 36 (3x12+6=42 in dec.), or 48 (4x12+8=56). This difficulty is obviated when numbers are written as Roman numerals or in words, which was also common in Latin. Multiple dozen (5x12), i.e., *kopa* in Czech and *Schock* in German, and twelve dozen (12x12), i.e., *veletucet* in Czech, *Gros* in German, were the medieval accounting entities also in Bohemia, e.g., Prague groschens. The minting of this silver coin started around 1300 after opening mines in Kutná Hora Town.

3.3. Unit conversions and relationships

Just as there were ells of different lengths in terms of place and time, there were also different ropes as the unit of length. But not only because of linear dependence. The number of ells was different for different ropes, whether it was the towns, lands later (Bohemia, Moravia, Silesia), or profession (tree or fish farmer, vigneron). Besides this, the change after the Great Fire of Prague Hradčany in 1541 was principal. During this, the paper standard of Prague ell was engulfed together with the "Land tables" (*Zemské desky* in Czech). These were established between 1260-78 as the land registry for real estates owned by hereditary right, i.e., under the allodial title as opposed to feudal land tenure. These books were restored in terms of content after the fire, but the old Bohemian rope with a length of 42 ells (cca 25 m) was replaced by the new land rope with a length of 52 ells later (ca 31 m). (Novotný, 1897, Sedláček, 1923).

Besides the merchant sums, the aforesaid *kopa* was also used in area records. The *lán*, i.e., large narrow field, was recorded as the number of patches multiplied by 60. These patches, *záhony* in Czech, were Bohemian units of measurement based on tillage, i.e., ridge and furrows. There were several types of such fields, differing in size according to time, region, soil quality, and owner (18-28 ha). One peasant's *lán* had an area of 8 *kop* of patches (i.e., 8x60), analogously manorial (10x60), clerical (11x60), or royal field (12x60).

3.4. Knotted cord and land surveying

The human body became the fundamentals of measurement, like the first surveyor's tools. The measuring rod, *pertica* or *decempeda,* is an example of a tool used by Roman surveyors, *agrimensores*. For longer distances, multiples had to be used. This is the case of a rope with knots at regular intervals, used not only as a unit

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but also as a tool by the land surveyors (*rope stretchers* in Egypt). Concerning the slack and humidity, the correction was introduced. The literal translation of the Czech *provazec* in the sense of a tool is *Zwölfknotenschnur* in German, and the *knotted cord* in English. A rope with a length of 12 parts could be used to survey the right angle by the Pythagorean theorem, but the triple 3-4-5 was known earlier. The groma was also used for right or straight angles in the Roman Empire later. Natural fibre rope was replaced by Gunter's chain made of metal (Hánek, 2012).

Measuring out the circle or concentric circles was the easiest way. It was enough to pin down a fixed point (a tree or stake) and stake out the perimeter formed by equal distances from the chosen centre in the spirit of Euclidean geometry. This shape can be seen in settlements and cultural landscapes, whether it is a pattern or a man-made structure. It concerns domain demarcation, built-up areas, or buildings. The so-called *újezd* could have been circular or of circular arcs at the very beginning if we did not consider the natural boundaries, etc. (Oliskiewicz-Krzywicka, 2021). These estates or manors were delimited in a wooded and sparsely populated area by riding horses. The terms *újezd* (riding around) and *ochoz* (walking around) can be found in historical sources as well as still-existing place names, i.e., toponyms. That is *circuitus, circumequitacio, ambitus, praedium,* etc., in Latin.

4. Case study – Teplá Abbey

4.1. Colonization and land tenure

The cold, rocky, and infertile highlands around Teplá were colonized by settlers of Bohemia at first, and it was Germanized only later. Strategic border location, gold panning, and tin deposits are mentioned in the territorial context. The Teplá settlement arose as a customs and hamlet and became a market village and a town at last. A centre of local property is assumed here. The property and founding of the monastery south of the town were connected with the name of Beatitude Hroznata from Ovenec, a nobleman and courtier of the royal court from an old Bohemian noble house. This happened soon after 1191 on his property or under his administration. The colonization of the dense forest commenced probably also on his initiative, not long before. Small settlements gradually emerged through slash-and-burn and clearing activity under the oversight of the members of his retinue. The feudal liege system and the activity of locators are not yet assumed by then compared to a later time. The monastery played a crucial part in the economic growth of this domestic enterprise as well as the continuance of colonization in more outlying locations (Šimák, 1938; Čechura, 1988; Charvátová, 1995; Klápště, 2012).



Fig. 4 – *Zahradka village (1183 FWR, 630 m AMSL) and wedge-shaped fragments of its radial pattern for 12 peasants, incl. 2 new ones by the List of tax duties from 1654. The ploughland spread out into the triangular shape given by rivulets. The field size ranges from 9 to 14 ha* (Google Earth).

4.2. Ecclesiastic farm estate

The Teplá farm estate occupied a large area around the Premonstratensian abbey in Teplá, from which it was administered. Not including Hroznata's testamentary disposition from 1197, bequeathing Teplá Town and belonging property (besides territory added by Duke Bretislav III) (Friedrich, 1904-07, CDB I, pp. 323-327), the first written records (FWR) of many explicit villages belonging to the estate date back to 1233 or 1273. The first is the date of purchase of adjacent Vidžín district and other villages: "*et donamus circuitum Withsin,...,..., Boguzlawe cum suis pertinentiis"* (Emler, 1882, RB I, pp.

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375-376). The second is the date when Pope Gregory X received the Teplá Monastery under the protection of the Apostolic See and reconfirmed its privileges and estates listed here: "*Gregorius pp. X monasterium Teplense sub protectione sedis apostolicae suscipit bona et privilegia eius confirmans"* (ib, RB II, p. 334).

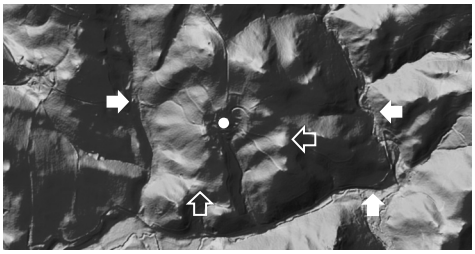


Fig. 5 – *Pistov village (1359 FWR, 610 m AMSL) and its radial pattern, elevation analysis by hillshade Z20, unfilled arrows - deforestation progress in a circle and beyond, filled arrows – present-day cadastre boundary along rivulets and mineral springs* (LSO, DTM 5G, ib).

The location activity of the monastery followed the previous phase, using the domestic populace initially if there were enough. The property consolidation had been taking place since the 13th century. The reason for this uniting of land property was to improve farming efficiency. The important year was 1341, when John, King of Bohemia, gave Teplá Abbey consent to the emphyteutic lease of their estates for the betterment of their state and the monastery itself. They had been held under Bohemian rights until then: "*Johannes, Boh. Rex ac Luc. Com. Benedae abbati totique conventui monasterii Theplensis concedit, ut bona sua jure theutunicali locare possint. – .. pro melioracione ipsorum status et monasterii bona eorum jure boemicali jacencia quelibet jure emphitheotico seu theutunicali locare ..* " (ib, RB IV, p. 371). The restructuring of the estate took place with an unsatisfactory outcome in those days, but the following abbots managed to eliminate the debt of the monastery.

The growth alternated with a decline afterward. The abbey and its estate were afflicted by the plague epidemic (1380-81). Some settlements were left almost abandoned, and as a result of this, farm activities were affected. This bleak economic state of affairs led to an offer of uncultivated land to new settlers by the later abbot. German settlers have settled permanently on the estate since then, based on the deep-rooted emphyteusis. This resettling was related to the gradual cultural and settlement transformation of the entire region, including some village patterns and architecture. Aside from the epidemic, the Hussite Wars (1419-34) also had a detrimental effect on the economy. A series of property disputes followed thereafter. However, mining proceeds allowed the monastery to bring the pledged property back into its possession. Surveyors from Cheb Town are mentioned when measuring the *Rayschpoch* Pond near Chodová Planá in 1491 (SOA in Plzeň, Teplá, klaster OPraem, L200). Besides this, the 16th century was a period of population growth and the arrival of German settlers associated with development. The Thirty Years' War interfered with the history of the estate in a particularly negative way, both World Wars later as well (Fiala, 1967; Kadlec, 2012; Knetlová, 2019). The post-war events also had a significantly negative impact, leading to the displacement of German residents as well as ensuing socialistic devastation.

4.3. Village analysis examples

Both Beranovka (Deutsch Borau) and Beranov (Böhmisch Borau) villages are very similar in terms of their location, circular pattern, and radial field system. As opposed to these, Rankovice village is of a completely different type.



Fig. 6 - *Beranov village (Böhmisch Borau, 1233 FWR, 725 m AMSL). Unlike earlier homesteads, existing ones are fully made of masonry. The houses are mainly oriented to the south, in a position above the pond and a tangential road, see Fig. 2.* (Cernansky, 2022).

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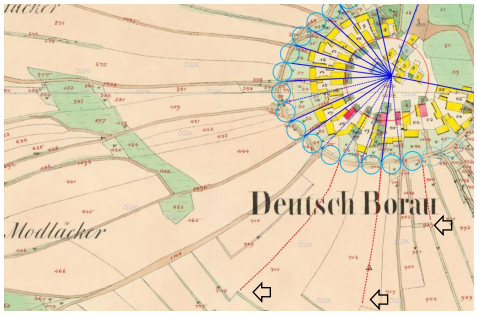


Fig. 7 - *Beranovka village (1233 FWR, resettled, 725 m AMSL) and the reconstruction of the modular pattern, incl. missing parts of the field boundaries. The module measured from the map along the backyard track is cca 15-16 Viennese fathoms, i.e., 48-51 ells.* (Drawing based on the Stable Cadastre map, 1839, scale 1: 2 880).

Rankovice village has a very regular surveying pattern, proving a later date of origin. Medieaval cultural deposits and structural residues were observed in the surroundings (Gnirs, 1936). There was also a small circular fortified house surrounded by a moat south of the present-day village, preserved in the terrain until now.

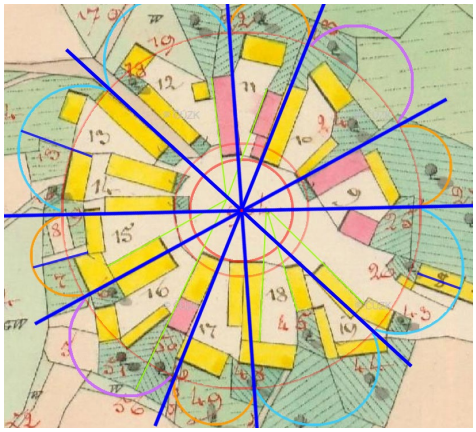


Fig. 8 – *Rankovice village (Rankowitz, 1273 FWR, 690 m AMSL), a new radial pattern for 11 peasants (BR, 1654). The built-up area in the disc and the place of houses on the village green circles are crucial for urban regeneration. The buildings do not intersect the main continuous radials, i.e., rays, in general. Changes in the homestead number or size took place within sectors. The ploughland is not radial, and the backyard track is missing. Semicircles indicate ratios only.* (Drawing based on the Stable Cadastre map, 1839, scale 1: 2 880).

5. Conclusion

There is a great diversity of circular villages not only in the Czech Republic (Cernansky, 2016) but also in the Teplá region. The use of a survey system incl. modules was confirmed for villages founded, rebuilt, or restructured later. This is important for local plans and new buildings, both their position and dimensions, as a lot of vernacular architecture ceased to exist in the 2nd half of the 20th century. The CQA, computed with the aid of the GPT app (or any other advanced program), neither affirmed the conclusions about the use of a specific module nor disproved it. The figures obtained by measurement or computation ranged within the expected divergence due to the unit difference and the map-making, inter alia.

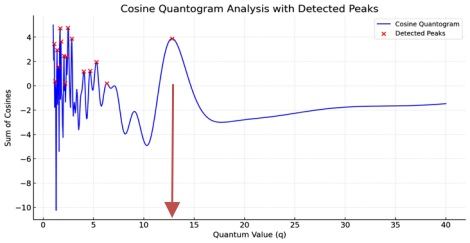


Fig. 9 - *CQA based on 20 repetitive but diverse figures measured from the Beranovka map (Fig. 6). The largest detected peak is about 13 Viennese fathoms, which is close to 42 ells, i.e., 1 old rope roughly* (Chat GPT).

After all, input accuracy and quality will always be the limiting factor regardless of the method or their combination. It is very difficult to identify a specific survey procedure if it was even applied in one go. The situation is complicated there due to the former border and bilingual area, conflicts, and combustible half-timbered buildings in the 19th century. Even multidisciplinarity does not always lead to the coveted target. The reason may be a lack of information due to time intervals or their financial and time-consuming demands. In this case, the simplified analysis may be useful for urban and rural regeneration in some cases. However, being acquainted with all the extant historical sources and the latest archaeological excavations is very advantageous beyond doubt.

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Decision Support Strategies for Urban Resilience: Mediterranean Historical Centres as Living Laboratories for Climate Adaptation

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Abstract

The current climate emergency underscores the necessity of well-designed "climate adaptation strategies" to reduce risks level and enhance resilience, particularly in complex urban contexts like European cities. These strategies face significant challenges in highly vulnerable regions such as the Mediterranean, a recognised "hotspot" for extreme weather events. Within this framework, historical centres represent critical areas requiring strategic approaches to improve "preparedness" with tailored solutions for Cultural Heritage. These strategies address the physical and material degradation of urban and architectural elements while accommodating for the unique features of the "heritage system." This study, part of an ongoing PhD research, aims to develop a Decision Support System (DSS) to guide public administrations in defining localised climate adaptation strategies. The methodology provides a structured framework for analysing and addressing climate risks. It starts with data collection from urban clusters to identify climate indicators and build site-specific datasets. These data are then critically analysed to identify vulnerabilities and critical hotspots. To manage data heterogeneity, the experimental methodology defines a normalisation process using benchmarking tools (Outdoor Damage Index), offering a standardised scale to assess risk levels. This process allows the creation of tailored adaptation strategies and supports decision-making for historical centres. This paper delves into the initial phases of the research, emphasising data acquisition and systematisation as foundational steps for creating a robust framework to guide climate adaptation in the Mediterranean's historical urban environments.

Keywords: *cultural heritage; historical centre; climate change; climate adaptation strategies; DSS*

1. Introduction

Climate change and extreme weather events destabilise delicate urban balance, exposing cities to critical scenarios. Shifts in climate patterns and temperatures represent one of the most significant threats of the 21st century. Although climate change is a phenomenon that has occurred for millions of years, over the past two centuries, this process has been accelerated by human activity and the increase in greenhouse gases, which have altered the global equilibrium and led to a rise in temperatures (European Environment Agency, 2018). At international level, both the Intergovernmental Panel on

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Climate Change (IPCC, 2023) and the United Nations through the United Nations Environment Programme (UNEP, 2024) emphasise adaptation processes aimed at increasing the resilience of urban systems to climate impacts. These impacts threaten both the tangible and intangible components of affected systems. These dynamics are increasingly affecting the domains of cultural heritage and historical settlements, which are characterised by layers of traditions that require protection (Mavrakou et al., 2025). Specifically because of its fragility, the resulting "cultural ecosystem" -as introduced by Battisti et al., 2024- represents an opportunity for the development of community-based laboratories focused on continuous innovation and ongoing experimentation. (Boeri et al., 2023). In this regard, adaptive measures can be preventive in nature and enhance resilience by providing support in response to extreme climate events (preparedness), through integrated strategies and preemptive actions that strengthen the adaptive capacity of heritage systems (Gandini et al., 2017).

This paper presents the partial results of the ongoing PhD research of one of its authors[1]. This study analyses the relationship between the vulnerable conditions of Mediterranean cultural heritage sites and the impacts generated by climate change, with the aim of identifying possible climate adaptation strategies. This paper focuses on the phase concerning the acquisition and subsequent systematisation of climate data, aimed at identifying critical hotspots in the selected case study areas. The methodology is structured into three phases: in the first and second phases, data related to the case studies are collected and analysed in order to identify the climatic vulnerability conditions of the examined sites. In the third phase, the results are normalised through benchmarking processes, with the aim of developing a climate adaptation strategy framework capable of supporting decision-making. This multiscalar, open, and transferable Decision Support System (DSS) is designed for public administrations, with the aim of promoting site-specific climate adaptation actions.

2. Climate change and cultural heritage, potential threats and possible strategies

The consequences of climate change affect every aspect of the urban system. Historical cities and small towns face the most severe impacts of these changes, exacerbated by their structural and formal vulnerabilities. The relationship between urban areas and climate has been widely analysed in scientific literature in recent years (Georgiadis, 2019; Boeri et al., 2023), through a multiscalar approach that moves from territorial and climatic scales to urban, public space and microclimatic scales. These spaces, often underutilised, require the employment of regenerative models and sustainable urban reactivation strategies in response to climate change. The complexity of designing interventions in such historically layered contexts is a widely debated subject (Gandini et al., 2017; Sesana et al., 2019). Among the most critical issues, historical centers represent a starting point for sustainable development strategies, in which key stakeholders and public administrations are called upon to define "how" and "what" should be done (Lauria, 2009).

To define strategies aligned with the needs of cultural heritage conservation, it is essential to

[1] Ongoing PhD research by F. Armocida (PhD Student, XXXVIII Cycle), PhD in Architecture at the Università Mediterranea di Reggio Calabria (dAeD Department). Dissertation title: "Climate adaptation strategies for cultural heritage resilience. A decision-support framework for climate adaptation actions in public spaces of historic centers in the Mediterranean area." Supervisors: Prof. F. Giglio, Prof. A. Sarlo (Department of Architecture and Design).

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establish a framework of the different risk levels associated with climate hazards. Climate change negatively affects cultural heritage materials and structures by accelerating their mechanical, chemical, and biological degradation. For example, extreme precipitation is a primary agent of material degradation, provoking effects such as corrosion, biological patina, efflorescence, and sub-efflorescence (Sesana et al., 2019; Giglio et al. 2024). Similarly, stronger winds carrying sand and pollutants can cause surface abrasion, water infiltration, and structural damage. Moreover, rising temperatures may exacerbate freeze-thaw cycles, accelerating cracking and physical aging of certain materials. For these reasons, it is crucial to adopt "preparedness measures". According to the IPCC (IPCC, 2012), these measures refer to the development of capacities and strategies that enable human and natural systems to anticipate, respond to, and recover from the impacts of climate change. The application of these strategies in historical centres involves preventive measures to reduce climate vulnerabilities and build urban resilience, adopting technologically advanced and innovative measures that are compatible with their historical and cultural values.

3. A DSS as climate adaptation tool for historical centre: experimental methodology

In this scenario, transitional policies tend to materialise in a fragmented and poorly coordinated manner. These processes are sometimes implemented through Decision Support Systems (DSS), which facilitate transitions and the analysis of complex issues by providing decision-makers with operational information (Aspen et al., 2023). Many of these systems are aimed at mitigating climate risks by visualising their effects, supported by future predictions (Newman et al., 2017).

The aim of this contribution is to explore how the selection, acquisition, and systematisation of climate data can support the development of a multiscalar, technical-scientific DSS capable of involving various stakeholders, including public administrations, professionals, and local communities. It proposes differentiated objectives for each group: from the planning and design of adaptation actions to the identification of strategies for enhancing climate awareness. In line with the findings of the relevant literature (Gandini et al. 2017; Shirvani Dastgerdi et al., 2022), the tool will support decision-makers in integrating climate adaptation strategies into local planning instruments. The DSS aims to support the achievement of the following specific objectives:

- Ensure that public administrations are able to strengthen and complete the guidelines of higher-level frameworks (e.g., National Climate Change Adaptation Plan), by engaging experts and research institutions in alignment with the governance and technical-scientific support structure suggested by the PNACC (Fig. 1).
- Ensure that professionals and research institutions conduct accurate analyses of climate impacts and vulnerabilities, assessing the adaptive capacity of the systems involved, in order to define urban resilience methodologies.
- Ensure that professionals and research institutions collect climate information for the evaluation of future scenarios related to Mediterranean historical centres, for risk assessment.
- Ensure that public administrations and professionals are able to identify adaptation strategies and actions consistent with the characteristics of the examined sites, following a site-specific approach.

In this regard, the DSS is structured as follows (Fig. 2):

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- Phase 1 (Scoping and data acquisition): Definition of main objectives and collection of data from urban clusters for the construction of climate datasets.
- Phase 2 (Selection of adaptation strategies): Identification of compatible climate adaptation strategies that consider future climate projections.
- Phase 3 and 4 (Review and Decision Making): Review of information, data verification, and subsequent decision-making phase or potential resubmission of the procedure (Fig. 1).

This paper focuses on the first two phases of the DSS, related to the acquisition of climate data (Scoping) and the selection of site-specific adaptation strategies (Selection of adaptation strategies), examining the following outputs for each (Fig. 3):

1. Calculate the effects of the hazard (Phase 1, Scoping): Acquisition of climate data from the case study samples and identification of climate indicators and sub-indicators for analysis, as well as the construction of datasets for the sample cases.
2. Data Systematisation (Phase 1, Scoping): Systematisation and critical analysis of data, identification of climate vulnerability and critical hotspots in the urban cluster.

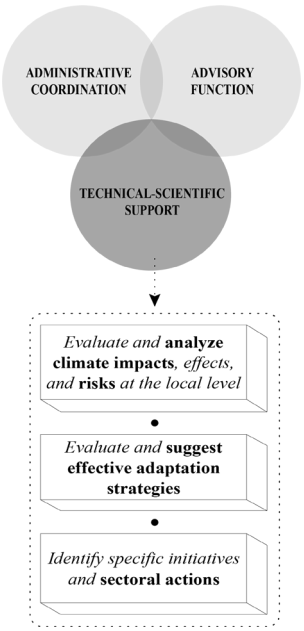


Fig. 1 – *Governance system suggested by the PNACC and tasks of the technical-scientific support structure* (Armocida, 2025).

3. Data Normalisation (Phase 1 and 2, Scoping and Selection of adaptation strategies). Standardisation and normalisation of data through benchmarking methodologies (Outdoor Damage Index), for the construction of a framework for climate adaptation strategies for cultural heritage.

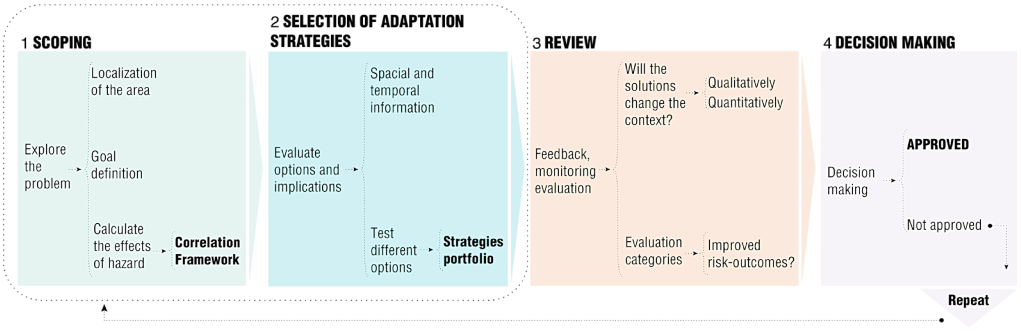


Fig. 2 – *Graphical representation of DSS's procedural phases* (Armocida, 2025).

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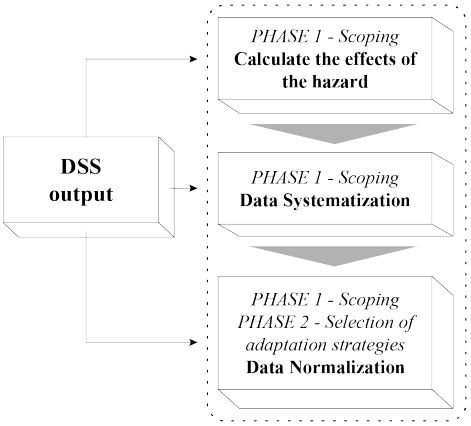


Fig. 3 – *DSS output* (Armocida, 2025).

Data acquisition was based on an experimental methodological framework (Fig. 4), starting with the identification of data input through the classification of indicators and sub-indicators. These indicators are essential for constructing the environmental conditions and include:

- Extreme temperatures, heat waves, and droughts;
- Extreme rainfall, storms, and floods;
- Severe winds;
- Sea level rise and wave action.

Each of these indicators, broken down into specific sub-indicators, was experimentally analysed using tools from the regenerative design field (Grasshopper, Ladybug, and Anemone). The results obtained are subjected to a review phase and external comparison with data extracted from literature or with empirical evidence drawn from context. In the final phase, to overcome the issue of heterogeneity in the results, the experimental normalisation method of the Outdoor Damage Index is used (Ravan et al, 2023; Giglio et al. 2024). The development of this index aims to assess the vulnerability of Cultural Heritage through the acquisition of various types of data and their subsequent conversion into comparable benchmarks. The normalisation system of the Outdoor Damage Index employs a benchmark scale from 0 to 3 based on the AHP (Analytic Hierarchy Process) method[2], where 0 represents the absence of risk and 3 represents the maximum risk (Fig. 5). The methodology allows for a more immediate comparison between the various indicators and sub-indicators in relation to current and future climatic conditions.

In the subsequent phase, current climate data for urban clusters are translated into projection scenarios for the time horizons of 2050 and 2080.

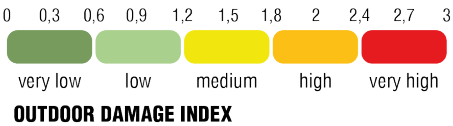


Fig. 5 – *Outdoor Damage Index score scale* (Armocida, 2025).

The reliability of the data is ensured by considering the Shared Socioeconomic Pathway (SSP) SSP3-8.5 scenario, which represents the most critical climate model (worst-case scenario), characterised by the highest greenhouse gas emissions, a rapid increase in temperatures, and poor international cooperation on climate and environment preservation. The construction of climate projections will provide an analysis of potential critical conditions to which the context will be exposed. Based on experimentally determined environmental conditions, a compendium of site-specific climate adaptation strategies will be developed. The strategies will not only aim to foster adaptation processes to future climate conditions but will also be tailored to the specificities of urban clusters, with the goal of ensuring

[2] The Analytic Hierarchy Process (AHP), initially formulated by Saaty and Kearns (1985), is a technique used to assign relative importance to different evaluation criteria in a decision-making procedure.

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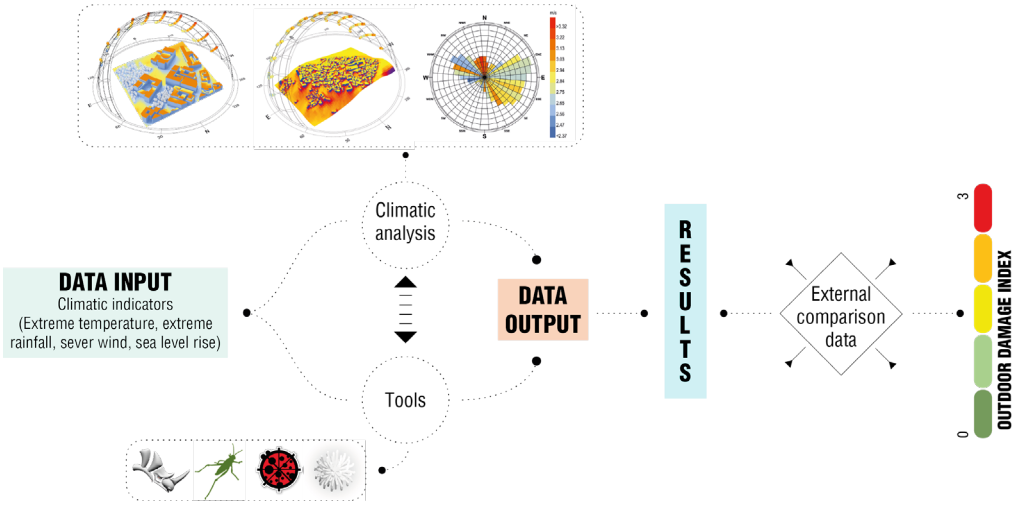


Fig. 4 – *Methodological framework for data acquisition* (Armocida, 2025).

interventions compatible with the "heritage system." The process simulates the activities of the DSS, which, once queried, will provide the user with climate adaptation strategies consistent with relevant qualitative data and experimental analyses conducted on site.

The monitoring process will include the application of the framework to small historical centres in the southern Mediterranean region, which share typological similarities and climatic challenges. The selected urban clusters are the historical centres of Gerace (in the province of Reggio Calabria) and Cosenza, both in Calabria (Italy), which, while presenting distinctive geomorphological characteristics, exhibit development of opposing climatic conditions. In particular, the analysis of urban runoff has revealed, in the case of Cosenza, worsened stormwater drainage conditions, attributable to the state of urban degradation in which the historical centre finds itself.

This choice will allow for the identification of differentiated instrumental responses, adaptable to contexts with heterogeneous climatic vulnerabilities.

4. Conclusions

The investigation of these topics reveals a fragmented body of knowledge, where climate, cultural heritage, and adaptive actions exhibit a disjointed behavior. Historical city centres face clear challenges in aligning with the strategic guidelines set at the central level, resulting in a lack of effective targeted measures. In this context, the main objectives of climate adaptation policies should combine site-specific climate emergencies responses with the adaptation needs of cultural heritage. The surfacing challenges for heritage contexts will involve historically compatible strategies that integrate innovative, biocompatible solutions (Nature-Based Solutions) with technologically advanced systems for water management (Sustainable Drainage Systems, or SuDS). These approaches could offer an effective response to future climate challenges impacting cultural heritage contexts. The experimental analysis presented proposes an integrated model whose primary output is the definition of a transferable methodology for other urban heritage contexts where low urban resilience to change is a common issue.

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The first results obtained from the research focused on defining a support methodology that, based on the identified case studies, has created a replicable model for similar contexts of Mediterranean historical centres. Furthermore, the experimental data collection and analysis process allowed for the construction of detailed and contextualised climatic datasets for each of the urban clusters examined. These initial results highlight preliminary guidelines for future policies. More specifically, it will be crucial to promote policies aimed at reducing climate risks through site-specific investigations and analytical processes calibrated to the morphological, historical, and environmental vulnerabilities and specificities of local contexts. It will also be essential to promote actions aimed at harmonising scientific criteria and technologies for the identification of climate hotspots in historical centres, ensuring replicability in line with the technical-scientific structure of the PNACC (see Fig.1). In this scenario, the role of the DSS lies in defining an operational protocol and a technical reference framework for the collection, analysis, and normalisation of climate data.

Further developments will concern the transfer of the PNACC governance model to the local scale, through the preparation of municipal climate action plans. In this case, the DSS will play a key role as an integrated decision-making platform, supporting the entire process: from the collection and systematisation of data to the identification of site-specific adaptation strategies. Potential obstacles may concern the complexity of coordination between the different institutional levels in translating national adaptation measures to local scale. In addition, regulatory limitations related to the protection of historical centres may hinder the adoption of innovative solutions for climate adaptation. Further critical issues include the possible lack of financial resources and technical skills in small municipalities, difficulties in standardising and making climate data comparable across different contexts, and the low participation of local stakeholders, which could compromise the effectiveness and acceptance of the adopted measures.

Finally, the research highlights how the growing attention towards Mediterranean historical centres represents a concrete opportunity to experiment with support strategies capable of providing effective solutions for contexts that preserve identity values of great significance.

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Building Archaeology in Support of UNESCO Rural Heritage Projects: The Case of Fortified Church of Viscri (Romania)

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Abstract
The multi-ethnic village of Viscri, the subject of numerous projects aimed at regenerating-built heritage, traditional crafts, and agricultural practices, has gained considerable prominence in recent years. However, the systematic inventorying of its built heritage values and the rigorous documentation of these in both the field and archives – to support the quality of ongoing projects and create a sustainable archive for the future – are still in their early stages. The fortified medieval church, which is a key landmark of the site and the oldest built core, lacks up-to-date scientific information (both on-site and in print or online publications), with available syntheses dating back to the late 1990s and early 2000s. Between 2020 and 2024, extensive research was conducted by a multidisciplinary team using building archaeology and German Bauforschung methodologies. This research has provided more precise and nuanced historical data regarding the evolution of the complex from the 12th century to the present, as well as insights into the historical roles of its spaces and fittings. The primary objective of this paper is to present the synthesis of the new information and discussions, which may be valuable to specialists, the ongoing restoration and regeneration project (which began in 2023), and the general public. Considering the extended duration of the project and the need for continued research and precise documentation, the second objective of this paper is to provide a list of significant open questions that can guide future studies of this case, which is relevant to world heritage.

Keywords: *Transylvania; Viscri fortified church; bauforschung; architectural research; dendrocronology*

1. Introduction

Viscri is a Transylvanian village, historically inhabited by Saxons, Romanians and Roma people. The origins of the settlement are estimated to date back to the 12th century and are linked to archaeological traces discovered in the area of the fortified church (Figs. 1-3). However, written references to about the fortified church appeared much later, around the year 1400, when the village of *Alba ecclesia* (i.e. the white church) is mentioned. The few surviving records also note that in 1494, the church received financial aid ("*pro structura ecclesiae Vyskirch*") in 1494 from the Sibiu Province and town. They also inform us that Viscri was a village of approximately 50 households around the year 1500 (Fabini, 1998). By the 2000s, the majority of Viscri's Saxon population moved to Germany.

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Nevertheless, with the assistance of several foreign experts and prominent Transylvanian Saxons, the few remaining residents of the village successfully undertook numerous regeneration projects that fostered tourism in the area.



Fig. 1 – *Aerial view vith Viscri* (Șuteu, 2024).



Fig. 2 – *The fortified church, view from the south* (Moldovan, Siffermann, 2024).

During the process of village regeneration, the medieval church was used for liturgical services by the small Evangelical community, while also hosting tourists and small cultural events. Initially, the church and its modest museum underwent minor repairs, primarily to ensure that they continued functionality.

However, certain key areas of the fortified complex remained unused for decades. The research on the monument stagnated until 2020, when the roof truss of the church began to be studied in detail by M. Moldovan and C. Siffermann. At that time, the parish community recognised the pressing need for a conservation and revitalisation project. The new project was undertaken by the MODUL 28 Sibiu architecture office in 2023. It provided the opportunity to not only pursue archaeological research but also to carry out non-invasive and minimally invasive research on the church, the towers, and bastions and segments of the fortification's curtain wall.

2. Objectives

First and foremost, the primary objective of this study was to reassess the construction phases of the fortified church in Viscri and its furnishing with wooden items, drawing on new sources that provide more reliable chronological information (dendrochronological analyses and epigraphy, cross-referenced with archival sources). This information stems from both published and unpublished research reports completed up to 2024. The paper offers a description of the historical components of the complex and a synthesis of the new findings and discussions, which may prove valuable to specialists, the ongoing restoration and regeneration project, and the general public. Given the extended duration of the project and the necessity for continued research and thorough documentation, the second objective of this paper is to highlight significant research gaps and open questions, providing direction for future studies of the Viscri fortified church.

3. Methodology

An in-depth understanding of a complex whose history spans from the Middle Ages to the present day, in a region with very few written records, can only be achieved through extensive multi- and interdisciplinary research. The 2020–2024 research team employed methodologies specific to *Bauforschung* and architectural archaeology, including historiographical research (in German, Hungarian, Romanian), archival and epigraphic research (painted or etched inscriptions, either *in situ* or copied in the archive) (I. Burnichioiu, M. L. Moldovan, F. Mihály, C. A. Siffermann), photogrammetry (M. L. Moldovan, C. A. Siffermann), 3D scanning (C. Șuteu), architectural surveys (M. L. Moldovan, C. A. Siffermann, MODUL 28), geophysical prospecting (M. Stibrányi et al.), archaeology (R. Lupescu), wall studies (L. Kiss), and particularly dendrochronology (Th. Eißing et al. from the Otto Friedrich University of Bamberg; B. Tóth from the Anno Domini Dendrolab in Miercurea Ciuc, RO).

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4. Complex description

The fortified complex in Viscri, which dominates the village and covers over 3300 m^2 (Figs. 1-3), consists of a single-nave church with a western tower. It is positioned in the centre of an enclosure fortified with towers (4) and rectangular bastions (2) that were constructed from stone of varying quality, as well as brick and wood. In the research reports written in Romanian, its major components were given abbreviated names (according to the cardinal points or their functionalities) that we will also employ here: church = C; church tower = T; gate tower = GT; southern tower = ST; western tower = WT; northern tower = NT; southern bastion (that houses the museum) = SB; eastern bastion = EB; i1 = main fortified enclosure that connects the towers and the bastions; Ci1 = the corridor that surrounds the courtyard near the i1 enclosure. GH, which is outside the fortified enclosure, to the south, stands for the fortress guard's former house (Germ. *Burghüterhaus*), and i2 is the outer, lower enclosure (Fig. 3).

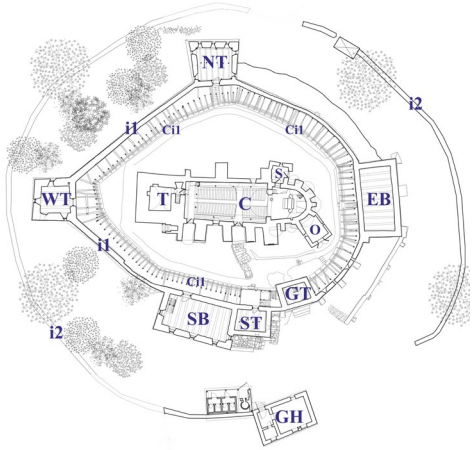


Fig. 3 – *The fortified complex in Viscri. Major components were given abbreviated names* (drawing by MODUL 28, after 3D scan by C. Șuteu).

The fortified enclosure can be accessed via a stone staircase between the GT and ST. Near it, at the GT, there is also a wooden gate that, in the past, allowed access for large equipment. At the end of the 19th century, steps were placed in front of it, making access exclusively pedestrian during community events. The old bells were installed on the top floor of the GT.

To the west, the church has a massive stone tower (T), with a narrow staircase across the walls of the lower levels and a balcony on the upper level. To the north and southeast, the church has an attached sacristy (S) and a room for the organ bellows (O). The walls of the sanctuary and nave feature buttresses of various sizes, with those of the sanctuary connected at the top by arches. The church has three entrances, on the south side of the nave (two on the ground floor and one on the upper level), each of the first two protected by a porch and the third accessed by a covered staircase. The overall appearance of the church reveals its non-uniform construction, reflecting the multiple building phases that occurred from the Middle Ages to the present day.

The upper levels of the WT and NT are not currently accessible because of the severe deterioration of the staircases and floors. From the patrol path of the fortified enclosure only a few vestiges remain, showing that it had been built on wooden corbels. In place of the patrol path, long since dismantled, the corridor called Ci1 stretches from the SB to the GT and houses several ethnographic items that visitors can view. The complex also had a second, lower outer enclosure, i2. Most of it is visible from the south, west, and north parts of the complex. On the southwest, i2 borders the cemetery (Fig. 2), while in the south it is connected to the GH (Fig. 3).

5. The 2020–2024 research results and discussion

5.1. The church

The older archaeological research endeavours, carried out between 1970 and 1971 (Dumitrache 1978; 1981), uncovered two monetary discoveries that were reassessed in the 21st century (Velter, 2002). These coins showed the oldest construction phases of the church in Viscri

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date back to the second half of the 12th century rather than the first half. In the second half of the century, a small Romanesque building was erected: a single-nave structure made of masonry, with a semi-circular apse that is still visible in the ground and in the current walls (as a result of the new wall research). Inside, there are three capitals and a fragment of a Romanesque column (as well as the baptismal font, which was created from two such pieces). These cannot yet be precisely correlated with the first church, although their style suggests that they are of the same period. Although there have long been suspicions that the first church could have been a basilica, archaeology (Lupescu, 2024) and geophysics (Stibrányi et al., 2023) have been as yet unable to provide concrete evidence for such a construction.

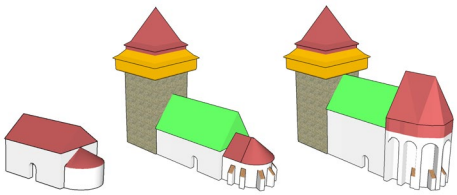


Fig. 4 – *Medieval construction phases of the church* (Moldovan, Siffermann, 2023, Fig. 10).

The western or eastern limits of the Romanesque building of the second half of the 12th century, with its semi-circular layout, have not yet been made visible to the public. However, parts of the elevation have already been identified and are visible (as a result of a wall survey) up to 5.25 m in height on the southern sides of the nave and at the triumphal arch. The initial Romanesque church (improperly called "chapel" by a segment of historiography) was extended towards the east somewhere around the year 1300, when a trapezoidal choir was built, enclosed by another apse, in a somewhat semi-circular layout. Subsequently, the western wall of the Romanesque nave was demolished and the liturgical space reached its maximum surface, which it retains today.

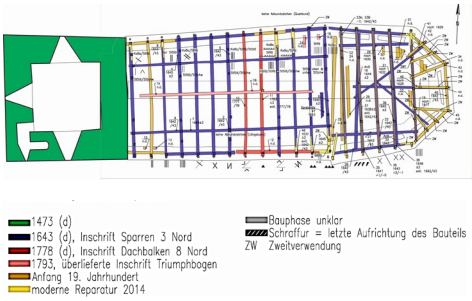


Fig. 5 – *Dating of the tower and the roof truss of the church. Building stages from 1473 to 2014 and details of the construction technique for the roof truss* (Moldovan, Siffermann).

Correlating the archaeological data from the 20th century (Dumitrache 1978; 1981), the decorative masonry data from 2021 and 2023–2024, and the dendrochronology findings from 2021–2023 reveals that construction work in the western part of the nave began only in the second half of the 15th century when the massive western tower was also erected (Figs. 5 & 6), with masonry up to the bell level. Dendrochronological samples analysed in two different laboratories, in 2021 (Bamberg) and 2023 (Miercurea Ciuc), have shown that the wooden parts of the tower originated from trees chopped in 1473 (in the case of elements from different elevations of the tower) (Eißing, 2021) and in 1493/94 (in the case of an element located behind the Gothic portal between the nave and the tower) (Tóth, 2023). Therefore, the church tower is not a 13th-century (donjon) tower, erected separately from the Romanesque church, as had been assumed and repeated numerous times in the scholarly literature.

The medieval church masonry underwent modifications higher on the walls as well. At approximately 4 m above ground level, the apse becomes polygonal. Wall research, as well as the surface irregularities, have revealed that traces of late Gothic ribbed brick vaults remain on the walls of the sanctuary and nave. Atop this structure, the church seems to have been equipped later with a defensive level (a redoubt).

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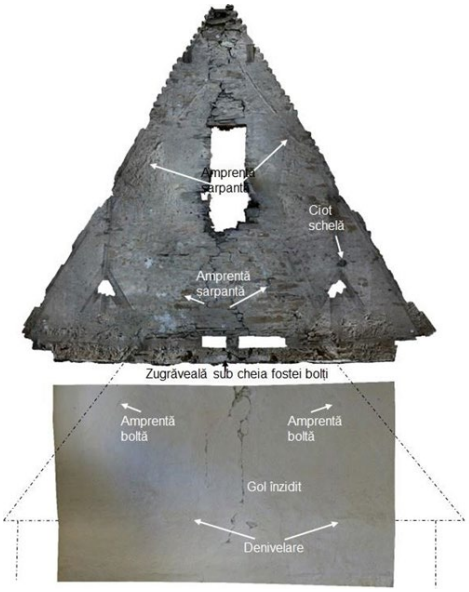


Fig. 6 – *Results of the research on the eastern wall of the church tower, facing the church interior old details and the roofs traces* (Moldovan and Siffermann, 2023).

In situ contextual data, correlated with the written sources from around the year 1494, indicates that this defensive level could have existed from the end of the 15th century or the beginning of the 16th until, at the latest, the installation of the current roof structure in 1643 (a date determined by the dendrochronological analysis and an inscription on a beam in the attic: *ANO 1643*) (Moldovan & Siffermann, 2021; 2023; 2024) (fig. 5). The oldest pieces of wooden furniture in the church date back to the same century, but to different years, namely, 1650, 1656 and 1694/1696 (Tóth, 2021; Mihály, 2021). Moreover, an inscription from 1670 that remains *in situ* shows that the church tower received a new patrol path; whether the tower's roof truss is from the same period has yet to be determined. In 1715, the church's expense book records the collection of donations for "the repair and renovation of our weakened church, which endangers the lives of its visitors." Two years later, works on the church are indeed documented (Horwath, 1940; Fabini, 1998). This was probably when the church lost its late Gothic ribbed vaults. We know with certainty that work was carried out on the church roof truss in 1778 (Moldovan & Siffermann, 2021; 2023; 2024). However, the switch to the flat wooden roof probably occurred in 1793, and not in 1743, despite the inscription painted in black on the triumphal arch that is recorded as *MDCCXXXXIII* (Fig. 7). The argument for the later dating is supported by structural evidence at the roof level and a copy of a 19th-century chronicle in the parish archive. In that archival copy, the inscription contains an additional "L": *MDCCLXXXXIII* (Moldovan and Siffermann, 2021; 2023; 2024). Overall, the works carried out in the 18th century were more extensive and more urgently necessary than the earlier changes, given the church's state of conservation. The chronology discussed above is complemented by other records of interventions found in archives, furniture bearing painted inscriptions, and dendrochronological analyses that produced the following dates: 1783, 1790, 1794/1795, 1790/1800 (Tóth, 2021; Mihály, 2021).



Fig. 7 – *View of the triumphal arch with painted inscription* (Burnichioiu, 2023).

The church walls were painted several times from the Middle Ages to the 18th century, as shown by the wall analyses (Kiss, 2023), and old images depict fragments of medieval frescoes (Fig. 8) and a decorative painting with inscriptions typical of the transition towards the Reformation. The research on the interior decoration is still in its incipient stages as the church has been opened permanently to be used for religious services and visits.

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Fig. 8 – *Fragment of medieval fresco* (Kiss, 2023).

Nonetheless, we can say that the current appearance of the church interior, with its painted wooden furniture on the first and second levels of the nave, as well as the choir stalls and the organ in the sanctuary, resulted from the extensive renovations the church underwent during the 18th and 19th centuries. The renovations carried out in the early 19th century were connected with an earthquake that had taken place in 1802, as well as to the need to equip the church with an organ (1817). When the roof structure and the attic ceiling were repaired, the Gothic windows of the church were bricked up, and new windows with pointed or circular arches were added. Additionally, a chamber for the organ pipes installed in probably around 1817 was added in the eastern part of the sanctuary and, according to an 1823 inscription, repairs were made to the upper part of the tower.

5.2. The fortified enclosure – i1

The archaeological research performed in 1970–1971 showed traces of an oval enclosure to the north, west and southwest of the church courtyard that could be contemporaneous with at least two curtain wall segments currently visible in elevations on the southeast and northeast, that have a different thickness than the rest of the i1 enclosure (Fig. 3). They were dated to the 14th century (Dumitrache 1978; 1981), but we believe that this requires further confirmation – in particular, because the dendrochronological analyses from 2023 showed that the oldest samples of wood embedded in the masonry originated from trees that had been felled in 1546 and around 1577.

Moreover, in the southern area of the fortification (in front of the SB), traces of the supports of a patrol path from the 16th century were preserved (Tóth, 2023).

The dendrochronological analyses also showed that the wood used in the SB was chopped in the winter of 1580–1581. The ST, which is next to the SB, contained wood from 1581 too, as well as wood from around 1478. However, the roof trusses of the SB and ST were remade in 1938.

The GT could be older than the ST, judging by its more archaic overall appearance and its small, semi-circular windows on the upper level. Nonetheless, the dendrochronology and the wall epigraphy have proven that several interventions occurred in the 15th–17th centuries. The final major intervention on this tower was made in 1953 on the top floor, the roof structure and the covering, as evidenced by the archival sources and *in situ* inscription.

The inscriptions in the plaster, together with the 2023 dendrochronological analyses, demonstrate that the 17th century was highly important for the fortification of the i1 and the organisation of the spaces inside the towers and bastions. Beginning in 1630, the current NT tower was built with three levels by the master builder Johann Hartmann from Lovnic (Leblang). In 1648–1649, the WT was raised with four levels by the masters David Zako, Stephan Schullerus, and Michael Fehlessel. During the same period, the curtain wall segments near the towers were built, where a wooden patrol path functioned. In 1970–1972, the roofs of the WT and NT underwent major repairs, according to archival data.

According to the dendrochronological analyses, the EB was erected during a construction phase after 1560 (Tóth, 2023). However, it has undergone numerous intervention campaigns, including a series of restorations in the 20th century, which require further investigation. The EB must be studied for the sake of both the fortification and the church, given that pieces

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dismantled from it (some of them dated to 1643) have been identified in the church's roof truss (Moldovan & Siffermann, 2021; 2023; 2024). Renovations also took place in 1828 (according to an inscription on the eastern wall) and 1891 (identified through dendrochronological analysis). The southern-eastern segment of the enclosure was completely rebuilt in the 1960s, and the upper part of the EB was rebuilt between 1970 and 1971.

5.3. The Ci1 corridor

The dendrochronological dating of a beam from the roof of the corridor attached to the western wall of EB to around the years 1765–1769 (Tóth, 2023), has provided an important reference point for this part of the complex, which housed the villagers' grain storerooms (Fig. 9). The patrol path from the 16th–17th centuries have been dismantled at that period.

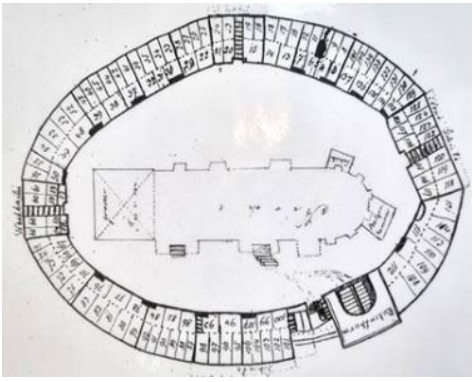


Fig. 9 – *Historical drawing of the Ci1, with access areas and numbered spaces* (displayed in museum).

6. Conclusions

The research conducted between 2020 and 2024, in addition to reassessing and critically integrating twentieth-century studies, has significantly enriched the scientific understanding of the fortified complex in Viscri. In recent years, the investigations carried out in this complex have made substantial progress, surpassing those performed at similar sites in southern Transylvania. The data have been compiled into a chronological table of the monument, which will be a working tool during the execution phases of the restoration and revitalization project and can be modified and updated as needed.

In conclusion, the ensemble of Viscri began in the second half of the 12th century with the construction of a small Romanesque church. The liturgical space was subsequently expanded both eastward and westward, reaching its maximum size by the second half of the 15th century (rather than the 13th century) when the western tower was erected. The medieval church was taller than its predecessor and included a defensive level. It was painted several times over the centuries, but its current interior appearance dates from the 18th–19th centuries. Originally, an oval enclosure with a somewhat smaller area surrounded the church. The construction campaigns of the 16th–17th centuries brought the i1 closer to the present structure, which now includes two towers and four bastions. During the 18th and 19th centuries, certain parts of the il lost some of their height and features (such as the parapet walk) and were replaced by the current corridor. Covered by a single-slope roof, the structure housed the villagers' numbered "grain rooms."

New studies must aim to address a series of major historical questions that remain unanswered. Where did the isolated Romanesque carved elements in the church originate? Was there ever a noble residence in Viscri (there are no sources on the subject from the early Middle Ages), or was it merely a multifunctional ecclesiastical complex for communal use? Could the study of the church identify the moment the community converted to the Reformation? When was the cemetery relocated outside the complex? Can we definitively rule out the theory that there was once a medieval basilica? What type of structures existed north of the church nave? What other buildings disappeared from the two courtyards? How can the oldest fortification be dated, and did

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it originally have towers? When did i2 appear? Is the GT a tower that belonged to the first enclosure around the Romanesque church? What were the purposes of the numerous spaces that were built over time?

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Identification and Conservation of Spatial Genes in Traditional Chinese Villages: A Case Study of Sandefan Village

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Abstract
Traditional villages in China constitute a newly proposed category of cultural heritage. It transcends the existing demarcation between tangible and intangible heritage categories and represents a systematic and living heritage. Within these villages, the representations of Chinese civilization, such as traditional residential buildings, village conventions and folk customs, traditional handicrafts, agricultural landscapes, have been created, inherited, and employed. Traditional villages are regarded as the 'gene bank' and 'living fossil' for China's traditional culture. In the conservation practice regarding the built environment of traditional villages, what truly matters is not the preservation of existing traditional houses or streets, but the long-established spatial order or rules that have steered the settlements' development for thousands of years. Hence, the identification and upkeep of the spatial genes guiding the development of residential settlements in traditional Chinese villages are of supreme significance. This research adopts genetic analysis approaches to summarize the construction regulations of traditional Chinese settlements and interpret their significance and cultural connotations. Subsequently, with Sandefan Village as a case, it utilizes the logical framework of gene identification - decoding - expression to systematically investigate, extract, and analyse the spatial genes of traditional villages, and further summarizes the strategies for the dynamic conservation of traditional villages based on safeguarding their spatial genes.

Keywords: *traditional Chinese villages; spatial genes; identification; analystic framework; case study*

1. Introduction

Traditional villages in China, which have endured for thousand years, carry rich historical memories and evidence of cultural development. As important witnesses to human civilization, they are treasures of humanity (Zhang et al., 2017). However, with the acceleration of China's modernization process, traditional villages in China have experienced rapid disappearance, and their conservation are facing unprecedented challenges (Yang et al., 2022). Therefore, since 2012, the Chinese government has launched a nationwide action to protect traditional villages. As of February 2025, a total of 8,155 national-level traditional villages have been identified and conservation practices have been implemented.

With the evolution and the deepening of scholarly inquiry, it has become increasingly evident that traditional villages are not merely a collection of material and immaterial heritage elements. They embody living histories and serve as dynamic carriers of cultural transmission and

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social development (Pan et al., 2024). Despite the increasing awareness of the importance of protecting traditional villages, existing conservation models continue to face significant challenges. Through GIS spatial analysis of national-level traditional villages from 2015 to 2020 in China, we have identified several concerning phenomena. During this period, 83.7% of traditional villages adopted a 'building freeze + functional replacement' strategy. While this approach has partially preserved the physical form of the villages, it has overlooked the preservation of their intrinsic vitality and cultural genes. Specifically, 61.2% of these villages have experienced a disruption in their genetic sequence, exemplified by a spatial entropy value difference of 0.47 between new construction areas and traditional textures. This discrepancy in spatial entropy values indicates a lack of organic integration between new developments and the traditional fabric of the villages, leading to the fragmentation of both their spatial structure and cultural heritage (Du & Chen, 2024).

Relying solely on the preservation of physical heritage elements can maintain the village's appearance in the short term but fails to sustain its intrinsic vitality. This conservation model treats traditional villages as 'specimens,' preserving their material form while neglecting their essence as living heritage. Under this approach, the cultural genes of traditional villages are largely frozen within deliberately preserved historical buildings and gradually lost in modern life (Li et al., 2024). In other words, contemporary conservation efforts risk severing the millennia-old transmission of spatial genetic codes that define these villages as living heritage. Therefore, it is imperative to establish a new conservation paradigm grounded in spatial genetic codes to ensure the sustainable development of traditional villages.

This study aims to conduct an in-depth analysis of the spatial genes of traditional Chinese villages, exploring how to achieve the inheritance and renewal of traditional spaces while protecting their dynamic vitality. By doing so, it seeks to provide new insights and methodologies for the sustainable development of living heritage, particularly that represented by traditional Chinese villages on a global scale. This paper proposes a gene identification-decoding-expression framework based on the three-helix gene structure model, driven by digital humanities. Using Sandefan village in China as a case study. From gene identification to decoding and expression, this framework not only enables precise identification and quantification of the village's spatial genes but also offers scientific decision support for its conservation and renewal. This research will provide methodological references for the conservation of living heritage on a global scale.

2. Literature Review

2.1. The shift of spatial gene metaphor in international research

The development of spatial gene theory has evolved from understanding the structure of space to exploring the rules governing its generation, and finally to the metaphorical conceptualization of spatial genes. In 1960, Kevin Lynch introduced the concept of urban image in his seminal work *The Image of the City*, marking a pioneering contribution to the cognitive study of spatial structure. This framework by Lynch laid the groundwork for subsequent research on spatial genes. In 1977, Christopher Alexander advanced the field with his *Pattern Language Theory,* which established a foundational approach to studying the rules of spatial generation. Alexander posited that buildings and urban spaces could be generated through a series of patterns analogous to biological genes, guiding the organization and evolution of space. This theory provided critical theoretical support for the development of spatial gene research.

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In recent years, significant advancements have been made in the field of spatial gene research. In 2021, the Space Syntax Laboratory introduced the *Architectural Gene Map Algorithm*, which employs computational methods to analyse the genetic characteristics of buildings and urban spaces. This innovative approach provides new technological tools for the preservation and revitalization of architectural and urban environments. The development of this algorithm signifies a pivotal transition in spatial gene research, marking the shift from theoretical exploration to practical application.

2.2. Significant Advancements in China

In China, significant advancements have been made in the research of spatial gene theory. In 2018, the team led by Duan Jin established a comprehensive spatial gene identification technology system, offering new methodologies for the planning and conservation of urban and rural areas through the systematic analysis of spatial genes. Duan Jin's research transcended the traditional dichotomy between material and non-material elements, conceptualizing the spatial gene as a three-helix gene structure model that encompasses the material layer (architectural form), institutional layer (construction regulations), and conceptual layer (feng shui ethics) (Duan et al., 2022). The application of this three-helix gene structure model in the preservation and renewal of traditional villages primarily involves an integrated analysis and conservation approach that addresses multiple dimensions, including the physical morphology, construction regulations, and cultural beliefs such as feng shui ethics.

Xiao Jing et al. noted that traditional conservation methods often reduce to the mere replication of typical traditional architectural styles, overlooking the historical stratification and diversity of historical districts (Xiao et al., 2024). Consequently, identifying spatial genes is crucial for transitioning from superficial form replication to the deeper inheritance of cultural context. In terms of specific applications, Liu Peilin introduced the theory of landscape genes to analyse the morphological characteristics of traditional Chinese settlements. This theory elucidates the primary historical landscape features by distinguishing between dominant genes and recessive genes (Hu et al., 2024).

In summary, the spatial gene theory has evolved from the gene metaphor prevalent in international research to the development of localized theoretical frameworks, offering new theoretical and technical support for the conservation and renewal of traditional villages. However, there remains a gap in methods that can effectively integrate both the implicit and explicit characteristics of spatial genes for practical application.

3. Research Methods

3.1. The analytical framework for the spatial genes of traditional villages

To thoroughly analyse the spatial genetic characteristics of traditional villages, this study builds upon previous research to design a comprehensive research framework. Firstly, it examines the impact of the village's material form, construction regulations, and feng shui ethics on its spatial structure using the three-helix gene structure model as a foundation. Subsequently, leveraging relevant technologies (detailed in subsequent sections), the study conducts a multi-dimensional analysis at the levels of village sites, residential blocks, and building units. This approach systematically parses the spatial characteristics of the village from the perspectives of gene identification, decoding, and expression.

High-precision three-dimensional data acquisition meticulously documented the village's architectural morphology, street layout, and spatial structure, providing foundational data for spatial gene analysis. Additionally, historical materials were collected, and semi-structured interviews were conducted to gather

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supplementary information. Through systematic retrieval and integrated quantitative and qualitative analysis, this approach ensured the detailed and accurate documentation of relevant data.

The three-helix gene structure model provides a framework for analysing traditional villages through three dimensions: material form, construction regulations, and feng shui ethics. In the context of specific spatial features within a village, these three aspects interact simultaneously and collectively shape the spatial genes. Therefore, when decoding spatial genes, an integrated and synchronous analysis of these dimensions is essential. This study divides the analysis into three hierarchical levels based on spatial scale. At each level, the decoding process incorporates information related to material form, institutional regulations, and cultural beliefs to achieve a comprehensive understanding. The three levels focus on the spatial genes of village sites, residential blocks, and building units, respectively. The analysis and research findings are illustrated using Sandefan Village as a case study in this research.

3.2. Research subject: Sandefan Village

Sandefan Village is situated in Jinan City, Shandong Province, within the central region of Shandong, the cradle of Confucianism. For millennia, this area has maintained an unbroken cultural development. The village exemplifies the preservation of traditional Chinese ethical order and village regulations, which are deeply embedded in daily life. Sandefan Village retains the construction standards from the Ming and Qing Dynasties (about 600 years ago), with ancient buildings comprising 72% of its total structures. This makes it a prime example of a village where both spatial elements and historical traditions are well-preserved. In late 2016, Sandefan Village was officially designated as a Traditional Chinese Village. Given its significance for studying the spatial genes of traditional villages, it has been chosen as a case study for this research (Fig. 1).



Fig. 1 – *Aerial photo of Sandefan village.*

4. Results: Identification of spatial genes

Taking Sandefan Village as a specific case, this study analyses the village from three dimensions —village sites, residential blocks, and building units—from the perspective of spatial scale.

In the identification and analysis of spatial genes at each level, considerations are given to the material, institutional, and conceptual layers of the village. The detailed analysis results are presented below.

4.1. Village site: The spatial relationship with natural resources

Sandefan Village is situated in the heart of central Shandong province of China, at 36°35'N and 117°29'E. The village covers an area of 14.3 square kilometres and has a population of 6,248, all of whom are Han Chinese. It is the largest village in central Shandong in terms of scale.

The soil in Sandefan Village is fertile and water resources are abundant. There are coal, limestone and other mineral resources around. The industrial structure of Sandefan Village is single, mainly traditional agricultural planting. The main economic crops are wheat and corn. It has a total of 391.75 hectares of cultivated land.

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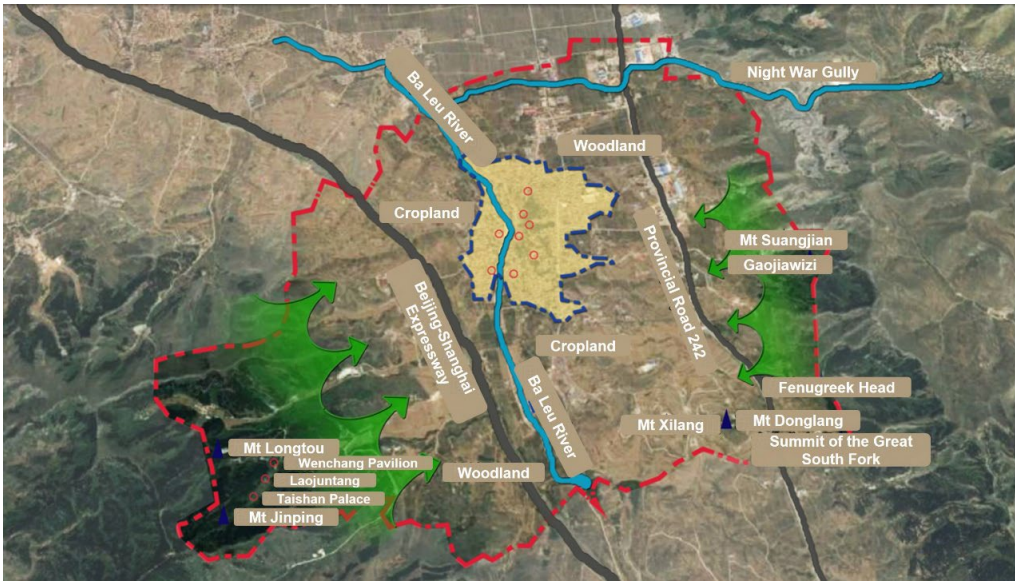


Fig. 2 – *Sandefan village location map.*

From a topographical perspective, Sandefan Village is nestled within an incompletely enclosed mountain basin, surrounded by hills on three sides. In terms of its site selection and layout relative to natural features, the village exhibits a distinct "lean yin and embracing yang" (负阴抱阳) characteristic. This spatial arrangement allows the village to fully benefit from sunlight exposure, ensuring optimal lighting and ventilation conditions. Additionally, it effectively shields the village from harsh northern winds during winter, thereby creating a comfortable living environment for its residents.

The Balou River traverses the village, dividing it into two primary regions: east and west. The residential areas are distributed along both banks of the river and have expanded in accordance with its course. However, this development has been constrained by the terrain's slope. The village exhibits a typical "viewing the mountains and resting by the river" (望山枕河) layout, which underscores the intimate relationship between the built environment and the natural surroundings.

"Viewing the mountains" refers to the practice of situating the village within visible distance of the mountains, rather than directly on them, whenever conditions permit. "Resting by the river" indicates that the village is typically located as close to the river as possible, often with the river running through the residential area. This "viewing the mountains and resting by the river" principle is a crucial guideline for village site selection and represents an important spatial gene of Sandefan Village.

4.2. Residential Blocks: The fusion of physical space and blood bond

According to the historical records preserved in the village, the current spatial layout of Sandefan Village was established approximately 600 years ago and has evolved over multiple generations. At its core, the "one street and ten lanes" form the fundamental framework of the village. These streets and lanes, together with the public space nodes created by the scattered religious buildings throughout the village, collectively define the spatial organization of the village.

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Influenced by Taoist culture, indigenous beliefs, and the natural worship of elements such as water, there are ten distinct faith-themed temples or memorial buildings scattered throughout the village. These include Taoist structures, shrines dedicated to water deities, and places of local worship. The buildings have diverse origins and were constructed between 600 and 200 years ago. Together with the alley gates along the ten main streets, these religious and memorial structures form the critical structural nodes of the village's public space.

Within a Chinese traditional village, residences of villagers from the same bloodline clan are typically concentrated together, forming relatively cohesive residential blocks. This settlement pattern based on kinship not only facilitates communication and mutual assistance within the clan but also aids in the preservation of family culture and traditional customs. Using social network analysis methods, an in-depth study was conducted on the bloodline relationships and the distribution of building clusters in Sandefan Village. The results indicate that the strength of bloodline relationships is as high as 0.78, which significantly influences the spatial organization of building groups.

During the development of Sandefan Village, a characteristic spatial pattern of "one street and ten lanes" emerged in the residential areas. Typically, families with shared ancestry expand gradually outward from a central street or alley, forming distinct clan settlements. Consequently, the village has developed from its initial spatial pattern of "one street and ten lanes" into a network of residential blocks. Therefore, the spatial structure of the village reflects the spatial distribution of bloodline clans. Due to the influence of major roads and the river, the village is divided into three sections, creating a typical "pin" (品) shaped structure (refer to Fig. 3). The built environment of Sandefan Village has consistently developed following this three-block "pin" structure. According to historical records, 89% of the village's residential blocks adhere to this pattern. Therefore, the "pin" shaped residential block division is an integral component of the village's spatial genealogy. The accompanying figure illustrates the layout of Sandefan Village during the Ming and Qing Dynasties compared with its current configuration.

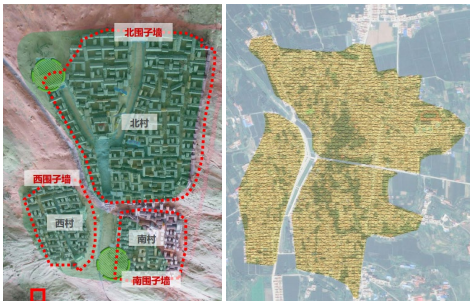


Fig 3 – *Picture-type pin (品) on village structure of Sandefan Village.*

4.3. Building Unit: Craftsmanship techniques follow spatial layout

The residential area of Sandefan Village and its surrounding jurisdiction are rich in cultural heritage. Within the village, several historical sites of local religious significance can be found, including the Yuwang Temple, Longwang Temple, and Guandi Temple. Additionally, historical features within Sandefan Village—such as streets, paved pathways, remnants of city walls, wells, and screen walls—complement the distinctive traditional architecture, collectively forming a village landscape with a pronounced Chinese traditional style. These ancient buildings have withstood the test of time and continue to fulfill their original functions to this day, occupying an irreplaceable position within the cultural inheritance of Sandefan Village. Given their uniqueness and representative significance, static preservation is deemed an appropriate conservation method. According to the historical data collected, the scale of the residential area and the traditional residences in Sandefan Village have been constantly expanding and changing. The residential form and the expansion rules of the residential area are the spatial genes that need to be focused on.

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While the mainstream contemporary residential form in Sandefan Village is a variant of the traditional quadrangle courtyard passed down from the Ming and Qing periods, it has adapted to modern family structures. In the central Shandong region, traditional quadrangle courtyards typically feature two or three entrances and accommodate multiple generations of a single family. However, with changes in family structure—such as fewer children and an increase in nuclear families—the residences in Sandefan Village have evolved. Today, most residences are occupied by two generations and have transformed into one-entrance courtyards. These one-entrance courtyards consist of a main building facing north, flanked by east and west rooms, and a south room used as a storage area or kitchen, forming an inward-facing courtyard. Although building materials and scales have evolved over time, the overall spatial layout, proportions, and architectural forms have been preserved.

Despite changes in building materials—where the original adobe and blue brick walls, along with thatch and blue tiles used by commoners, have been replaced by modern red brick walls and red tiles—the architectural form and typology have remained consistent. Firstly, the spatial configuration of the courtyards retains its centripetal and introverted layout, and the hard mountain roof style suitable for common dwellings has been preserved. The development of building materials has led to varying degrees of expansion in the width and depth of building bays. However, residential spaces typically expand proportionally.

In addition, Sandefan Village adheres to the "Yabai (压白)" system. The "Yabai" system employs specific numerical combinations, particularly those considered auspicious, to ensure that building dimensions align with feng shui requirements for good fortune and prosperity. Mathematically, it follows a set of established logical rules to screen and match dimensional values, ensuring harmonious spatial proportions. It was found that room widths strictly adhere to the "Yabai" system in Sandefan, with a variance of only 0.15 square meters. This precise modular approach not only ensures standardized and harmonious building dimensions but also contributes to the village's overall cohesive architectural style.

5. Discussion: Decoding and expression of spatial genes

Considering the living heritage attributes of traditional villages, their spatial development must adapt to and evolve in response to the changing needs of residents. Therefore, based on the spatial genes extracted from Sandefan Village, this study formulates the following strategic measures and recommendations for the conservation of built environments in traditional Chinese villages from the perspective of spatial gene inheritance.

Firstly, it is essential to control and constrain the expansion of the village's built-up area towards the surrounding mountains. Based on the established spatial genes of traditional village site selection—namely "leaning yin and facing yang" and "viewing a mountain and resting against a river"—Sandefan Village has developed a sequential spatial relationship where residential areas, farming zones, and mountain landscapes coexist in a specific order. A river runs through the village, embodying these two spatial genes. Therefore, during future village expansion, it is crucial to protect the agricultural land between the built-up area and the mountains. Future development should focus on expanding along the river, either upstream or downstream.

Secondly, regarding the spatial layout of residential blocks, development will continue within the existing triangular zoning structure. The core of the village's public space remains centered on the axis formed by "one main street and ten lanes" along with key religious buildings. The design of residential blocks will consider the accessibility and connectivity between these

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important public buildings and residential areas. This approach does not imply freezing the current built environment; rather, it allows for new construction while preserving the essential spatial relationships.

Finally, the conservation and control of specific building units are differentiated into two categories. Firstly, traditional temples, local faith spaces, and assembly areas possess unique and representative characteristics and should not be arbitrarily modified or replicated. The preservation of these primarily adopts a static conservation approach. For residential buildings, the recommended design for new constructions is the one-entrance courtyard with a hard mountain roof quadrangle. Additionally, the building scale must adhere to the "chi-bai" rule. The orientation of buildings, street and alley alignments, and the overall block texture should conform to and replicate existing spatial relationships.

6. Conclusions

This study focuses on the challenges in the conservation practices of traditional Chinese villages. It addresses the contradiction between preserving the material architectural forms of traditional villages and meeting the contemporary spatial needs of villagers, emphasizing the living heritage attributes of these villages. By thoroughly investigating their inherent characteristics, this research has developed a spatial gene recognition framework that is feasible, referable, and applicable. Additionally, it proposes corresponding strategies for the conservation and sustainable development of traditional villages. Using Sandefan Village as a case study, the research successfully identifies the village's unique spatial genes and provides conservation strategies. The limitations of this study are primarily reflected in the singularity of the case sample and the particularity of the cultural geography, significant variations may exist in the spatial gene representation systems across different regions of China. Therefore, future research should focus cross-regional comparative studies.

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Interpretations and Sensitive Representations for the Documentation of Matera Vernacular Heritage

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Abstract
This contribution promotes the understanding of the historical heritage of one of the most iconic locations in Italy, the town of Matera in the Murgia. It addresses issues such as the representation, documentation and dissemination of this ancient heritage, carved into the living limestone, which still bears witness to peculiar knowledge and building traditions. The complex and heterogeneous, tangible and intangible heritage was analysed and described through life drawing and careful observations of the whole and of the detail, from a distance and from close, from top to bottom and from bottom to top. These numerous critical readings highlighted the preciousness of Matera's limestone materials, textures that characterise the "sassi", the calcarenite vernacular dwellings representing the symbol of the town. It is always necessary, to transmit and enhance the material, chromatic, cultural, symbolic element that strongly distinguishes these assets, trying to convey, through sensitive representations, also the underlying intangible elements. A contemporary documentation of panoramas, landscapes and views of Sasso Barisano and Sasso Caveoso not only shows the state of conservation of the places but creates the prerequisite for their maintenance and enhancement. The spatial emotions that each place evokes are captured in on site drawings and realised with water technique without the use of preliminary pencil drawing, which, all together, constitute scientific material for the development and promotion of the urban area. In the context of cultural heritage scenario, the value of emotional and suggestive approaches to the representation of views or panoramas is valuable: the process triggered by drawing has great potential to understand and convey the heritage and can generate processes of regeneration and long-term sustainable development.

Keywords: *hand-drawing; documentation; Matera heritage; vernacular; communication*

1. Introduction

The experience of knowledge and documentation through life drawing of the historical city centre of Matera was articulated within the core of the Sasso Barisano, Sasso Caveoso and the Civita, emblematic places due to the presence of the typical heritage in calcarenite: the *sassi*. The drawings aimed to capture the material and immaterial essence of the local architecture through personal watercolour studies and mixed graphic techniques produced by the researchers. Peculiar views of the urban spaces, conveying the preciousness of the limestone material of the vernacular sassi have been selected.

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The sassi are the ancient dwellings dug into the soft rock of the Murgia Materana, which for centuries have made up the urban fabric. Matera became a UNESCO heritage site in 1993, together with the Park of the Rock Churches. On a morphological level, the centre of Matera is enclosed to the east in the bed of the Murgia Materana and Gravina Park, where the river (Torrente Gravina di Matera) flows, while from north to south-west the modern city develops with contemporary urban expansion.

The map (Fig. 1) depicts the foreshortenings and perspectives in which the drawings were realised (by optic cones), throughout an itinerary performed in the heart of the historical centre, between the Sasso Barisano and Caveoso, with some overall views of the Civita, and the skyline dominated by the cathedral.

The itinerary, interpreted as an *observatory* in movement, creates direct relationships with people, involving the designer's senses with subjective and emotional perceptions (Lynch, 2006). It is the colour that plays a fundamental role in this expressive and perceptive, fluid, dynamic research based on the experiential knowledge of heritage through life drawing (Cullen, 1961). The drawings were produced using the watercolour technique, some of these in a monochrome version, other with different colours, focusing on specific details (Le Corbusier, 2002). Figure 2, shows the skyline of Civita overlooking the Dome, drawn in an ephemeral style, where the colour fades progressively from top to bottom (Itten, 2010).

Drawing from life forces us to pause and look carefully at details; it is a mental and physical action that stimulates and develops the primary cerebral processes behind all our activities (Arnhei, 1974). Since drawing is a universal language, it is understood by all cultures and fosters unity between them (Ching, 2014).

2. Objectives and methodology

As previously mentioned, this paper aims at reviving the historical importance of drawing by hand. Drawing is a cultural expressive form, (Giacomelli, 2014) unifying different cultures and a tool we use to represent the natural environment and the work of human hands.

Drawing from life facilitates the ability to appreciate the riches of our cultural heritage, often supported by a personal sketchbook, which allows the collection of the architect's visual and graphic perceptions (Jones, 2011).

One of the objectives of this proposal is to enhance the relationship between human beings, public assets of the historical sassi and the landscape of Matera. Both the natural and manmade environment is a precious resource for the population and cannot be ignored. Drawing from life can teach the community to understand, appreciate and develop this resource as well as facilitate a moment of reflection and research/action (Munari, 1977).

The methodological approach we are proposing, to disseminate the value of such rich heritage, is through participatory *Life Drawing* workshop. The scope of the activity is to teach participants to use drawing to fine–tune their ability to observe and analyse reality, preserving the beauty of Materan heritage (Chiavoni, 2012). The activity could be organized by the University or by the Municipality to encourage populations and visitors to engage within the heritage of Matera. Thanks to the numerous experiences of academic initiatives proposed by the researchers over time and based on the workshop held in 2023 in Matera between University of Sapienza in Rome and University of Basilicata, Faculty of Architecture, it has been possible to trace a methodological proposal. This experience witnessed the strength of drawing which activated different critical readings on urban space, architecture, materials and immaterial assets of the historical centre of Matera (Maestro, 2012).

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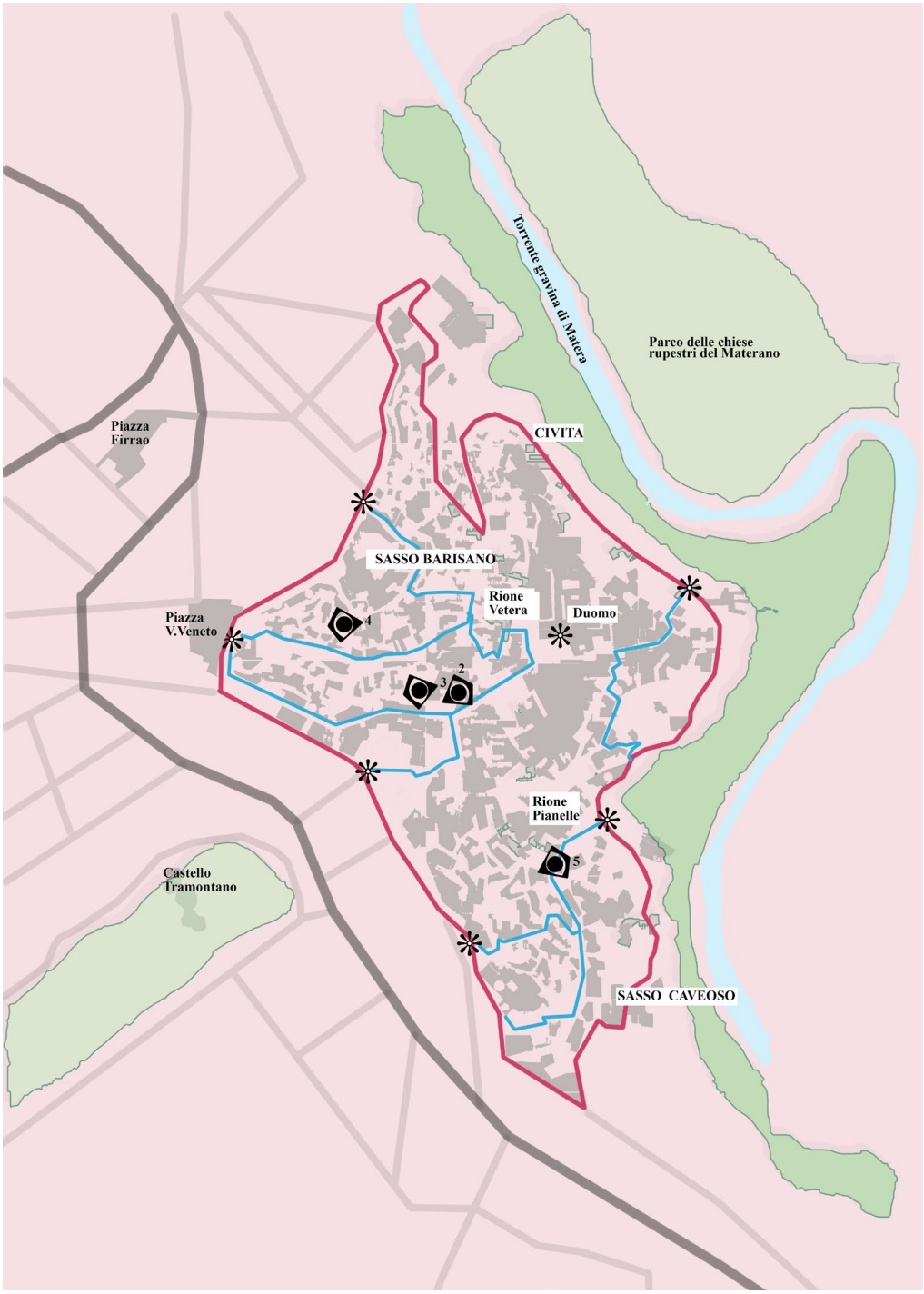


Fig. 1 – *Map of Matera and key itinerary points* (De Santis, 2025).

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Fig. 2 – *Watercolour of Matera* (De Santis, 2023).

Therefore, numerous activities, seen as educational itineraries and workshops involving drawing from life can be organised for small groups of participants. The work will be divided into simplified and advanced educational laboratories which facilitate the illustration and taught drawing from life basic rules, formal criteria of proportion and geometry, as well as issues inherent perspective's rules (Migliari, 2004).

3. Results

Representation methods and drawings produced during the hands-on activities will be digitally disseminated: presentations, screenings, short films, videos, video clips, documentaries (Albisinni, 2002).

An essential aspect of this research stands in the possibility to compare the critical approach of each researcher through life drawing activities. Indeed, the applied methodology allowed to capture different nuances and interpretations related to the study of Matera's heritage, highlighting intangible values through drawings that otherwise could not have been traced (Ackerman, 2003).

One example is the overall view of the stones captured from a panoramic terrace overlooking the maze of narrow streets in the centre of Matera. In addition, many drawings show also an abstract view enhancing certain aspects of the vernacular sassi. In figure 3, a monochromatic watercolour focuses on architectural elements, such as the arches and small openings characterizing the vernacular structure of sassi. Figure 4 shows the dynamic movement of the architecture of these beautiful calcarenite textured caves, using wide blank areas and irregular traits (Eco, 2013).

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Fig. 3 – *Details of Sassi* (De Santis, 2023).



Fig. 4 – *Details of Sassi* (De Santis, 2023).

One of the expected results is to digitise the drawings and insert them within a virtual route generated by *My Maps app*. The service allows the creation of online Google maps, helping users to customise a route, insert icons, attach photographs, add lines or GPS tracks and organise the map into layers. The service also allows maps to be shared and exported in formats compatible with qGis or Google Earth through the export of kml formats.

A main path can be identified and travelled through a '*slow itinerary*', where singular cases of historical heritage have been identified and linked to significant viewpoints. Figure 5 shows the complex pattern of sassi, vegetation and a narrow staircase located at the foot of the rupestrian church of Madonna de Idris. The watercolour could be associated to the digital itinerary proposed on Mymapps and then visualized by the user on its smartphone.

Here, some sensitive representations of the city are shown, realized during the performed journey; townscapes in watercolor both in monochrome and color reveal the intangible values of the places (Figs. 6–10). These drawings stand as privileged frames of Matera and illustrate the urban complexity of nature and artifice, landscape and built heritage (Morlacchi, 2008, 2015).

The different critical graphic interpretations constitute a fundamental documentation for the acknowledgement of such articulated and



Fig. 5 – *Details of Madonna de Idris* (De Santis, 2023).

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valuable cultural heritage and suggest its enhancement (Pelosi, 2016). Through direct observations, quick and simplified sketches allow us to understand not only the geometric, structural and formal aspects of urban space but also the intimate and hidden valences (Fig. 11).



Fig. 6 – *Watercolour of Matera* (Emanuela Chiavoni, 2023).



Fig. 7 – *Watercolour of Matera* (Emanuela Chiavoni, 2023).



Fig. 8 – *Watercolour of Matera* (Emanuela Chiavoni, 2023).



Fig. 9 – *Watercolour of Matera* (Emanuela Chiavoni, 2023).



Fig. 10 – *Watercolour of Matera* (Emanuela Chiavoni, 2023).



Fig. 11 – *Watercolour of Matera* (Emanuela Chiavoni, 2023).

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Drawing from life, whether freehand, line or with a brush, allows people to relate to the urban environment and triggers a unique and non-transmissible process of awareness (Brandi, 1960). Through watercolor representation, carried out without the basis of pencil drawing, one can learn the contrast between light and shadow in buildings, to better identify the volumetrics, and, as in this case, even the most complex ones.

4. Conclusions

One of the future goals will be to disseminate the digital maps created to local authorities and other public agencies involved in heritage management and transmission on open access portals. From life drawing campaigns will derive narratives, sensitive graphics, analogical, which can be subsequently processed and digitally post produced.

All representations will converge into a digital archive (Steiner, 2009) which documents material and immaterial values of Matera. It can be navigated and always implemented with other *'sensitive'* representations (Bruno, 2006).

Drawings, including freehand sketches and preliminary visual graphic notes of the perceptual itinerary, will converge in the digital archive to show the entire process carried out through the time. The archive will therefore become a meaningful tool of knowledge of the city of Matera, sharing a new analogic methodological approach.

It stores the graphic qualities of an outstanding example of vernacular historical heritage. Moreover, it can also be enjoyed in a dynamic mode with the possibility of comparing different representations of the city thanks to the drawings it preserves.

The ultimate scope of this contribution has been to underline the value of sensitive hand drawn watercolor techniques to depict the peculiarities of historical vernacular heritage, adopting scientific and critical analogic approaches to representation. As architects, we believe that life drawing could strongly support a thorough understanding of the urban pattern and acknowledgment of heritage's values (Smith, 2005; Robbins, 1994). In conclusion, the application of analogic means of representation for onsite research has proved to be an effective and valuable tool of knowledge, expanding the perception of built environment and thus worth to be adopted for future research.

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Mapping the Urban and Rural Character of Historic Sites in Spain through a Digital Database

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Topic: T3.1. Studies of historic urban and rural areas

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Abstract

In Spain, the Historic Site was the first accepted typology that included protection of architectural heritage in a global and integrating way. This fact inspired the creation of a digital database with all the historic sites in Spain, 733 in total, called "Spanish Historic Site Database". It is a rigorous and innovative tool that, for the first time, compiles all the parameters related to these cultural assets, while also enabling the identification of the most pressing issues concerning their protection. This study focuses on one of these parameters, the urban or rural character of historic sites, and establishes a system of classification according to this condition. In this respect, all of them have been identified and sorted by Autonomous Regions and by their own character through the review of data from official Spanish agencies. These findings are presented in the form of tables, a map and a detailed analysis, showing a clear predominance of rural over urban areas and a homogeneous territorial distribution. This research establishes a system of classification of Historic Sites depending on their rural or urban character.

Keywords: *historic site; cultural heritage; urban sites; rural sites; heritage protection; database*

1. Introduction

The protection of cultural heritage, as a scientific discipline, began to consider the importance and conservation of historic sites in the mid-20th century. Up to this point, protection had focused primarily on the care of monuments and archaeological sites; however, the devastation of the Second World War shifted the focus to the protection of historic centres. In this regard, it is necessary to highlight the *Convention for the Protection of Cultural Property in the Event of Armed Conflict with Regulations for the Execution of the Convention* (1954) and the *Convention concerning the Protection of the World Cultural and Natural Heritage* (1972), which represented a qualitative leap in the field of cultural heritage conservation. On the one hand, "for the first time in history, the principles on which experts had debated for nearly a century became the subject of an international system" (Bandarin & Van Oers, 2014); on the other hand, a specific definition of 'groups of buildings and sites' was proposed and, in addition, specific guidelines for historic towns and city centres were provided. Fifteen years later, the *Charter for the Conservation of Historic Towns and Urban Areas* (1987), included methods and instruments for planning and action in historic cities. Furthermore, it proposed multidisciplinary work in such planning, requiring analysis of archaeological, historical, architectural, technical, sociological and economic data in conservation plans.

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As early as the 1990s the *European Urban Charter* was adopted by the Council of Europe's Congress of Local and Regional Authorities. It main purpose was to provide practical urban management advice for local authorities and citizens alike. In respect of historic centres, they are fully defined and there is a strong defense of their relevance for society, along the lines of their predecessor, the *European Charter of the Architectural Heritage* (1975). In terms of heritage protection, this very positive vision of historic sites reached at the end of the century was, certainly, a step forward.

Nevertheless, we must not forget that all the documents discussed are the result of international meetings; hence, they were intended as recommendations, not mandatory rules, to include the principles in their heritage and urban policies. Since that time, each country has developed its own strategy and set of instruments for integrated heritage management.

In Spain, the Historic Site (*Conjunto Histórico*) was the first accepted typology that included protection of architectural heritage in a global and integrating way. From 1929, the year of the first declarations of historic towns, until the end of the 20th century, the Historic Site was the only heritage management instrument used in order to protect the territory and its cultural assets. Consequently, their presence in this country is more than notorious and represents one of the most important heritage typologies because of its historic, artistic, social, urban planning and tourist dimensions. This fact inspired the doctoral thesis entitled 'The history of protection of Historic Sites in Spain' (2022), whose general objective was the scientific and rigorous evaluation of this heritage typology.

On the one hand, this study includes a theoretical analysis of the legal development of historic sites. On the other hand, a database presents all the parameters relating to this typology: year of declaration, geographical border, urban planning, inclusion on the 'World Heritage List' and a classification into urban and rural sites. This issue, the urban or rural character of historic sites, is precisely the one that is analysed in this study.

2. Objectives and methodology

This research proposes a rigorous study of the character of the Spanish historic sites in accordance with heritage needs, with the ultimate aim of fulfill the parameters of analysis necessary for their study through the following objectives:

- To classify historic sites as urban or rural.
- To assess the rural or urban trend of historic sites of the Spanish Autonomous Regions.
- To map urban and rural historic sites.

The starting point for this study was the creation of a digital database with all the historic sites in Spain, 733 in total, called *Spanish Historic Site Database.* It is a rigorous and innovative tool that, for the first time, compiles all the parameters related to historic sites, while also enabling the identification of the most pressing issues concerning their protection. In the course of the research, the urban or rural character of historic sites was identified as one of the parameters to be taken into account. Therefore, it was essential to find a suitable method for determining whether a historic site should be considered rural or urban. In this respect, it has been very important to review the data from official Spanish agencies, such as the Ministry of Housing and Urban Agenda or the National Statistics Institute. Then, the rural or urban condition of the 733 historic sites was identified, one by one, and recorded on the *Spanish Historic Site Database.* Finally, a map of Spain was designed with all the historic sites ordered by color according to their rural or urban character.

3. Results and discussion

Article 15 of the *Spanish Historical Heritage Act 16/1985*, defines the Historic Site as a grouping of immovable assets forming a unit of settlement. The variety of settlement units referred to is not

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specified, although it is known that these could traditionally be either urban or rural in character; in fact, five regional acts.[1] have incorporated in their own definitions that the groupings that make up a historic site can be urban or rural.

In order to establish the rural or urban trend of historic sites, it is first necessary to analyse the overall situation of the different municipalities in Spain.

3.1. Spain, a rural country with large urban areas

To classify a place according to its territorial entity (province capital, city, village, hamlet, etc.) is straightforward, because of it is sufficient to consult the *Register of Local Institutions (REL)* of the National Statistics Institute. However, classifying an area as rural or urban is a difficult task. Traditionally, two criteria are used: typology according to population size or typology according to population density. Nevertheless, in recent years, many experts have pointed out the imprecision of these classifications, as they only focus on demographics, leaving aside the character of the different areas and numerous factors that condition the classification of a place as urban or rural. For instance, economists focus on functional definitions based on economic variables (income, production, employment, etc.); by contrast, ecologists and environmental scientists tend to emphasise the characteristics of the landscape and the natural environment. In conclusion, "there is no universally accepted definition of rural area" (Reig et al., 2016). This means that, depending on the country or institution conducting the study on whether an area is urban or rural, the parameters to be taken into account and the methodology differ.

In order to find the most objective and specific method possible, the data have been obtained from the *Digital Atlas of Urban Areas* of the Spanish Ministry of Housing and Urban Agenda, which takes into account parameters based on population statistics, housing and territorial structure statistics and urban dynamics. As far as rural areas is concerned, of the 8131 Spanish municipalities, 6955 belong to this category (Table 1). This indicates that Spain is a predominantly rural country, although in recent years, the number of rural municipalities has decreased whereas the number of small urban areas has increased.

Table 1 – *Urban and rural municipalities in Spain* (Castellón Valderrama, 2025).

	2020	**2023**
Large urban areas	755	755
Small urban areas	322	381
Rural areas	7054	6995

3.2. Urban and rural historic sites in Spain

Bearing this in mind, it is to be expected that most of the Spanish historic sites also fall into the rural category, however, before entering into such an analysis, it is necessary to consider a few questions. On the one hand, the majority of historic sites correspond to the old town or historic centre of a city, but, some of them are located in small localities, villages and even hamlets. On the other hand, during the 20th century, some cultural assets were declared as historic sites, but they do not correspond to the current definition of this typology, for instance, archaeological or industrial sites.

According this approach, of the 733 historic sites identified, 725 have been taken into account for classification as large urban area, small urban area or rural area, as they appear in the *Digital*

[1] Historical Heritage of Andalucía Act 14/2007, Historical Heritage of Illes Balears Act 1/2005, Cultural Heritage of Canarias Act 11/2019, Historical and Cultural Heritage of Extremadura Act 3/2011 and Historical, Cultural and Artistic Heritage of La Rioja Act 7/2014.

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Table 2 – *Urban and rural Historic Sites in Spain* (Castellón Valderrama, 2024).

	Total	Large urban areas	Small urban areas	Total urban areas	Total rural areas
Municipalities	8131	755	381	1136	6995
% of total municipalities		9.28%	4.69%	13.97%	86.03%
Historic sites	725	165	51	216	509
% of total historic sites		22.76%	7.03%	29.79%	70.21%

Atlas of Urban Areas. The remaining 8 historic sites correspond to industrial sites such as "Minas de la Reunión", or cultural heritage routes such as "El Camino de Santiago" or "Vía de la Plata". As a result, the division of urban and rural areas in Spain can be compared with the same situation applied to historic sites (Table 2).

By comparison, we observe a predominance of rural areas in Spain, with 86.03% of municipalities. However, when focusing on historic sites, this percentage drops to 70.21%, indicating that, particularly in certain regions, this typology is more closely associated with cities. As can be seen, with regard to historic sites, the general trend is maintained, in that most of them are located in rural areas, although not by such a difference.

Thus, the percentage of urban historic sites has doubled with respect to the total number of urban municipalities, rising from 13.97% to 29.79%. This condition, and its geographical correspondence, can be seen at a glance in the map that classifies the Spanish Historic Sites according to their urban or rural character (Fig. 1). This map shows that in the southern part of the Iberian Peninsula and in the Archipelagos the number of urban historic sites, whether in large or small areas, increases considerably. Besides, this figure shows the large population centres and the so-called 'España vaciada', empty Spain.

For the purpose of knowing more precisely the distribution of historic sites in urban or rural areas, the specific data by Autonomous Regions are shown (Table 3), which range from 25% of rural sites in Murcia to 90.91% in the case of Extremadura, which gives a national average of 70.21%. From here, it can be seen that seven Regions exceed this average: Aragón, Cantabria, Castilla-La Mancha, Castilla y León, Cataluña, Extremadura and Navarra. Whereas, in the rest of the Autonomous Regions, the presence of historic sites in urban areas is beginning to be greater, even becoming predominant or equal in the cases of Canarias, Madrid, Murcia and Comunidad Valenciana[2].

In general terms, there is a clear correspondence between the character of the historic sites of an area and the total number of municipalities that comprise it, so it is not surprising that the historic sites of Extremadura, Cantabria, both Castillas and Navarra are overwhelmingly rural.

This same trend is found in the Autonomous Regions with a high number of urban historic sites, for example, Canarias or Comunidad Valenciana, which translates into a predominance of urban especially on its coast, are essentially urban, historic sites in these areas. Nevertheless, there is one exception to be taken into account, which is also clearly shown on the map of historic sites: Cataluña.

[2] Ceuta and Melilla are urban areas, but as they are autonomous cities and not Autonomous Regions, they have not been mentioned in this reference, although they have been taken into account in the data collection.

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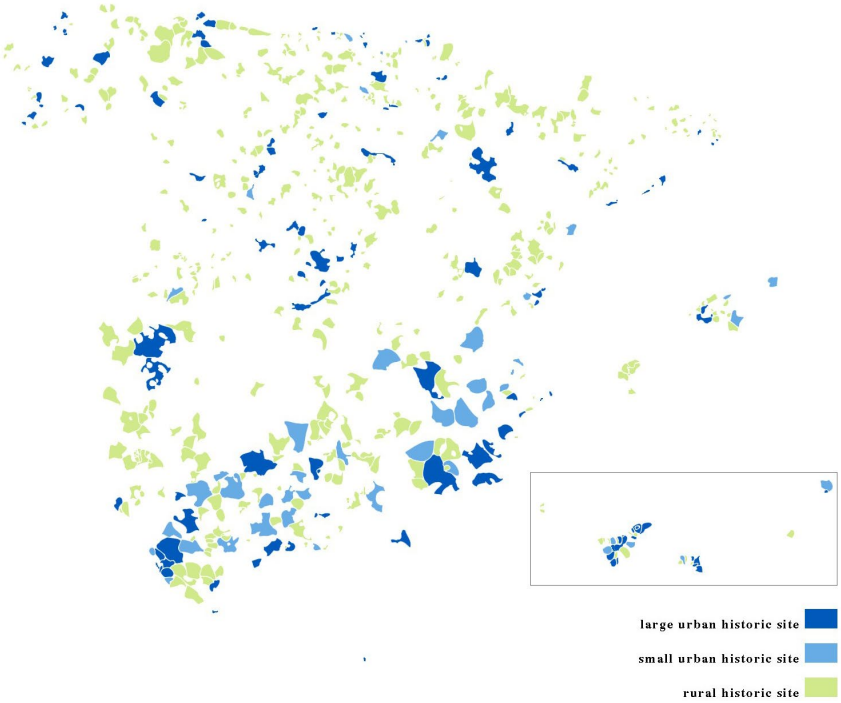


Fig. 1 – *Historic Sites in Spain* (Castellón Valderrama, 2025).

This Region has a large urban area comprising a high number of municipalities, however, the historic sites declared in Cataluña are not located in this area, but are located especially in the interior of the Community, with 44 rural historic sites out of the 14 urban ones registered.

4. Conclusions

The conducted analysis of the historic sites has shown the great presence of this typology of protection in Spain, being the most important one in terms of architectural assets. In this respect, its homogeneous territorial distribution has also been demonstrated. Furthermore, this research establishes a system of classification of historic sites depending on their rural or urban character. For this purpose, the *Spanish Historic Site Database* has been key, since it represents a primary source of information, establishes a shared operational methodology and sets priorities with the aim of protecting and preserving this heritage assets. Thus, all Spanish historic sites have been identified and sorted by Autonomous Regions and by their own character. Consequently, the number of urban and rural areas has been identified with a clear predominance of rural over urban sites. However, despite this predominance of rural sites, urban historic sites account for a higher percentage than urban municipalities, with 29.79% and 13.97% respectively. In this regard, it has also been shown that the Autonomous Regions with the largest urban areas have the largest number of urban historic sites, with the exception of Cataluña, which has a greater number of rural historic sites.

As a result, all these aspects are represented in the map of historic sites, which classifies them according to their location: within a large urban area, a small urban area, or a rural area. Furthermore, this map serves as a consultation tool accessible to the general public, as it is easy to understand. In a single image, it is possible to

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Table 3 - *Urban and rural Historic Sites in Autonomous Regions* (Castellón Valderrama, 2024).

	Historic sites	Large urban areas	Small urban areas	% total urban areas	Rural areas	% rural areas
Andalucía	122	20	18	31.15%	84	68.85%
Aragón	50	6	-	12%	44	88 %
Asturias	25	8	-	32%	17	68 %
Baleares	33	7	3	30.30%	23	69.70%
Canarias	48	22	9	64.58%	17	35.42%
Cantabria	27	6	1	25.93%	20	74.07%
Castilla-La Mancha	42	4	4	19.05%	34	80.95%
Castilla y León	123	16	2	14.63%	105	85.37%
Cataluña	58	13	1	24.14%	44	75.86%
Ceuta	5	5	-	100 %	-	0 %
Extremadura	33	2	1	9.09%	30	90.91%
Galicia	38	13	-	34.21%	25	65.79%
La Rioja	9	3	-	33.33%	6	66.66%
Madrid	22	11	-	50 %	11	50 %
Melilla	1	1	-	100 %	-	0 %
Región de Murcia	12	6	3	75 %	3	25 %
Navarra	15	2	1	20 %	12	80 %
País Vasco	28	8	2	35.71%	18	64.29%
Comunidad Valenciana	34	12	6	52.94%	16	47.06%
TOTAL	725	165	51	29.79%	509	70.21%

clearly observe the outcomes of this study: the predominance of historic sites as a typology for heritage protection, the distribution of the 733 Spanish historic sites, and whether they are situated in urban or rural areas. Finally, it is important to highlight the significance of this factor within the town planning legislation of each locality. According to *Spanish Historical Heritage Act 16/1985*, all historic sites must have a 'Special Protection Plan' specifically designed for them. Therefore, understanding whether a historic site is rural or urban is a key factor in the development of its corresponding 'Special Protection Plan'.

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Physical and Social Vulnerability to Heat Waves in Rural Communities with Vernacular Architecture: Villages in the Montesinho Natural Park (Portugal) as a Case Study

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Abstract

Vernacular architecture in depopulating rural areas faces critical challenges due to climate change, particularly with the rise in extreme events like heat waves. These events threaten the conservation of buildings and the well-being of their inhabitants, especially in regions undergoing demographic decline and an aging population. The sustainability of these structures, built with traditional materials and techniques, raises important questions about their ability to withstand current and future conditions especially in dry and warm climates. This study explores the combined physical and social vulnerability of vernacular buildings exposed to heat waves, focusing on how architectural and sociodemographic factors influence the resilience of these structures and their inhabitants. Using a vulnerability index-based methodology and an on-site data collection, vulnerability levels across a variety of vernacular buildings and vulnerable households have been identified. The results emphasize how passive design features can help to mitigate the effects of extreme heat. At the same time, social factors worsen vulnerability, particularly for aging and low-income populations—common characteristics of many depopulating rural areas. This research underscores the importance of protecting the cultural and functional value of vernacular architecture, positioning it not only as a component of rural identity but also as a critical resource for climate adaptation.

Keywords: *vulnerability assessment; rural depopulation; vernacular architecture; heatwaves*

1. Introduction

In recent decades, climate change and rural depopulation have threatened the resilience of rural communities, especially in vulnerable Mediterranean regions. Rising temperatures have intensified heatwaves, posing health risks (Ballester et al., 2023), and affecting the built environment. Vernacular architecture in rural areas, made with traditional materials and techniques, is often prepared for local climate, but the increasing extreme natural events related

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to heat, can accelerate their deterioration compromising structural, aesthetic, and historical values (Intergovernmental Panel on Climate Change (IPCC), 2023). As a key part of rural identity, many of these buildings were designed for past climates, raising concerns about their ability to ensure comfort and safety nowadays.

Rural areas are also affected by depopulation, a phenomenon that diminishes the capacity of these communities to address environmental challenges, leading to the loss of human capital, traditional knowledge, and adaptive capacity. In the Mediterranean region, this trend poses a significant threat to the social and economic fabric of rural communities. The exodus of working-age individuals results in an aging population, a reduced labour force, and the decline of essential services. This demographic shift intensifies existing vulnerabilities, making these communities particularly susceptible to the impacts of climate change. Moreover, the erosion of traditional knowledge, social networks, and economic opportunities, especially in contexts lacking robust socioeconomic revitalization strategies, further undermines their ability to adapt and recover from environmental hazards, perpetuating a cycle of vulnerability (Graus et al., 2024).

Understanding vulnerability is essential for evaluating how communities and their environments cope with climate-induced hazards, and for developing effective strategies (Tate, 2012). Social vulnerability reflects susceptibility to harm based on demographic, economic, and inequality factors, while physical vulnerability measures how well the built environment withstands climatic impacts. Although extensive research has examined these topics independently, there is a notable gap in studies that holistically integrate both aspects particularly in rural settings characterized by traditional vernacular architecture and ongoing depopulation.

This study presents an integrated vulnerability index for rural settings, assessing the social and physical vulnerability of vernacular buildings and their inhabitants to heatwaves through key indicators. By combining both indices, it seeks to be a tool to identify vulnerability hotspots and guide targeted interventions against extreme heat. The research is conducted in two villages within Montesinho Natural Park (MNP) in northern Portugal, a case study within the INHAVIT project, which is aimed at promoting sustainable strategies for rehabilitating cultural built heritage in the park (FCT, 2021).

2. Methodology

The parameter-based index developed in this study integrates two critical components to assess vulnerability to heatwaves: the physical vulnerability of vernacular housing and the social vulnerability of its inhabitants. Integrating social and physical vulnerability assessments provides a more comprehensive understanding of risk during heatwaves. This holistic approach recognizes that the impact of extreme heat is not solely determined by a building's physical properties but is also deeply influenced by the socio-economic conditions of its residents. This interaction enables the development of a robust index that reflects the intertwined nature of human and built environment vulnerabilities, offering valuable insights for targeted interventions in rural depopulating areas. The methodology is structured into three main phases: (i) Framework Development, (ii) Fieldwork and Building Assessment, and (iii) Vulnerability Analysis.

2.1. Framework development

2.1.1. Selection and definition of indicators

Both social and physical vulnerability parameters were selected based on established frameworks from earlier studies, but field observations helped to identify context-specific indicators.

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For the physical component nine indicators were selected to assess the performance of building envelopes against overheating during heatwaves: (P1) Building Height, (P2) Building Age, (P3) Wall Material and Thickness, (P4) Roof Material, (P5) Location and Window-Wall Ratio, (P6) Type of Window, (P7) Shading, (P8) Wall Exposure, and (P9) Surrounding Vegetation. Similarly, for the social component 15 indicators were selected and organized into three dimensions: (D1) Vulnerable Groups, comprising (P1) Age Range, (P2) Gender, (P3) Special Needs, (P4) Household Composition, and (P5) Social Services; (D2) Socioeconomic Status, comprising (P6) Job Status, (P7) Unemployed Member, and (P8) Income Range; and (D3) Social Capacities, comprising (P9) Education Level, (P10) TV/Radio Ownership, (P11) Internet Access, (P12) Awareness Program Participation, (P13) Support Network, (P14) Telephone Ownership, and (P15) Car Ownership. This consistent selection approach, grounded in established literature and field observations, ensures that both sets of indicators are well-tailored to capture the multifaceted nature of vulnerability in rural Mediterranean settings.

2.1.2. Field instruments design

Two types of survey instruments were designed for in situ data collection, integrating selected parameters for social and physical vulnerability while incorporating additional items to capture local context. Physical surveys recorded building characteristics, including construction materials, conservation state, accessibility, and basic services. Data on building envelope performance against overheating was systematically collected using an online tool for real-time geotagged documentation. Social surveys gathered information on demographics, economic status, and community participation from residents in MNP. Questions covered age, gender, employment, income, education, and local support networks. Before application, both instruments underwent rigorous revision, pilot testing, and validation to ensure clarity and effectiveness, enhancing their clarity for field researchers and local respondents, ensuring reliable data for analysis.

2.1.3. Weighting process of parameters

To determine the relative importance of each parameter for the index construction, both social and physical vulnerability parameters were weighted using the Analytic Hierarchy Process (AHP) (Saaty, 1987). This process involved conducting online surveys with expert groups, who performed pairwise comparisons between parameters based on their perceived contribution to vulnerability. Experts rated the importance of one parameter over another using a scale from 1 to 9, where 1 indicated equal importance, and 9 signified extreme importance of one factor over the other. The responses were then processed to generate a weight matrix, ensuring consistency in the assigned values. For both components (physical and social) the final weights were obtained by averaging expert responses. This approach ensured that the index accurately reflected expert judgment while maintaining a systematic and transparent weighting process.

2.2. Fieldwork and building sssessment

2.2.1. Study area

The study was conducted in two depopulating rural villages within Montesinho Natural Park (MNP) in Portugal, a region characterized by an aging population, economic decline, and vernacular architecture at risk of deterioration. These conditions make the area particularly vulnerable to climate hazards such as heatwaves, wildfires, and floods. The selection of the villages was based on demographic decline, building conservation state, and community willingness to participate. Prior research efforts and visits to the case study for recognition and

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characterization of the built environment (Arias Tapiero et al., 2024), facilitated the identification of representative villages for a detailed vulnerability assessment. Multiple field visits were conducted to collect both social and physical vulnerability data, ensuring an integrated understanding of the challenges faced by local communities and their built environment.

2.2.2. Data collection procedure

Fieldwork combined several methods to assess both physical and social vulnerability. Physical vulnerability was evaluated by characterizing vernacular buildings on-site, documenting materials, structural systems, and condition. A cloud-based application enabled a georeferenced digital inventory with photos and videos, while drone surveys provided photogrammetric data to analyze structural conditions and spatial relationships. Social vulnerability was assessed through household surveys, collecting demographic, economic, and community participation data. Despite challenges such as remoteness, limited internet, weather variability, and fluctuating resident availability, the use of digital mapping tools, drones, and structured surveys ensured a systematic and comprehensive assessment of vulnerability in these depopulating rural communities.

2.3. Vulnerability analysis

Once collected, the data underwent systematic digitalization and structuring to facilitate analysis. The datasets were initially processed separately, ensuring that each dataset retained the specificity of its respective parameters. Physical vulnerability data was organized by parameters related to building envelope and social vulnerability data, was categorized into three sub-indices: vulnerable groups, socioeconomic status, and social capacities. To enable a comparative and integrated analysis, both datasets were later standardized to a common scoring system. To calculate the sub-indices, each vulnerability component (physical and social) was assigned a sub-index based on the weighted aggregation of its respective parameter scores.

For the Physical Vulnerability Index (PVI), all nine parameters were considered individually. A score from 1 (low vulnerability) to 4 (very high vulnerability) was assigned to each parameter based on its contribution to vulnerability. These scores were then multiplied by their respective AHP-derived weights and summed up to generate the component index. The Social Vulnerability Index (SVI) consists of three dimensions (vulnerable groups, socioeconomic status, and social capacities), each containing a set of parameters. Similarly, a score from 1 (very low vulnerability) to 5 (very high vulnerability) was assigned to each parameter. Then each score was multiplied by its assigned weight and aggregated to form a sub-index for each dimension. The final Social Vulnerability Sub-Index (SVI) was then computed by weighing and summing the dimensions' sub-indices. Finally, the Integrated Index Framework (IV) aimed to combine the components into a single measure, applying a multiplicative approach: $IV = PVI \times SVI$. In this case, social vulnerability acts as an amplifier of physical vulnerability, reflecting the idea that households with high social vulnerability (e.g., elderly populations, low-income households, lack of support networks) are less able to adapt to poor building conditions, increasing their overall risk during heatwaves. To map the distribution of vulnerability across the study area, GIS tools were employed.

3. Results and discussion

3.1. Physical vulnerability of buildings

The analysis categorizes buildings into five risk levels: very low, low, medium, high, and very high. In Village 1 (Fig. 1), most buildings (58.8%) fall under the medium vulnerability

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category, while 33.3% exhibit low vulnerability. Only 7.8% of the buildings are classified as highly vulnerable. Conversely, in Village 2, the vulnerability distribution indicates a higher proportion of buildings at elevated vulnerability levels. A 64.5% majority of buildings are classified as medium vulnerability, followed by 21.5% in the high vulnerability category.

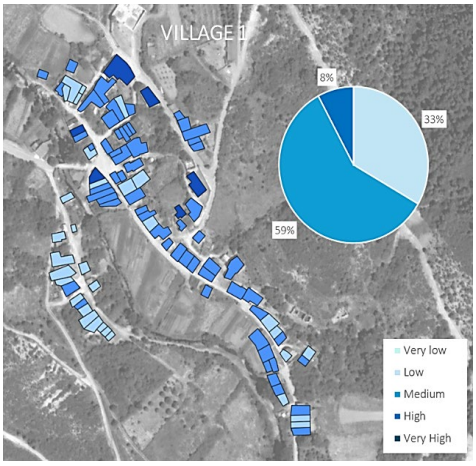


Fig. 1 – *Spatial representation of the Physical Vulnerability Index in village 1.*

The results indicate that while most buildings in both villages fall into the medium vulnerability range, Village 2 has a higher proportion in the high vulnerability category. In Village 1, the most critical factors were building age and shading, suggesting poor energy efficiency due to older structures lacking thermal regulations and insufficient shading increasing heat exposure. Roof materials and wall exposure had a lesser but notable impact. In Village 2, vulnerability was influenced by building age, roof material, window type, and shading. Absorptive roof materials increased heat retention, while poorly insulated windows allowed more heat infiltration. Limited shading further exacerbated thermal stress. While both villages share key risk factors, Village 2 exhibits a broader range of vulnerabilities.

3.2. Social vulnerability of buildings

The analysis (Fig. 2) highlights that Village 1 exhibits the highest levels, with 80% of its population classified as highly or very highly vulnerable. This reflects a combination of demographic, economic, and societal challenges. Village 2 shows lower vulnerability, with 40% of its population falling into the low vulnerability category. The remaining 60% of Village 2's population falls within the medium vulnerability range, indicating better resilience compared to Village 1.

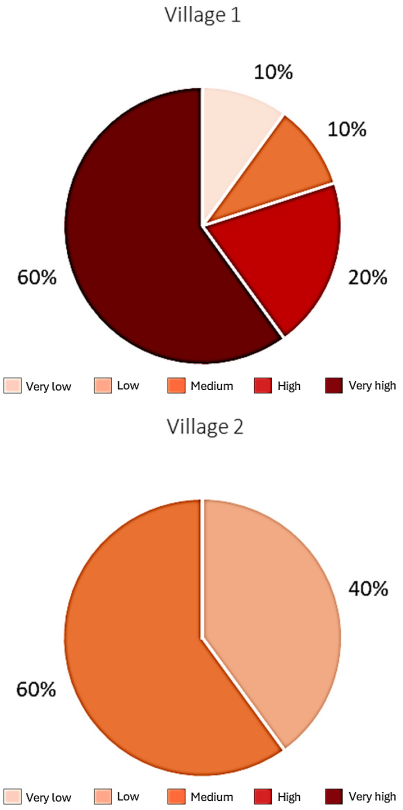


Fig. 2 – *Spatial representation of the Social Vulnerability Index in village 2.*

From a dimensional perspective, Village 1's high vulnerability stems primarily from its aging population (D1) and economic instability (D2). A significant portion of the population is over 65

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years old, often living alone or in elderly-only households, increasing risks related to mobility limitations and social isolation. Additionally, approximately 70% of Village 1's households experience high socioeconomic vulnerability, largely due to a dependence on pensions and limited economic opportunities. Village 2 presents a different vulnerability profile. While it also has a substantial elderly population, it benefits from a more stable economic environment, partially supported by small-scale tourism and foreign residents. However, societal cohesion remains a challenge, as new residents have not fully integrated into the local community, leading to weak social networks and limited communal support in times of crisis.

3.3. Integrated vulnerability analysis

The integrated vulnerability assessment, obtained by combining the Physical Vulnerability Index (PVI) and the Social Vulnerability Index (SVI), reveals a predominance of very low vulnerability in both villages. In Village 1, 91.2% of buildings fall into the very low vulnerability category, with 2.9% classified as low and 5.9% as medium. No buildings were identified in the high or very high vulnerability categories. Similarly, Village 2 exhibits 90.7% of buildings in the very low vulnerability category, while 8.4% are classified as low and only 0.9% as medium, with no buildings in the high or very high categories.

These results suggest that despite the high social vulnerability identified in Village 1, the low physical vulnerability of its built environment mitigates overall risk levels. This could be attributed to the persistence of vernacular construction techniques, which prioritize local materials and passive cooling strategies, enhancing the resilience of buildings to environmental stressors. In contrast, Village 2, which exhibits lower social vulnerability and a slightly higher proportion of buildings in the low vulnerability category, appears to benefit from economic factors that support building maintenance and adaptive reuse.

The presence of foreign residents and tourism-related activity may contribute to better upkeep and rehabilitation efforts, reducing deterioration despite long-term demographic decline. The absence of high and very high vulnerability buildings in both villages suggests that structural resilience plays a crucial role in mitigating overall vulnerability, even in areas facing depopulation. However, the differences in the



Fig. 3 – *Spatial representation of the Integrated Vulnerability Index in village 1 and 2.*

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proportion of low and medium vulnerability buildings indicate that economic activity and demographic composition also influence the extent to which communities can maintain their built environment over time.

4. Conclusions

Although certain physical and social parameters show elevated levels of vulnerability in both villages, the integrated vulnerability remains predominantly low or very low. This suggests that, despite the presence of structural and sociodemographic risk factors, these do not combine significantly enough to result in critical levels of vulnerability in absolute terms. However, the identification of specific physical and social parameters with a higher incidence highlights the need for differentiated mitigation strategies. Improvements in infrastructure, support programs for vulnerable groups, and rural revitalization policies could further strengthen the resilience of these communities in the face of future environmental and sociodemographic challenges. This work serves as an initial step in profiling the vulnerability of these rural communities, helping to identify the most vulnerable individuals and areas. By doing so, it aims to inform the development of targeted strategies that can be refined and adapted over time to enhance resilience and promote long-term sustainability.

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Re-naturalizing Minor Centers with Strong Historical Connotations: Strategies and Technologies

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Abstract
The new 2020 Leipzig Charter, which is shaping European policies for integrated and sustainable urban development, recognizes rural areas' functional role for cities. "Marginal" areas play a decisive role in reinventing a climate change-aware and ecologically sustainable development model, resilient to imbalances caused by the prevalence of the built environment over nature. This has led to soil, river, and coast fragility. The paper addresses the issue of regenerating places through soft blue/green actions (urban greening and technologies for a circular water pathway), which adapt the urban environment to ongoing climate change while aiming to improve the livability of urban spaces. The design hypotheses deal with the physical and intangible characters and specificities of these contexts that impose an attitude of minimal invasiveness, preservation, and respect for architectural and urban values. The text cites case studies and proposals for targeted actions that consider combined solutions for re-naturalizing minor Sicilian urban centers with relevant historical-architectural peculiarities. Minor centers have an inherent vocation for constant human-nature exchange. This is proven by the history of their settlement, which often suffices to evoke the ancient knowledge and techniques lost over time.

Keywords: *rural areas; urban valorization; urban space rehabilitation; sustainable development*

1. Introduction

Inner areas have dealt with demographic and economic decline over the past decades and now stand as marginal areas. Moreover, these areas have kept a strong resilience toward human intervention and uncontrolled urbanization phenomena. This preserved their architectural and landscape heritage, still largely characterizing the quality of urban public space. European policies such as the Green Deal and contemporary movements such as the New European Bauhaus suggest redesigning our cities from a both climate-neutral and human-centered perspective (European Union, 2022). The importance of people-friendly cities is also making small and medium-sized towns and villages new sustainable models. The new 2020 Leipzig Charter recognizes rural areas' functional role for cities, and these can be pleasant places to live again (Risi et al., 2020). The features of some urban centers with strong historical connotations are still evident and appreciable today and can be reevaluated as *smartness*. This *smartness* derives from both physical and cultural centuries-old stratification, of which small towns, customs, and traditions are the most immediate sediment

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(Pinto, 2022). In minor centers, regenerating means finding new ways to augment natural resources, much more present than in cities. Inner areas play a decisive role in reinventing a climate change-aware development model, resilient toward the imbalances caused by the prevalence of the built environment over nature.

The green economy and the circular economy have restored the importance of the balance with natural dynamics, which were the guiding principles of the rural economy. Quality of life standards and demands have changed, but the conviction that dialogue with nature cannot be ignored has once again taken hold. Today, re-naturalizing urban centers is the challenge. This also brings into play the eco-city or green city, where the relationships between technologies, green infrastructure, circular resource processes, and comfort are synthesized at the urban scale. The complex situation of urban density and global warming has been the starting point for global initiatives such as Agenda 2030 and the Sustainable Development Goals, where biodiversity conservation technologies, such as Nature-Based Solutions (NBS), can contribute to the well-being of cities and society as a whole and support current challenges. NBSs fulfill several specific functions (e.g., flood reduction, air temperature reduction, etc.) (Saquib et al., 2022), affecting both quantitative (e.g., accumulated water volume) and qualitative parameters, such as population well-being.

The soft urban regeneration actions allowed by NBSs affect climate change mitigation and adaptation. Thanks to their minimal invasiveness, they can combine the goal of environmental redevelopment with the intent to evoke the distinctiveness and identities of places through a joint regeneration of the built environment. The actions identified are blue-green (green spaces, water, and other ecosystem services). They aim at improving thermo-hygrometric conditions and air quality while achieving new circular water management. The use of blue/green technologies was evaluated based on the high percentage of impermeable surfaces, now present in all urban centers. This has amplified the urban heat island phenomenon, especially in hot climates such as those in southern Italy, making sunny urban spaces unlivable during much of the day. Experimentation in minor centers has several advantages: the exaltation of an original vocation for sustainability; the implementation of design solutions in a global and complete capacity, these territories being less vast and complex than metropolitan realities; and the possibility of achieving effective results in a short time (Mamì & Nicolini, 2024). The issues addressed could be opportunities for development and conferring new desirability. In some contexts, they already produce these impacts and could have a trailing effect on other initiatives.

2. Hypotheses for the sustainable regeneration of minor centers. Design themes and methods

The contribution aims at proposing simple strategies and actions to revive small centres in a state of neglect. The design themes identified here for the regeneration of minor centers with strong historical connotations turn to the redevelopment of urban space through soft actions that can also generate a better habitat in terms of thermo-hygrometric comfort. These actions concern urban greening and circular water resource management. Both actions are part of climate change mitigation and adaptation measures and have direct consequences in improving the livability of urban space. The study sites were chosen so as to enhance a large but circumscribed area of historic architectural value. Objectives and possible expeditious solutions are briefly outlined here for each theme. It was necessary to continuously deal with the characteristics and specificities of the built environment, which suggested a path and objectives on a case-by-case basis each time. The studies of each urban area start with an analysis

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of the context in all its physical and social dimensions. The analysis itself suggests the outcomes: these urban settings, in their settlement principle, benefitted from the direct relationship with nature, and the principle of water collection and conservation was the basis of their design since ancient times. The anamnesis of the history of places can guide us, too. In very small, high-altitude towns, the relationship with the countryside did not require specific greening solutions; rather, density was preferred for climatic reasons. Over time, various events have led to the need for regeneration: urban sprawl has sometimes alienated the historic center from the countryside; centers afflicted by earthquakes have urban voids that could allow for reinterpretation. The studied proposals experiment with urban systemic solutions and affect the centers under study as wholes in a multiscalar relationship from the territorial context to the urban and building contexts, down to the single technological solution. The adopted planning and design vision aims at the valorization of the original vocation for sustainability, expressed according to modern needs and performance goals.

2.1. Circular water resource management in urban space

Although collecting and minimizing water waste has concerned humans since ancient origins, the urbanization processes that have developed in recent decades have changed habits toward uncontrolled resource consumption. Southern Italy is now experiencing a serious drought problem, which also involves discontinuous water supply service. The natural water cycle is altered by the increase of impermeable surfaces, which have almost eliminated evapotranspiration phenomena. Moreover, they have increased the volumes of runoff water, causing irrepressible flooding. The water cycle raises several heterogeneous issues, which have already clearly influenced the evolution of the urban landscape in the past and stand as cultural invariants to be considered within urban space regeneration hypotheses. In many minor centers, rethinking circular water resource management could mean restoring an ancient infrastructure already built for that purpose. Collecting and storing water is an ancient practice in Italy and around the world; just think, for example, of the many cisterns found in ancient cave villages in southern Italy (e.g., Matera, Gravina di Puglia, etc.); in Peru, ancient cochas or artificial lagoons consisting of symmetrical furrows still exist today to help collect rainwater by channeling it and then used for cultivation or to provide water for livestock (Esenarro et al., 2023). Archaeological evidence in Sicily (at Solunto) and Greece (Crete, in the Palace of Knossos) testifies to special attention to rainwater adduction: each building had one or more cisterns located below the first floor (Bianchi & D'Acunto, 2020). Rainwater was channeled through pipes, made of terracotta or masonry, fixed on the wall. To avoid wasting water, overflow evacuation was done through sewage pipes directed to other cisterns or on paved roads. The Romans then incorporated this technique by building open tanks fed by rainwater falling from roofs whose overflow was connected to the cisterns. In Sicily, the Norman-age landscape was a perfect blend of human intervention and nature, with wise use of natural resources, especially water: a genuine harmony between elements for sustenance, such as mills and the agricultural system, and those reserved for recreational activities, such as gardens and hunting grounds. Until the mid-twentieth century, rain harvesting was widespread throughout southern Italy; however, following the implementation of aqueduct systems, this culture of water conservation waned. Later combined with widespread soil sealing, this led to today's critical condition. In many cases, the cisterns and the ancient canals were abandoned, pouring today in a dilapidated condition and sometimes becoming receptacles for garbage and uncultivated greenery.

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Our attention was attracted by a minor center in the Sicilian hinterland, Altofonte (PA) (approx. 9,100 inhab.), where the role played by the Arabs regarding the use of water resources in the territory surfaces in the ingenious system of canals. These performed a water channeling function; part was used for the mills that still exist today, while another part was used for the irrigation system of crops such as citrus and sugarcane introduced at that time. All water control was entrusted to a skillful mechanism: the mills.

Today, one is in ruins; another only presents the twill with piers and arches (Fig. 1); finally, one has recently been regenerated as a museum illustrating the mechanics of this technology. The water that moved these mills was redeployed to serve the fields through an intricate system of canalizations and geogs. The water purification system was also interesting; the water, saturated with organic substances and milling wastes, flowed through the terraced landscape, which acted as a filter. Land fertilization occurred naturally through the retention of these substances. This can be considered the archetype of new phytodepuration systems.

For Altofonte, the intervention area where it was decided to activate a more sustainable use of water resources is the oldest built-up area; specifically, the theme of rainwater recovery was explored in depth. This knowledge, combined with modern water-aware urban design, turns to improving the efficiency of the water resource and improving the livability of cities. The logistical and operational management of water sewage/treatment and distribution poses the need to design the service according to the physicality and morphology of the city based on its specificities and past practices. This can be realized through various processes: first and foremost, the regeneration of previous water collection, storage, purification, and distribution systems; the preservation or restoration of permeable surfaces in all catchment areas; the incorporation of new permeable and vegetated areas aimed at improving the permeability of soils; the installation of new storage and treatment facilities where possible, without altering the character of the built environment; and the use of water-saving devices. In addition, the infrastructure for circular water management includes urban lakes, canals, rivers, fountains, and rain gardens.

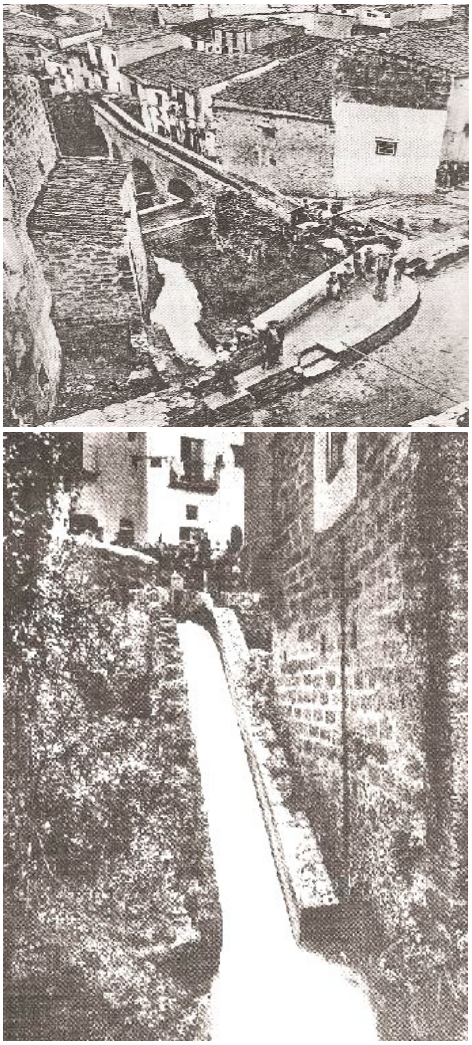


Fig. 1 – *View of the twill from the mill toward the town of Altofonte (PA)* (Assessorato della Cultura e Pubblica Istruzione del Comune di Altofonte, 1998).

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Fig. 2 – *Circular water redesign in Altofonte (PA). Rainwater is collected without altering the roofs and pavements,with minimal new infrastructure (adduction channels in the figure below). Thought was given to the elevation pattern of the area by identifying water routes. The vision includes the design of a phytodepuration area and of a green area by planting native plants through systems to consolidate hydrogeological risk soils (in the figure above)* (Di Matteo, 2025).

The first operation was the calculation of the amount of collected rainwater following the European standards UNI EN 75213 and UNI EN 85814. Thinking that it would be possible to confine the areas of land where to collect rainwater, thought was given to the elevation of the urban center area and then plotting a system of new canals and recovery of old ones where possible. In Italy, Legislative Decree 152/99 encourages settlements with population equivalents between 50 and 2000 people to use natural purification systems such as phytodepuration and lagooning. In addition to their functional aspects, these actions should also be minimally invasive at the landscape level and useful in re-establishing particular bioclimatic conditions (Daglio, 2014). Rainwater harvesting and treatment with bio-retention facilities also enable the adaptation of urban space to heat waves by regulating the microclimate through evaporation. Phytodepuration systems allow the realization of new green areas as wetlands and urban park (Fig. 2). Water purified in the phytodepuration zone can be redistributed and reused for urban purposes (e.g. street cleaning and irrigation uses) and construction (cleaning, supply toilet cisterns, heating and cooling systems).

Beginning with the redesign of water services, punctual interventions in the redevelopment of the built environment can shape opportunities for urban regeneration (Nicolini & Mamì, 2024).

2.2. Urban green planning

Urban green planning is globally regarded as an innovative and dutiful approach to managing natural areas and ecosystem services to protect biodiversity. In Italy, the natural landscape is

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protected by the Code of Cultural Heritage and Landscape (Legislative Decree. 22/1/2004 No.42, Art.131) as cultural heritage and national identity. Among the various landscape components, vegetation plays a priority role, not only in environmental aspects but also in aesthetic-ornamental and historical-cultural aspects. These aspects particularly affect urban and agricultural landscapes, where the interrelationship between natural and anthropogenic components is more evident (Mininni, 2011).

Today, the benefits of green solutions for people and the environment are increasingly appreciated, representing a relevant element of urban resilience. In dense urban settings, the targeted action of greenery on the microclimate may be evident (Nicolini, 2024). The ability to regulate temperatures occurs through the exchange of water vapor between the vegetation and the atmosphere due to the joint effect of plant transpiration and water content evaporation. There are numerous studies concerning the benefits induced by vegetation on the absorption of pollutant particles. Air biofiltration is achieved by a cycle of simultaneous processes where chemical compounds are degraded at the roots and soil rich in microorganisms (fungi, bacteria, etc.) that feed on the pollutant particles. Leaves also contribute to the decrease of pollutants through phytodepuration. In dense urban environments, the most common noise pollution is from vehicular traffic, and vegetated barriers can reduce high-frequency noise. The width of the barrier is linearly proportional to the amount of sound absorption. In addition to the environmental benefits, greenery induces visual comfort generated by two very different aspects: the first is the shielding effect and, therefore, protection from solar glare; the second regards the socio-psychological dimension, due to the relaxing effects that the vision of vegetation generates on the human mind.

The performance of green solutions is never standard and, therefore, must be specifically designed. In addition to the influence of climate and exposure orientation, many variables depend on technologies, the design of the planting system, the irrigation and fertilization system, and the type of plants and substrate.



Fig. 3 – *Urban greening hypothesis in Vita (TP) (1,700 inhabitants). From left to right: Current state and public space regeneration project: organization of pedestrian paths and paving and proposed terraced green urban park* (Amato, 2025).

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Contextualization and diversity of plant species must always be considered to make urban greenery more durable. Green infrastructure includes an integrated system of natural areas and other open spaces: flowerbeds, trees, gardens, green walls, green roofs, parks, and urban forests. Vegetated drainage surfaces, rain gardens (shallow depressed areas), and bioswales (vegetated channels in long, narrow spaces) collect rainwater. The studied urban center is Vita (1,740 inhab.), a municipality in the province of Trapani. Like many inner Sicilian centers, it has suffered depopulation over the years due to a lack of services and infrastructure, regressing economies, the degradation of the built environment, and the abandonment and depletion of agricultural land. This adds to the fact that in 1968 it was part of the municipalities affected by the Belice earthquake, which led to the displacement of the population from the historic center to the new center positioned in a sort of continuity with the pre-existing city. At present, the City Hall and some religious buildings make the old center a place to walk through but not to live in. The effects of the earthquake on the buildings have continued over time since the catastrophe, forcing the administration to demolish housing units with severe structural issues. This resulted in generating spaces without identity, "urban voids". The case study was indeed represented by these spaces, now sealed soils - sun-drenched areas in a state of neglect.

The first approach to the evaluation of urban greenery is inspired by the old concept of "urban standard" - that is, the evaluation of the per capita availability of green areas (Atelli, et. al., 2018). Vita, like many Sicilian historic centers, shows the widespread presence of sealed soil devoid of vegetation. The greenery surrounding the town is visible from scenic views, but it cannot be said to contribute to improving the quality of life. Moreover, there is no connection between green spaces (urban and non-urban). Among possible urban greening solutions, an urban vegetable garden could also actively involve the urban community (Fig. 3). Urban gardens' contribution to citizens' well-being represents a "social use value", even more when standing as an opportunity to re-functionalize abandoned and degraded areas. The urban community involved in the development of urban agriculture is embedded in a process of urban civicism, resulting in a sense of caring for their landscape with a willingness to maintain it. The urban greening project has been developed by identifying several areas to be converted into: urban gardens with herbs, an urban park with ornamental plants, and furnished and shaded rest areas with fruit and ornamental trees. Possible ecological connections between different areas of naturalistic value, agricultural use, and urban greenery have also been identified, proposing a fabric of green corridors. Aside from the historic center, permeable and semi-permeable soils have also been designed in parking lots outside the city, interchange parking lots, and various inner parking lots. It is so-called "road greenery": in addition to the benefits described above, it fulfills infrastructure mitigation, serving as a visual screen and as a filter to noise and dust. Ecological corridors along major traffic arteries serve the same purpose. In addition to greenery, a semi-permeable material has been identified to repave the parking areas: drainage concrete, whose cement mix is designed to produce hollow spaces after curing. This ensures the passage of water and thus avoids water stagnation and reduces the effect of heat islands in urban centers.

3. Conclusions

One first reflection is on the importance of understanding the contexts. Smaller towns often constitute open-air handbooks; their urban design derives from conscious choices that one could make resurface today. The second one is about soft actions, which are particularly adaptable and repeatable in urban settings with strong historical connotations, pursuing the aid of two natural elements: greenery and water.

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The return to the natural environment is the innovativeness required of architectural projects in today's oversealed urban space. The re-naturalization of urban space is crucial in the fight against pollution and the abatement of particulate matter and is also fundamental to making cities attractive and comfortable. The strategies and actions described aim to revive small towns in a state of neglect yet with strong historical and architectural identities. Today, these towns are regarded as primal models of balance. Minimal innovative technologies can ensure a better quality of life, restoring the sense of inclusiveness that such small-scale realities already embody. The submitted proposals aim to create a sustainable and circular city that is ecologically, culturally, and socio-politically competitive while enhancing and respecting its history and heritage. What has been presented is a small example of urban technological design; however, it covers low-cost, minimally invasive interventions that could bring back the ancient attractiveness of these places. This, moreover, could have a trailing effect on other initiatives. In such small settings, minimal actions carry weight, and the results of investments can be seen quickly, with a real possibility of involving the city's community. If well designed, green urban can make cities more attractive and develop a sense of caring for places, possibly producing urban reuse and building regeneration activities.

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Study and Evaluation of the Seismic Features of a Rural Roman Temple: The Case of the Temple of Ain Harcha, Lebanon

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Abstract

This study examines the architectural resilience of the Roman temple of Ain Harcha, located in a seismically active zone on the western slope of Mount Hermon in Lebanon. The temple maintained most of its original architectural form for nearly 2,000 years in a rural, earthquake-prone region, making it a valuable case study. The article provides a general analysis of the temple's architectural layout, material properties and structural design, clarifying its construction methods and ability to withstand earthquakes. The study also examines the temple's seismic resilience through the nonlinear damage model simulation and the pushover analysis. This research contributes to the understanding of seismic-aware practices in rural Roman temples and highlights how ancient building knowledge adapted to the geological context can inform modern conservation and seismic risk strategies.

Keywords: *Ain Harcha; roman temple; seismic features; damage model; seismic resilience; stone construction*

1. Introduction

The temple of Ain Harcha is in Lebanon, located in the Eastern Mediterranean region. Syria borders the country to the north and east, Palestine/Israel to the south, and the Mediterranean Sea to the west. The temple lies approximately 2 km west of the village of Ain Harcha in the Rachaya district of the Bekaa governorate, close to the Lebanese Syrian border and within the western slopes of Mount Hermon. It is considered part of an ancient rural sanctuary encompassing the temple, a necropolis with rock-cut tombs, residential structures and other ruins integrated into the rocky terrain surrounding it.

This temple presents an interesting case both archaeologically and architecturally, as it has maintained most of its stone structure despite being in an area prone to frequent seismic activity.

Archaeologically and architecturally, the temple presents a compelling case: it has survived numerous earthquakes over two millennia with relatively limited structural damage. The temple had a single intervention in 1938 that consolidated its western façade which had major fissures. Although it is a rural temple, which might often be regarded as a secondary site compared to more prominent temples like those in Baalbek, it warrants attention for study.

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Structurally, the temple belongs to the category of articulated monumental constructions of the Greco-Roman world (Stiros, 2020). These constructions, built with heavy materials like stone or brick, behave very differently under seismic activity compared to modern buildings. Stiros notes that such buildings exhibit unique seismic responses, particularly when mortar is absent. He argues that their failure often results not from seismic activity alone, but from the compounded effects of human interventions, environmental stressors, and lack of maintenance over centuries.

The Roman and Greek buildings have a unique seismic response that differs from stone structures built with mortar, as Stiros explained in his study. Contrary to the prevailing opinion, he argued that these buildings can withstand earthquakes. He added that their collapse is mainly due to human and natural interventions and the gradual weakening of their structure over time due to the accumulated impact of these factors without proper maintenance (Stiros, 2020).

This article summarises the study of the temple's structural characteristics to understand what features have contributed to its survival. The study examines the structural elements visible in the temple's construction that may have improved its resistance to seismic events. In addition, it digitally assesses the temple's ability to withstand seismic conditions to verify that the damages observed are primarily due to the accumulation of seismic effects rather than other factors.

2. The context of the temple

2.1. Geological context

Since the temple is situated on the slopes of Mount Hermon, it is important to clarify that the mountain is considered a critical geographical landmark in the region and lies at the intersection of borders between Lebanon, Syria and Palestine/ Israel. In addition, Mount Hermon is the highest peak of the Anti-Lebanon range, with an altitude of 2814 meters. Geologically, mount Hermon is characterised by the Jurassic limestone composition that allows it to serve as a natural water reservoir that feeds numerous springs on its slopes that support fertile agriculture and rural settlements like Ain Harcha.

Such characterisation supported the existence of historical sanctuaries on the slopes of Mount Hermon. It influenced the local construction techniques within them, and it is evident in the use of locally sourced limestone in the buildings of these sanctuaries and their temples, like that of Ain Harcha.

2.2. Seismic context

Seismically and based on the seismic evaluation conducted by Harajli, Lebanon is located along the Dead Sea transform fault system that extends from the Red Sea to the Taurus Mountains in Turkey (Huijer et al., 2016). This fault system branches into a complex network of faults in Lebanon and Syria, forming the Lebanon mountain range and the Anti-Lebanon range. The Sanctuary and the Temple of Ain Harcha location are affected by these faults, mainly the faults of Rashaya and Hasbaya due to their position between them.

Based on the maximum ground acceleration coefficient, the division for the seismic hazard zoning in Lebanon shows two main zones across Lebanon, one with 0.20 g and the other with 0.3g (Huijer et al., 2016). The temple of Ain Harcha is situated in a zone with a coefficient of 0.3g, indicating that it has medium to high seismic risk.

2.3. Historical context

The exact construction date of the Ain Harcha temple is still not defined due to the lack of comprehensive archaeological studies for the sanctuary and the region of Mount Hermon. However, an epigraphic study by Julien Aliquot confirms the temple's existence in the 1st century CE. An inscription dated to 116 CE corroborates this timeline.

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Fig. 1 – *Axonometric views for a photogrammetric model of the temple of Ain Harcha, clarifying its current condition* (Authors, 2025).

There is no evidence of the temple's use during the Byzantine period when many sanctuaries in the region were abandoned (Aliquot, 2008).

Aliquot added that rural sanctuaries like the one in Ain Harcha had significant roles in the religious and social identity of Mount Hermon during the Hellenistic and Roman periods of the region. In parallel to their religious value, these sites were symbols of community status and commitment (Aliquot, 2008).

3. Architectural configuration and typology

The Ain Harcha Temple is built on an extended rocky platform within a sanctuary. It follows a rectangular plan, oriented eastward, allowing access from the pronaos. Unlike most Roman temples, it lacks a large staircase but retains key architectural elements such as a podium, antae walls, portico columns, entablature, and pediment. The temple follows the Ionic order, evident in the sculpted antae columns and volute capitals.

The typology of the temple is *distyle in antis*, characterised by extended *antae* walls that frame the entrance and imitate Ionic columns. The temple's dimensions are 13.8 meters in length, 7 meters in width, and 13.7 meters in height, closely following Vitruvian principles except for its height, which also varies due to the sloping terrain. The temple was constructed using locally quarried limestone and built with the *Opus Quadratum* technique, characterised by stacked rectangular stone blocks without mortar. The 1-meter thickness of the *Cella* walls consists of double layers of stone blocks arranged in the *Alternis Curis* pattern, ensuring stability. In contrast, the *antae* walls are 70 cm thick and single-layered.

One of the temple's most distinctive features is the seismic isolation system incorporated into its podium. The foundation consists of a hollow base divided into three compartments; a technique observed in other Italic-Roman temples. Diosono clarified that this design helps dissipate seismic forces, enhancing the seismic resistance of the building. His primary case study was Temple B in Pietrabbondante, Italy, where he defined the function of its podium as a seismic shield. (Diosono et al., 2023)

4. Structural system of the temple

The structural system of the Ain Harcha temple is analysed based on its geometry, load distribution, mechanical parameters, and material behaviour to assess its main structural features. These factors are based on Quelhas et al. study that focuses on the characterisation of the stone masonry walls (Quelhas et al., 2014).

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4.1. Geometry

The temple's geometric characteristics, such as its simple form, orthogonal foundation and symmetry, can give the temple efficient load transfer and structural equilibrium. The double leaf load-bearing walls allow the temple to resist lateral form seismic activity and wind. The limited openings in the eastern facade also help maintain stability.

4.2. Load distribution

The podium is the primary load-bearing structure, with perimeter walls transferring loads to the ground. Internal columns and longitudinal beams provide intermediate support, reducing span lengths. The floor system helps redistribute loads through internal walls and podium columns. Antae walls stabilize the temple's body, while shorter walls reinforce transverse connections. Columns on the eastern facade primarily support the pediment and the roof. The wooden roof, which is characterized by its lightweight, is connected to the upper part of the walls. The joint points between the roof and the walls can introduce tension forces under seismic effects.

4.3. Mechanical parameters

The temple's dry-stone construction significantly enhances compressive strength and stiffness compared to mortar masonry. The *Opus Quadratum* technique improves lateral stability by increasing contact between stones. The double-skin masonry in *Cella* walls, with transverse stones and rough interior surfaces, helps counteract expansion and contraction, reducing material stress.

4.4. Material behaviour

Constructed primarily from limestone, the temple relies on the stone's high compressive strength while mitigating its weakness in tension through precise stone fitting and dry-stone construction. The wooden roof reduces dead loads on walls, preventing excessive structural stress.

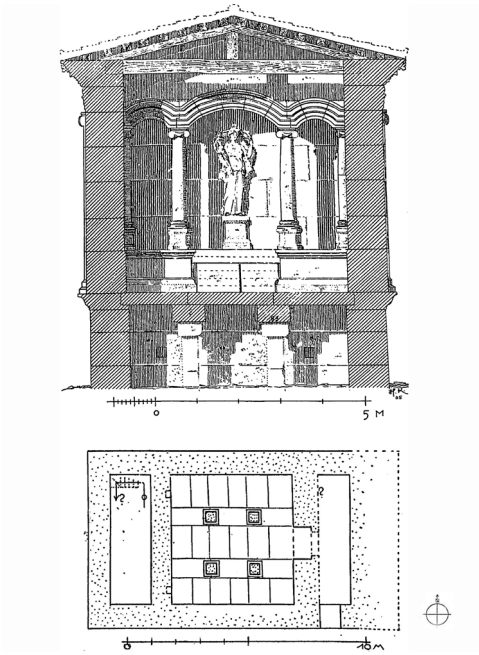


Fig. 2 – *Section and plan clarifying the podium composition of the temple of Ain Harcha* (Krencker & Zschietzschmann, 1938).

Overall, the Ain Harcha temple's structural design demonstrates a strategic approach to ensuring long-term stability, particularly against seismic activity and environmental conditions.

5. Methodology of digital seismic evaluation

The structural analysis of the Ain Harcha temple was carried out using digital modelling tools that allow for non-linear assessment of stone masonry structures. Due to the complex behaviour of dry-jointed limestone under load, a non-linear approach was favoured over a linear one, as it more accurately captures masonry's progressive deformation and damage when subjected to seismic forces. The study of the temple uses nonlinear analysis that accounts for deformation and material damage. The aim of this evaluation is to verify the ability of the structural elements of the temple to resist the seismic effects and evaluate its performance.

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5.1. Digital model preparation and processing

The preparation and the processing methodology for these evaluations are based on the thesis work of Alonso Dura (Alonso Dura, 2003). It is important to clarify that the 3D digital model of the Ain Harcha temple was created to replicate its original condition, based on illustrations by Krincker and Zeichman. The model was designed with differentiated structural elements to ensure accuracy in analysis.

To prepare the model for importation into the ANGLE software, it underwent several steps:

The original Nurbs model was converted into a volumetric mesh model using GiD software, ensuring accuracy for later analysis. The mesh model was then imported into AutoCAD, where the Angle plugin was used to apply a generic stone material due to the lack of exact material samples. During this stage, the temple's weight was also calculated.

Finally, the model was imported into the ANGLE program to conduct a nonlinear damage analysis and assess its seismic vulnerability.

5.2. Nonlinear Damage Model

A model based on damage mechanics is used to describe the evolution of cracks in the material through internal variables. Cracking is represented as local damage that affects the material's stiffness, and its progression is modelled using a damage function.

This model, implemented in the ANGLE program, considers three key aspects:

1. Different behaviour in compression and tension.
2. Stiffness degradation due to mechanical stresses.
3. Influence of the finite element mesh size on the structural response.

The damage in this model is measured using a scalar index (d), which indicates the degree of material deterioration, ranging from 0 (undamaged) to 1 (total deterioration). Stiffness reduction is modelled proportionally to (1-d). To calculate it, the norm of the strain tensor is evaluated, and the damage variable is determined based on parameters such as the material's fracture energy and the characteristic length of the finite element mesh (Oñate et al., 1996).

Within this damage model, two horizontal forces hypotheses were applied to the temple of Ain Harcha. The first is the direction of the Y-axis, which resembles the seismic forces approaching the temple from the south to the north. The second is in the direction of the X-axis, where it resembles the seismic forces approaching the temple from the west toward the east. As for the ground acceleration coefficient, 0.3 g was applied to match the seismic condition at the temple's site.

5.3. Seismic Vulnerability Assessment

The PUSHOVER method from the Eurocode EC-8 is applied, a nonlinear static analysis that simulates seismic action by incrementally applying horizontal loads until collapse. The capacity curve of the structure is obtained and compared with the seismic demand curve to determine the Performance Point, which helps assess the level of structural damage (European Commission, 1998).

Table 1 – *Definitions of damage thresholds.*

Damage Thresholds	Definition
Slight	$\bar{S}_{d1}=0.7\cdot Dy$
Moderate	$\bar{S}_{d2}=Dy$
Severe	$\bar{S}_{d3}=Dy+0.25\cdot(Du-Dy)$
Complete	$\bar{S}_{d4}=Du$

In summary, this study employs an isotropic damage model and nonlinear analysis to evaluate the structural response of masonry buildings, integrating seismic vulnerability assessment using the PUSHOVER method.

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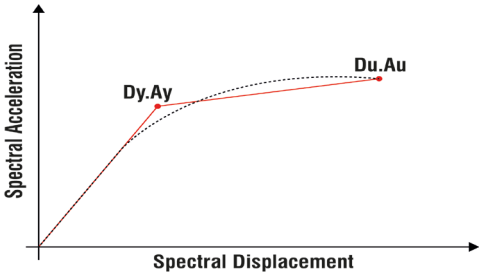


Fig. 3 – *Acceleration-Displacement Response Spectrum diagram* (Chopra, 1988).

6. Results

6.1 Results of the Nonlinear Damage Model

6.1.1. Case 1: South-to-North Forces (Y-Axis)

In the first case, where forces are applied in the Y direction, from south to north, the most affected area is the northern facade, with a significant impact on the eastern facade. This led to the collapse of the entrance columns and a noticeable inclination in the northern facade, ultimately resulting in structural failure (Fig. 4).

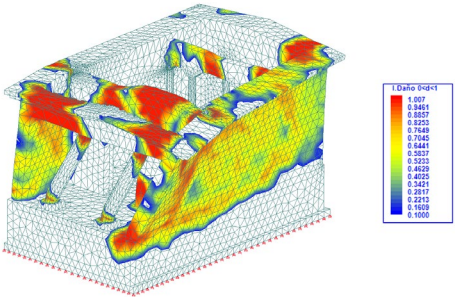


Fig. 4 – *Result of the first case of the Nonlinear Damage Model* (Authors, 2025).

6.1.2. Case 2: West-to-East Forces (X-Axis)

In the second case of the nonlinear damage model, forces are applied in the X direction, from west to east. The temple structure demonstrates good resistance in handling these seismic forces in that direction; however, it shows weaknesses at the eastern facade, which includes the columns and most openings. This resulted in the collapse of the lentil and the upper part of the façade (Fig. 5).

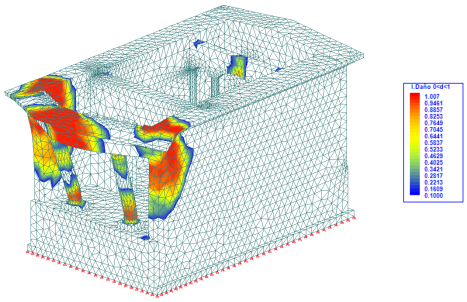


Fig. 5 – *Result of the second case of the Nonlinear Damage Model* (Authors, 2025).

6.2. Results of the Seismic Vulnerability Assessment

6.2.1. Case 1: South-to-North Forces (Y-Axis)

The pushover analysis for Case 1 (north-to-south horizontal forces) shows moderate ductility or tensile stress response (ratio: 1.70). The structure can sustain significant lateral displacement, with a yield displacement (Dy) of 7.8 cm and ultimate displacement (Du) of 4.51 cm. The performance point occurs at 2.11 cm (SDF) and 19.69 cm (MDOF). The pushover curve (red) transitions from elastic to nonlinear, indicating energy absorption capacity. The demand spectrum (green) intersects the pushover curve at the performance point, suggesting moderate inelastic deformation capacity. However, the ductility ratio indicates limited energy dissipation, highlighting the potential for improving post-yield behaviour and seismic resilience (Fig. 6).

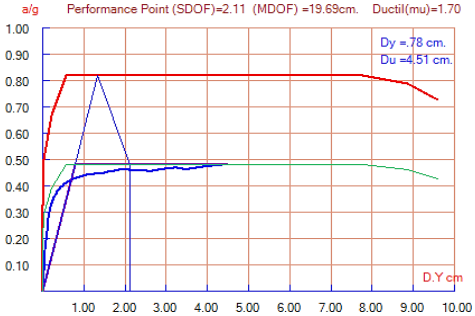


Fig. 6 – *Graphical result for the Pushover analysis of the temple in the first Case* (Authors, 2025).

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The analysis suggests that the structure has a moderate inelastic deformation capacity, which can sustain some damage while maintaining stability. However, with a ductility ratio of 1.70, it may have limited energy dissipation capabilities compared to more ductile designs. While the structure is not highly brittle, there is room for improvement to enhance its post-yield behaviour and overall seismic resilience.

6.2.2. Case 2: West-to-East Forces (X-Axis)

Case 2 shows lower ductility (ratio: 1.16) with reduced lateral displacement capacity. The performance point occurs at 1.98 cm (SDF) and 9.30 cm (MDOF), with Dy at 1.48 cm and Du at 4.64 cm. The pushover curve flattens after yielding, indicating limited deformation capacity and higher stiffness but lower ductility than Case 1. This brittle behaviour makes the structure more vulnerable to seismic forces, risking collapse. Improvements like ductile detailing or energy dissipation elements are recommended to enhance seismic performance (Fig. 7).

In comparison to Case 1, it is evident that Case 2 has higher stiffness but lower ductility. This means it may resist initial lateral forces more effectively but cannot absorb energy and deform without experiencing structural failure.

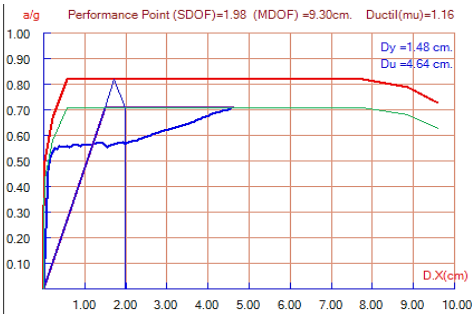


Fig. 7 – *Graphical result for the Pushover analysis of the temple in the second Case* (Authors, 2025).

The lower ductility ratio of 1.16 suggests a more brittle behaviour, which is undesirable in seismic-prone regions, as brittle failure can lead to collapse.

7. Conclusions

The nonlinear damage model simulation scenarios indicate that the temple structure exhibits a good seismic response despite the observed damage. Notably, the damaged areas in the temple model closely resemble the affected sections in their current condition. This similarity suggests that, after 2000 years, the temple has effectively managed the accumulation of seismic faults. The current damage can primarily be attributed to seismic effects, aligning with the digital seismic response.

The Seismic Vulnerability Assessment revealed that the temple structure can sustain damage from seismic forces in the worst-case scenario, but it will have severe deformations without collapsing. The first case assessment reached a severe damage threshold ($S^{-}d3 = 1.712$), below the performance point value of 2.11. The second case of the assessment showed moderate damage ($S^{-}d3 = 2.27$), exceeding the performance point value. The structure struggles to withstand large seismic displacements, especially under west-to-east forces, increasing its risk of damage or failure during strong earthquakes.

Based on seismic simulations and observations, it proves that the temple's resilience to earthquakes is due to seismic features in its construction, which are the following:

- The podium, composed of horizontal partial height walls, short columns, and three central voids, is a passive seismic isolation system. This composition allowed the flooring slabs to function as a diaphragm that reduces friction and lateral forces. This podium design helps filter the seismic energy by reducing absorption and extending the vibration period.
- The temple features thick load-bearing walls with articulated elements that absorb seismic forces while maintaining rigidity. A uniform distribution of stiffness helps prevent stress concentration.

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- The walls have an orthogonal arrangement and balanced mass distribution that work together to prevent collapse. Shorter Horizontal walls reinforce the longer walls, further enhancing stability.

These constructive features have allowed the temple to withstand centuries of seismic activity while preserving its structural integrity. The temple of Ain Harcha in Lebanon exemplifies Roman anti-seismic construction techniques specific to local contexts. Furthermore, it highlights specific architectural choices that serve both stylistic and performance-related purposes, even in rural settings.

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The Roman Villas in the Territorial Context of Ancient Pompeii: Conservation of Vernacular Characters and New Forms of Accessibility to the Archaeological Heritage

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Abstract

The archaeological site of Pompeii has a territorial dimension. Numerous other sites of historical, architectural and archaeological interest gravitate around it and dependent on it, such as Civita Giuliana, Villa Regina, Oplontis, the Bourbon powder factory, the Castle of Lettere, the Archaeological Park of Longola, the Stabiae excavations, the Royal Palace of Quisisana, Villa San Marco and Villa Arianna. In addition to this extensive architectural and archaeological heritage, the Pompeii Archaeological Park also includes a vast vernacular heritage, made up of numerous farms, farmhouses, ruins and structures of great testimonial value. The rusticae Roman villas cover the agricultural plain and define enormous potential for the future management of the Park. The relative proximity and the high number of structures of interest present allow us to hypothesize an integrated use of the archaeological and vernacular heritage, creating a "widespread archaeological park", also useful for the regeneration of the urban context. The proposed contribution intends to analyse the consistency of the vernacular heritage that is included in the Archaeological Park of Pompeii, providing possible strategic and design solutions that promote its knowledge, allow its conservation and facilitate the relationship of the Pompeii site with the surrounding context. For the sites of Oplontis, Villa Regina and Civita Giuliana, in particular, an integrated mobility circuit is hypothesized, enhancing both the archaeological and vernacular characteristics of the ancient pre-existences. Even by organizing a walk along the external walls of the Pompeii archaeological park, which can be visited together with the green ring of the annexed agricultural areas, it is possible to decongest the site, which is increasingly crowded, and offer new opportunities for visiting and perceiving the ancient city.

Keywords: *conservation; vernacular characters; archaeological heritage; Pompeii; Roman villas*

1. Introduction

Beyond the ancient city walls and the perimeter of the necropolises, the Archaeological Park of Pompeii is also responsible for the protection and enhancement of the archaeological heritage characterizing the Vesuvian territory. This includes the so-called "territorial sites" of *Boscoreale, Civita Giuliana, Oplontis, Stabiae, Longola, Castello di Lettere*, the Bourbon Gunpowder Factory (*Polverificio Borbonico*), and the Royal Palace of Quisisana (Reggia di Quisisana) (Fig.1).

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These sites, which fall within the buffer zone established by the UNESCO Plan, have constituted, since October 2023, the Greater Pompeii (*Grande Pompei*), a distributed archaeological park aimed at expanding the cultural and tourist offerings of the Vesuvian hinterland (Pesando & Guidobaldi, 2018). The project seeks to create new cultural and touristic hubs by interconnecting the archaeological sites across the territory, improving transportation infrastructure, enhancing site accessibility and heritage management (Picone, 2014; Picone & Cappelli 2020), and alleviating the anthropogenic pressure on the ancient city of Pompeii.

The archaeological sites of Pompeii and its suburban area offer a valuable glimpse into the daily life and society of ancient Pompeii, which, following the catastrophic eruption of 79 CE, was buried under a thick layer of pyroclastic materials along with several other settlements in the region (Picone & Osanna, 2018; Picone et al., 2020; Picone, 2011).

In addition to its extensive architectural and archaeological heritage, the Archaeological Park of Pompeii also encompasses a significant vernacular heritage, consisting of numerous farms, rural properties (*masserie*), ruins, and structures of great historical and testimonial value. These elements represent significant potential for the future management and development of the Archeological Park.

2. The Roman villas in the territorial context of Ancient Pompeii

The territory extending between the slopes of Vesuvius and the facing heights of the Lattari Mountains, traversed by the broad plain of the Sarno River, was, in Roman times, a highly fertile area densely populated with productive settlements and farms of various sizes, each with adjoining agricultural lands. This region was traditionally divided into two districts: the ager pompeianus and the ager stabianus. However, the destruction of the city of Stabiae by Silla in 89 BCE led to the subsequent dependency of the latter district on the nearby city of Nuceria. Beyond the urban centers, in the countryside and along the coastline, the Roman landscape was characterized by the presence of villas, which could serve different purposes (Stefani, 2000). The villa urbana (or villa d'otium) was primarily a residential structure, often featuring colonnades and lavishly decorated reception and leisure spaces.

These villas were typically set within vast gardens adorned with sculptures and fountains. In most cases, they were built on natural or artificial terraces (*basis villae*), in scenic locations or at the foothills of elevated terrain.

Near the coast, some villas were equipped with pools and facilities for fish and mollusk farming.



Fig. 1 – *Pompeii and the so-called "territorial sites" of Boscoreale, Civita Giuliana, Oplontis, Stabiae, Longola, Castello di Lettere, the Bourbon Gunpowder Factory (Polverificio Borbonico), and the Royal Palace of Quisisana (Reggia di Quisisana)* (Cappelli, 2021).

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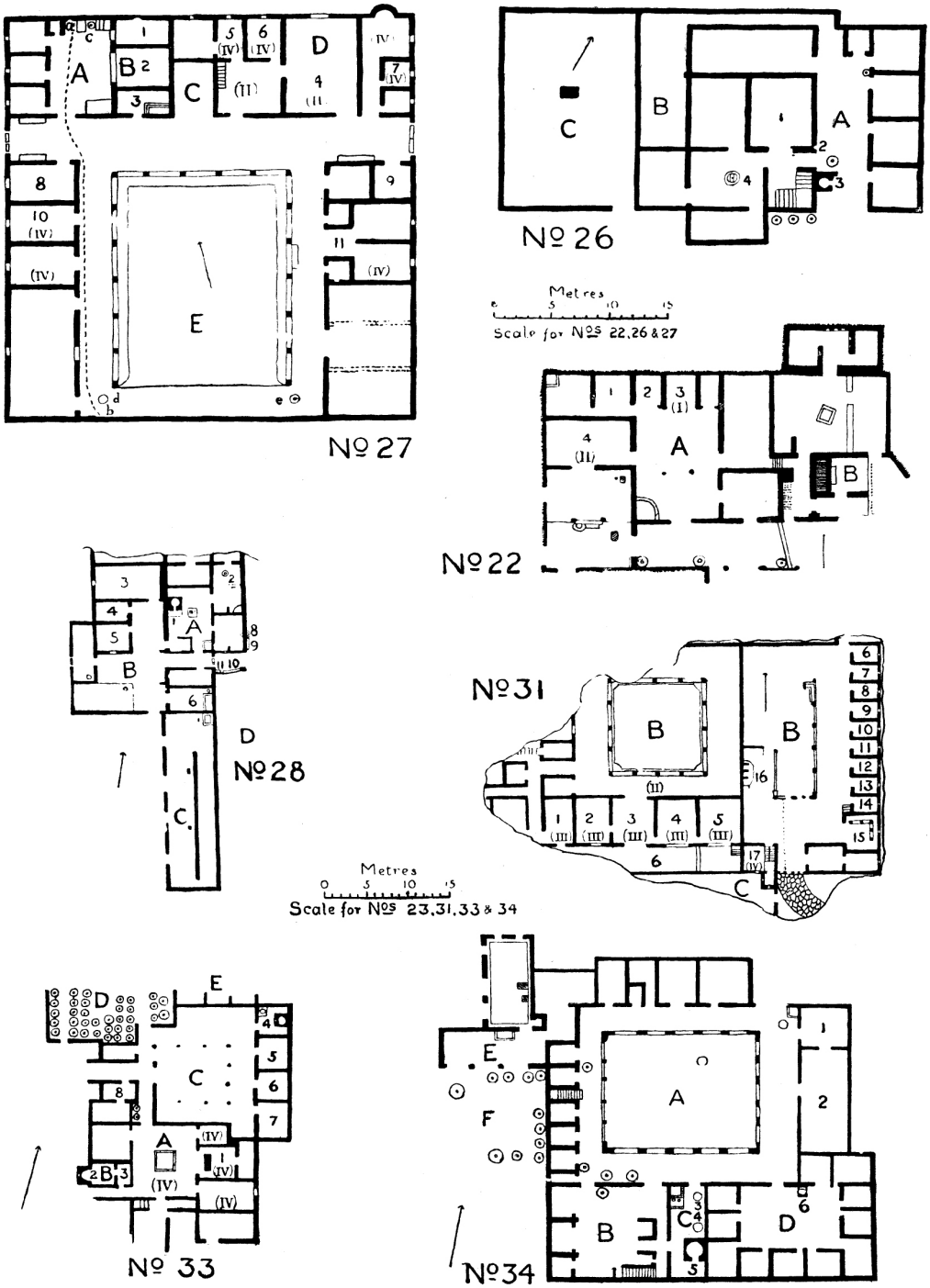


Fig. 2 – *Plans of Campanian Villae rusticae* (Rosotovtzeff, 1963).

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The *villae d'otium* were built in panoramic locations, outside urban centers but near them. Their architectural design was conceived to embrace the surrounding landscape, framing scenic views through elaborate colonnades. In contrast, the *villa rustica*, functionally like modern farms, had a simpler layout, with rooms arranged around a central portico. It was distinguished by the presence of spaces dedicated to productive activities and large storage areas for goods.

To date, the remains of 39 villas have been discovered in the area buried under lapilli and ash during the eruption (Fig. 2). Twelve of these were excavated between 1749 and 1782 in the Castellammare di Stabia area, while the remaining villas have been uncovered over the past fifty years, primarily in the immediate surroundings of Pompeii or in neighboring municipalities such as Boscoreale, Scafati, and Gragnano.

A list of 36 of these villas, organized chronologically based on their discovery, is included in "Social and Economic History of the Roman Empire", published by Rosotovtzeff in 1963 (Carrington, 1931). The author concludes his analysis by emphasizing the importance of an in-depth study of the *villae rusticae* of Campania, with particular attention to their construction history.

Most Vesuvian hinterland villas were reburied after excavation, leaving their architectural study difficult today. Information is limited to often incomplete or missing reports, with scarce documentation on materials and techniques, and few records of structural details. As a result, the analysis of *villae rusticae* relies primarily on wall decorations and occasional references to construction techniques, such as the use of *opus reticulatum* or the alternation of brick courses and shaped tuff blocks. Similarly, descriptions of tools and furnishings found within these villas are often imprecise, further complicating the reconstruction of their history and function.

Among the more recently discovered examples near the Archaeological Park of Pompeii, *Villa Regina* in Boscoreale (De Caro, 1994) is particularly noteworthy (Fig. 3).

This small farm, built in the Silla period (1st century BCE), was centered around a *cella vinaria* housing 18 buried dolia for the storage of must obtained from the vineyard surrounding the villa (Fig. 4). The farmstead was equipped with a space for wine production, as well as rooms designated for domestic and agricultural activities, including stables and storage areas.



Fig. 3 – *Villa Regina in Boscoreale* (Fiore, 2023).



Fig. 4 – *Boscoreale, Villa Regina. The 18 buried dolia for the storage of must* (Fiore, 2023).

The only distinguished room within the *pars urbana* was the triclinium, adorned with Third Style wall paintings, while additional living quarters were located on the upper floor, accessible by a staircase.

At the time of the eruption, the farmstead was likely used exclusively for agricultural production, as it had sustained significant

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damage from the earthquake that struck the Vesuvian area in 62 AD and was still awaiting structural reinforcement.

The study of *Villa Regina* has provided valuable insights, by analogy, into the construction techniques commonly employed in the vernacular architecture of Pompeii's suburban landscape. These techniques involved the use of locally sourced materials such as Vesuvian stone, brick, and, in some cases, tuff. Wooden elements were frequently used for horizontal structures, particularly roofing, which underwent periodic replacement. *Villa Regina* currently presents several conservation challenges. From a material perspective, modern restoration interventions have introduced incompatible materials—such as reinforced concrete—and surface treatments that now require urgent de-restoration efforts. From a socio-environmental standpoint, the villa is situated in a challenging urban context, surrounded by public and social housing developments, which limit opportunities for site enhancement and the promotion of the villa and the nearby *Antiquarium*.

Other noteworthy examples include the six Stabian villas on the Varano Hill, near Castellammare di Stabia, which exhibit characteristics of residences primarily intended for *otium*. In these estates, no rustic sections have been documented, as no structures associated with agricultural production or estate management have been identified to date. It is plausible that such functional components were instead located in separate rustic complexes within the surrounding area (Barbet & Miniero, 1999; Miniero, 2015).

The functions hosted by the large complexes of *villae d'otium* on the Varano Hill were almost exclusively residential, with extensive thermal and living quarters richly decorated.

The most famous example is *Villa San Marco* in Stabiae (Allroggen-Bedel, 1999; Rescigno & Zuchtriegel, 2022). Here, the decorations of the nymphaeum, completed shortly before the eruption of 79 CE, confirm its function as a luxury residence, which continued until the final phase of the site's existence. In terms of materials and construction techniques, *Villa San Marco* features walls primarily built using *opus vittatum* and *opus reticulatum* with local tuff blocks, dating from between 89 CE and 62 CE, as well as *opus latericium* from the post-earthquake construction phase of 62 CE. Of particular interest are some wall panels in *opus craticium*, found in a recently excavated area in the northern sector of the villa. As for decorative elements and finishes, aside from the highly valuable painted plaster, notable survivals include mosaic floors in various rooms, including the *tablinum*, stucco coverings on the columns of the *atrium* and lower peristyle, and the partially preserved twisted masonry columns, stucco-covered in the upper peristyle, which were severely damaged by the 1980 earthquake.

The comparison of these cases allows for the identification of architectural invariants that have withstood territorial transformations and changes in their productive uses. This resilience, common to all the vernacular architectures of the Vesuvian region, is based on the repetition of traditional models, materials, and techniques, which today represent an architectural heritage to be recovered and safeguarded.

3. A new fruition for the ancient vernacular heritage in Pompeii

In recent years, in addition to investing in the extensive built heritage of the Pompeii Archaeological Park, projects and research aimed at enhancing and improving the accessibility of the Pompeian archaeological site have expanded beyond its boundaries, establishing new relationships with the surrounding territory and its key areas. These new connections have the potential to become attractive focal points, offering a more diverse and enriched tourism experience. Among these

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initiatives are the biennial research activities, technical-scientific consulting, and educational support program titled "*Pompei fuori le mura: la città antica, le necropoli, gli accessi moderni, la Buffer zone, i siti* minori", established between the Pompeii Archaeological Park, the Specialization School in Architectural Heritage and Landscape, and the Department of Architecture at the University of Naples Federico II.

The objectives of the agreement were: to deepen the historical and material-constructional knowledge of the necropolises and the modern entrances to the Park; to study indirect sources (bibliography, iconography, cartography, archival documents, etc.) and integrate the surveys and documentation already held by the Park; to directly assess the material and constructional specificities of the structures, identifying the most recurring phenomena of damage and degradation of the structures, including modern ones, within the Park.

These objectives align with the strategic development lines of the Pompeii Archaeological Park. In particular, the identification of visit models that facilitate the connection of the ancient city of Pompeii with the smaller sites, especially *Oplontis* and *Boscoreale*, with the aim of experimenting with an initial integrated circuit. In these areas, considerable importance was given to the naturalistic and rural dimension of the places, as well as the predominant characteristics of vernacular architecture and landscape. These are crucial for balancing conservation and safeguarding needs, particularly considering urban and territorial development (Ricci, 2006).

Creating new urban connections between the ancient city of Pompeii and neighboring sites is an essential action in the post-pandemic phase (Picone, 2022). It aims to preserve the archaeological, urban, and landscape values of the area while simultaneously initiating strategies for the enhancement of the Vesuvius archaeological system. This requires conscious and more residential tourism, which would have positive impacts on the economy and the "Heritage Community", mindful of its vernacular past.

One of the most feasible connections is the one linking the Villa of the Mysteries with the *Villa Regina* site in *Boscoreale* and its *Antiquarium,* which holds numerous artifacts of extraordinary interest for understanding rural and daily life both within and outside Pompeii (Fig. 5).

The museum, opened in 1991, has significant educational value as it illustrates, with the help of multimedia tools, the uses, customs, and traditional agricultural production methods of the Roman period in the Vesuvius region.

This context was particularly favorable for human settlement and land use. The museum displays numerous artifacts, often found in exceptional conditions beneath the ash and lava layers during excavations carried out between the late 19th century and the early 20th century.

Many of the items, including tools and material evidence of technological advancements in agricultural production, were found in some of Pompeii's houses and the rural and luxury villas outside the city walls. These items provide highly accurate data on the lifestyle, economic conditions, and customs of the inhabitants of this area during Roman times.

In the context of a multi-scalar planning approach aimed at achieving the objectives of the plan, many initiatives have also been undertaken at the municipal level.

One such initiative is the project approved and funded by the Municipality of *Boscoreale* for an archaeological walking trail that, on foot and with light transportation (bicycles, scooters, etc.), would connect the *Villa dei Misteri* to *Antiquarium* and Villa Regina.

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The recent discovery of a suburban villa in the *Civita Giuliana* area (Fig. 6), located between *Porta Vesuvio* and *Boscoreale*, presents a new opportunity for visitation and serves as a key point in the route that leads out of the city and heads towards Mount Vesuvius, regaining its evocative landscape dimension. The finds, resulting from ongoing excavations, include horse skeletons, fragments of a parade chariot, and other daily life objects, providing a picture of life in the extramural residences of Pompeii that reflects the rural character of the area prior to the eruption.

Consequently, after securing and restoring the area, enhancing this connection route between Pompeii, *Civita Giuliana*, and *Boscoreale* could offer a new "thematic" perspective on life outside the city, while simultaneously alleviating congestion in the urban center of ancient Pompeii.

Starting from *Boscoreale*, a new slow-traffic connection could be established with the site of Torre Annunziata through new urban development routes. On the other hand, the connection with the Stabia site, where the two villas of San Marco and Arianna are located, along with the Libero D'Orsi Museum with its newly inaugurated exhibition in 2021, presents a different opportunity. In this case, due to the considerable distance and the urban landscape often in a state of degradation, the archaeological park has recently experimented with a shuttle service to transport Pompeii visitors to the Stabia site.

Strengthening sustainable mobility and fostering more conscious and residential tourism encourages visitors to explore the various sites of the Vesuvius area outside the walls of Pompeii, while being mindful of its deeply rooted agricultural past, thus represents the new challenge for the Archeological Park. This challenge also extends to other stakeholders, including the scientific community, which directs the methodological choices for the revival and enhancement of the territory.



Fig. 5 – *One of the bronze artifacts on display at the Antiquarium of Villa Regina in Boscoreale* (Cappelli, 2023).



Fig. 6 – *The ongoing excavations in the Civita Giuliana area* (Cappelli, 2023).

4. Conclusions

The "Greater Pompeii" project, led by the Archaeological Park of Pompeii, exemplifies multi-scalar cultural planning to enhance heritage and create a polycentric archaeological system. By including territorial sites and rural vernacular architecture, it highlights renewed interest in historical land use and the diverse material culture shaping Vesuvian identity.

Studies of *villae rusticae* and *villae d'otium*, along with construction techniques and materials, have deepened understanding of Roman-era settlement and production in Pompeii,

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Boscoreale, Oplontis, and Stabiae (Pesando & Guidobaldi, 2018). Despite fragmented data, these cases reveal the interplay between urban and rural life, agriculture, and elite leisure, supporting conservation based on material and typological continuity.

Integrating outlying sites into thematic routes and sustainable mobility networks addresses overcrowding in Pompeii's core and promotes inclusive, community-oriented tourism. Academic institutions contribute by developing shared methodologies and guidelines.

Ultimately, enhancing Vesuvian vernacular heritage – both tangible and intangible – offers a unique opportunity to align conservation, access, and sustainability within a historically grounded territorial vision.

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The San Antonio Neighbourhood of Valencia and the Church that Gives it its Name

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Abstract

In the city of Valencia (Spain), there is a neighborhood within the district of Zaidía called San Antonio, with a church currently bearing the same name. On the current Calle Sagunto, formerly Murviedro, caserío "dels Orriols" and just 1400 meters from the Torres de Serranos, this monument is found, unremarkable on the outside, beautiful on the inside. The land was purchased in 1333 and the church was founded in 1409 by the Hospitaller Brothers of San Antonio Abad, who built a house and hospital to treat erysipelas or St. Anthony's fire. The objective of this research is to study the evolution of the urban environment from the 14th century to the 18th century, when due to the construction of the General Hospital of Valencia in 1512, the hospital lost its functions and the Antonian Order had to transform and adapt to the style and circumstances of each era to avoid disappearing. Archival documents and historical cartography help to uncover this unknown part of Valencia extramuros.

Keywords: *Antoniano; hospital; neighbourhood; neoclassical church*

1. Introduction

The city of Valencia, located in the east of Spain, is made up of 19 districts and each district is subdivided into neighbourhoods. Within all of them, we focus on the district number 05, called 'Saïdia' or Zaidía. (Moreno Pérez, 2017) The district shares borders with 6 other regions: Rascanya, Benimaclet, Pla de Reial, Ciutat Vella, Campanar and Benicalap, and in this area runs a part of the old riverbed of the Turia, from the bridge of San José, through the bridge of Serranos and the 'Trinitat', and cuts off before reaching the bridge of Real..(Moreno Pérez, 2017). Zaidía gets its name from the disappeared monastery of Zaídia, called "Royal Monastery of Santa María de Gratia Dei," which was located at the intersection of the current Constitución Avenue with Málaga Street. Founded in 1265 by Teresa Gil de Vidaurre, third wife of King Jaime I the Conqueror, who donated her estate for this purpose. After being abandoned by Jaime I, Teresa Gil retired to the Zaídia monastery, which she herself had founded, and where she died in 1285. Zaídia was a country house and recreation place for the Muslim king Abú Zayd. The monastery of Santa María de Gracia, located in this almunia, was known as "de la Zaidia" due to its location and the Muslim king Zayd. (Diez Arnal, n.d.) The monastery was destroyed during the War of Independence (1808) along with the Royal Palace of Valencia to stop the French invasion. The nuns managed to build a new one after the war, but it did not survive the Valencia flood of 1957 (Diez Arnal, n.d.).

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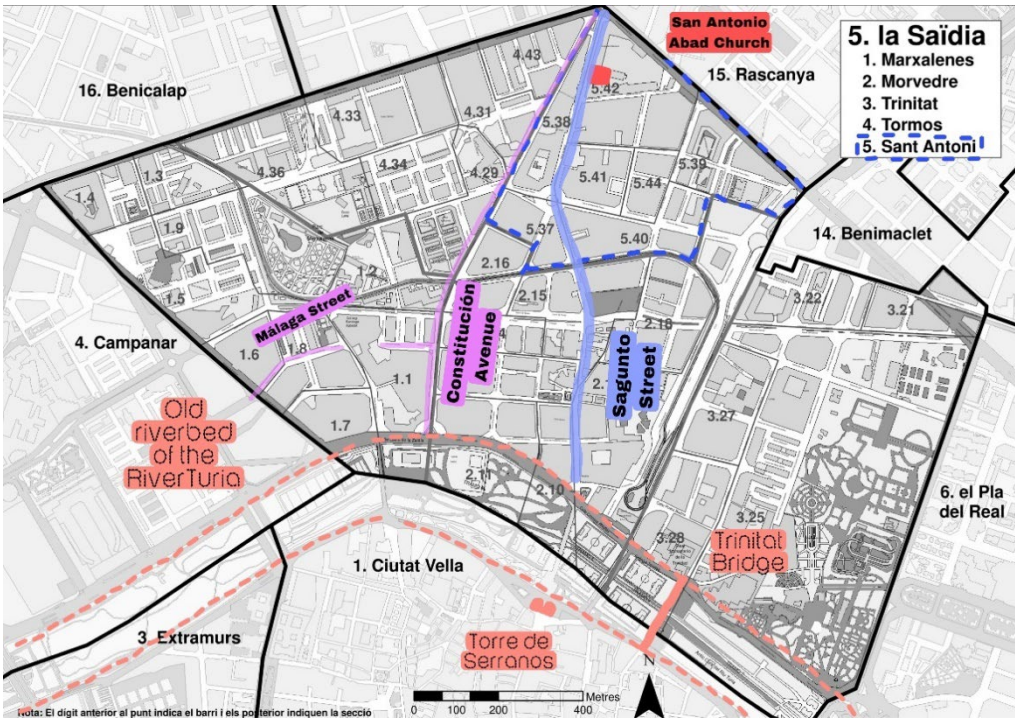


Fig. 1 – *Valencia, districts and neighbourhoods. Location of the monument* (Ayuntamiento de Valencia, 2025).

The other neighborhoods that make up the district are: Marxalenes, Morvedre, Trinitat, Tormos, and San Antoni. The analysis focuses on the neighborhood of "San Antoni" or San Antonio and the reason for its name. What relevance did it have to be given and maintained the name? It must be taken into account that this neighborhood is part of present-day Valencia but, in the past, it was considered part of the periphery, the outskirts or rather, extramural Valencia. The objective of this article is to study the evolution of the urban environment of the San Antonio neighborhood from the 14th century to the 18th century, analyzing how the construction of the General Hospital of Valencia in 1512 impacted the functions of the San Antonio Abad hospital and how the Antonian Order transformed and adapted to the circumstances of each era to avoid disappearing. Archival documents and historical cartography help to uncover this unknown part of extramural Valencia extramuros.

2. Methodology

To carry out this research on the evolution of the urban environment of the San Antonio neighborhood and the transformation of the Antonian Order, the following methods have been used:

1. Analysis of Archival Document: Historical documents and archival records have been reviewed and analyzed, providing detailed information on the foundation, evolution, and transformation of the San Antonio Abad hospital and the Antonian Order. These documents include land purchase records, construction permits, and other official documents of the time.

2. Study of Historical Cartography: An exhaustive study of the historical cartography of Valencia has been conducted, focusing on maps and plans that show the evolution of the

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San Antonio neighborhood and its surroundings from the 14th century to the 18th century. The cartography has allowed identifying changes in the urban structure and the buildings of the hospital and the church.

3. Review of Bibliographic Sources: Various bibliographic sources have been consulted, including books, academic articles, and specialized publications that address the history of Valencia, the Antonian Order, and medieval hospital architecture. These sources have provided historical context and helped interpret the data obtained from archival documents and cartography.

4. Direct Observation: Direct observation of the architectural remains and current buildings of the San Antonio neighborhood and the San Antonio Abad church has been carried out. This observation has allowed corroborating the information obtained from documentary and cartographic sources and has provided a more detailed view of the architectural transformation over the centuries.

3.Development

3.1. History of the San Antonio neighborhood and the momonymous church

3.1.1. Foundation and evolution of the San Antonio Abad Hospital

The San Antonio neighborhood, located in the Zaidía district in Valencia, owes its name to the San Antonio Abad church. This monument, unremarkable on the outside but beautiful on the inside, was founded in 1409 by the Hospitaller Brothers of San Antonio Abad, who built a house and hospital to treat erysipelas or St. Anthony's fire.

The land was purchased in 1333, and the church is located on the current Calle Sagunto, formerly Murviedro, caserío “dels Orriols”, just 1400 meters from the Torres de Serranos (Eslava Castillo, 1976; Molina i Figueres, 1997).

3.1.2. Description of medieval hospitals in Valencia

During the Middle Ages, the hospital network in Valencia was fundamental. In the 13th century, six hospitals were founded, of which only one was initiated by civilians. In the first half of the 14th century, more hospitals were created such as “En Clapers”, San Antón, and “Dels Beguins”, and three more in the last quarter of the century, including the Poor Priests' hospital, “En Conill” and “En Bou”. Of these last four, only the Antonian and Santa María hospitals were ecclesiastical in nature (Rubio Vela, 1984).

The operation of these hospitals was supervised by the municipality, which inspected all centers, resorting to the bishopric for a mixed commission to carry out inspections. Inspections are documented in 1346 and 1370. This vigilance and municipal interest led to four hospitals depending on the city government by the end of the 14th century, marking the beginning of the municipalization of hospitals in Valencia (Consorcio Hospital General Universitari Valencia, n.d.; Rubio Vela, 1984).

3.1.3. The Hospital Network of the “Cami de Morvedre”

The Morvedre road, now Calle Sagunto, in northern Valencia, housed three extramural hospitals: “En Clapers”, the San Lázaro leprosarium, and the San Antonio Abad hospital. In 1333, the Antonians acquired land on this road, allowing the construction of settlements with good hygiene and economy. In 1340, they built their first hermitage and established the brotherhood (Faus Gabandé, 2011; Faus Prieto, 2009).

Although there is no clear description of the hospital complex of the Regular Canons of San Antonio, it is known that the extramural centers shared similar distribution characteristics, except for San Lázaro, which had separate pavilions due to its nature as a leprosarium (Gallent Marco, 2009; Rodrigo Pertegás, 1927).

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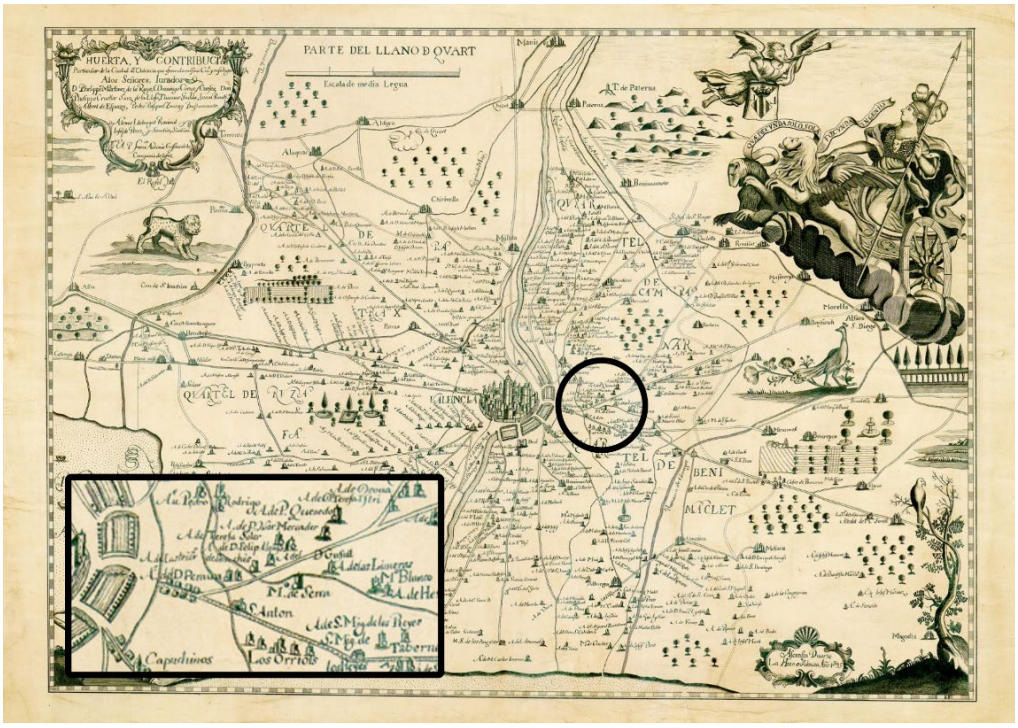


Fig. 2 – *The only map showing the location of the property between the 14th and 18th centuries. Map of 1695* (Cassaus Antonio Francisco, 1965).

The "En Clapers" hospital, contemporary to San Antonio and located 900 meters on the same Calle Sagunto, presents the most similar building physiognomy. Built on November 23, 1392, its building typology consists of two buildings joined by three diaphragm arches, a testero wall, and a facade wall. Its ruins were discovered in 1995 (Teixidor i Trilles, 1767; Unidad Técnica del Ayuntamiento de Valencia, 1995).

3.2. Architectural and urban transformation

3.2.1. Foundation and evolution of the San Antonio Abad Hospital

In 1333, the Antonianos purchased the land, and in 1340, they invoked the papal privilege to establish the brotherhood of the saint. By that time, a first hospital and its monastic dependencies must have already been completed (Blanco Gómez, 2015). In 1353, the Canons Regular of Saint Anthony received authorization to solicit alms in their diocese. At the end of the 14th century, in 1392, King John I authorized the creation of the Brotherhood of Young Farmers or Zagales with Saint Anthony as their patron. Various guilds adopted Saint Anthony as their patron, and the guild shields of the donors as well as the coat of arms of María de Castilla could be seen years later on the polychrome wooden ceiling of the medieval Gothic hospital (Blanco Gómez, 2015).

According to the remains and existing documentation, it is determined that the Gothic hospital consisted of three diaphragm arches, a chancel, and a façade, enclosed with side walls with circular windows. Surrounding it were the various conventual dependencies (dormitories, kitchen) and a chapel. Attached to the façade were the porter's lodge and the infirmary. The roof was formed between the pointed arches by a late Gothic polychrome wooden ceiling (Blanco Estévez, 2022; Blanco Gómez, 2015, 2023).

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Fig. 3 – *Wooden ceiling 1est "Crujía"* (Blanco, 2013).

3.2.2. Transformation and end of the Antonianos

During the 15th century, the municipality considered it essential to create its own hospital network to rationalize healthcare services. This unification process began around 1482 and culminated in 1512 with the creation of the General Hospital (Blanco Gómez, 2015; Faus Gabandé, 2011). The Antonianos began fundraising in 1469 after the ratification by King John II on July 15, 1467, indicating that they were becoming aware that their situation was about to change, ending their hospital functions with the construction of the General Hospital of Valencia in 1512. Therefore, the Antonianos had to reinvent themselves to avoid disappearing (Blanco Gómez, 2023; Herrera García et al., 1985).

The transformation into the church we know today took place over two and a half centuries. They modified and expanded their buildings, constructing a communion chapel, adapting to the Tridentine style that brought a new way of keeping and displaying the Body of Christ, leading to a new liturgy (Barragán de la Rosa, 2018). A neoclassical church was built within the hospital, with a wide barrel vault with two rows of lowered lunettes. The enclosure was expanded to give it the shape of a Latin cross and become a single nave with side chapels. A large dome was built at the crossing, and the Corinthian order was used for the interior cladding. A new façade and an atrium were built before the entrance to the church (Barragán de la Rosa, 2018; Bérchez, 1987; Llopis Alonso & Perdigón Fernández, 2010).

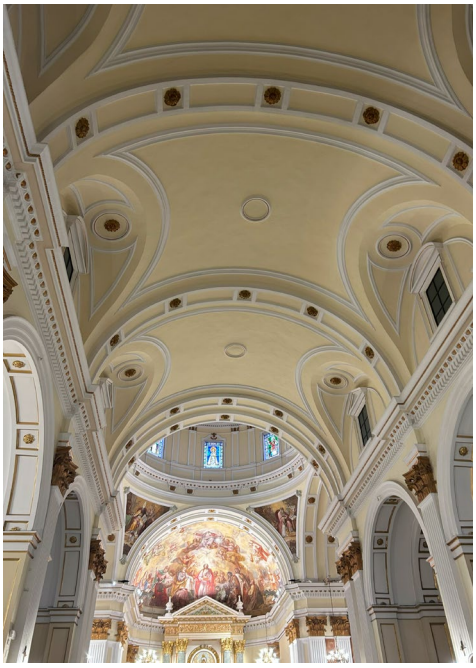


Fig 4 – Church interior after masking (Blanco, 2025).

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Fig. 5 – *Neoclassical cloister* (Blanco, 2025).

To complete the conventual complex, a two-story cloister of molded bricks and a stone base was built, where the completion date of the work, 1768, can be read in its corner. The existing bell tower was also raised with molded brick attached to the sacristy space. This work was carried out by Fray Francisco de Santa Bárbara (1731-1802), a friar architect who also built the parish church of Burjassot between 1765 and 1763 and the unfinished new cloister of the Monastery of San Miguel de los Reyes (Eslava Castillo, 1976).

4. Results and discussion

4.1. Impact of the construction of the General Hospital of Valencia in 1512 and adaptation of the Antonian Order

The construction of the General Hospital of Valencia in 1512 centralized healthcare services, leading to the loss of functions of the San Antonio Abad Hospital. This change forced the Antonian Order to adapt and transform its buildings and functions to remain relevant. The adaptability of the Antonian Order is a notable example of institutional and architectural resilience in response to significant changes in the socio-economic and political environment. Architectural modifications, including the construction of new chapels, a neoclassical church, and a two-story cloister, allowed the Antonian Order to continue its activities until the late 18th century, when the order was suppressed by Pope Pius VI in 1787 (Blanco Gómez, 2023; Eslava Castillo, 1976).

4.2. Discoveries in archival documents and historical cartography and graphic quality

The analysis of archival documents and historical cartography has revealed unknown aspects of Valencia outside the city walls, providing detailed information about the foundation and evolution of the San Antonio Abad Hospital and the architectural transformations it underwent over the centuries. However, the research has

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identified the need to improve the graphic quality of cartographic documentation and to include well-identified photographic documentation. The low graphic quality of some documents has hindered the visualization and understanding of certain aspects of urban and architectural evolution. The inclusion of well-identified and processed photographs would help make the explanation more comprehensible (Blanco Gómez, 2023; Gallent Marco, 2009; Rodrigo Pertegás, 1927).

4.3. Interpretation of the results

The findings of this research have important implications for the urban and architectural history of Valencia. The evolution of the San Antonio neighborhood and the transformation of the Antonian Order provide a detailed view of how religious and hospital institutions have influenced the urban and architectural development of the city. Additionally, the research highlights the importance of preserving and studying archival documents and historical cartography to better understand the evolution of urban environments.

5. Conclusions

The research on the evolution of the urban environment of the San Antonio neighborhood and the transformation of the Antonian Order has revealed several important findings:

1. Impact of the General Hospital of Valencia in 1512: The construction of the General Hospital of Valencia in 1512 centralized healthcare services, leading to the loss of functions of the San Antonio Abad Hospital. This change forced the Antonian Order to adapt and transform its buildings and functions to remain relevant.
2. Adaptability of the Antonian Order: The Antonian Order demonstrated a remarkable ability to adapt over the centuries. This adaptability was reflected in architectural modifications and the expansion of its buildings, including the construction of a neoclassical church and a two-story cloister. These transformations allowed the Antonian Order to continue its activities until the late 18th century
3. Discoveries in Archival Documents and Historical Cartography: The analysis of archival documents and historical cartography has uncovered unknown aspects of Valencia outside the city walls. Historical records have provided detailed information about the foundation and evolution of the San Antonio Abad Hospital, as well as the architectural transformations it underwent over the centuries.
4. Importance of Graphic Quality and Photographic Documentation: The research has identified the need to improve the graphic quality of cartographic documentation and to include well-identified photographic documentation. These visual tools are essential for facilitating the understanding of urban and architectural changes and for effectively communicating the findings.
5. Contribution to the Knowledge of Valencia's Historical Heritage: The findings of this research have important implications for the urban and architectural history of Valencia. The evolution of the San Antonio neighborhood and the transformation of the Antonian Order provide a detailed view of how religious and hospital institutions have influenced the urban and architectural development of the city.
6. Future Research: Additional studies are recommended to delve deeper into the history of other religious and hospital institutions in Valencia and their impact on urban development. The inclusion of high-quality visual tools, such as photographs and detailed maps, is essential for improving the understanding and communication of the findings.

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Traces and Memories of a Rural Reuse of Roman Amphitheatres: Archaeological Restoration and Landscape

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Abstract

Following the rise of Christianity and the severe economic crisis that affected the late Roman empire in Europe, Roman amphitheatres faced different fates, influenced by functional, social and economic factors. Urban systems gradually pushed amphitheatres out of the main urban core. They became isolated, and their ruins were repurposed for agriculture and for the defence from nearby cities. Over the years, these structures were buried to make way for new terraces or agricultural fields. In some other cases, they were altered by overlapping layers of other elements for residential or productive purposes. Despite this, the ancient amphitheatres have endured and drawn attention due to their ruins, their landscape and the narrative of their palimpsest. This narrative highlights the archaeological component and tells the story of their transformation over time. By focusing on significant case studies, such as the Anfiteatro Campano of Santa Maria Capua Vetere and the amphitheatre of Cuma, this study aims to examine the vernacular values of the ancient ruins, as well as the outcomes of the farmers activities –such as drainage channels or signs of ploughing and cultivation– on archaeology and landscape. The study proposes possible strategies and criteria for conserving the archaeological sites and enhancing the use of the storytelling, to communicate both their original story and their agricultural reuse over the years.

Keywords: *roman amphitheatres; archaeology; restoration; landscape; rural reuse; memories*

1. Introduction

The Roman amphitheaters were abandoned or repurposed after centuries of hosting successful and popular *ludi gladiatorii* and *venationes*. These practices came to an end due to a series of circumstances that contributed to their decline, with the spread of Christianity being foremost among them. Emperor Constantine himself condemned such brutal spectacles (Ambrosino, 2013), although they continued to be performed throughout the fourth century. Even in the early years of the fifth century, Saint Augustine references them in his writings (Carena, 2016).

Beyond the *pietas* introduced by Christianity and the socio-political transformations, the primary reason for the decline of gladiatorial *ludi* was undoubtedly economic. The crisis of the Roman political and social system led to the collapse of evergetism (Mingoia, 2004), and consequently, to the dismantling of the costly organizational machinery that sustained gladiatorial combats and *venationes*.

With the exception of sporadic forms of social aggregation –such as sporting events or strictly hunting-related activities that continued in the now-decommissioned arenas– a clear break with

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the past occurred, leading Roman amphitheatres toward highly diverse destinies. In some cases, these structures were abandoned and left to deteriorate, primarily due to natural causes such as earthquakes. In other cases, they were damaged by human actions, including the spoliation of architectural and decorative elements for the recovery of construction materials or lime production. In yet other instances, structural and functional adaptations and repurposing rendered ancient amphitheatres closely tied to the history of the cities to which they belonged.

These transformations (Capoferro Cencetti, 1996; Ortolani, 2007; Pedersoli, 2008), while radically altering the original meaning and modifying their architectural frameworks, in some ways facilitated the structural preservation of ancient entertainment buildings, allowing them to survive over the centuries in various forms. Over time, multiple modes of reuse can be identified –military-defensive, residential, productive, sacred-funerary– each exploiting the architectural and constructive characteristics of these particular structures, their urban or extra-urban locations, their public, private, or ecclesiastical ownership, and the historical events that shaped them prior to reuse. Some of these repurposings were passive and indiscriminate, driven by the economic and practical necessity of reusing ruins as solid foundations for new buildings; others, however, were active and intentional, aimed at exploiting structurally functional elements both architecturally and symbolically.

From the medieval period onwards, the contraction of urban systems frequently resulted in the exclusion of large entertainment monuments from city centres, leaving them isolated and repurposed as agricultural outposts or defensive strongholds protecting nearby urban settlements. Amphitheatres, in particular, underwent a more profound transformation in response to substantial demographic growth. The structural and formal characteristics of these monumental constructions –originally conceived as spaces designed “all around to look” (Treccani 2008)– were significantly modified and reinterpreted to accommodate various forms of residential reuse.

In the case of extra-urban amphitheatres, however, numerous iconographic and cartographic sources attest that these structures were either gradually buried –due to the development of new terraces or agricultural plots– or transformed through successive superimpositions, with their volumes repurposed for marginal residential or productive functions. Nevertheless, the morphological features, size, and location of ancient amphitheatres in relation to inhabited centres favoured their agricultural reuse following their abandonment. Over time, the ruins were progressively enveloped by soil and vegetation. Through cultivation, involving plowing and planting operations of varying degrees of invasiveness, ancient amphitheatres have endured, and now require particular attention with regard to their ruins, their landscape context, and their historical stratigraphy. Conservation and research efforts concerning these sites must adopt a strongly multidisciplinary approach, involving botanists, agronomists, landscape architects, and archaeologists. The complex undertaking of restoration projects involves emphasizing the archaeological dimension, which necessitates prior analysis of the site's characteristics, structural consolidation, and the protection of surviving surfaces. The restoration intervention must also acknowledge the rural elements introduced by agricultural activity, including vernacular architecture built adjacent to or atop ancient remains, as well as the hydraulic and logistical systems in their landscape setting. An interdisciplinary approach is essential for analysing the architectural and landscape values that should be integrated into the restoration process.

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Such an approach provides the necessary strategies and criteria for conservation, enhanced accessibility, and effective storytelling –both of the archaeological sites themselves and of their agricultural reuse over time.

2. The Anfiteatro Campano in Santa Maria Capua Vetere. Archaeological characteristics and rural memories

In some cases, the agricultural reuse of ancient buildings for performances is documented solely through indirect sources, such as archival records or travel literature. This is the case of the Anfiteatro Campano in Santa Maria Capua Vetere (Fig. 1), for which significant iconographic evidence exists, offering insight into "agricultural" phases of the ancient ruins of Capua, as well as on their survival and resilience.



Fig. 1 – *Aerial photo of the Anfiteatro Campano in Santa Maria Capua Vetere* (Aloi, 2023).

A watercolour by William Turner and Thomas Girtin (Fig. 2), currently housed at the Tate Gallery in London[1], depicts the architectural remains of the Anfiteatro Campano from an aerial perspective. Aligned with the aesthetic sensibilities of the ruinist tradition, the drawing employs delicate lines, nuanced shadowing, and a carefully constructed luminosity to convey a tranquil rural atmosphere – foregrounding the pastoral setting over the amphitheatre's archaeological character. Turner's watercolour, dated between 1794 and 1798[2], depicts the Amphitheatre of Capua in muted tones, with minimal details and faint architectural lines, that seem to downplay the grandeur of the ancient ruins. Turner's work 'reproduces' a sketch by John Robert Cozens from 1782, which is preserved in the valuable *Beckford notebooks* in Manchester.

Reflecting the typical canons of English landscape painting, Cozens' sketch conveys an almost emotional perception of the architectural remains. This stands in contrast to the investigative nature and scientific objectives of survey drawings. As noted by Mangone (2021), Cozens' work shifts focus from analytical representation to the expression of the feelings of unease and solitude evoked by the site (Fig. 3).

A farmer, alone with his plow, cultivates a cornfield within the arena of the amphitheatre, which has been completely levelled and repurposed for agricultural use. This evocative image lacks precise measurements or material indications, yet it serves as a potent testament to the phase of abandonment and reuse of the amphitheatre at the end of the eighteenth century. The practice of employing the amphitheatre as a sort of greenhouse dates back dates back several centuries[3]: as early as 1585, the Government of the City of Santa Maria issued a protective measure for the monument to ensure that "nothing more grows in his navel" (Venosta, Solari, 1982, pp. 16-17).

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[1] *The Amphitheatre of ancient Capua*, ink and watercolour. The work is part of the Album of Copies of Italian Views for Dr. Thomas Monro [Turner bequest CCCLXXIII 60], ca. 1794-1798, London, Tate Gallery.

[2] Turner had not yet crossed the Italian peninsula but he studied and replicated its architecture and landscapes based on copies of views by other English painters.

[3] This data finds precise confirmation in the Memoirs on the monuments of antiquity and fine arts by Roberto Paolini (Paolini 1812, p. 258) and in the nineteenth-century engraving by Franz Ludwig Catel, entitled *In Capua i muli vanno del basto il peso a scaricar*.

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Fig. 2 – *J.M. William Turner, Thomas Girtin, The Amphitheatre of Ancient Capua, 1794-8* (in Album of Copies of Italian Views for Dr. Thomas Monro, Londra, Tate).



Fig. 3 – *John Robert Cozens, The Amphitheatre of Ancient Capua, 1794–97* (Courtesy of the Whitworth, The University of Manchester).

The suitability of the Anfiteatro Campano for agricultural activities persisted until the nineteenth century. During the consolidation and reconfiguration efforts led by Ulisse Rizzi (Cappelli, 2023), a mulberry plantation was established on the embankment surrounding the amphitheatre in order to "provide shade for visitors of the Anfiteatro Campano and generate a modest income at minimal cost"[4]. Archival documents preserved in the State Archives of Naples record routine maintenance interventions conducted in 1850, which included efforts to "uproot […] the weeds, the wild plants" and to "water the mulberries planted there"[5]. In the following decades and throughout the twentieth century, the rural character of the Anfiteatro Campano gradually disappeared. Agricultural cultivation was abandoned by the late nineteenth century, and the "green" environment in which the ancient entertainment structure now stands is the result of landscape interventions designed to arrange the external areas, as well as the spontaneous proliferation of vegetation along the crests of the *cavea* walls, within the uncovered radial wedges, and along the external pathways. For a time, the arena itself remained green, but it has recently been paved, erasing even the vestiges of its agricultural past.

3. The Anfiteatro Cumano in the Phlegraean Fields. Agricultural reuse and the possibilities of archaeological restoration

Even today, some ancient entertainment buildings retain physical traces of their agricultural reuse, with certain sites still being cultivated after decades. A notable example is the Roman amphitheatre of Cumae, whose foundation dates back to the late 2nd century BCE to early 1st century BCE. Located outside the defensive walls of the ancient city of Cumae, the site selected for the construction of the Anfiteatro Cumano was inherently suited to a naturalistic design. The *cavea* was built by taking advantage of the natural slope of Monte Grillo, situated in the southern suburb of the city.

[4] The proposal to plant mulberry trees dates back to December 1848 and was put forward by the Commission for the reforms of the Royal Bourbon Museum and Excavations of Antiquities. See ASNA, Real museo borbonico e Soprintendenza generale degli scavi 1848-1864, 324.I.004, «Piantagione di gelsi nell'Anfiteatro Campano, per rendita e per dare ombra ai visitatori».

[5] *Idem.*

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Following its abandonment between 325 and 438 CE, due to the abolition of gladiatorial games, the ancient entertainment building underwent extensive spoliation of its materials, particularly during the Gothic War (535–553 CE). Between the 6th and 7th centuries CE, part of the amphitheatre was repurposed for ceramic production, while other areas were transformed into burial sites.

Between the 8th and 16th centuries CE, a progressive accumulation of alluvial material led to the gradual infilling of the cavea, ultimately resulting in the complete burial of the amphitheatre's ruins. The first cartographic evidence of the Anfiteatro Cumano in the area of ancient Cumae dates to the mid-18th century. Initially, the structure was generically identified and attributed to a complex of "Fabbriche Antiche".[6] (Giuliani, 2013). However, by the second half of the 18th century, its original function began to be partially recognized. In the maps by Francesco La Marra, the structure is labelled as "Circus cum", and in 1768, Thom. Rajola produced a plan of the site[7] – an interpretative reconstruction based on the few visible above-ground structures. Throughout the 19th century, the Anfiteatro Cumano gained increasing prominence in cartographic representations, with progressively more detailed depictions, particularly by Jean Claude Richard De Saint Non in 1780, Filippo Morghen in the early 19th century, and later Andrea De Jorio and Karl Julius Beloch, who included it in his historical treatise *Campanien*.

From an iconographic perspective, the works of Cuciniello-Bianchi and Pietro Parboni – Thomas Dessoulavy are of particular interest. Despite a twenty-year gap between their drawings, the state of preservation of the amphitheatre appears virtually unchanged in both. Common features are clearly visible, such as the arches of the foundation structures of the summa *cavea* and the presence of a 19th-century house farm, which incorporates one of the entrances to the arena as well as part of the *cavea*'s elliptical structure. A pivotal moment in the stratigraphic history of the Anfiteatro Cumano occurred with the construction of the house farm atop the remains of the ancient entertainment structure. Prior to this, the site had been characterized by ongoing abandonment and sporadic interest from travellers and scholars who depicted its remains. However, subsequent construction work resulted in the complete destruction of the *porta triumphalis*, compromising the continuity of the monument's geometry.



Fig. 4 – *Cuma (Pozzuoli, Italia), Amphitheater, perimeter wall with arches, interior and exterior. Ernest Nash, American Academy in Rome - Fototeca Unione, 1957, FU.Cuma.ANF.1. and FU.Cuma.ANF.1.* (Digital image courtesy of the American Academy in Rome, Photographic Archive).

[6] We refer to the two graphic works by Nicolò Petrini (1750) and Antonio Hermil (1767), very similar cartographic productions.

[7] This plan is included in the book by Paolo Antonio Paoli "Avanzi delle antichità esistenti a Pozzuoli Cuma e Baja".

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The agricultural and productive reuse of the Anfiteatro Cumano was actively pursued and legitimized in the early decades of the 20th century (Fig. 4). The soil accumulated within the cavea of the amphitheatre was cultivated by farmers from nearby Bacoli, who were authorized by the then Archaeological Superintendency of Naples and Caserta. The concessionaires of the amphitheatre's land were required to eliminate crops that could potentially damage the emerging archaeological structures and were also obliged to comply with the Superintendency's directives, which mandated the gradual reduction of agricultural activity should future research needs arise.

However, it was only in the early 1990s that the necessity for in-depth investigations into the amphitheatre's archaeological remains became evident. These investigations were aimed at consolidating the structures and implementing safeguarding measures through stabilization and restoration interventions. By that time, the remains were in a severe state of deterioration and instability.

A series of excavations were carried out by Paolo Caputo, the archaeologist responsible for the excavations at Cumae, as part of a project initiated by the Archaeological Superintendency of Naples and Caserta. This project was structured in two phases – Kyme I (1994–1997) and Kyme II (1999–2002). In October 2000, a comprehensive series of restoration efforts were undertaken, which included the removal of invasive vegetation, the cleaning of surviving structures, structural consolidation and integration, and the installation of new seating, all conducted according to a principle of minimal intervention.

Currently, the Anfiteatro Cumano (Fig. 5) is not accessible to the public, as it is not included in the official itinerary of the Cumae Archaeological Park, to which it belongs. The site urgently requires further restoration and stabilization efforts. Several conservation challenges persist due to constant exposure to atmospheric agents, the presence of invasive vegetation, and insufficient maintenance. Additionally, the site presents significant accessibility issues and limitations in visitor perception and experience. The route between the Cumae Archaeological Park and the Anfiteatro Cumano is not walkable, and the two sites remain disconnected and unintegrated. Within the amphitheatre itself, there are no visitor pathways, informational signage, or interpretive devices. The central space of the amphitheatre is still preserved as a valuable cultivated garden, framed by partially reclaimed archaeological structures.

Only a comprehensive and well-planned excavation and restoration initiative can enhance the understanding of this ancient entertainment structure and amplify its archaeological significance. Such an initiative would highlight the interplay between ancient monumental architecture, the natural landscape, and human productive activity.

In alignment with the most recent trends in archaeological restoration – emphasizing biodiversity, sustainability, and ethical interventions – agricultural production could be integrated into the broader process of excavation, conservation, enhancement, and site management (Matteini, 2006). It is impossible to exclude the natural and rural dimension from the recovery and valorisation of this Campanian archaeological site, particularly given the historically established image of the Anfiteatro Cumano and its *genius loci*.

4. Conclusions

Ancient amphitheatres, due to their extra-urban location and morphological characteristics, were often incorporated into productive activities following their abandonment. In particular, the cultivation of these sites has played a significant role in their preservation, while simultaneously enhancing the landscape dimension of their ruins.

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Fig. 5 – *Aerial photo of the Anfiteatro Cumano* (Caputo, 2024).

The inseparable relationship between archaeology, landscape, and human activity serves as the foundational premise for any excavation, restoration, and enhancement project involving these sites. In cases where agricultural activity and the rural dimension are attested only through indirect sources – such as in the case of the Anfiteatro Campano of Santa Maria Capua Vetere – it is crucial to preserve their historical memory by incorporating the agricultural reuse phases into the site's narrative. On the other hand, when ancient entertainment buildings still retain physical traces of their "cultivation" – as in the case of the Anfiteatro Cumano in the Phlegraean Fields – it becomes essential to develop a multidisciplinary and informed project for restoration and valorisation.

Starting with archaeological excavations, which are essential for expanding knowledge of the site's remains, it is necessary to consider both the phases of construction and reuse. This approach highlights the archaeological component within its naturalistic context, explicitly showcasing the vernacular characteristics of the rural modifications brought about by agricultural activity.

These elements –constructive, landscape, and productive values, both tangible and intangible– must be integrated into the restoration project. They should be preserved, narrated, and transmitted to future generations.

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Traditional Landscape Geography of China's Ou Region: A Perspective from Water and Soil Transformation

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Abstract

The Ou region, located in the lower reaches of China's Ou River basin, was originally a marine-transgressed territory. A millennium ago, as the sea receded eastward, it left behind brine-saturated marshlands and lacustrine depressions. Through centuries of hydrological transformation, employing a series of land reclamation strategies, people gradually converted this once untillable wilderness into a fertile waterscape. This study focuses on the Ou region of China, integrating historical aerial maps, traditional cartographic materials, local gazetteers, and field investigations. It first examines the geomorphological context of land-water development in the region, then analyses how three hydraulic systems—seawalls-dikes-sluices, ponds-canals, and polder fields, along with salt production activities have reshaped the terrain, demonstrating the profound anthropogenic impacts on landform evolution.

Keywords: *Ou region; hydro-agricultural wisdom; geomorphic patterns; fluvial systems*

1. Introduction

The natural landscape may appear stable to us in the present day, but when viewed through a millennium-long temporal lens, it has consistently undergone a process of dynamic change. This can be primarily attributed to the continuously evolving hydrological system of this land and the persistent land transformations carried out by the local ancestors. The correlation between the land and its inhabitants is unmistakable, as land alterations transcend mere geographical boundaries, manifesting in distinct morphologies and thereby suggesting differentiated land management strategies.

In terms of the research region, the transitions between sea and land and the land development processes in Ou region are particularly emblematic. Geographers such as Wu Songdi and Kang Wugang have approached the discussion from the perspective of water conservancy facilities, delving into the profound connections between the sea-land transitions and land development in Ou region, thus emphasizing the intimate relationship between environmental transformations and water conservancy structures.

Specifically, the Ou region basin exhibits a topographic feature of "high in the west and low in the east", with a water network presenting a spatial pattern of "west to east".

The various tributaries intersect across the plain area, forming a complex hydrological system.

As recorded in *Yongjia County Annals*:

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"The land is higher in the west and lower in the east; numerous rivers flow from west to east, meandering through the wilderness, combining and diverging. Despite their variations in size and depth, they hold significant implications for civil affairs concerning water conservancy" (Zhang et al., 2010).

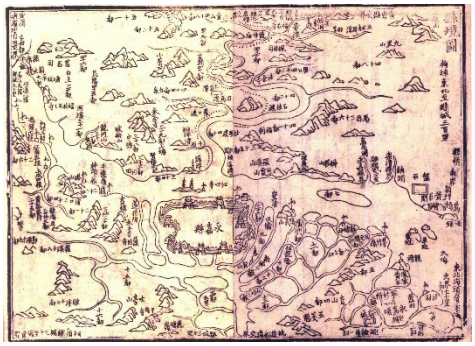


Fig. 1 – *The geographical landscape of the Ou region depicted in the general map of Yongjia County during the Qing Dynasty* (Zhong, 2014, p. 93).

2. The natural changes of geography

The collision of tectonic plates forged towering mountain ranges, while gravitational forces channeled water relentlessly downward, sculpting river valleys through persistent erosion. Dispersed streams gradually converged, their combined might swelling until they coalesced into a formidable hydrological entity—the river.

The Ou River, this particular watercourse, winds eastward in sinuous curves, bearing sedimentary loads that accumulate steadily at its estuary. Stratum by stratum, these alluvial deposits gradually constructed new landforms, giving rise to a fertile river delta.

Through this geomorphological process, the terrain extended persistently eastward, advancing toward the ocean to form expansive coastal plains. Across hundreds of millions of years of orogenic and marine transformations, the Ou region evolved its distinctive tripartite topography—an interconnected system of "mountain-plain-coastal" zones.

During marine transgressions, tidal floods reached the borders of ancient Yongjia County, when Mount Daluo stood as an isolated island. *The Classic of Mountains and Seas* records:"Ou dwells amid the waves, as does Min." Scholar Guo Pu annotated: "Modern Yongning County in Linhai—Eastern Ou—lies within the Qihai Sea." Yongning County during the Eastern Jin Dynasty corresponds to the central area of modern-day Ou region, which was part of Linhai Commandery. Based on the descriptions in the Classic of Mountains and Seas and Guo Pu's annotations, it can be inferred that the Ou region was once a vast expanse of water, where the early inhabitants lived by and depended on the sea.

The coastline shifted eastward to present-day Xiaohe township by the Southern Dynasties (420–589 CE), retreating further to Mount Daluo's eastern foothills during the Song Dynasty (960–1279 CE).

Through the Ming-Qing periods to modern times, fluvial-tidal sedimentation has persistently reshaped the littoral zone. The interplay of riverine and marine forces generated successive mudflats and sandbars, propelling the coastline's eastward advance—a geomorphological process that continues to mold the region's ecological and cultural identity.

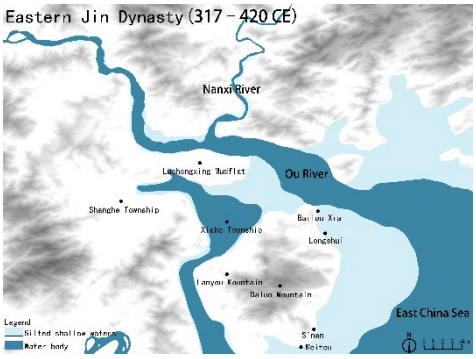


Fig. 2 – *Illustrative map of the maritime areas around the Ou region during the Eastern Jin Dynasty* (adapted from Cao, 2025).

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3. The phased development of mountain-plain-coastal area transitions

From the evolution of mountains and seas, we can clearly see the entire Ou region has experienced the phased development of mountain-plain-sea transitions. The emergence of this regional landscape was by no means accidental; rather, it was fundamentally preconditioned by the constraints and endowments of its natural geography. Among all these natural prerequisites, it is primarily a land bordered by the sea. The continuous movement of people along the coastline, advancing eastward and retreating, is the overarching backdrop that has spanned millennia in this geographical region. In ancient times, this place was mostly covered by the sea. With the eastward shift of the sea, people moved from the mountains towards the sea for land development, gradually transforming this land into a marshy homeland suitable for both production and living.

The foothill settlements were the earliest types of villages to appear. At that time, the coastal plains were still invaded by the sea. The ancient ancestors “turned hills into fields”, transforming the high foothill plains into habitable places. With the development of irrigation technology and the population growth brought by the migration southward, people began a long process of reclaiming land from the sea. In order to acquire more productive land, people first transformed the marshes left by the receding sea through the method of “building polders relying on canals”. As the available land became increasingly scarce, people began to enclose and cultivate salt fields on the tidal flats between the sea and the land, transforming the coastal brine lands through the method of “boiling the sea into land”. Over the course of thousands of years, the geographical landscape of flooded areas and salt marshes was completely rewritten. A series of creek villages, river villages, and port villages were constructed on this continuously changing land in Ou region.

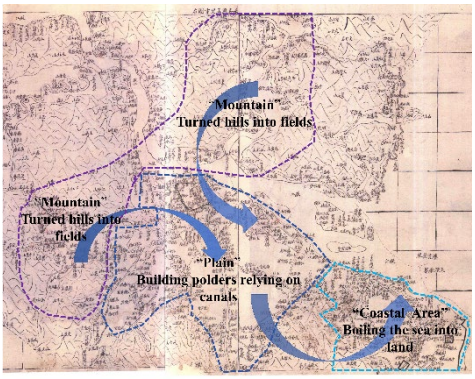


Fig. 3 – *Schematic diagram of phased development from mountains to the coastal area* (adapted from Cao, 2025).

In general, the region's land and water transformation requires addressing four challenges: 1.Managing the tidal surges of the Ou River and seawater intrusion to achieve the goal of resisting saltwater and storing freshwater; 2.Reorganizing and transforming the formation of estuarine lakes and marshes left behind by the receding seawater; 3.Converting the marshes into arable farmland; 4.Transforming the coastal brine lands into cultivable fields.

The resolution of these four challenges relies on three systems and one industry: the seawalls-dikes-sluices system, the ponds-canals system, the polder fields system, and the salt industry. The formation of a regional water network of rivers and lakes depends primarily on the seawall system, which “defends against tides externally and protects river channels internally”. Derived from this, the seawalls-dikes-sluices system achieves the purpose of “repelling saltwater externally and storing freshwater internally”, making the plains a relatively independent hydrological unit. The ponds-canals system transforms the marshes left after the seawater recedes, while the polder hydraulic system addresses agricultural production challenges. The parallel linkage of these three systems ultimately results in the formation of a stable internal river water network in Ou region.Simultaneously, to transform the coastal

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brine lands, people boiled salt on the mudflats. Through salt production activities, the land was desalinated and made suitable for agricultural cultivation. The water network left behind by salt production activities can also serve as a hydraulic foundation for subsequent agricultural cultivation.

3.1. The Seawalls-Dikes-Sluices System

Situated between land and sea, the Ou region, a millennium ago, was a marshy land that repelled salt, with the east bordering the vast ocean and the Ou River blocking it to the north. Rivers linked to the tides of the East China Sea; should seawater intrude, the land would be flooded with brine, turning arable land into saline-alkali wasteland.

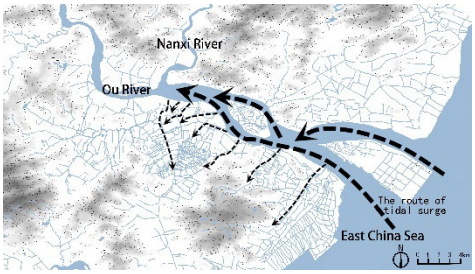


Fig. 4 – *The route of the tidal surge of the Ou River* (adapted from Cao, 2025).

The key to transforming from a salt-repelling marsh to a habitable wetland is to resist saltwater and store freshwater. During the Southern Dynasties period, the coastline extended to what is now known as San Yang. To prevent the flooding of the East China Sea, people initially constructed a seawall,which called "Nan Tang". The coastal area had an extensive shoreline, making embankment construction a complex and massive undertaking that could not be completed quickly. To achieve the extended seawall project spanning hundreds of miles, people first protected the soil and water using a method called "dike". Dike, a small embankment, primarily served to "protect fields by obstructing rivers and safeguarding farmlands". While seawalls functioned as coastal barriers, dikes regulated the equilibrium of inland water networks. "Water flows through channels, blocked by seawalls, supplemented by dike". Dikes complemented the seawall, "stabilizing rivers with dike for the common good." Local villagers built dike using soil and stones to control water flow and protect farmlands.

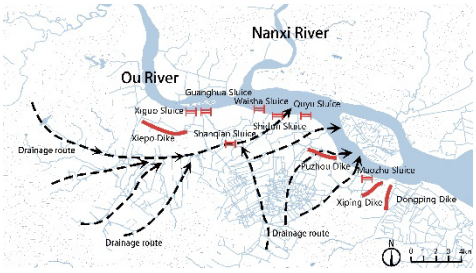


Fig. 5 – *Distribution diagram of dikes and sluices* (adapted from Cao, 2025).

Simultaneously, the Ou River lies at the mouth of the sea, where the river and sea interact, and tides are interconnected. During high tides, the sea tide drives the river tide, carrying seawater into the river waterway. To address the issue of seawater intruding upriver during high tides, people constructed sluices (also known as doumen) at the river's mouth to resist the backflow of seawater. As noted by Huang Yi, a local resident of the Qing Dynasty, "Thousands of streams converge and flow downstream, relying on doumen for drainage. In droughts, it stores water; in floods, it drains water. It is truly the throat of water management, the lifeline of fields and gardens... If the city walls are not strong, they are vulnerable in emergencies; if the sluices are not firm, droughts and floods are imminent".

The seawalls, dikes, and sluices work together, releasing water into the river during dry periods and draining water into the river during floods, the internal river water network becomes a controllable system. This system not only effectively addresses the issue of saltwater intrusion but also provides stable freshwater resources for agricultural production. Through the construction of seawalls, people successfully prevented the flooding of seawater; through the

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building of dikes, they controlled the flooding of rivers and streams; and by setting up sluices, they effectively managed the problem of seawater backflow. The implementation of this series of water conservancy projects gradually transformed the originally salt-repelling and uncultivable tidal flats into a habitable wetland suitable for cultivation.

3.2. The ponds-canals System

The formation of the ponds-canals system largely originated from the transformation process of estuarine lakes - ponds and related natural river channels. The region of Ou, Wenzhou, once comprised numerous bays, estuarine lakes, and marshes—a land texture gradually formed by rainwater inundation and tidal erosion after the eastward shift of the sea. The seawalls-dikes-sluices system isolated the intrusion of ocean tides, making the plain area a relatively independent regional unit, enabling local ancestors to transform the marshes left behind by the receding seawater.

An important event in shaping the water network texture of the plain was the "Sanxi Water Control"(a hydrological project in 844 AD). In the fourth year of Huichang (844 AD), Wei Yong, the governor of Wenzhou, mobilized the people to manage the water disasters of Sanxi. They dredged river channels and excavated a ten-mile lake to divert and distribute water. The lake near the city area was called "West Lake", while the one located south of the city was called "South Lake". Embankments were built at river mouths to divert water flow, ultimately leading into the Wenrui Canal. In case of heavy rain and floods, water was discharged near the Ou River. After the "Sanxi Water Control", the internal river water network of the ancient Yongjia Plain became stable. The "Yongjia County Annals" recorded: "The water in Yongjia branches and converges, the upper and lower river villages converge at Huichang Lake, flow into the river, and discharge into the sea". This water conservancy project not only solved the water disaster problems at that time but also laid the foundation for the pattern of the plain water network for future generations.

After the Song Dynasty, the plain water management system entered a stage of iterative development. During this period, the ponds-canals system in Ou region gradually took shape. As the coastline moved eastward, the seawalls originally used to resist tidal waves gradually evolved into inland rivers—the Wenrui Canal, which has a vast water surface with a dense network of tributaries. The local ancestors utilized the Wenrui Canal and its connected ponds, estuaries, streams, and rivers to achieve regional connectivity, promoting agricultural irrigation, transportation, and economic development.

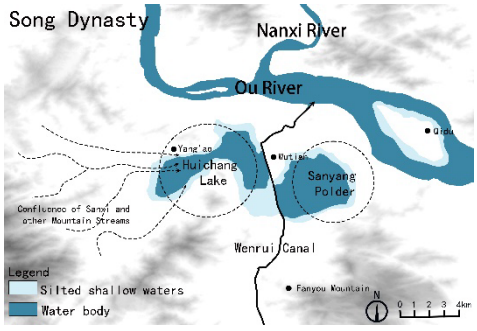


Fig. 6 – *The relationship between Huichang Lake, Wenrui Canal, and their surrounding areas during the Song Dynasty* (adapted from Cao, 2025).

3.3. The Polder Field System

The combination of the seawall-dike-sluice gate system with the ponds-canals system has successfully achieved the purpose of "rejecting saltwater and storing freshwater", leading to the formation of a relatively stable inland river network in the plain area. However, despite the effective water resource management by these two systems, the transformation of marshes and lakes into arable farmland remains a pressing challenge in agricultural production.

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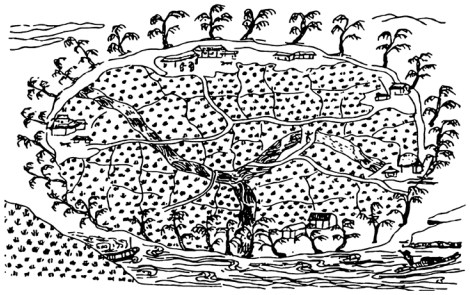


Fig. 7 – *The morphology of polder fields described in "Illustrated Record of Wanchun Polder"* (adapted from Shen Kuo, The Collection of Changxing, Vol. 21 "Illustrated Record of Wanchun Polder", 1060s CE).

During this process, the Wenrui Canal played a crucial role. It received water from mountain streams and marshes, diverting it through sluice gates into the rivers and seas, serving as the hub of the regional water network. Leveraging the Wenrui Canal, people constructed embankments along the edges of marshes, dug ditches, and established a sophisticated drainage and irrigation system. The embankments were utilized to prevent the intrusion of external water bodies, while the ditches were used for water conveyance and drainage, thereby facilitating the cultivation of farmland.



Fig. 8 – *The polder landscape of the Ou region (Sohu, 2025).* (Retrieved April 27, 2025, from https://www.sohu.com/a/548670822_99953014).

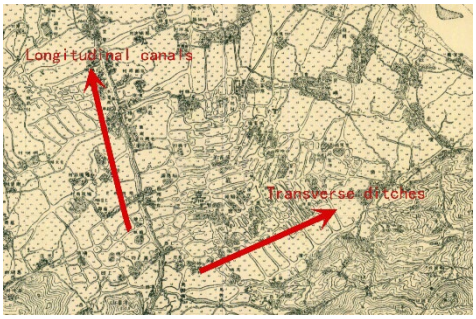


Fig. 9 – *Diagram of the water network structure of "longitudinal canals and transverse ditches*" (adapted from Cao, 2025).

The combination of canals and polder fields eventually formed the water network pattern of "longitudinal canals and transverse ditches". The term "longitudinal canals" refers to the canals and rivers flowing longitudinally, connecting the Ou River and Feiyun River, serving as the backbone of the regional water network; while "transverse ditches" are small waterways that transversely connect the canals, utilized to regulate the distribution of local water flow. As recorded in the "Water Resources Chronicle of Zhejiang Province": "Land reclamation along the ditches." Through the construction of canal, excavation, and dredging of ditches, people gradually transformed the silted mudflats into arable land. Across vast expanses of land, rivers intersect, forming an embanked field water network characterized by the interweaving of rivers and ditches, creating a network of "crisscrossing waterways, longitudinal canals, and transverse ditches".

3.4. Boiling the Sea into Land

As the sea continued to recede in the Tang and Song dynasties, the eastern part of Daluo Mountain formed a vast expanse of saltwater overflow and tidal inundation mudflats. The salt-alkali mudflats were unsuitable for cultivation, presenting a pressing need for transforming the saline-alkali land into arable agricultural production bases.

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At this time, salt production became a crucial means of reclaiming land from the sea, serving as an indispensable process in converting the salt-alkali land into cultivable farmland.

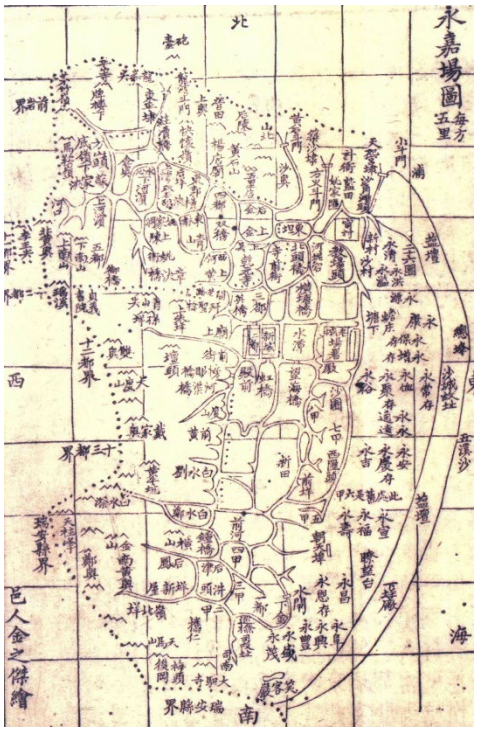


Fig. 10 – *Map of Yongjia Saltworks* (Zhong, 2014, p. 95).

This process evolved over a millennium. An essential milestone was the establishment of the Yongjia Salt Field during the Song Dynasty, significantly accelerating the transformation of the mountain and sea. Over centuries, people on the coastal mudflats gradually transformed the uncultivable salt-alkali mudflats into arable farmland by extracting salt through seawater boiling. The illustration "Map of Yongjia Saltworks" provides a geographic cross-section for exploring the dynamic changes in the geographical landscape of the region. The Yongjia Field Map details the division of rural and urban areas and the distribution of settlements in the late Qing Dynasty Yongjia Field. It states:

> "Yongjia Salt Field is thirty miles southeast of the county town, covering half of Huagai Township from one to four districts, and half of Yingfu Township with five districts, extending over thirty miles from northeast to southwest. Yongchang Fort is called Xincheng, while the old city is called Yongxing Fort" (Zhang et al., 2010).

Through the practice of "boiling the sea into land", people systematically transformed coastal mudflats, ultimately establishing a salt-centered hydraulic network along the shoreline. Tidal erosion naturally carved numerous gullies and depressions along the shoreline, which salt workers dredged into saltwater channels to harness brine tides. Concurrently, as the coastline shifted eastward, communities were compelled to "relocate saltworks following brine sources", repurposing existing seawalls into irrigation canals. These saltwater channels, irrigation canals, and natural waterways interconnected, forming an intricate transportation system for salt distribution.

The salt-making process fostered communal settlements organized around Tuanzao (salt-production units). As saltworks progressively moved eastward, inland soils became arable. Implemented during the late Qing Dynasty, the "saltworks-to-farmland conversion" policy accelerated agriculture's replacement of salt production. Agricultural settlements consequently expanded, gradually absorbing the original stove-canal communities. In the modern landscape, these salt-production villages have been entirely supplanted by farming communities, with only faint topographical traces remaining as testaments to their historical presence.

3. Conclusion

The relationship between humans and the land is an ancient and enduring theme that permeates throughout the development of human civilization. Since the local ancestors first began

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inhabiting this land, the morphology of the land has been slowly evolving through continuous rewriting, exhibiting complex and dynamic interactions between humans and the environment. This process not only reflects the wisdom of humanity in adapting to the natural environment but also demonstrates the determination of humans to transform nature.

In this historical progression, the ancestors of the Ou region demonstrated outstanding environmental adaptation and transformational intelligence. Relying on the natural water network and mountainous terrain, they constructed a systematic network of regional water conservancy projects, enabling scientific regulation of the regional hydrology. In the low plains, facing a natural environment characterized by interlacing rivers and lakes and extensive marshes, the ancestors adapted to the conditions. They initially constructed seawalls, pond rivers, and embanked ponds along water bodies to control salinity and store fresh water, followed by implementing land reclamation projects to convert wetlands into arable fields. On the coastal mudflats, addressing the challenges of saline-alkali land unsuitable for cultivation, the ancestors creatively adopted a development strategy known as "salt first, agriculture later", improving the land through salt-related activities before transitioning to agricultural cultivation. This gradual land development model not only showcases the ancestors' profound understanding of natural laws but also highlights their innovative thinking in land utilization.

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Transformation of an Area with Industrial Buildings in the Ottoman Empire in the 19th Century: İstanbul, Zeytinburnu

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Abstract
The modernization movements experienced in the Ottoman Empire in the 19th century also affected the urban space of İstanbul. In parallel, what happened after the industrial revolution transformed small-scale production workshops into industrial facilities. As a result of these developments, large-scale industrial structures dominant in the traditional fabric were built in different regions of İstanbul. Factors such as transportation, raw materials and large areas were taken into consideration when constructing industrial buildings. According to these factors, some regions in İstanbul were consciously chosen as industrial centers. One of these regions was today's Zeytinburnu district, which is outside the city walls in İstanbul. As a result, the modernization efforts initiated in the Ottoman Empire in the 19th century caused radical transformations in the morphological structure of İstanbul. In this context, Zeytinburnu one of the peripheral areas of the city outside the city walls has become one of the new industrial production areas in a planned manner. The main purpose of this study is to examine the spatial transformation shaped by the construction of industrial structures within the urban development process of Zeytinburnu in the 19th century. The studies are focused on the Kazlıçeşme region, which has been an important production area throughout history in the Zeytinburnu district. The effects of urban transformation, especially in the 19th century, on the physical environment were evaluated comparatively through historical maps, archive documents and old visuals.

Keywords: *Zeytinburnu; Kazlıçeşme; industrial heritage; 19th century ottoman urbanism; urban morphology*

1. Introduction

After the Tanzimat Period, the modernization movements that started at the administrative level especially in the last period of the Ottoman Empire, began to affect a large part of social life.[1].

Under the influence of modernization movements, great changes and transformations were experienced socially. Architecture was also greatly affected by these changes. In the Ottoman geography which was trying to quickly adapt to the innovations brought by the modernization process, İstanbul was one of the cities that

[1] Tanzimat Edict: The edict of Sultan Abdülmecid, which was read by Mustafa Reşid Pasha in Gülhane in 1839 and is also called the Tanzimat Edict because it started the Tanzimat era. (TDV, Islamic Encyclopedia)

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experienced the greatest change. As a result of modernization a rapid search was undertaken to find answers to the new emerging functions (Eldem, 2012). In the 19th century, the Ottoman economy also changed according to the production materials and the new order. The Ottoman industry which previously consisted mostly of small workshops in the neighborhoods, gave way to large production facilities. As a result of this transformation, some regions of the city became industrial centers and its peripheries were inevitably affected by this change. In some regions, large-scale production facilities transformed the existing built environment. This transformation; was one of the important turning points for the urban history of İstanbul (Çelik, 2016). One of the regions where the urban space was transformed with industrial structures was the area within the borders of today's Zeytinburnu district. This study aims to examine how the production facilities in the Zeytinburnu region of İstanbul shaped their surroundings and the urban fabric after the Industrial Revolution (1760) and to provide a resource for urban history research and conservation efforts.

The methodology determined in the study was generally aimed at revealing the transformation experienced before and after the 19th century. Therefore, first the situation of Zeytinburnu before the 19th century was addressed. This is also very important in terms of understanding the environment in which the political, economic and architectural movements experienced in the 19th century occurred. Then, the events that ignited and accelerated the industrial movements experienced in the 19th century were addressed. In addition, the industrial structures built were listed chronologically. The reason for this was to reveal the years and production materials of the factories built. Some parameters were determined in terms of how these structures transformed the urban space and the traces of the transformation were analyzed according to these parameters. The first of these parameters was the increase in the number of workers and the increase in the number of population and housing. Other important parameters were the change in transportation systems and the emerging urban needs (health, education, religion). Although the scope of the study was generally Zeytinburnu district, the method designed to better analyze the transformation in urban space in the 19th century was studied in detail in the Kazlıçeşme region.



Fig. 1 – *Map of İstanbul and Location Zeytinburnu* (wikipedia.com).

2. Zeytinburnu urban history

Zeytinburnu is a region on the European side of İstanbul, bordering the Sea of Marmara. Until the 19th century, it was a settlement that touched the walls of İstanbul and was located just outside the walls. The urban history of the region was examined under two separate headings, pre-19th century and 19th century.

2.1. Zentinburnu and Kazlıçeşme district before the 19th century

During the Ottoman period the first settlement area within the borders of today's Zeytinburnu was around Kazlıçeşme. After the conquest of İstanbul (1453), tanneries were established in this area and over time the region became the center of leatherworking activities (Özvar, 2006). These are Takkeci İbrahim Ağa Mosque built in the 16th century, Yenikapı Mevlevi Lodge, Merkez Efendi Complex, Seyyid Nizam Lodge, Merzifonlu Kara Mustafa Pasha Mosque built in the 17th century and Perişan Baba Lodge in the 19th century (Akbulut, 2006).

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Evliya Çelebi[2] gave information about the settlement in Kazlıçeşme in his Seyahatname. He mentioned the Kazlıçeşme Mosque and the seven small mosques outside the mosque. He also mentioned the existence of tanneries in this area. He also mentioned the existence of workers' neighborhoods in this area where single people working in tanneries lived rather than married families (Özvar, 2006).

2.2. Zeytinburnu and district region in the 19th century

Zeytinburnu was a small-scale settlement until the Tanzimat. In the 18th and 19th centuries, significant production activities were carried out in this area. After the Tanzimat Period, it gained an important place in the industrialization process of the Ottoman Empire. One of the biggest moves planned and realized by the Ottoman Empire which started with Mahmud II[3] was Zeytinburnu and the other was the industrial complexes established in Bakırköy which borders Zeytinburnu. Thanks to the foreign engineers and workers to be brought to these complexes and the Industrial School built in connection with the factory, Zeytinburnu became the focus of the industrialization of the Ottoman Period (Özvar, 2006, p. 90; Akansu & Çorakbaş, 2022).

A dense settlement process in Zeytinburnu began during the reign of Abdülhamid II[4]. The fact that one of the two largest industrial complexes established in İstanbul was in Zeytinburnu increased the population here. The factories and surrounding residences and the virgin areas outside the city walls began to be developed (Yelmen, 2006). The industrial complex established in Zeytinburnu initially produced for the army.



Fig. 2 – *Map of Zeytinburnu* (Zeytinburnu Rehberi, 2020).



Fig. 3 – *Kazlıçeşme (in the İstanbul miniature in the Hünernâme by Seyyid Lokman (d. after 1601)* (büyükistanbultarihi.net).

[2] Evliya Çelebi: The Great Turkish Traveler. (TDV, Encyclopedia of Islam)

[3] Mahmud II, Sultan of Ottoman (1808-1839).

[4] Abdülhamid II, Sultan of Ottoman (1876-1909).

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The complex included a gunpowder mill, a rifle mill, a cartridge factory and a military hospital (Yelmen, 2006). Along with the industrial structures, settlements were concentrated especially around Kazlıçeşme and today's Yenidoğan neighborhood. These were followed by Sümer, Yeşiltepe and others (Fig. 4).



Fig. 4 – *Air photo of Zeytinburnu, 1960's* (yedikule.org).

3. Industrial buildings built in Zeytinburnu in the 19th century and urban transformation

3.1. Industrial buildings built in Zeytinburnu in the 19th century

Leather production activities were carried out in the Kazlıçeşme region of Zeytinburnu from the Byzantine period to the 1950s. Modern industrial facilities were built with the westernization activities that started in the 19th century. Production activities in Zeytinburnu can be divided into two main groups as leather and military. Zeytinburnu was chosen for factories because of its proximity to the sea, suitable land for industrial facilities and being a settlement outside the city.

The most important modern industrial facility established in the 19th century was the Zeytinburnu Mavzer and Iron Steel factories, which were established for military purposes. Some structures from the group of buildings built and designed as an industrial production complex have survived to the present day (Fig. 5).



Fig. 5 – *Zeytinburnu Iron Factory* (kultur envanteri.com).

The leather workshops that started in the Byzantine period in the Kazlıçeşme neighborhood of Zeytinburnu district continued their activities until the 1980s. Today, the structures in this area have been demolished and the area is used as a parking lot. The table below includes industrial structures built in the 19th century, their construction years and their current status.

3.2. Urban transformation in Zeytinburnu in the 19th century

Zeytinburnu witnessed every step of the Ottoman industrialization process in the 19th century, and iron, steel, mauser-cartridge, railway, chemical and textile factories were established with new technology in addition to traditional production tanneries.

Tanneries and factories in Kazlıçeşme are located close to water resources required for processing raw materials, making production processes more efficient. Kazlıçeşme has historically been a rich region in terms of underground water reserves. This strategic location has increased the efficiency of processing processes and reinforced the region's importance as an industrial center. Sea transportation has also been taken into consideration, and for this reason industrial structures have generally been built along the Kazlıçeşme coastline (Fig. 6). (Çekin & Kuruçay, 2020).

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Table 1 – *Important factories built in Kazlıçeşme throughout history.*

Name of Factory	Function	Date	Today Situation
Kazlıçeşme Leather AtelEier	Textile	15. yy – 20. yy	non existing today
Zeytinburnu Textile Factory	Textile	1842	non existing today
Yedikule Gashouse	Energy	1880	existing today
Zeytinburnu Chemistry	Chemistry	1902	Non existing today
Zeytinburnu Mauser and Cartridge Factory	Power and gun	1902	existing today
Zeytinburnu Steel Factory	Steel	1902	non existing today

In the 19th century, modern industrial facilities began to be established after the traditional production tanneries. Zeytinburnu's urban space also began to transform with factories producing iron, steel, mauser-cartridge, chemical and textile. It would be more accurate to examine the results of this transformation under subheadings such as housing growth, urban needs and transportation.

3.2.1. Population and housing

Industrial activities in Zeytinburnu began at the end of the 18th century. The population and housing density in the region which was a settlement outside the city walls before the 19th century and was described as non-urban was not high. Zeytinburnu which became an industrial center with its increasing number of industrial structures in the 19th century, began to receive migration. As a result of this migration, a need for housing emerged. It was important for the urban activities to be revealed that the population that came to establish factories or to work was family or single.

It is possible to talk about a worker population here with the establishment of leather workshops in Kazlıçeşme after the conquest. The accommodation of workers working in the leather workshops that continued until the 1950s was very important for the urban transformation of Zeytinburnu. It is thought that the workers working in these leather workshops were single. Evliya Çelebi also mentioned in his narratives that this region smelled very bad and that tanners[5] generally stayed near the workshops, away from the city (Medium, n.d.).

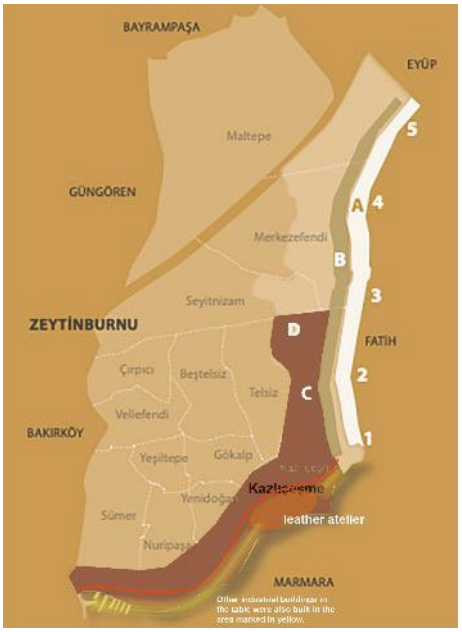


Fig. 6 – *Map of Zeytinburnu* (Zeytinburnu Rehberi, 2020).

[5] Tanner: worker in a leather workshop.

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Fig. 7 – *Map of Kazlıçeşme District, Jacques Pervititch, 1939* (Salt Archieve).

3.2.2. Transportation

The most important innovation in transportation in Zeytinburnu was the construction of the railway in the 19th century. The arrival of the railway in Zeytinburnu also increased industrial activities in the region. Railway transportation was also an important criterion in the location selection criteria of factories. Considering the fact that industrial facilities use a large amount of raw materials and energy as well as the transportation situation, location selection and transportation networks gain great importance (Fig. 8).

Transportation was important for the region both while industrial facilities were operating and after they were closed. The opening of the Ottoman-Rumeli railway in 1870 met the transportation needs of industrial facilities for the market (Kırlı, 2018).

3.2.3. Urban needs

After 1842, agricultural and military industrial facilities were established in Zeytinburnu and the neighboring district Bakırköy. A farm was established for the Basma factory on the Veliefendi coast where the planting methods of cotton, the raw material of the factory were taught, and different methods of agriculture were tried.

With the increase in population, the mobility in the region led to the emergence of different urban needs. Some of the factories were established as small self-sufficient towns. Bakırköy Gunpowder Mill included an oven and a stove (Kırlı, 2018).



Fig. 8 – *Texture Analysis, designed by Jacques Pervititch Map 1939* (Darendeli, 2025).

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The increase in the population in the region brought health services with it. After the Bakırköy and Azatlı gunpowder mills started operating, the existing Munitions War Hospital became insufficient due to the increase in the population. In 1847, a new hospital building was built by Halil Pasha as Zeytinburnu Military Hospital(Kırlı, 2018) (Fig. 10).



Fig. 9 – *Kazlıçeşme Air Photo* (Google Earth, 2025).

4. Conclusion

Zeytinburnu which was an untouched area before the 19th century, entered a rapid transformation in the 1780s. It is possible to see the traces of this transformation today.

Because the transformation that started in the 19th century continued rapidly and unplanned in the 20th century and examples of shantytown culture began to be seen intensively in the region.

This is an important subject that can be the subject of another study. Within the scope of this study; the factories built in the 19th century and the transformation that took place were examined. The traces of this transformation were discussed through the Kazlıçeşme region, which was an important production area in history.

In the 19th century, Kazlıçeşme stands out as one of the areas where the transition from traditional production practices to an industrially focused spatial organization was embodied in the context of the modernization process of the Ottoman Empire. Especially with the reform movements after the Tanzimat Peirod the region transformed into an industrial zone where historically established leather production and tannery activities were structured in a more systematic and controlled manner. This transformation was not limited to the physical restructuring of production areas but also led to significant changes in the social fabric with the development of housing areas for the workforce.



Fig. 10 – *Zeytinburnu Military Hospital* (kulturenvanteri.com).

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The transformation that Kazlıçeşme went through during this period should be evaluated as an important reference point today in terms of the preservation of both the industrial heritage and the early urban morphology.

As a result, Zeytinburnu and especially Kazlıçeşme provide one of the early examples of the transition to an industrially focused spatial organization as part of the 19th century Ottoman modernization policies. The fact that these areas were located outside the city walls limited the urbanization effects of the Industrial Revolution; the close location of the factories affected the logistics and social infrastructure.

Industrialization in this period initiated a significant transformation process not only in production areas but also in terms of housing, transportation and social needs. With this identity change, Kazlıçeşme reveals both the evolution of the physical environment and the reshaping of the social structure, and this process constitutes an important reference for conservation and planning studies.

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A New Paradigm toward Resilient Morphogenetic Open Processes

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Abstract

In various urban contexts across Latin America and Southern Europe, the management of stormwater faces a structural paradox: the physical and symbolic invisibilization of temporary watercourses — quebradas, barrancos, ramblas — coincides with an increasing exposure to hydrogeological risk Quito (Ecuador) and Valencia (Spain) do not represent case studies to be compared, but rather emblematic conditions of a recurring fragility that manifests through similar patterns in geographically and culturally distinct settings. The material and perceptual erasure of intermittent hydrological systems — a consequence of urban development models disconnected from local geography and memory — has produced widespread vulnerability, further exacerbated by the intensification of extreme weather events linked to climate change. Within this framework, the research proposes a paradigm shift: how can the underlying causes of contemporary catastrophic effects be transformed into design variables? How can we move beyond reactive, emergency-driven, and sectoral approaches, towards transformation processes capable of acting systemically across time and space? The proposed transition is grounded in a processual and adaptive perspective, integrating interdisciplinary and interscalar dimensions. The new paradigm is not structured around fixed stages but rather conceived as a flexible method that recognizes and intervenes in systems of fragility, preparing territories to coexist with risk and outlining a "morphogenetic geography of resilience." The methodological framework is articulated in three phases: i) Analytical-descriptive: the development of an etymological taxonomy of terms related to catastrophe and an analysis of current approaches to risk management; ii) Critical-interpretive: the identification of key aspects of the proposed paradigm and the methodological steps required for its implementation; iii) Propositional-operative: the testing and evaluation of the approach through emblematic contexts, interpreted not as exceptions, but as symptomatic expressions of a structurally exposed urban condition.

Keywords: *catastrophe; new paradigm; resiliency; morphogenetic geography*

1. Introduction

The origin of the investigation. Understand Quito as a city without memory. In Invisible Cities, Italo Calvino (1974) explores the relationship between cities and memory. Among the imagined cities, Quito resembles Leonia — a place of perpetual amnesia: "The city of Leonia refashions itself every day." While Leonia forgets through daily renewal, Quito's memory loss is deeper, rooted in the deliberate erasure of its geomorphological memory.

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The city continues to evolve without acknowledging the physical foundations upon which it stands. Located at 2,850 meters above sea level on a narrow Andean plateau, Quito's topography — shaped by the Pichincha volcano — includes over 120 seasonal ravines (quebradas). These once served as drainage channels, defensive corridors, and ecological connectors. In recent decades, however, urban expansion has filled and buried many of them, replacing them with rigid infrastructure inadequate for contemporary hydrological demands. Between 2005 and 2014 alone, 804 floods were officially reported (Trizio et al., 2022), confirming the warnings of geographer Pierre Peltre, who in 1989 foresaw the consequences of sealing these ravines. This process has disproportionately affected vulnerable populations, often pushed into high-risk zones. The city continues to rely on reactive emergency measures, without addressing the deeper spatial and ecological causes of disaster. This context calls for a paradigm shift — one that integrates hydrogeographic conditions as active design variables, rather than residual constraints.

Quito's condition is not unique. In Valencia (Spain), a city shaped by ramblas — intermittent watercourses embedded in the urban fabric — a different but parallel disconnection is evident. Unlike Quito, where many hydrological structures have been physically concealed, in Valencia these systems remain visible. Yet their seasonal and low-flow nature leads to their symbolic marginalization: the public rarely perceives them as potential threats, despite the increasing intensity of extreme weather events.

Rather than isolated cases, Quito and Valencia reflect a recurring urban condition: systemic fragility rooted in the denial — physical or perceptual — of temporary hydrological systems. Both cities suffer from a loss of memory regarding their hydrogeographic foundations. This highlights the need for a new paradigm that addresses the root causes of disasters, moving away from the reactive "disaster cycle" to a proactive, interdisciplinary approach that adapts to changing contexts.

2. Catastrophe Taxonomy

The taxonomy outlined here builds on selected terms that reflect the language of catastrophic events while guiding a shift toward a morphogenetic, evolving, and resilient paradigm. This approach acknowledges how systems interact, destabilize, and regenerate over time. The chosen pairs -Catastrophe/Emergency, Crisis/Resilience, Project/Process, and Reconstruction/Regeneration- serve as conceptual tools for understanding sudden change and its potential for renewal.

2.1. Catastrophe and emergency

The term catastrophe, from the Greek *Katastrophé*, refers to upheaval and disorder, marking an event that abruptly destabilizes an otherwise stable system. Whether caused by human actions -such as war, terrorism, or technological failure- or natural disasters like earthquakes and floods, catastrophes trigger profound disruptions. Their frequency is increasing due to urban concentration, environmental exploitation, and climate change, affecting not only physical structures but also social and technological networks.

The concept of emergency has a dual interpretation. The Latin root *emergere* suggests an unforeseen condition that reveals new relationships and possibilities, aligning with complex systems theory. Meanwhile, in its common use, emergency denotes a crisis requiring immediate intervention. This dual nature highlights how emergencies are not only moments of disruption but also opportunities for transformation. In urban planning, this means shifting beyond short-term crisis management toward systemic strategies that integrate adaptability into spatial and infrastructural design.

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2.2. Crisis and resilience

Crisis, derived from the Greek Krisis (decision, judgment), marks a moment of instability in which existing structures must confront their limitations. While crises expose system vulnerabilities, they also serve as catalysts for transformation. Studies in morphogenesis illustrate that crises do not simply erase the past but retain structural "DNA," allowing continuity through change.



Fig. 1 – *Morphoclimatic Risk – Torrential Lava/Mud FlowsLa Gasca - Quito* (A. Cárdenas, El Universo).

Resilience describes a system's capacity to absorb shocks, adapt, and evolve. Originating in engineering and biology, the term has become central in urban studies. In engineering, resilience refers to a material's ability to recover its form after stress; in biology, it denotes an ecosystem's capacity for self-regulation and adaptation. Applied to urban planning, resilience suggests that cities should not strive for a return to past conditions but must develop flexible systems capable of evolving through disruption.

Tropical forests offer a compelling analogy. Their complexity, redundancy, and networked interactions allow individual components to fail without threatening the entire system. Similarly, resilient urban environments should avoid rigid, hierarchical planning in favor of adaptable, interconnected structures that can withstand and respond to crises dynamically. Instead of treating crises as purely destructive, this perspective embraces them as opportunities for renewal, encouraging a shift toward long-term urban sustainability.



Fig. 2 – *Underground Dripping effect. Vial del Trebol. Quito, Ecuador* (Salazar et al., 2010).

2.3 Project as process

Traditionally, architectural projects have been conceived as static blueprints, with a clear trajectory from conception to completion. The term project, from Latin *Projèctus* ("to throw forward"), suggests a future-oriented action. However, this conventional approach is increasingly inadequate in contemporary urban contexts, where unpredictability demands a shift toward process-driven design. The term process (*Procèssus*, "to progress") conveys an ongoing adaptation rather than a fixed endpoint.

This shift is particularly relevant in environments subject to recurring disasters. Standard reconstruction efforts often focus on restoring "normality" within a rigid timeframe, failing to account for interim needs, future risks, or evolving societal demands. A process-based model instead prioritizes flexibility, iterative adaptation, and feedback loops.

This approach aligns with Agile methodologies in software development, where projects are structured around incremental improvements rather than predetermined solutions. Urban design can benefit from similar principles, embracing open-ended frameworks that allow solutions to emerge dynamically in response to changing conditions. By recognizing that the future is not a static outcome but an evolving interaction of variables, this model enhances the resilience of built environments and fosters a more adaptive architectural practice.

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2.4. Reconstruction and regeneration

Following a disaster, reconstruction is often seen as the primary response, driven by a desire to restore what was lost. However, this impulse can be problematic, as it assumes that past conditions can be reinstated without considering their evolution. Reconstruction, in its conventional sense, risks erasing the complex layers of history that define a place.

In contrast, regeneration suggests a more adaptive approach. Derived from re- (again) and genesis (origin), regeneration is not a mere repetition of the past but a transformation that integrates historical remnants into new configurations. Instead of aiming for an exact restoration, regeneration acknowledges the scars and traces left by catastrophe, incorporating them into the evolving urban fabric.

This approach requires a recognition of loss—a "grieving process" that allows for reflection before reconstruction. Rather than erasing past destruction, regeneration seeks to reinterpret it, ensuring that what remains is not only preserved but reintegrated in a way that respects history while addressing contemporary needs.

The conventional tabula rasa mentality, which prioritizes erasure in favor of entirely new designs, is thus replaced by a more layered methodology that builds upon the existing structural and cultural context.

Regeneration-driven urban interventions are deeply rooted in their local history. Rather than simply replicating old forms, they reinterpret them within the framework of modern functional demands. For example, instead of reconstructing a historic building purely for its aesthetic value, a regenerative approach might retain key structural and symbolic elements while adapting interior spaces for contemporary use.

This ensures that the essence of the place endures even as it evolves.

2.5. Reflections about Catastrophe Taxonomy

Integrating these concepts—catastrophe and emergency, crisis and resilience, project and process, reconstruction and regeneration—requires a fundamental shift in how urban and architectural design respond to disruption. Planning cannot remain confined to static models that ignore the broader dynamics of risk, memory, and transformation.

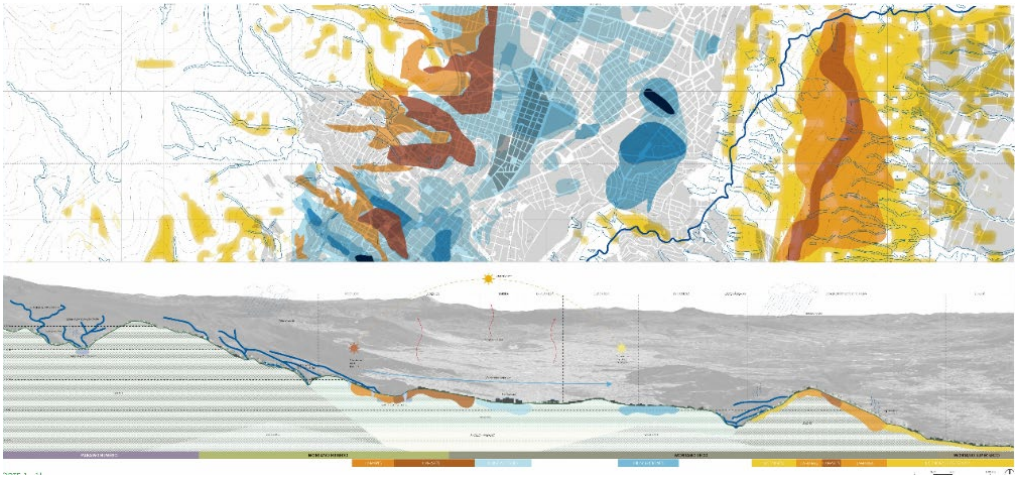


Fig. 3 – *Risk map of Ejido sector of Quito,Ecuador. DAU VI Urban project Laboratory, FADA PUCE* (Bracchi, Van Sluys, Andrade, Montaños, 2023).

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Instead, a forward-looking approach must acknowledge that each catastrophic event introduces the potential for new spatial and social orders, that every crisis holds the possibility for reinvention, and that every project must be conceived as a dynamic process rather than a finite solution. This perspective challenges outdated models that resist change, advocating instead for an approach that integrates disruption as an inherent part of design. By recognizing that nothing remains immutable and that crises can be opportunities for transformation, architects, urban planners, and policymakers can create environments that are not only resilient but capable of generating sustainable, adaptive futures.

3. A new paradigm

The taxonomy reveals alternatives to current practices in catastrophic events, focusing on the genetic and generative aspects of places. It advocates for a shift from static project forecasts to adaptive processes that respond to emergent conditions. Current protocols operate independently, with disciplines fragmented and lacking integration, especially during post-emergency interventions. Architecture, urban planning, and landscape design typically intervene after crises, often addressing population needs rather than considering place characteristics, sometimes causing further destruction. Emergency management often demands swift action, leaving little time for deep evaluations of places and cultures.

A paradigm shift is necessary, replacing fragmented practices with a holistic, genetic approach that embeds resilience and regeneration into places. This approach must establish interdisciplinary networks, adapt to new conditions, and embrace flexible configuration principles. Projects should evolve from static to dynamic processes, incorporating emergency and crisis as design variables. The natural and artificial environmental systems must be predisposed to adapt to various catastrophic events through case-specific configurations.

This new paradigm includes: 1) Shifting from post-catastrophe interventions to integrated, holistic design; 2) Moving from rigid protocols to open, evolving processes; 3) Predisposing places for adaptive evolution with responses emerging from system interactions; 4) Developing a new system based on the deep structure and genetic elements of places, addressing future needs with dynamic principles. At this point, the research questions how to achieve this new paradigm: what strategies and methods can enable places to activate and respond to critical conditions? The research proposes three open methodological steps, defined as pre-catastrophe, internalizing potential catastrophic phenomena within urban, architectural, and landscape design. Subsequently to these methodological steps, some principles of predisposition of places are drawn up, derived from studies conducted by M. Mehaffy and N.A. Salìngaros (2013), based on Christopher Alexander's geometric properties in The Nature of Order (2002-2004).

The methodological steps include:

1. **Context Reading:** Collect quantitative and qualitative data, organizing it into measurable categories using maps, sections, 3D models, and dynamic infographics to reflect temporal variations. Gather multiscale information on risks, physical-spatial, socio-cultural, and techno-environmental data from both the intervention area and its broader context. The focus is on spatial categories, land artificialization, energy use, and pollution levels, emphasizing the need for interdisciplinary collaboration among architects, urban planners, engineers, geologists, and others.
2. **Interpretation and Identification of Sensitive Areas:** Analyzing risk data with spatial layers provides critical insights for disaster planning. Merely identifying safe zones by distance is insufficient, as it ignores factors like service access, infrastructure, and psychological impacts. Layer analysis reveals

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past designs overlooked emergencies, where some areas, despite being "safe," may lack accessibility or necessary services. Identifying vulnerable zones and disaster-response areas at multiple scales is crucial to reducing exposure and improving resilience. A systemic understanding, involving both scientific and social communities, is key to initiating integrated planning processes.

3. **Predisposition of Places:** Principles of Adaptability and Resilient Geometries: Identifying optimal areas through spatial, social, economic, and environmental indicators is just the first step. These areas must be transformed into resilient locations capable of adapting over time and space to meet diverse needs. Sites selected previously should act as landscape-infrastructural backbones, reconfiguring urban, natural, and productive landscapes based on their specificities. This creates an evolutionary and flexible system that supports social functions in normal conditions but adapts during emergencies, integrating new structures with existing fabric. Planning must focus not only on centralities but also on spaces between nodes, ensuring system coherence and adaptability via principles that configure a multipolar network.

How to Predispose Places? Resilient systems exhibit diversity, multiscale distribution, adaptation, and self-organization, reflecting evolutionary diversity (Mehaffy & Salìngaros, 2013), similar to Alexander's adaptive morphogenesis (2003), where forms emerge from successive transformations. Mehaffy and Salìngaros define geometric categories tied to resilient systems, providing the foundation for the four design principles developed by this research and aimed at predisposing places to withstand and adapt to disasters:

- **Weaving of Matrix:** Diversity arises from small adaptations. Alexander critiques perfect symmetry, as no natural organism exhibits it. Small differences foster strength and diversity. Each transformation nucleus should be placed on geometries that challenge static perfection, using boundaries and variable interventions to create a dynamic, multiscale system shaping architectural, urban, and landscape spaces.
- **Networks' Multiplication:** Transformation cores, from small to large scale, are interconnected in a hierarchical system. Stronger and weaker elements support one another. These networks extend outward to connect with the broader context and other

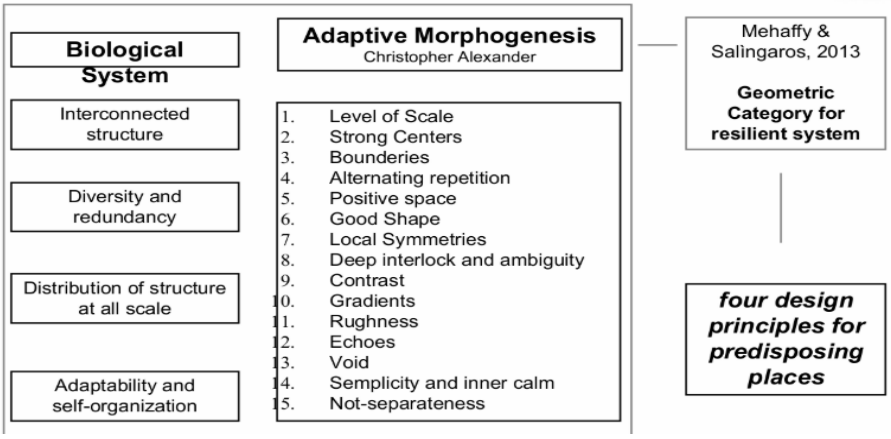


Fig. 4 – *Principles of adaptability and resilience geometries* (Bracchi, 2024).

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centralities, ensuring resilience. Reserve networks for energy production, water collection, waste elimination, and virtual connections between places and people must be integrated.

- **Relationship Between Structures:** In nature, fractals repeat at various scales, such as tree trunks and branches. This structural repetition enhances durability and adaptability. The system's multiscale structure prevents collapse when smaller branches fall. Contexts should have structural systems operating at various scales, generating relationships from territorial to architectural levels. This concept, the "structure of form," identifies genetic-structural aspects that anchor new interventions, promoting dynamic transformation linked to deep aspects of the place.
- **Interaction Among Boundaries:** Transformation cores must reconnect with the context, emphasizing the importance of boundaries. Though often viewed negatively, boundaries are sites of convergence and conflict resolution, creating transitional spaces. Boundaries are places of continuous evolution, dissolving rigidities and integrating differences. Originating from woven fabric, boundaries require roughness, accommodating diverse influences from outside.

5. Conclusions.

The methodology proposed for contexts like Quito and Valencia highlights the need to address the relationship between geomorphological conditions, urban development, and morpho-climatic risks. These contexts, with their ravines or flood-prone areas, present an opportunity to rethink urban resilience through a dynamic Urban Code that accounts for the physical, sociocultural, and technological-environmental characteristics of vulnerable areas.

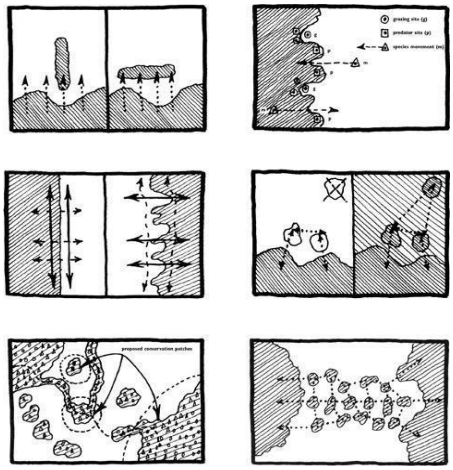


Fig. 5 – *Interaction among boundaries* (Bracchi, 2024).

In both Quito and Valencia, the presence of intermittent watercourses — hidden in Quito and visible but underappreciated in Valencia — reveals a shared challenge of integrating these spaces into urban planning. The methodology supports multiscalar interventions, ensuring flexibility and enabling cities to respond to new challenges without reverting to past conditions. This open-ended process emphasizes preparing urban spaces for future disasters, rather than merely reacting to their aftermath.

The current approach to post-disaster intervention is outdated, as it fails to address local specificities and typically focuses on the immediate aftermath of catastrophes. The proposed paradigm shift integrates disaster preparedness into the design process, ensuring that urban areas are predisposed to mitigate calamities. This requires a holistic, interdisciplinary approach, involving not only urban planners, architects, and landscape architects, but also active participation from the local population, who must take ownership of their environments. By fostering resilience through adaptive strategies, this approach aims to transform vulnerable areas into regenerative spaces.

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For contexts like Quito and Valencia, applying this methodology could transform areas that are currently perceived as threats — such as ravines and flood-prone zones — into resilient and multifunctional spaces. These cases, rather than offering specific interventions, act as paradigmatic references to reflect on how urban planning and design can better engage with hydrological temporality, integrate ecological features, and address vulnerability in a changing climate. Ultimately, this approach has broader implications for urban areas worldwide, promoting resilience to climate change and natural disasters, and encouraging sustainable development that responds to emerging environmental challenges.

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After the Earthquake: The 'Interrupted' Landscapes

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Abstract

The seismic event that hit Central Italy in 2016 was exceptional, due to the total mix of architecture and context. A historical building heritage that, like all minor urban contexts, suffers from its own fragility, attributable to a poor propensity to assign to it a specific 'monumental' character; a weakness that puts at risk the conservation of a value that is identity-related even before being historical-architectural. Today the (unavoidable) question arises of the methods of reconstruction of this landscape: on the one hand there is the need to quickly repair the damage caused by an earthquake that has disconnected not only the structures but also the consciences and the very identity of the populations; on the other hand the need to reconstruct large portions of a historical fabric that has stratified over the centuries and is today characterized by 'interrupted' landscapes. The conception of the landscape dimension outlined by the European Landscape Convention eliminates, instead, the dualism between 'natural environment' and 'cultural environment' understood as a place of identity of values. The extension of the concept of monument to broader areas and dimensions poses new critical and interpretative problems relating to the 'sense of place' and consequently requires the adoption of appropriate intervention tools, connected to urban planning discipline and territorial planning methodologies, to be combined with those specific to restoration. In terms of urban memory, it will therefore be necessary to promote a reconstruction process, based on the repair, recovery and restoration of what was saved from the earthquake, preserving the pre-existing road and land structure and avoiding methods of complete demolition and subsequent reconstruction from scratch; the reconstruction-translation of minor historical nuclei and the consequent, contextual, cancellation of permanent signs would in fact definitively remove every trace of their evolutionary memory, generating 'non-places'.

Keywords: *urban center; context; earthquake; landscape; identity heritage; reconstruction*

1. Introduction

"Construire, c'est collaborer avec la terre, laisser l'empreinte de l'homme sur un paysage qui sera changé à jamais" (Yourcenar**,** 1951). The 'minor' urban centres are elements of social and anthropological recognition, and an identity heritage before the historical and artistic heritage of the community.

Their progressive disappearance, which has been witnessed for some decades, entails the loss of the role of witnesses of a technical-constructive history that characterizes the 'sense of place'. A character that constitutes the peculiarity of that territory whose conservation could instead favor its recovery. The numerous restoration interventions and the remakes that can be observed in the historical buildings testify to the

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emergence, over the centuries, of an advanced constructive culture that has determined a specific character of resilience.

Another element characterizing these realities is constituted by the close relationship with the context; a 'built'/'landscape' set in which the latter, far from the concept of 'immutable natural landscape', of romantic derivation, should be understood as the outcome of its interaction with the work of man. A landscape whose forms are continually subject to modifications (Fig. 1).

The landscape/context, a representation of the communities that create and transform it, becomes "a distinctive character of places, which therefore belongs to the places themselves (…) [distinguished] by 'objective' traits that contribute to establishing their identity, that is, their being precisely that place and therefore to [attributing] to them their own *genius loci*" (D'Angelo, 2004, p. 26); it is no coincidence that the European Landscape Convention establishes that "the landscape designates a certain part of the territory, as it is perceived by the populations, whose character derives from the action of natural and/or human factors and their interrelations". The landscape is therefore interpreted as synonymous with territorial context; a reality that the seismic event changes radically, since the consequent interventions are destined to radically affect the physiognomy of the territories affected. This is particularly evident in the case in which urban centres of minimal size and located in mountain areas are affected, "fragile" landscapes, fully integrated with the surrounding territory. In fact, over time, landscapes settle into a fabric of memories, a 'widespread heritage' that constitutes one of the primary elements of a population's identity.

If, therefore, the landscape is a "perception of places" (D'Angelo, 2021, p. 22) or 'documentary place', the seismic event, by preventing such perception, determines the so-called 'interrupted landscapes' (Fig. 2).

2. Identity and memory of the landscape

The object of the reflection is therefore how to recompose the fracture generated between identity and territory (the place of memory). In the 19th century the 'landscape' movement had highlighted the valorization of the environmental context, or the idea that the interpretation of the values of the work of art cannot be conducted by isolating the monument from the environment; a concept fully expressed by Ruskin in *The stones of Venice*.



Fig. 1 – *Castelluccio di Norcia (Perugia), 2018. An example of integration between architecture and landscape* (Umbria Region website).



Fig. 2 – *Castelluccio di Norcia (Perugia), after the earthquake that hit Umbria in 2016* (D'Avino).

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At the beginning of the 20th century a new interdisciplinary approach emerged, generated by the confluence of other disciplines in the study of the territory: history, economics, demography. The theme of the landscape, understood as a 'historical document', is assumed as an autonomous sector of image: the study of geography is converted into the study of history stratified in places.

From this perspective it therefore appears evident that each individual construction cannot be distinguished from its context; rather it should be understood as part of a whole, of a context of even broader value since an interactive relationship is established between the two entities in the constitution of the image: "On the one hand, the monument contributes to the formation of the urban image, on the other, its architectural image itself obtains, in the context, the increase of being" (Asta, 1997, p. 83). The relationship that the city establishes with the context is in fact a relationship that conditions and shapes its entire structure, from the layout of the routes to the shape of the blocks, up to the shape of the homes and its spaces of relation. The consideration of the environmental dimension also allows us to understand the primary causes as well as the overlapping of the effects in the different manifestations of damage to the heritage, particularly in the case of areas subject to seismic risk.

The entire urban fabric is therefore constituted as a historical context, which however does not know a constitutive act in a specific historical moment, being rather linked to an evolutionary concept, in continuous becoming. We must look at the city as the product of a series of processes, of a sequence of modifications that have occurred over long periods of time, all of which contribute to its authenticity and to the formation of the identity of places.

> "Recognizing the coexistence of nature, culture and history in the landscape and assuming the aesthetic identity of a place as the result of the interaction of these three elements involves (…) the commitment to think about the protection of the landscape" (D'Angelo, 2004, p. 27).

The primary objective of preserving the meaning of a place, therefore, does not allow interventions that modify the pre-existing road and land structure, a document that is still permanent, recognizable, and the most authentic testimony of the first anthropic structuring.

Undoubtedly, it cannot be ignored that there are conditions that risk compromising the recovery of smaller urban centers after the seismic event: first of all, the extent of the damage caused to the historical-architectural heritage, the geological insecurity of the affected areas and the progressive depopulation of mountain areas, also due to their objective economic marginality. In particular, the 'total' abandonment of urban centers (with the consequent structural deterioration of buildings, and the progressive shift of the built environment towards areas with greater development prospects) lead to the loss of the memory of places, of their value as testimony.

3. Preserving the context

Therefore, rather than asking 'how', we need to ask ourselves 'what' to conserve, placing in the background the substantial issue of safeguarding the physical signs that History has impressed on those territories, helping to consolidate their value as 'active memory'.

The historian Le Goff argued that:

> "Collective memory elaborates an interpretation of personal experience and is implemented in parallel with the flow of experience with continuous narrative interpretation. It therefore appears to be tied to a physical space, so that the landscape of our existence (…) [becomes] an inseparable part of our cultural identity (…), the foundation of the sense of continuity with the past" (Le Goff, 1978, p. 40).

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Not considering historical architecture as a unitary organism, albeit stratified, but rather as a sum of valuable elements undoubtedly entails significant effects from the point of view of the landscape context. Just as it is not possible to identify the buildings to which, exclusively, repair or rebuild interventions should be reserved on the basis of purely functional considerations, excluding from such measures the architectures in a state of ruin already in disuse (Fig. 3).

The ruins due to a catastrophe, such as an earthquake, do not in fact represent the outcome of the slow passage of time on matter, but are the present, 'the time of destruction', and as such they provoke in the people who live in those places a feeling of loss of identity that can lead to abandonment. It is therefore necessary to recover the fragmented elements to rediscover their identity bond, and to grasp those suggestions still expressed by the same fragments capable of guiding their 'textual recomposition', towards a modern critical edition of the ancient text, in which the traces of the historical story are preserved intact. Faced with the problem of '*where*' and '*how*' to rebuild, posed by the immediate need to intervene to safeguard a settlement fabric (which is also economic and social), some choices must be made: first of all, understanding the context since:

> "The extension of the concept of monument to different areas and dimensions poses new critical and interpretative problems relating to the 'sense of place'. It is also necessary to adopt appropriate intervention tools, linked to urban planning and territorial planning methodologies, to be combined with those specific to restoration" (D'Avino, 2019, p. 96).

It also seems necessary to use appropriate language, capable of dialoguing with the ancient, supporting its reintegration into the contemporary historical circuit without abuses, but also aimed at improving its anti-seismic performance (Fig. 4).

With regard to the first term of the question, a reconstruction plan for historic centers should derive from a historical-evolutionary reading of the city that places at the center the theme of recognizing the formative processes of the fabric and construction and the knowledge of their outcomes on the material structure of the built environment. It is necessary to remove any hypothesis of an uncritical re-proposal of the original 'type', identifiable as an invariant model since each urban element must be understood in its characteristic singularity.



Fig. 3 – *Accumoli (Rieti). The rubble of the town after the 2016 earthquake* (D’Avino).



Fig. 4 – *Norcia, aerial view. The architectural text fragmented after the 2016 earthquake* (D’Avino).

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In essence, it is a question of making the role of historical knowledge of the mechanisms of development of the city increasingly active in the practice of conservation, so that "the past takes on a design dimension" (Carbonara, 2018, p. 12). Then there is the problem of the old-new nexus that refers to the debate, triggered in the post-war period, about the reconstruction "as it was, where it was"; although this formula was already widely revised in its first postulate from its first applications, sometimes generating construction solutions diametrically antithetical to the original ones. The extension to larger environments, the connections with urban planning and planning, involve the adoption of new forms of planning and landscape management capable of restoring the signs of historical stratification and naturalistic characteristics. Nor are the dictates of 'philological' restoration, an uncertain attempt at historical removal conducted through simplified forms and with distinct materials, supposedly neutral, suitable for recovering its values, precisely because the primary objective is that of preserving the meaning of the place, of the identity inherent in its landscape; also risking generating an urban ensemble that is neither respectful of the ancient nor frankly modern.

The issue of post-earthquake recovery of historic centers does not in fact end with the practice of restoring the built environment but also affects the landscape: the condition for which such events (earthquakes, landslides and floods) do not cause damage to hills and rivers does not lead, consequently, to consider that there is no relationship between landscape and earthquake. It is therefore necessary to extend critical understanding to the sense of place, trying to grasp the connections between architecture and its surroundings. Particular attention should be paid to the theme of the relationship between the recovery/conservation of historical buildings and the reconstruction/revitalization of places: beyond the indispensable urgent interventions aimed at solving contingent housing needs as well as securing the damaged historical architectural heritage, the debate on reconstruction should be brought back into the context of a cultural policy that takes the theme of seismic risk and the consequent operational lines as its horizon.

Just as it is necessary to safeguard "the indissoluble link between this heritage, protection of the peculiarities of historical centers and at the same time the need for their adaptation to the changed (and changeable) living conditions of the multifaceted contemporary society; these aspects are no less 'functional' to their revitalization" (D'Avino, 2020, p. 251). In some cases, in fact, the need to activate a process of revaluation of the villages with the aim of creating a new identity, of reconstituting a sense of belonging, has imposed interventions (even of an economic nature) that are careless of the functional characteristics and the original distribution logic, without considering the peculiarity of the places.

> "By rebuilding the inhabited centers damaged by the earthquake on another site, a utopia would be created in the most strictly etymological sense of non-place, in which the character of negation would be imprinted in the total absence, in an ahistorical framework, of references to identity and memory" (D'Avino, 2019, p. 101).

Thus, determining in the inhabitants that sense of 'disorientation' to which Paolo D'Angelo has referred several times (D'Angelo, 2021, p. 31). An in-depth analysis of what has been preserved leads us to consider how the stable character of the architectural forms persisting in the places affected by the earthquake is due to their proven 'syntactic' adequacy to the physical and geological characteristics of the context. In terms of urban memory, it will be necessary to encourage a process of reconstruction of the discontinuous and fragmented text following a seismic event, which will have to be 'repaired' rather than rebuilt.

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> “The relationship that the city establishes with the context is in fact a relationship that conditions and shapes its entire structure, from the layout of the routes to the shape of the blocks, up to the shape of the homes and its relational spaces” (D’Avino, 2020, p. 97).

4. Conclusions

In summary, there is no doubt that the territories hit by the 2016 earthquake constitute an important cultural and landscape heritage; a value recognizable in the permanence of morphological structures, historical routes, in the farm structure of the soils and in the continuity of construction traditions. A historical reality that is identified in the landscape and therefore constitutes an element of identity of belonging of the communities to the places.

In consideration of this, in the post-earthquake phase it is necessary to promote the conditions for the creation of a contemporary rural landscape, strongly rooted in the structures and signs of the existing landscape, but profoundly renewed in terms of functionality and safety.

To achieve this goal, it is therefore necessary to rethink the very idea of landscape. It is necessary to redefine, within the reconstruction program, the structure of the landscape adjacent to the historical centers. One possible direction is constituted by the integration between landscape and the agricultural world, promoting a 'landscape vision' of the rural territory and at the same time orienting the necessary transformations; evaluating a priori the effects that such interventions could have on the landscape. A reorganization of vegetation can, for example, play a significant role in the characterization of the landscape, also contributing to the mitigation of the risk deriving from catastrophic phenomena such as landslides or floods.

It must also assume awareness of the intangible value of the landscape. The resulting interventions to safeguard the territories of the internal areas must be directed towards the development of a new entrepreneurship that identifies non-consumerist tourism as a resource; with the related effect of reversing the process of gradual depopulation of these territories that has been witnessed for several decades.

A loss of the 'sense of place', with consequent disorientation of the identity of the population that lived there, to which the widespread demolitions of historic villages practiced widely after the 2016 earthquake undoubtedly contributed (Fig. 5).



Fig. 5 – Grisciano di Accumoli (Rieti). *Selective demolition of the historic center, 2018* (D’Avino).



Fig. 6 – Chiavano di Cascia. *Abandonment of the original settlement and reconstruction outside the site* (D’Avino).

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The demolitions carried out in many smaller centers as well as the vast and undifferentiated operations to remove the rubble, implemented after the seismic event of 2016, contrast with the sense of physical and symbolic continuity of the urban landscape. In such cases, in fact, the *ubi et consistam*, trace and memory of those settlements is missing, compromising the reading of the original fabric.

The solution does not lie in "conserving in ruins while respecting the landscape context", as suggested by the '*Guidelines*' drawn up in 2017, since, by limiting the value contribution of the architecture of the past to the sole testimony of the event, it leads to a reductively 'romantic', passé appreciation; also forcing continuous conservation interventions. Nor is the hoped-for "permanence of strong walls that will constitute the cornerstones for planning the recomposition of the urban fabric" valid, since their conservation does not guarantee, in itself, a reconstruction of the urban cells in continuity with the past, conditioned rather by economic factors.

Another practice to be avoided is the relocation of urban centers; carried out after the seismic event of 1979 (and re-proposed in the legislation following the earthquake of 2016). The sense of 'alienation', of fracture between memory and landscape, which is caused by the reconstruction of the settlement outside the original site, a practice widely adopted in the regions of Central Italy during the second half of the twentieth century, is evident. The conservation of the ruins of an ancient settlement, as if there were a 'temporal suspension', and its contextual relocation determines an insurmountable dichotomy between the two nuclei: the ancient one where the traces of identity are destined, over time, to be lost in oblivion; the modern one, ahistorical application of abstract models, incapable of producing the expected reactivation of a vital process in the absence of the original identity values (Figs. 6 & 7).



Fig. 7 – *Castel S. Maria di Cascia. The delocalised reconstruction after 1997 earthquake* (D'Avino).

A similar disorientation is impressed by the construction, on the edges of the historical built environment, of temporary housing structures due to the evident discrepancy that these generate between the historical complexity of the original fabric and the urbanized area following the emergency (Fig. 8).

Their construction must therefore be implemented only for the time necessary to carry out the projects included in the Reconstruction Plans. It is necessary that after the emergency phase such homes are abandoned and are in no case included in the development forecasts of the urban area; this would in fact determine a homogeneous landscape indifferent to the characteristics of the places.

The economic recovery of the territories hit by the earthquake will instead be determined by the reconstruction, together with the residences, of the places of production. The consequence will be the protection of the agricultural landscape and the removal of the risk of depopulation. The reconstruction must rather be seen above all as a possible opportunity for redevelopment/creation of the rural landscape while preserving the historical territorial structure and the geomorphology of that territory.

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Fig. 8 – *Norcia, aerial view. Temporary housing can be seen to the northeast* (Umbria Region website).

It is necessary to resort to specific Recovery Plans, a tool modulated on the instances of conservation, recomposition and reconstruction of the identity of the centers damaged or destroyed by the earthquake but at the same time firmly anchored to a development perspective of those settlements. The solution lies in the choices that will be adopted: a reconstruction that does not safeguard the 'stone documents' that escaped the destruction of the earthquake does not save the inhabitants from a process of disorientation; even if it must be accepted that the reconstruction will still involve a transformation of the landscape. In this process it is naturally necessary to avoid the inclusion of incongruous functions, such as residential areas and isolated productive activities. Furthermore, post-earthquake interventions of 'densification' or 'settlement expansion' must be avoided, even if dictated by safety reasons, if not induced by substantial social or economic transformations. Such transformations could in fact determine a gradual alteration of the characteristics of the agricultural landscape, making it uniform with that on the edges of the urbanized area and, in essence, erasing the tradition and memory linked to that world.

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Forum Novum at Mile X of Via Traiana (Italy)

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Abstract
The project we are presenting starts from the strong point represented by the Via Appia, registered in the UNESCO WHL. The construction of the via Appia network was started in 321 BC and completed in 109 AD, when Emperor Trajan built via Traiana from Benevento to Brindisi. At mile X of the Via Traiana stood the town of Forum Novum, a place of historical stratification, that profoundly influenced the surrounding territory, giving rise to the medieval settlement system and determining the layout of the landscape. It represents the lighthouse area from which to restart and around which to plan and structure regeneration engine interventions. The strategy of the project starts from the territorial potential, where the pivotal element from which the whole project unravels is the Forum Novum site; the whole project is based on the potential of the territory and the Forum Novum site is where it unravels. The strategic vision of the territorial regeneration program constitutes an integration between the UNESCO site "Via Appia. Regina Viarum" and interventions on historic centers, to improve infrastructures and upgrade old public buildings, which will become a central part of the 'Borghi' project, hosting its activities. The idea is to make permanent the workshop activities on topography, study and reconstruction of the landscape and archaeological research, with Universities and Schools, making this territory an incubator of spin-offs on "cultural heritage supply chain." Our aim is to generate opportunities, triggering a virtuous circle supported by public and private stakeholders. It will involve the Municipalities with a view to the rediscovery, conservation, enhancement and promotion of the pedagogy of the territory and its cultural, landscape and environmental values. Scientific research fits into local communities in an integrated way, triggering the need for tourist residentiality and the birth of businesses in the sector of culture.

Keywords: *regeneration; archeology; identity; development*

1. Introduction

The funding provided by the National Recovery and Resilience Plan (NRP), Mission 1: Digitisation, Innovation, Competitiveness and Culture, Component 3: Culture 4.0, Measure 2: 'Regeneration of small cultural sites, cultural, religious and rural heritage, Investment 2.1: 'Attractiveness of Historic Villages', financed by the European Union Next Generation EU, represent an opportunity to revive and revitalise small municipalities that represent the identity of our country as well as eloquent containers of art, literature, architecture and culture. Intervention strategies for the archaeological area of the Forum Novum and the linear section of the Via Traiana in the municipalities of Paduli and Sant'Arcangelo Trimonte are described below, with the aim of promoting economic, social and cultural development.

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2. The territorial context

The territories of Paduli and Sant'Arcangelo have taken on their current configuration, both in terms of settlement and rural landscape, as a result of their location between Benevento and the communications to the east. These routes, although they have been marked by their specific characteristics and functions in terms of land management and territorial domination over the millennia, have remained essentially unchanged. The "Via" between Beneventum and Brundisium, which in the 2nd century A.D. became the Via Traiana and was an integral part of the "Appia-Traiana" road system, followed ancient walks, with the probable presence of a Via Minucia, a circumstance confirmed by the site of the Forum Novum, X mile from Traiana, which as a *novum* (new) suggests the pre-existence of a *vetus* (ancient).

The route of the Via Traiana became the Via Sacra Langobardorum during the Lombard domination of southern Italy and their need to reach their "national sanctuary" at Monte Sant'Angelo. It is probable that in this period the settlement of Forum Novum coincided with one of the 12 Norman baronies (1041), more precisely "Santarcangelum", giving life to the castles of Paduli and Montemalo (now Sant'Arcangelo Trimonte), as well as the nearby Apice, Buonalbergo, Ariano Irpino, Montecalvo Irpino. The consular road, which preserves the most important bridges of the imperial age, continued its function as a pilgrimage and trade route towards the Gargano and Apulia in the following centuries.

It was along this line that the Benevento-Foggia railway line, completed in 1870, and the SS 90 and 90bis (State Roads) were built, following the Miscano and Cervaro valleys to cross the Apennine ridge. Today these *viae* are followed by the official route of the Via Francigena in the Benevento-Buonalbergo section.



Fig. 1 – *Map of the area, Via Appia Traiana* (Image from Google Earth)

This area (Fig. 1), which has played a central role in the historical development of central and southern Italy, has become marginalised and has undergone major processes of depopulation and social desertification, with serious repercussions on the hydrogeological structure of the territory, following the abandonment of agriculture and the lack of management of the natural infrastructure network. Furthermore, depopulation has led to the abandonment of inhabited urban areas, with an impoverishment of the value of real estate, mainly due to the lack of maintenance of the same and to acts of vandalism and plundering of decorative elements resulting from the lack of control. The high environmental value of these places remains unchanged, for which they still retain their inherent potential for development, both in terms of permanent housing and tourism. At the same time, there are numerous cultural emergencies that have been layered over time: archaeological sites, monumental emergencies, ancient centres, rural landscapes and environmental assets.

3. Aims and objectives

3.1 Knowledge

Improving the level of knowledge of the assets present in the territory is the primary condition for their exploitation and promotion with a view to the economic and social development of the territory.

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Knowledge creates opportunities for development, and knowledge must be invested by local communities and the scientific community in the form of cultural, scientific and technological awareness and competence.

Increasing the attractiveness of the territory, its cultural and artistic enrichment, the increase in the range of services, can slow down depopulation and desertification.

3.2. Project objectives

The main objectives of the project are:

1. To increase the level of knowledge of the assets present in the territory, making them opportunities for training with participatory processes that see the presence of university research centres, secondary schools, territorial educational schools.
2. To promote interaction between the territory and local communities, with different forms of tourism: cultural and artistic, environmental and naturalistic, slow and sustainable, already practised.
3. To combat depopulation and social desertification by creating employment opportunities, by identifying the reasons for the attractiveness of the territory that can encourage the arrival of people from outside.
4. To preserve the real estate heritage and the rural environment through the reuse of existing buildings and the agricultural management of the land. This objective is closely linked to the previous one, as it is the inverse of depopulation and social desertification.
5. Introducing incentives for innovation and culture as a precondition for the creation of businesses, both in terms of the management of new forms of tourism (slow, experiential, cultural) and those linked to the knowledge, protection and valorisation of cultural, landscape and heritage assets.



Fig. 2 – *Paduli, view of the historic centre* (Luigi Salierno, 2023).

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4. Methodology

4.1. The strategic vision

Forum Novum is the point of greatest strategic strength that brings together and unites the two territories and the two communities.

The strategic vision of the integrated intervention programme is linked to the main cultural and landscape asset of the territory, the Appia Traianea - declared a UNESCO World Heritage Site within the same "Appia, Regina Viarum" site - with the two main elements that characterise it in this territory: The Forum Novum and the Ponte Latrone, with the stretch of land that joins these two areas of emergency, where there are numerous traces of in-situ paving, as well as a well-preserved rural landscape with views over the Miscano valley and the Fortore, watershed between Campania and Apulia, of particular environmental interest.

The strategy also includes interventions in the historic centres of the municipalities involved, with the aim of improving infrastructure and rehabilitating renovated public buildings without defined functions, spaces that will become an integral and functional part of the "Borghi" (villages) project.

4.2. The Driving Idea

The driving idea is the resumption of an activity related to the study and reconstruction of the ancient landscape and archaeological research in the area already experimented in 2021 in collaboration with Unisalento, within which the Laboratory of Ancient Topography and Photogrammetry (LabTAF) is active, operating through digital and advanced technologies.

The idea is to make the presence of the laboratory permanent, both for undergraduate and postgraduate archaeology students and as an incubator for technological spin-offs operating in the "cultural heritage supply chain".

This "beacon" project aims to generate a series of opportunities in various sectors, creating a virtuous circle driven by public and private stakeholders, developing an integrated territorial project involving the ancient villages of Paduli and Sant'Arcangelo and the rural areas, with the aim of preserving, enhancing and promoting cultural, landscape and environmental values.

Another driving force is contemporary art inserted into the rural landscape, starting with the *Chiesetta* in Contrada Torre, a work by the internationally renowned artist Mimmo Paladino, and involving other renowned artists in a journey where land art and street art can add value and become an element of further attraction and characterisation of the territory itself.

4.3. Lines of intervention

The lines of action to be implemented in order to achieve the objectives are as follows:

1. The Forum Novum site, a place of millenary historical stratification, must be re-evaluated not only as an archaeological testimony, through research, studies and historical reconstructions, making it accessible and usable, but also as an awareness of opportunities and growth of local communities through involvement and participatory training.

   It is only through this multifaceted approach that the Forum Novum can become a nexus of "lighthouse interventions" with the aim of promoting territorial and social knowledge, protection and enhancement.

2. The symbolic places of the historical centres, in particular the "palaces", will be transformed into educational, didactic and innovative centres; the old urban fabric will be restored for residential purposes, while unique places, such as the caves in the tuff, will host temporary and permanent art installations.

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3. The historical-cultural itineraries, indicative of a territorial vocation for "passage" and hospitality, will become contemporary interpreters of this millenary predisposition.

4. Art and culture, as a way of interpreting the territory through "special people" who will leave their mark, will become another reason for the territory's attractiveness.



Fig. 3 – *Forum Novum, archaelogy students* (Salierno, 2024)

5. Discussion

The analysis carried out clearly shows the effectiveness of the training activities within the strategic line outlined. This effectiveness is translated into concrete actions on the ground through two separate projects:

- Appia goes to school
- Training at university level

Appia Goes to School is an intervention foreseen in the management plan of the UNESCO site, which provides for the creation, in the medium term, of a network of partnerships between secondary schools for the development of projects for the knowledge and valorisation of the system of cultural assets linked to the Via Appia.

In particular, a number of secondary schools in Benevento, Roma and Brindisi have already embarked on the building up a network among schools; one of the projects in about analogic photography, entitled "Ashby and Gardner +111", in which they took their students back to the very places where the two archaeologists and photographers from the British School in Rome took their photographs in 1913, in an extensive photographic reportage along the consular roads of Appia and Traiana.

The project allowed the young people to physically walk and travel along the route they were learning about, and the photographs, taken today with analogue cameras and in formats similar to those of the early 20th century, offered multiple educational insights: from observing the landscape and its transformations to learning about photographic techniques and the history of photography; from studying monuments and archaeological areas to musealisation through the use of ICT.

The project "L'Appia va a scuola" (The Appian Way goes to school) will also, during the school year 2024-2025 and hopefully in the following years, find a convergence and further development with the "Progetto Borghi" (Village Project) implemented by the Municipalities of Paduli and Sant'Arcangelo Trimonte, thanks to an intervention included in this integrated programme on the educational pathways to be created and implemented in spaces suitable for learning.

As far as university training is concerned, the network of universities working on the Appian Way UNESCO site and the Via Traiana project of the University of Salento have already come together in the integrated intervention programme "Forum Novum: the origins of the districts", thanks to an agreement signed between the Municipality of Paduli, the leader of the "Borghi Project" and the Department of Cultural Heritage of the University of Salento/Unisalento. This collaboration has made it possible to set up a 'field school' for archaeology students from various Italian and foreign universities on the site of the Forum Novum and along the section of the Via Traiana that crosses these areas, as well as to collaborate and provide scientific support for various projects included in the Integrated Programme.

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To this end, the 'Archaeological Research, Teaching and Training Laboratories' are currently being built in the historical centre of Paduli (again as part of the 'Forum Novum: L'origine dei Borghi' project), with an adjoining guesthouse. The aim of this facility is to support archaeological research and training in archaeology by equipping these rooms with tools for the initial study and cataloguing of artefacts found during archaeological surveys and excavations, computer tools for the topographical study of the territory, and rooms for teaching and research.



Fig. 3 – *Forum Novum, first excavations* (Salierno, 2024)

These spaces can be made available to any university or research centre that requests them for research purposes, with the obligation to publish and share the results of such research.

In the longer term, the main expected result is the creation of a linear archaeological park of the Via Traiana, which could extend at least from Benevento to Aequum Tuticum, coinciding with “Component 19” of the UNESCO site “Via Appia. Regina Viarum”. An itinerary of cultural and landscape value, where the presence of explanatory panels and a wifi system, through which the multimedia itinerary could be transmitted, would be flanked by a naturalistic and environmental context equipped for tourism and a stay of comfort and quality.

6. Outcomes

The results of this stage are expressed in terms of expectations.

An increase in the employment rate, with particular emphasis on women and young people. To take advantage of the opportunities offered by cultural and natural emergencies in order to reinforce the trend that has been developing for some years now, which sees cultural, adventure and slow tourism as the main asset on which to base the development policies of these territories. There are two strong points on which activities can be based: the inclusion of the Appia, regina viarum site in the UNESCO World Heritage List and the inclusion of the southern Via Francigena as an independent part of the Via Francigena Cultural Route from Canterbury to Leuca. The second element in particular has already led to a significant increase in the number of "passages" of pilgrims, both individuals and organised groups, travelling along the Benevento-Buonalbergo section and crossing the territories of Paduli and Sant'Arcangelo. In 2021, the Department of Cultural Heritage of the University of Salento organised a "field" training experience for the acquisition of CFUs for 24 archaeology students from different universities, using the Forum Novum site as a laboratory. The Municipalities agreed with the University of Salento to make the activity stable by providing accommodation, training and laboratory facilities. In fact, this implies the creation of employment opportunities. In addition, an incubator for companies specialising in the application of innovative technologies applied to the BBCC is planned, in agreement with UniSalento and other universities, which could counteract the brain drain and local professionalism.

Counteracting the demographic exodus; The main reasons for the demographic exodus and social desertification are related to the lack of services (young families), the lack of job opportunities (university emigration becomes permanent) and the lack of advanced technological infrastructure (lack of teleworking jobs). A fibre optic data network is being built throughout the area. This infrastructure already

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had a positive impact during the pandemic, when several young people, including those working abroad, were able to "return home" while continuing to work. The planned interventions are intended to create conditions for staying in the area, not only for short-term tourism, but also for medium- and long-term residence. Short-term tourism will determine the need for tourist service activities and may affect the increase of jobs in the sector (services, agrotourism and agriculture); medium and long-term stays will be determined by the activities of artistic residencies, where artists will be invited/attracted by the possibilities of expression, the beauty of the places, the quality and the cost of living. Finally, employment opportunities, especially for young people with a high professional profile, determined by the creation of an incubator/showcase of digital technologies applied to cultural heritage, favoured by the IT infrastructure now available and with the financial support of business incentives (the "Avviso Borghi" business incentive and measures by Invitalia, Cultura Crea or Italia Economia Sociale), will give young families the opportunity to settle permanently in these villages and work from there all over the world.

Increasing cultural participation; The focus of the whole project on the main cultural features of the area, the Via Traiana, the rural landscape and villages, the Via Francigena, together with the search for the interaction of these elements with artistic events, aims overall at increasing cultural participation. This participation will be addressed at several levels. Already in 2014, projects aimed at developing audiences through the organisation of cultural events/low impact tourism were organised by various associations in the area, grouped together in a committee. These were mainly aimed at the local population, which always participated in large numbers and with great interest, in order to make them aware of the cultural richness and diversity of their territory and, through knowledge, to contribute to its protection, enhancement and promotion. Another "strand" is that of schools, with some experiences already implemented with local primary and secondary schools, which will take a stable form with educational paths supported by intangible infrastructures created with the scientific support of UniSalento. In addition, the creation of artistic itineraries and residences to enrich and diversify the cultural offer related to slow tourism will pursue the objective of increasing the cultural participation of a very wide and diversified public, coming at least from a national and European territorial area. Finally, the focus will be on attracting specialists, thanks to the creation of a permanent laboratory in collaboration with the University of Salento, whose facilities may also be made available to other Italian and foreign universities, following a trend that has been underway for some years, due to the presence of important archaeological and monumental sites that are almost completely unknown.

Increase in tourist flows. Today there is a growing demand for "walking" among Italians and foreigners alike, and the Via Francigena from Rome to Leuca has a great potential that is almost completely untapped. However, this is short-term or very short-term tourism. Hikers spend only a few hours in a single area and even less time on the cultural attractions of the place. However, this type of tourism has a great potential for communication (word of mouth, social networks) and for returning as a "settled" tourist.

The aim of the project, to be implemented mainly through communication and events, is to use this potential to diversify it into medium and long-term tourism, transforming it into experiential and cultural tourism. It will also make it possible to exchange experiences with other areas. This is the direction taken by the measures relating to the network of Micaelian itineraries, which offers numerous opportunities at regional, national and international level.

Finally, there is the very important sector of anthropological-cultural interest linked to the

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origins of one's ancestors. This is generally tourism aimed at 2nd, 3rd or 4th generation emigrants, usually from abroad.

7. Conclusions

The landscape surrounding archaeological heritage is changing. Archaeological sites are no longer seen as mines from which material can be extracted to create great museum exhibitions in large urban centres, and the archaeological find is no longer seen as a static entity whose value lies in its physicality, uniqueness and compliance with collecting principles.

This idea, inherited from art history, has had disastrous consequences: archaeological assets have been expropriated from their places of origin, with the result that archaeological areas scattered throughout the country have been abandoned, effectively depriving them of their economic, tourist and cultural potential. Modern archaeology reverses this trend and aims not only to discover treasures of recognised artistic value, but also to become a scientific method of contextual analysis.

In essence, archaeology no longer seeks only objects, but above all information that helps to reconstruct the historical and environmental context of the sites studied. Having underestimated the economic potential of archaeological sites in recent decades, we now have the opportunity to launch experimental initiatives and processes, open to a variety of collaborating subjects, in order to open up avenues of cultural and social entrepreneurship spread throughout the community, which becomes an actor and guarantees integration and coordination between the subjects involved.

Promoting archaeological parks as a means of activating social and economic cooperation networks means identifying growth pathways that are geared towards economic development while improving environmental sustainability, but above all it means abandoning the idea that cultural resources should be taken away from those who have experienced them and handed over to the management of managers who are only experts in profit, in order to leave space, action and emotional experience to those who, in various ways, feel a conscious part of this piece of territory and time. These are ways of developing archaeological areas as a lever for social innovation, based on the roots of identity and therefore capable of generating value and well-being for the community.

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Hands-on Approach in Dry Stone Architecture and Landscape Heritage Safeguard: the Case of Kato Meropi (Greece)

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Abstract

The paper explores a culturally sustainable framework for safeguarding the intangible values and material traces of the vernacular architecture and its associated traditional landscape, focusing on Kato Meropi, a depopulated village of Epirus, Northen Greece, emblematic of eroding rural landscape. Situated in the Gormos river valley, the landscape's mountainous terrain led the indigenous populations in the necessity of regulating the reliefs creating terraced hillsides and dry-stone structures, forming an agricultural landscape. The approach recognizes the dry-stone houses, walls and terraces as heritage and a carrier of historical footprints, orchestrated by both tangible and intangible values. The research positions Kato Meropi as a living laboratory for transdisciplinary experimentation and as a cultural landscape that integrates heritage preservation with community engagement. By recognizing dry-stone houses and walls as sources of collective memory and historical continuity, the study establishes a dual focus. Firstly, developing protective frameworks that acknowledge these structures as components of a dynamic cultural landscape and then, showcasing participatory methodologies through on-site workshops taking place in Epirus. The key findings underline the importance of intergenerational dialogue within social practises, in reviving artisanal skills and reconnecting communities with their cultural topography. The proposed model emphasizes cultural sustainability approached through civic participation, opting to counteract heritage decomposition, reinforcing collective identity. Conclusions stress the need of employing intangible practices and rural activities into adaptive preservation strategies, ensuring their viability as active socio-ecological resources.

Keywords: *cultural sustainability; vernacular heritage; intangible values; traditional landscape; cross-generation; civic engagement*

1. Introduction

The dry stone is the construction technique that only uses the stone as a construction material without any other bonding material. The predominant dry-stone constructions in the area of Kato Meropi, taken as an example, are the walls used to delimit properties, anchor the land, store stones or retain and channel water. There are also other types of buildings such as farmhouses, threshing floors, lime kilns, among others. The inhabitants created their residencies attached to their land properties destined for handling agricultural and livestock production as an integral part of their everyday life.

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The abandoned village is situated approximately 61 kilometers from Ioannina, positioned between two mountain ranges and adjacent to the southeastern sector of the Ano Gormos Valley. The settlement is constructed at an elevation of 750 meters above sea level, on the foothills of the Nemertsika Mountains (Fig. 1). This area was chosen as a case study since it is an uncharted territory both culturally and architecturally, in the process of heritage designation. The art of dry-stone construction, including its associated knowledge and techniques, has been inscribed on UNESCO's Representative List of the Intangible Cultural Heritage of Humanity, with Greece as a participating country in this multinational designation (UNESCO ICH, 2024).

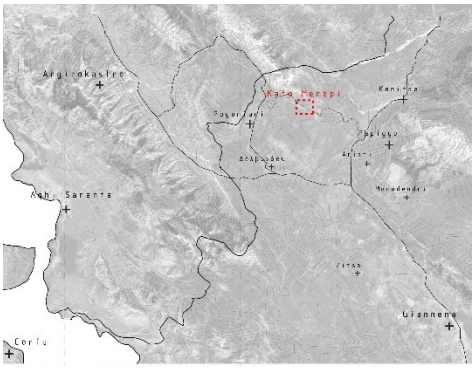


Fig. 1 – *Map of North-West Greece, Kato Meropi* (Author, 2025).

The history of the village starts from the prehistoric times. Archaeological research to date proves that the area of Kato Meropi has been inhabited since the early Iron Age, as a cemetery of that period has been found in the area. Around the valley, citadels, defensive complexes, burial sites and monuments have been identified, which is why it has been classified as an archaeological site (Kleitsas, 2012). Important religious sites in the area have been classified as historical monuments, as in the Byzantine period Kato Meropi is reported to have been a Kefalochori (main village), but in the 17th century it seems to have declined (Kostoulas, 2003).

Eventually, the village began to bustle with life until 1940, but after some years it hosted the brutal battles of the Greek civil war. The progressive abandonment of rural areas and farmland that began in the 1960s led to the disintegration and disappearance of many of these cultural traces. As Agnoletti Mauro writes in his research about terraced landscapes: "Since the 1960s, the development of industrial agriculture and the abandonment of the countryside resulted to the deterioration and sometimes even the disappearance of traditional practices" (Agnoletti et al.,2015).

In recent years, the village of Kato Meropi has experienced significant depopulation and is now largely abandoned, with a remaining population of approximately 80 residents, the majority of whom are engaged primarily in agriculture and livestock farming. Particular attention is directed to the area illustrated in diagram (Fig. 2), where a cluster of residential and utility buildings is located. The area is rich in architectural features, that warrants for further investigation, and the proximity of these structures favours the dynamic of an ensemble as a cohesive unit.

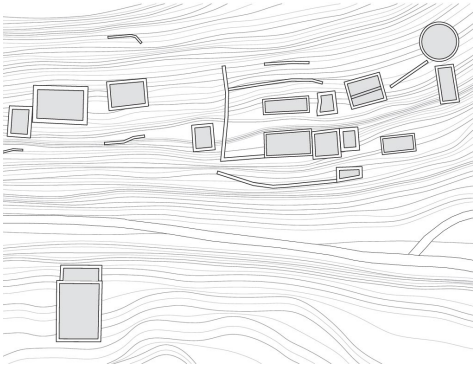


Fig. 2 – *Area of focus, selected shells* (Author, 2025).

2. Objectives

1. To trace the historical values related to the construction and evolution of the dry-stone architecture in this specific traditional landscape.

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2. To acknowledge its current potentials, threats and adaptive capacity, in terms of cultural and social sustainability.
3. To propose an enhancement of the intrinsic relationship between this landscape and cultural heritage in terms of cultural sustainability.
4. To examine protection mechanisms of vernacular architecture: conceptualization of sustainable management and maintenance with regenerative collective actions.
5. To propose experiential learning of vernacular building for heritage safeguard, collaborative workshops and enhancement of local interest through participation.

3. Methodology

The research adopts a mixed-methods approach combining archival and literature review to establish the historical and theoretical context. As well, quantitative fieldwork (topographic survey, data collection, photographs) to document the current state of the site. Participatory action research and ethnographic methods are used including the exposition of collaborative workshops, whereas they serve both as platforms for co-creating knowledge, reviving artisanal skills, and fostering intergenerational dialogue.

4. State of art

4.1 The current conditions

The selected shells for investigation are made of dry-stone construction as shown in the following figure (Fig. 3). Among these structures, some exhibit traces of reinforcement or restoration work, particularly in their foundations, implemented by local inhabitants to prevent wall collapse caused by lateral soil movement on the hillside. The shells were dwellings and houses, with two or more floors, with the ground floor being a storage and a nursery for animals, enclosing constructions associated with water: wells, cisterns, washing places and reservoirs. Attached to the house there were stables for livestock as well as agricultural production like circular threshing barns, sometimes working as demarcation elements and walls. In general, these various constructions and auxiliary facilities were principally connected to agricultural activity and the establishment of land-owning boundaries.



Fig. 3 – *Current state of vernacular structures and relief walls* (Author, 2025).

4.2 Diagnosis of the problem

The structures remain entirely abandoned and exposed to natural decay, despite their proximity to actively inhabited dwellings. The abandonment of dry-stone constructions, so called "*xerolithies*" in Greek, put rural zones at risk, since they play a strategic role in environmental conservation attempts (Jiménez, 2021). There is the risk of complete extinction of the traces of the rural community that lived in this place and the memories of a socio-politically reforming period in Greek history (Kostoulas, 2003).

The primary issue is aptly outlined by Mauro Agnoletti regarding Tuscan landscapes, who notes that such dereliction extends beyond Italy, as documented in scholarly literature. He points out that these shifts of the traditional agricultural landscape, resulted in the progressive extinction of natural structures that were portraying significant values in the social perception of the local communities, not only as an interpretation of cultural identity but as well as a reference to

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sustainable management of the rural land, controlling changes and reduction of degradation (Agnoletti, et al., 2015). Therefore, the artisan know-how of the area's dry-stone construction, which used to be a vital profession for the local economy, is in danger of intergenerational eclipse. The preservation of this art form has been recognized by UNESCO as intangible cultural heritage and warrants continuous protection for its historical significance, as well as for its role in safeguarding the landscape and supporting environmental sustainability.

4.3. Acknowledgment of opportunities

According to Celeste Jiménez, there is a need for new uses for heritage assets that improve the preservation of the biodiversity while safeguarding the intangible cultural heritage (Jiménez, 2021). The entity of the dilapidated structures, simultaneously stands as an opportunity for the creation of common spaces and allows the emergence of place-making for communal activity. As Geoffrey Gowlland writes: "The text of the UNESCO decision underlines the importance of creating learning structures for the promotion of the art of dry-stone walling" (Gowlland, 2024). Inscribed in the 2024 convent of UNESCO, dry-stone construction encourages social cohesion and is an intrinsically collective practice. One would think that this is an important advantage of dry-stone heritage sites. The process is a naturally collaborative art that promotes dialog, collaboration and forges communities to work along to create and restore structures, transmitting the expertise to future generations (ICH, UNESCO, 2024).

Moreover, the interaction between nature and culture in these areas creates a visual narrative that transcends generations. In any event, they constitute a heritage that must be preserved and revalued (López-Estébanez, et al., 2024). The terms of the Convention for the Safeguarding of the Intangible Cultural Heritage (UNESCO, 2003, Article 2), attest that the knowledge of this construction technique can be inherited from generation to generation. Specifically: "it is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history", and "it provides communities and groups involved with a sense of identity and continuity" (Jiménez, 2021).

5. Results and discussion

This chapter discusses the necessity of actions and different strategies for approaching cultural sustainability, using the analysed case study as a site for experimentation. Through the protection and advocacy of landscape's intangible values, deriving from local populations, bottom -up, and reflecting on the importance of architectural and landscape heritage.

5.1. Cultural sustainability and protection of heritage intangible values

Initially, not much attention was paid to cultural sustainability that could form the fourth pillar or be the foundation of and for sustainability. Whereas ecological, social and economic dimensions of sustainability usually treat landscape mainly as a physical entity, as an area or object of design, the cultural dimension adds a layer that addresses the intangible aspects of landscape such as a memory or a representation (Palang, et al. ,2017).

To understand how culture functions as a benefit for sustainability, rather than as an obstacle, is the key to the advancement of cultural sustainability. Hannes Palang et al. write that from this point of view: ''the role of culture as a means to give meaning and value to tangible, intangible and even invisible landscapes become crucial'' (Palang, et al. ,2017). With a closer view of Antrop's writings, two ways of achieving sustainability emerge, namely, the conservation of certain landscape types or values and their management (Antrop, 2006). For aiming and acting towards sustainable landscapes, stakeholders should focus on sustaining the practices and values needed.

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Antrop states on the matter, that: ‘’ Considering preservation of inherited natural and cultural values ‘as long as possible’, demands a different strategy than sustaining landscape qualities for continuing economic benefits. Based upon the paradigm that only functional structures in the landscape will persist, sustaining heritage values is often linked to enhancing economic benefit, which might lead, in cases of overuse, to a deterioration of these initial qualities. Sustainable urbanized landscapes imply completely different aspects than sustainable rural ones’’ (Antrop, 2005).

The findings of Katriina Soini and Birkeland shed light on the connection of cultural sustainability and cultural heritage, organized around seven storylines: heritage, vitality, economic viability, diversity, locality, eco-cultural resilience, and eco-cultural civilization, diagnosing them as interlinked and overlapping aspects. David Throsby states that: “cultural heritage comprises a stock of cultural capital that has been inherited from previous generations and can be handed onto future generations” (Throsby, 2008).

From one side, tangible heritage concerns the rehabilitation of material cultural heritage, such as historical buildings, monuments, and nature conservation areas. On the other side, intangible heritage covered issues such as knowledge and traditions associated with tangible heritage. In many cases, material and immaterial aspects of heritage were interlinked. Additionally, heritage values are an important part of the collective identity that is deeply associated with landscape, which is viewed as a vital source of inspiration and well-being for society (Soini & Birkeland, 2014). In the context of landscape, for instance, built heritage was viewed as contributing not only to physical and visual sustainability but also to the social and cultural viability of landscapes, local identity, and sense of place (Vileniske, 2008).

5.2 Eco-cultural resilience and civic participation

Drawing on Soini and Birkeland’s framework, landscape, as a localized construct, embodies a sense of place and functions as an integral component of place-making practices. Eco-cultural resilience in a landscape may refer to culture as an essential part of the resilience of that landscape. It is targeted on the relationship of human community and nature and their interaction within various contexts, landscapes, and ecosystems seeking a balance between humans and nature (Soini, K. & Birkeland, I., 2014). Moreover, this story line suggests that community management of natural resources provokes a greater notion of responsibility and better guardianship of the land. It also integrates indigenous knowledge and tradition in management decisions (Soini & Birkeland, 2014, & Grinspoon, 2002).

The protection of the stone selection ability and their placement, without mortar or dry soil at most, has moved the attention from walls to walling too. As a result, the idea of authenticity should be rediscussed to preserve not only some existing monuments and amazing landscape, but a living heritage and a sustainable land use (López-Estébanez, et al., 2024). The art of dry stone merges a widespread technique with respect for local conditions and the exclusive use of local building materials. As such, there are intentions and possibilities to maintain these landscapes, although there is no regional or national strategy capable of extending these actions to the entire territory and not only to the most intensely protected spaces (López-Estébanez, et al., 2024).

The strategy explored by this article concerns the establishment of the legal framework for safeguarding dry-stone construction through active civic engagement of local and broader communities, shortening the gap between generations of craftspeople. The specific site could be employed as a foundation for

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development of participatory models in the heritage management of cultural landscapes, as for example: realization of dry-stone courses and workshops and elaboration of didactic resources, execution of a virtual platform and actions to transfer the technique through formal and informal training (Mallafrè Balsells, 2021). This scope could contextualize the mobilisation of local community, the active participation and experiential apprentice of artisans and local authorities for the incorporation of this technique as a cultural heritage under protection.

As mentioned before, the ecological aspect of the action does not refer only to the enrichment of ecosystem but also in raising the awareness of ecological consciousness. The sensibilization towards zero impact building techniques of dry-stone building needs to be extroverted and systematized as a method of sustainability promotion. In his book "*Architecture without architects*", Bernard Rudofsky analyses the art of building by exploring the untraced world of "non-pedigreed" architecture, labelling it conventionally as "vernacular, anonymous, spontaneous, indigenous, rural", noting the scarcity of documents, delimiting importantly our look towards it (Rudofsky, 1964).

5.3 Experiential apprenticeship and knowledge production

Nowadays, several organisations in Greece have already put in practice workshops about building with local materials in disposal and acknowledging the idiosyncrasy of resources, providing an experiential apprenticeship for vernacular architecture to participants, rebuilding an architecture whereas "everyone is an architect".

The chosen study case is Boulouki, an organisation of architects, artisans and geologists that are actively orchestrating workshops for re-building elements of vernacular architecture, emitting knowledge about traditional construction. This initiative increases awareness about dry stone walling techniques and generates biodiversity, creating landscapes and resources for rural development and reaffirming collective identities as cultural heritage. Every material is obtained locally, requiring expert knowledge of the surrounding terrain and its geomorphological characteristics, the location of the appropriate stones and rocks for the construction. Their various projects have cultural, ethical as well as environmental scope and the appropriate research and expertise. They aim to initiate and re-activate the traditional architecture that blends and recreates natural features of the place, the fauna and flora (Boulouki, 2018-2020).

Therefore, it's understandable that the principal threat to sustainability seems to be our capacities for acknowledging the menaces and the human knowledge production itself. The most effective way of stimulating eco-cultural thinking and sustainable practices, is education for various groups and levels. Besides education, the role of bottom-up initiatives (Goncz, et al., 2007; Birkeland, 2008) and art- driven workshop sessions, are seen as useful for enhancing cultural evolution. The key-tools for place-driven and problem-driven approaches, are to be found in interdisciplinarity and transdisciplinarity. Inviting locals, artisans, cultural heritage experts and artists, opts to cross various boundaries between disciplines and produce knowledge.

Furthermore, the aforementioned provide crucial means to bridge sectors and organisation, but also past and future, local and global, which often are considered opposites, in the field of research and planning (Palang, & Soini, 2017). Birkeland states: "The co-design of research and planning processes and co-creation of knowledge with those who are involved in landscape development provide a means to mobilize social and cultural resources associated with a re-animation of place" (Birkeland, 2008). The nomination file for the inscription of "the art of dry-stone walling, knowledge and techniques" in the UNESCO List, states that dry stone technique

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exemplifies a harmonious relationship between human beings and nature. It contributes to the dissemination of values such as sustainability, proportionality, consistency, moderate intervention and exclusive use of the resources that are truly needed and found locally (UNESCO, 2018).

6.Conclusions

In conclusion, investigating about the kind of heritage most difficult to be recognized as such, the vernacular heritage is also one of the most challenging in terms of preservation and is still considered a "minor heritage", laying in the shadow, partially due to the fact that "it is always there", being neglected, abandoned and culturally devalued (Gonçalves, 2018; Gonçalves et al., 2017). However, it is precisely this type of heritage that has a greater sense of identity, with the cultural roots of a community and with its land (Gonçalves et al., 2017).

In this last part, a gravitational importance must be given to the intergenerational transmission of knowledge and the necessity for its contextualization. Gustavo Araoz investigates about the shift in the focus of ICOMOS Charter at 1999, in the need for conserving vernacular heritage, which advanced the notion that effective protection of the vernacular heritage depends on protecting the inter-generational transmission of the traditional knowledge that enables its endurance (ICOMOS, 1999). This created further awareness that vernacular architecture and settlements transform in time since the society, as a creator, constantly grows, advances and adapts to new needs. Consequently, the values of traditional heritage no longer reside exclusively in physical fabric but also in intangible concepts that exist in perpetual evolution (Araoz, 2021).

Environmental and cultural benefits depend on the effort of our communities to bridge the gaps or the lost links to the past and act against ignorance. The key is to reconvert it into "useful heritage" by formulating new uses, reinforcing its identity and enhancing its cultural and social value (Jiménez de Madariaga, 2021). As well, reusing heritage gives birth to the opportunity of retrofitting according to environmental exigencies that must occupy a protagonist role in this paradigm. Restorative culture must first be one that is environmentally aware and the societies that are working towards the minimization of harmful environmental impacts, must be considered to be at least environmentally awakening (Birkeland, 2008).

As Marc Antrop stresses in his conclusions, the knowledge of history about ordinary people and management traditions, is still poorly assimilated. When decisions need to be taken for the future management of traditional landscapes, their restoration or creation of new ones, much wisdom and inspiration must be employed, in order to achieve sustainable management. Finally, he emphasizes: "Landscapes of the past cannot be brought back, but ways how valuable elements and areas can be preserved and become embedded functionally in the modern urbanized and globalized society must be studied" (Antrop, 2005).

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Holy Spaces, Contemporary Art: Reuse and Conservation in Naples' Churches (Italy)

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Abstract

The article explores the effects of contemporary art on heritage preservation in the adaptive reuse of decommissioned churches, with a focus on the case study of the Rione Sanità in Naples (Italy). The growing secularisation and the progressive abandonment of churches have led to the need to find new uses for these spaces, which were once places of worship. In this context, contemporary art has played a central role in breathing new life into these buildings, transforming them into cultural spaces, art galleries, creative studios, or places of reflection. However, this process is not without challenges. The artistic transformations of churches risk compromising their original meaning and altering their architectural integrity, leading to the loss of significant historical and symbolic value. In the context of the Rione Sanità, the use of art as a tool for regeneration has had a significant impact on the neighbourhood, but the implications of this type of reuse require a more in-depth reflection on its long-term consequences.

Keywords: *adaptive reuse; community involvement; urban regeneration; bottom-up approach*

1. Introduction

"The function should be a tool, not a goal, of conservation" (Fiorani, 2017, p. 119). With these words, Donatella Fiorani highlights the complex challenge of selecting appropriate functions for decommissioned ecclesiastical heritage. This issue has grown more urgent amid Western secularisation, prompting a broad debate among institutions, Vatican offices, local communities, and scholars on strategies for preserving and repurposing these buildings (Coomans, 2012; Fiorani et al., 2017; Chavardés & Dufieux, 2018; Capanni, 2019; Montanari 2021). Reassigning new functions to sacred buildings requires integrating architectural restoration, conservation methodologies, and urban regeneration, while also addressing their sociological and symbolic significance (Casiello et al., 2011; Russo, 2018). The abandonment of these structures not only leads to a loss of cultural identity but also affects urban life, contributing to material and environmental degradation, marginalization, and missed opportunities for community engagement.

In this context, art – historically linked to sacred architecture – serves as a strategic tool for adaptive reuse. This study examines ongoing experiments employing contemporary art to repurpose religious spaces, critically assessing their processes and effects, both positive and problematic. Using Naples and the Sanità district as a case study, it explores how these initiatives

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balance functional adaptation with the preservation of religious heritage's material and intangible values. Additionally, these projects aim to enhance urban vitality and foster social innovation by involving young professionals, artists, researchers, and vulnerable communities, promoting a sustainable and respectful model of reuse (Cerreta et al., 2020).

2. A framework of strategies

Contemporary art acts as a catalyst for the material and intangible regeneration of disused churches, reinterpreting their values and redefining their role within the community (Fig. 1). Across different contexts, artistic interventions establish diverse forms of dialogue with these spaces, yielding varied outcomes – some fostering integration and renewal, others generating challenges in the relationship between contemporary art and sacred architecture, in both material and immaterial form (Pollone, 2024). To streamline a broad and complex discussion, we can identify, at this stage of the research, four main types of intervention – subject, of course, to further refinement: the commissioning of works by internationally renowned artists to reactivate these spaces, even temporarily (1); the conversion of churches into museums (2); their transformation into creative studios (3); the reinterpretation of the church itself as raw material for a contemporary artwork (4).

1. A widely adopted approach involves the temporary use of site-specific installations to raise funds for the restoration of deconsecrated churches. This strategy brings new vitality to these buildings by hosting an ever-changing array of artworks while also raising questions about the compatibility between the hosted works and the architectural space. In some cases, these initiatives contribute to the implementation of phased conservation projects, often leading to the establishment of dedicated associations to support such efforts. This phenomenon appears globally. Among them are St. Andrew's Collegiate Chapel in West Philadelphia and the 'ghost church' of St. George in the Czech Republic. In both cases, highly immersive installations have rekindled public interest in the host churches while prompting reflection on their identity. Installation art proves to be a powerful medium for amplifying the spatial and evocative qualities of sacred architecture, creating an immersive, multisensory experience that dissolves the boundary between artwork and environment (Koestlé-Cate, 2016, p. 27). The success of these initiatives, which offer sustainable models with minimal alterations, is also closely linked to the principles of a 'low-entropy economy' – an approach that prioritizes the dematerialization of interventions, considering heritage sites as places for new experiences and, consequently, new uses (Cerreta et al., 2021).

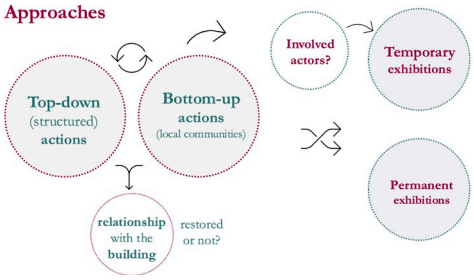


Fig. 1 – *Scheme of possible approaches to the reuse of ecclesiastical spaces* (Authors).

2. In this case, the transformation stems from a forward-looking vision of the role that sacred buildings can play in contemporary cultural discourse. In many instances, gallerists, drawn to the aesthetic appeal of the building's state of decay, initiate projects to reopen churches as contemporary art centres. Some of these initiatives establish dedicated programs to support the architectural repurposing, while others utilise former churches to house art collections lacking permanent exhibition spaces. Early examples of this approach

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include the JTG Detroit Project, curated by gallerist Paul Johnson in the former Woods Cathedral in Detroit (USA), and the restoration of San Rocco Church in Como, Italy, supported by the Volta Association. In some experiences, the virtual component becomes predominant, as in the Artothèque of Mons, Belgium (Titeux, 2018). Other cases, such as the Church of Sant'Agnese in Padua (now home to the Fondazione Alberto Peruzzo) and Berlin's brutalist Church of St. Agnes (now König Galerie), have undergone significant restorations, involving modifications to their surfaces to accommodate their new function (Dölle, 2018; Trevisan & Peruzzo, 2022).

3. In other cases, deconsecrated churches have been transformed into artist studios – spaces for creative exploration that interact with their architectural setting, either permanently or temporarily. Notable examples include St. Etheldreda's Church in Norwich (UK), which has hosted an artist studio since 1980, and a former church in Harlem (USA) that became a workspace for the artist Julie Mehretu during the production of monumental pieces for the San Francisco Museum of Modern Art. These spaces are valued not only for their architectural uniqueness but also for their emotional and inspirational potential. In some cases, this artistic repurposing fosters community engagement through bottom-up initiatives. Events such as *Art in Romney Marsh* (AiRM), held within medieval churches in southeast England, and workshops at Berwick Church encourage direct interaction between artists and the public, prompting debate on art, architecture, and community. In this process, contemporary art plays a crucial role – not only as a catalyst but also as a tool for reintegrating places of worship into everyday life. These buildings become hubs for art and reflection.

4. Finally, a deconsecrated church can itself become an artwork – its structure and surfaces serving as a medium for artistic reinvention. In such cases, interventions often treat the church as an incomplete and malleable entity rather than a finished historical artifact, challenging conventional perceptions of the space. These transformations differ in scope and effect. Notable examples include the Church of San Juan Bautista de Alarcón (Fernández-Cobián, 2015, p. 61–72) and the 'Kaos Temple' in Llanera (formerly the Church of Santa Barbara, Spain) (Fernández-Cobián, 2022), where extensive artistic interventions have redefined the buildings' roles, reshaping them into spaces for contemporary cultural expression without, however, truly considering the value of the pre-existing structures.

3. A perspective from Naples

The historic centre of Naples, a UNESCO World Heritage Site with over six hundred places of worship, presents a paradigmatic case for analysing the phenomenon of the decommissioning and reuse of religious architecture. Alongside the grand ecclesiastical complexes, a microcosm of smaller sacred spaces survives, often overlooked despite their historical and decorative value. The gradual abandonment or inappropriate repurposing of these buildings – converted into commercial spaces, parking lots, or exhibitions with no artistic relevance – highlights a decline in awareness of their value, once a reflection of the social status of their patrons (Russo, 2017).

Approximately 50% of the closed churches in Naples belong to confraternities (Alabiso et al., 2016, p. 49) whose role has diminished over time, depriving these buildings of their primary reason for preservation. This structural crisis, seemingly at odds with UNESCO protection status, has been partially (Russo, 2017, p. 276) addressed by the Curia, which in 2011 launched a call for

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proposals to repurpose abandoned sacred spaces for cultural, spiritual, and educational use. These spaces were granted free of charge to associations and institutions with the condition that they be maintained in a safe and accessible state. Initiated before similar interventions in other European contexts, this initiative has led to the reopening of some places of worship, now transformed into artisan workshops, exhibition halls, and conference venues.[1] (Alabisio et al., 2016, p. 39).

At the same time, institutional projects focusing on contemporary art – falling within the first category identified in the previous section – have promoted site-specific exhibitions in churches such as Santa Luciella (Valenti, 2024, p. 114–116), Santissimi Filippo e Giacomo[2], Carminiello a Toledo, San Giuseppe delle Scalze, and Santa Croce al Mercato. Moreover, since 2021, the Department of Architecture of the University of Naples Federico II (V. Russo, S. Pollone, L. Romano) and the TU Delft (M.T.A van Thoor) have been conducting annual international workshops – "Adaptive design for historic churches and their context" – aimed at engaging internationals students in proposals for the reuse of Naples' unused heritage, in close collaboration with local institutions and associations such as *L'Altra Napoli*[3].

3.1. The case of *Rione Sanità*: a bottom-up regeneration model

To explore the positive and negative impacts of contemporary art in disused churches, the emblematic case of *Rione Sanità* is analysed (Giammetti, 2022; Loffredo, 2022, p. 178). This district hosts a wide range of initiatives that allow for a comparative analysis of various interventions within a difficult social context, shaped by a shared approach to heritage conservation and a distinct vision of religious spaces. This setting provides deeper insight into the motivations behind operational choices and their long-term implications.

Rione Sanità represents an exemplary case of bottom-up urban regeneration where sacred heritage has become the cornerstone of a broader transformation process, affecting not only places of worship but also the entire social and urban fabric. Marginalised since the 19th century, the neighbourhood has activated a complex dialogue between tradition and innovation, leveraging art and culture as instruments of redemption and participation (Fig. 2). The regeneration began in the 2000s, driven by the new parish priest of the Basilica of Santa Maria della Sanità and supported by foundations, associations, and professionals. A key early initiative transformed the Church of San Gennaro Extra Moenia –

[1] Smaller and well-preserved buildings have recently been repurposed. Examples include the Arciconfraternita di Santa Maria delle Grazie (2014, Grimaldi bookstore), San Rocco in Chiaia (2012, Fondazione Pietà dei Turchini), and San Nicola a Pistaso (2012, AREN). The Curia also assigned Santa Patrizia (2008, Ambra Restauri), Santa Maria della Luce (2009, Medart), and San Giovanni Maggiore (2012, Order of Engineers). Earlier, the Superintendence supported reuse, assigning Santa Maria di Betlemme (2002, Nuova Orchestra Scarlatti), Santa Caterina da Siena (1997, Fondazione Pietà dei Turchini), and in 1992, Pappacoda Chapel and Saints Demetrio and Bonifacio to universities.

[2] In an abandoned space of the church, during EDIT Naples and the EDIT CULT program, designer Allegra Hicks presented her work "DIVINAZIONE," a 3.5x2.5 meters embroidered silk tapestry. The piece is a tribute to the church, whose sacredness is tied to the patron saints of silk workers. The space also features other elements made from silk, honoured in both sculptures and textile works.

[3] The students' work focused on the churches of San Demetrio e Bonifacio (2021–22), the Church of the Compagnia della Disciplina della Santa Croce (2023), and the Church of Sant'Eligio ai Chiavettieri (2024).

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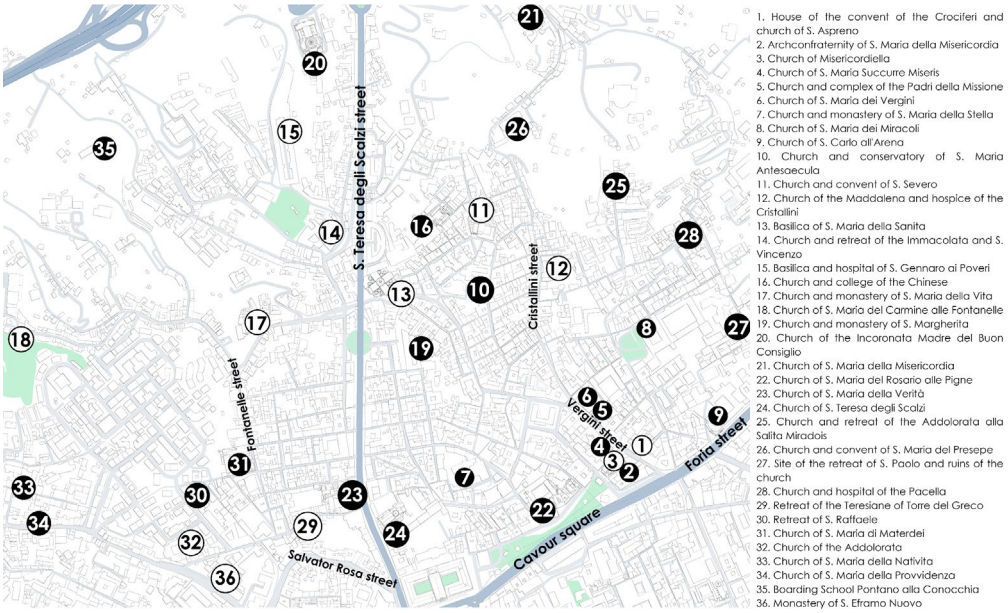


Fig. 2 – *Naples, part of Municipality 3, Rione Sanità district. The numbers indicate the historic religious churches or complexes in the area. Specifically, numbers marked with a white circle and black number represent sites hosting social and cultural activities. 1. Jago Museum, 3. Centre for contemporary art – SMMAVE, 11. Recording studio, Headquarters of the Sanitansamble Orchestra, 12. Cinema, Drama school, Business incubator, 13. Business incubator, Fondazione Comunità San Gennaro publisher, 14. Theatre, Business incubator, 15. Space for contemporary art, 17. Disused church; Homeless shelter, Territorial hub for families – La Tenda ONLUS, 18. Occasional artist residency, 29. Disused complex, Social space for civic and collective uses – Giardino Liberato, 32. Disused church, Centre for contemporary art – Casa Morra Greco, 36. Common Good – Ex OPG "Je so' pazzo"* (Vitagliano).

formerly a pharmaceutical warehouse – into a space for contemporary art, alongside the revitalization of the Catacombs of San Gennaro (Flora, 2020, p. 164). From the outset, the project extended beyond individual buildings, incorporating surrounding public spaces. Artistic installations and murals created with the participation of children and teenagers helped reawaken a sense of belonging and environmental care (Loffredo, 2022, p. 177).

Initiatives such as *Adotta una piazza* engaged local merchants and artisans, turning them into active players in the regeneration of public spaces and restoring streets and squares to their communal function (Flora, 2020, p. 165).

Regarding disused religious spaces, their gradual reoccupation resembled a form of urban acupuncture, largely driven by artists drawn to the emotional charge of such architectural settings. One of the most emblematic interventions was led by the artist Jago, after donating *Figlio Velato* to the city of Naples and displaying it in the *Cappella dei Bianchi* of the Church of San Severo Fuori le Mura, transformed the 18th-century Church of Sant'Aspreno ai Crociferi into a public studio, later converted into a museum (Fig. 3). Closed after the 1980 earthquake, the church became Jago's workspace in 2020, just before the onset of the pandemic, and was opened to the public as a museum in 2022. Conceived as an exhibition space for the internationally renowned artist (Flora, 2023, pp. 110–117), the site – currently being restored – provides a fascinating setting for displaying his works, producing a marked material contrast.

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Particularly significant was the reopening of a secondary entrance with a 17th-century portal, which, if preserved, could help revitalise the adjacent alley, Vico Crociferi.

Another initiative, with an even greater emphasis on community involvement than the previous one, was the reopening of the Church of Santa Maria Maddalena ai Cristallini (Scotto di Vettimo 2025) (Fig. 4). Sixty young participants took part in artistic workshops led by international artists such as Tono Cruz and Mono González as part of the *Luce al Rione Sanità* project. Their work resulted in a layered intervention, with over twenty shades of blue used to depict local residents' faces, reproduced both as murals and as suspended photographic portraits. A boat, crafted by inmates from Secondigliano Prison, was placed near the altar. The contrast between the new mural decorations and the historic surfaces is striking. Although local community involvement was significant, this approach cannot be considered a replicable model due to the complex and often challenging relationship it establishes with the pre-existing architectural and artistic heritage.



Fig. 3 – *Naples, Church of Sant'Aspreno ai Crociferi, now Jago Museum, 2024* (Romano).

A different and more complex case is the long-standing management of the Church of Santa Maria della Misericordia ai Vergini (Fig. 5). In 2015, an agreement between the *Centro per l'Arte Contemporanea SMMAVE* and the Archconfraternity of Santa Maria della Misericordia entrusted the church's upkeep, recovery, and promotion to the ongoing work of volunteers from the cultural association led by artist Christian Leperino. After years of abandonment, the church has been successfully reopened and transformed into a centre for visual arts and historical research, hosting events and workshops for children and students. The artist managing the space actively engages local youth in various artistic experiences, offering opportunities for creative participation. However, the project initially faced resistance from the local community, which viewed the growing attention toward the neighbourhood with scepticism. A sustainable model for the enhancement and revitalization of the site was made possible solely through sustained dialogue with associations and cultural institutions, notably the National Archaeological Museum (MANN).



Fig. 4 – *Naples, Church of Santa Maria Maddalena ai Cristallini, 2024* (Romano).

Finally, several recent interventions have sparked debate over the relationship between murals and historic façades. Among the most discussed are *Resis-ti-amo* by Francisco Bosoletti, painted on the side wall of the Basilica of Santa Maria della Sanità, and the large-scale artwork by Tono Cruz and Mono González, which transformed the exterior surfaces of the bell tower and rectory of the Church of Maria Santissima del Carmine alle Fontanelle.

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Fig. 5 – *Naples, Church of S. Maria della Misericordiella, 2024* (Romano).

In both cases, the local community played an active role: in the first, by participating in a workshop held alongside the mural's creation; in the second, by helping design during the artists' residency. Here, architectural surfaces were sacrificed to make way for collective artwork aimed at strengthening the neighbourhood's sense of identity. However, the approaches differ: Bosoletti's work, confined to a secondary, blind wall rather than the church's main entrance, harmonizes with the architecture, community, and urban landscape. In contrast, Cruz and González's mural redefined the ornamental framework of the surfaces. Yet, despite its bold visual impact, the decision to retain certain monochromatic mouldings preserves the legibility of the church's architectural registers.

4. Conclusion

The experience of *Rione Sanità* shows how the reuse of churches can drive urban regeneration with significant social and economic effects (Amestoy & Casalini, 2021, pp. 399–401), while requiring reflection on its limitations. Art and culture foster collective participation and reclaim public space, often through universities collaborations in dialogue with local communities (Flora, 2021); yet, religious architectures risk losing their original meaning, becoming neutral containers or artifacts stripped of identity.

While integrating art, community, and heritage confirms the value of a participatory approach, it raises challenges regarding the impact on the meaning and fabric of the spaces. Reuse decisions should result from careful comparison of alternatives, aiming to respect the architecture's original vocation and materials, while allowing shared reinterpretation for its preservation (Russo, 2017, p. 281). Discussion tables should thus welcome diverse perspectives, fostering dialogue between expertise and interests, capable of generating not simple compromises but solutions that reconcile heritage protection with new functions, preserving its past, present, and future meanings.

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Masonry Walls Restoration and Urban Regeneration in the Clock Tower of Monóvar (Alicante, Spain)

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Topic: T3.2. Intervention and regeneration projects

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Abstract

The paper presents the historical restoration and musealization of Monóvar's clock tower. This isolated 18th-century tower was initially built to house the public clock, marking one of the earliest known examples in the Comunitat Valenciana of a secular timekeeping structure. Unlike most towers of the time, which were part of religious buildings, this project was driven by the local civil government to assert municipal control over timekeeping. The tower was constructed using a mix of stone masonry techniques, with varying material qualities, including well-cut ashlar, irregular stonework, and poor-quality rubble masonry. Stress tests revealed low tensile strength values, and due to construction deficiencies, the upper section developed a slight tilt, which has remained stable since its original construction. Over the years, several interventions were carried out the most intensive intervention occurred between the 1960s and 1970s, involving widespread use of cement, modifications to the façades, and the replacement of original materials with prefabricated elements, also masonry walls were added to visually correct the tilt. Following the recent demolition of a nearby building, which led to a landslide, concerns emerged about the tower's foundation and overall stability. However, analysis confirmed that the tilt has remained stable since its construction. Due to the masonry's poor quality, reinforcement was necessary and was implemented using lime injections. The landslide also exposed a previously undocumented Muslim cemetery, where thirteen burials were discovered and carefully excavated, adding an important layer to Monóvar's historical narrative. This archaeological site has been integrated into the urban project through a musealization, which includes a new walkway that encircles the tower, the cemetery, and two viewing platforms. These interventions enhance the site's cultural and historical significance by giving visitors a deeper understanding of Monóvar's past, from its medieval Islamic period to its 18th-century civic developments. This project preserves and reinterprets the architectural heritage, fostering a stronger connection between the historic fabric and the contemporary urban landscape.

Keywords: *clock tower; masonry wall; muslim cementery; landslide; Monovar*

1. Introduction

Monóvar, a town in the Vinalopó Valley, has had a defined urban structure since the 12th century (Azuar, 2016). It is built on the southern slopes of a series of hills, the highest of which was the site of a medieval castle. In the early 18th century, the town council constructed a clock

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tower separate from the church to reclaim the control of time from religious institutions, a move aligned with Enlightenment ideals promoting the separation of church and state (Fig. 1). Unlike most towns, which added a clock to existing buildings, Monóvar was unique in constructing a dedicated, standalone tower for this purpose (Vidal, 2000). At that time, the bell marked the rhythm of the daily life, scheduling the routine for religious and lay matters (García, 2016).

On April 27, 1734, the council held a public auction for the tower's construction. The contract was awarded to Tomás Querol, a master stonemason from Alicante, for 308 pounds. Querol, at that time working on the parish church of Aspe, completed the tower within six months, finishing on October 18 of the same year. The tower was built on a hill called the "zamoha" near Monóvar's urban borders. The bells were added in 1798, though it remains uncertain whether a clock was installed then.

The tower's design borrowed from religious bell towers, utilizing counterbalancing techniques developed in the 17th and 18th centuries to achieve stability and visual lightness (Fig. 2), like the vertical trims on the tower's main body.

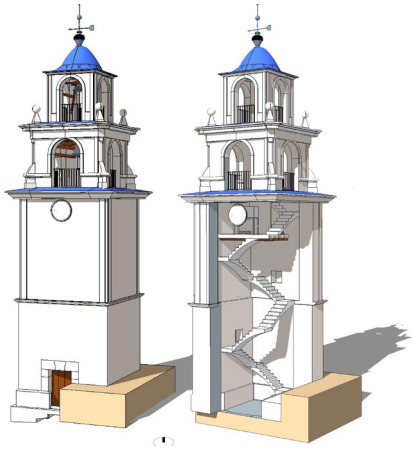


Fig. 2 – *Recreation of the tower's original image.*

The structure consists of a masonry base with varying quality materials. The lower sections use well-cut ashlar, transitioning to irregular masonry and eventually rubble masonry of poor quality bound with low-quality lime mortar (Fig. 3). Cornices and decorative elements were made of soft, easily eroded sandstone. Inside, a tabicated vaulted staircase spirals around the perimeter in a traditional castellana style. As usual, the walls diminish in size as the tower gets higher. A traditional vault system (*revoltó i bigueta*) was used to build the slabs on the two bell's body floors.



Fig. 1 – *Demarcation plan from Elda's county archive (1748).*

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Fig. 3 – *Masonry wall's composition.*

The bell chamber was intended to be topped with a dome on pendentives, but only the pendentives were completed, and a simple vaulted ceiling was installed instead. Two wooden structures support the bells, distributing their weight to the tower's corners, one on each floor.

Over the centuries, several modifications altered the original structure. When the mechanical clock system was added, it was necessary to demolish the original stairs and build the one visible today. It also seems that this affected several windows, closing them (Fig. 4).

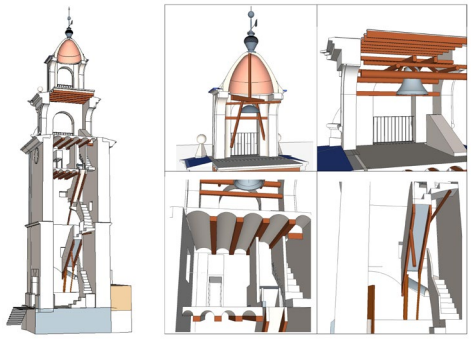


Fig. 4 – *Current stairs and interior of the clock tower.*

A significant intervention in the early 20th century added masonry reinforcements to the northern and eastern facades to counteract the tower's inclination in the lower body.

In the 1960s, the tower underwent extensive modifications: cement replaced the original lime plaster, sandstone moldings were substituted with concrete elements, the northern and eastern facades were clad in brick to mask the inclination, and the bell chamber floor was resurfaced. The tower's original whitewashed appearance was also replaced with a yellow finish more in line with mid-20th-century historicist trends.

The archaeological intervention was necessary due to the designation of the Clock Tower as a Local Heritage Asset (Bien de Relevancia Local - BRL), which mandates a prior study before any work can be undertaken on the tower or its surroundings (Ley 4/1998, art. 62). The historical graffiti inside the tower were documented, along with an analysis of the construction system and any possible remodeling visible during the restoration process.

A 2022 report identified human remains within the site of the tower, which were at risk of being lost due to erosion and the ongoing construction work. This led to the excavation, aimed at recovering the remains and documenting any additional cultural evidence that might have been preserved in the areas impacted by the construction activities on the site.

This paper presents the restoration of Monóvar's 18th-century clock tower. After outlining the tower's historical context, the methodology used in its structural and archaeological assessment, and the technical solutions implemented is presented. The intervention is framed within broader heritage preservation practices, emphasizing minimal intervention, material authenticity, and the integration of cultural heritage into urban space.

2. Methodology

2.1. Intervention goals

The project's main goal is to stabilize the tower, stabilize the nearby terrain, and create a new urban space around the tower.

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To meet these goals, a procedural methodology has been followed for the data collection. First, the tower was visually inspected to determine its current preservation state, and data from historical sources were collected. Second, a series of tests have been performed to obtain data from different sources.

2.2. Pathologies

At a visual glance, several pathologies were detected on the tower. The tower presented an inclination of 13 cm to its southeast side. The façade presented different damage. There were humidity stains under the ledge, vertical cracks along the southern façade, and general cracking on the mortar. The wooden structure for the bell presented damage from an olden xylophage attack and rot.

The most crucial damage was on the terrain. Two nearby houses were demolished recently and provoked a major landslide. During the landslide, a human bone was unearthed. The extent of the slide covered several meters and raised concerns about potential impacts on the tower's foundations and stability.

2.3. Data collection campaign

After the inspection, a campaign test was developed to obtain data and evaluate the tower's structural performance. A specific campaign test was explicitly defined to obtain the relevant data. It was fractioned into two parts: tests on the tower and tests on the terrain.

The tests were performed on the tower to obtain descriptive information about the preservation state of different materials, their structural capabilities, and their composition. Simple and double flat jack test were performed on the other walls, accompanied by several archaeological borings to ensure its composition. Degradation and structural resistance tests were performed on the wooden structure using seismographic systems from AIDIMME.

The data from the terrain was critical to ensure the tower's stability, and due to this difficult access, some tests were hard to perform. A topographical representation of the site was developed to obtain accurate geometrical data on the terrain and the tower. One SPT was performed to learn about the layers on the terrain. Its information was contrasted and completed with two electrical tomography profiles and a granulometric test on the slide, as it was impossible to perform more tests.

2.4. Archaeological site

The tower structure was monitored during the removal of the cement and the opening of the original windows, documenting the process photographically. Graffiti was identified, cleaned, and documented using digital photography and photogrammetry (Valente and Barazzetti, 2020), noting their typology, technique, and condition.

In the archaeological excavation of the site, strata, structures and materials were documented, with samples taken for possible future analysis. The information was recorded in files, photographs and photogrammetric models. Materials were cleaned, catalogued, and deposited at the Archaeological Museum of Alicante (MARQ).

3. Results

3.1. Structural stability of the tower

The tower is composed of two prisms with a square base. The first body has a size of 4.80 x 4.80 m at its base, and it is reduced to 4.30 x 4.30 on its second body. While the first body is mainly straight, the second is tilted towards the southwest (Table 1).

Table 1 – *Inclination measurements per corner.*

Façade	Inclination	Downfall
Façade N	0.84º	0.164 m
Façade W	1.77º	0.345 m
Façade S	1.86º	0.362 m
Façade E	0.81º	0.158 m
Center	0.66º	0.130 m

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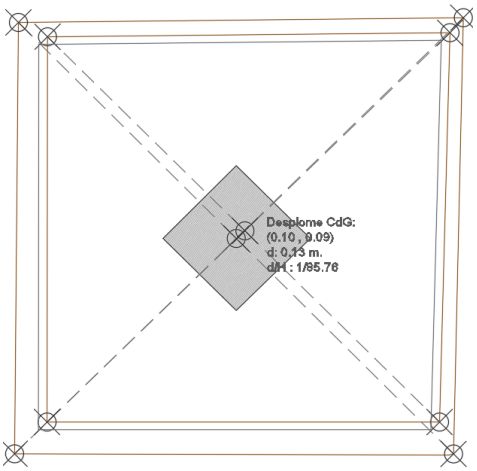


Fig. 5 – *Relative displacement of reference points.*

Because of the downfall, the center of gravity from both bodies is not aligned. There is 13 cm from one center of gravity to the other with a d/Z ratio of 1/86.7 (Fig. 5).

Despite this displacement and the inclination of the tower both centres of gravity are entirely inside the central core of the tower's section. So, the tower is perfectly stable as the gravitational forces upon it do not create any tensile efforts on its base.

During the execution it was discovered that the northern and western façades were covered with a non-structural brick masonry of variable depth. This wall was built in the last intervention in 1960s to correct the tower's inclination visually. These brick walls were demolished during the execution, recovering the original shape and volume of the clock tower.

3.2. Masonry walls description

The quality of the masonry walls was deemed as "LOW," with a Masonry Quality Index (MQI) ranging from 1.12-2.13. The stone and lime mortar wall were not well consolidated and presented several gaps with a size equivalent to that of the used stone.

Table 2 – *Flat-jack test results.*

Wall	Tensile strength (MPa)
East	0.49
West	0.43

The flat-jack test results (Table 2) are coherent with the MQI and the rest of the data. High air volume and low horizontal continuity are critical to the wall's cohesion. The results indicate that the building experiences a significant load for its capacity, using 43.95% of it, contrary to the usual 10% capacity usage in other masonry structures.

A lime mortar of a liquid consistency was injected to reinforce the walls. A grid of 50 x 50 cm was drilled in every façade with a hole of 20 mm. By using a low-pressure pump working at 2 atm. of pressure or lower, the mortar was injected from the bottom to the top. The injection continued until the mortar reached out in the wall, either by another drill or a cavity. Several mortar compositions were tried to adjust the mixture to the ideal consistency, adjusting sand granulometry and fluidizing additive. At the end, the mortar used was *Morcem® Cal Inyección Consolidante* from *Grupo Puma*, as it was not possible to use nearby sands.

After performing the injection, the façades have been covered with coloured lime mortar. The mortar has been applied with a layer of continuous thickness despite the irregularities in the masonry. The decorations have been reproduced with the measurements from the previous intervention, and the colour scheme has been chosen based upon typological studies on similar buildings on the zone.

3.3. Wooden structure and bell restoration

The degradation test on the different wooden structural elements of the bells and the stairs showed damage in all the elements. There were elements that had suffered an attack from xylophages but were no longer active. There were also rotten parts due to atmospheric exposure.

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Every element was treated based on its necessities based on this criterion: the rotten wood was chiseled and sanded, and missing parts were reconstructed using epoxy resin and glass-fiber rebars to reinforce them. No element was replaced, and they were all treated to prevent further xylophage attacks.

3.4 Graffiti on the walls

The study of the graffiti on the tower walls has focused on their cataloguing and analysis, carried out in collaboration with Irene Agües, expert in historical graffiti. Nearly 200 samples have been recorded, with dates ranging from the 1910s to the present day. These markings consist primarily of names and dates, though several figurative examples also stand out, including a depiction of a bell tower with a weathervane (Fig. 6), a boat, and several human figures.



Fig. 6 – *Figurative charcoal graffito representing the dome of a bell tower with a weather vane.*

The graffiti were created using a range of techniques, including charcoal, incisions made with sharp instruments, paint, and markings on fresh plaster. This record is especially valuable as it captures the interactions of various individuals with the building, showcasing a diverse array of techniques, styles, and messages (Lozano 2023).

3.5 Terrain stabilization

The slide near the tower was caused by the collapse of two nearby houses on Sacristan Street, 23 and 25. The landslide created a 7.5-meter-high terrain scarp. Due to its steep slope and soil composition, the slide is considered unstable (Fig. 7). The security factor is 1.7 in normal conditions, and it is reduced to 1.4 in seismic conditions.

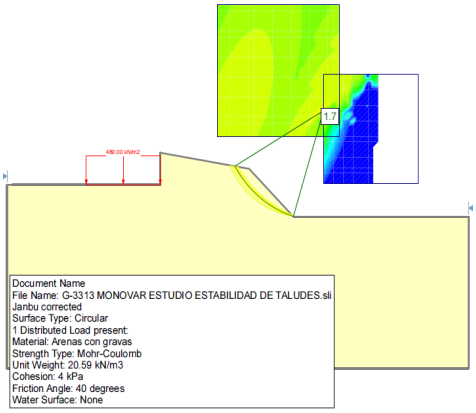


Fig. 7 – *Security factor of the slide.*

The slide does not currently affect the tower's foundation as the loads under them do not collide with it. Despite this, its instability and atmospheric erosion will affect it in the future. During the time gap between the studies and the execution (11 months), the slide top had neared around 50 cm toward the tower's base.

The terrain stabilization has been solved by combining two methods, cutting the height in two and diminishing the structural needs (Fig. 8). The lower part sustains the terrain using a concrete brick wall. The concrete bricks are filled with reinforced concrete. The wall impedes the slope to advance and takes advantage of the natural ground friction angle to improve its performance.

In contrast, the upper section was adapted to the existing slope and reinforced by applying shotcrete directly onto the terrain.

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Fig. 8 – *Terrain stabilization solutions.*

The tomography and penetration analysis provided insights into the terrain's profile. It was used to determine the state of the tower's foundations. The admissible soil tension is 0.25 MPa, while the tower max pressure is 0.19 MPa. The test also showed a layer of debris 1.2 to 2m deep and temporary humidity deposits.

3.6 Excavation and the *maqbara*

Two distinct periods of use were identified on the tower site. The earliest corresponds to a place of burial from the Islamic medieval period, a *maqbara* or cemetery (Echevarria 2020, 83). A total of 12 tombs were discovered, though their preservation is generally poor. Later constructions, debris deposits, and natural erosion have caused many of the tombs to be only partially preserved. Furthermore, the presence of insects and plants has also contributed to the deterioration of the human remains.

Despite conservation issues, such as insect activity, erosion (Fig. 9) and subsequent uses of the site, two types of tombs have been identified. Excavated directly in the ground, simple graves and graves with a lateral steps/rim can be observed. These graves feature a lateral rim where adobe blocks or stone slabs are placed, adopting a form similar to a shed roof. The orientation of the tombs aligned NE-SW, and the positioning of the bodies—on their right side with their faces directed towards the S-SE—suggest that these burial sites date to the Islamic period, a pattern also observed in nearby *maqâbir* (Jover et al., 2005; Lopez Segui et al., 2005; Olcina et al., 2008). Additionally, no grave goods have been found within the tombs in keeping with Islamic burial practices.



Fig. 9 – *View of tomb 1 showing how erosion has made part of the tomb disappear, the tibia and fibula of the buried individual are suspended in the section of the ground.*

The study of the skeletal remains is still in its preliminary stages, but it has already provided valuable insights. It has revealed individuals from all age groups: 2 infants, 1 adolescent, and 9 adults. In terms of biological sex, 1 female, 2 probable females, and 3 probable males have been identified, while the sex of the remaining individuals remains undetermined.

The second phase of use identified is linked to the construction of the Clock Tower in 1734 or possibly to later remodeling efforts. A stone carving area was uncovered, revealing splinters and fragments of partially carved stone. Additionally, two structures built with stone and lime mortar were documented, likely used to support a platform or crane. These structures were later covered with building materials, ceramics, plastics, and other debris, which accumulated in the refuse dump that occupied the tower site until the commencement of the restoration work.

3.7 Urban Intervention

The surroundings of the tower are now a new urban area. A walking area around the tower with two agora-like meeting points for the people to observe Monovar's main monuments and historical center. The walk crosses the musealized *maqbara*, showing the remains of their ancestors. A new and unique place in town to understand where they come from and the importance of History.

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4. Conclusions

The archaeological interventions have made it possible to identify and preserve parts of Monóvar's cultural heritage at risk of disappearing. They have also made it possible to locate the town's first urban archaeological site and integrate it into its surroundings, thus enriching its cultural offer for residents and visitors.

Data collection has proven necessary for the heritage preservation of this building. Historical data and the tests performed before the intervention have been critical to its success as they have demonstrated the tower's stability after all these years.

The suitability of the solutions is essential for heritage preservation, and only with profound knowledge can it be achieved.

Ongoing studies based on these findings are expected to enrich not only the historical and cultural understanding of Monóvar but also to contribute to broader discussions on heritage preservation practices, aligning with international approaches that emphasize contextual research, minimal intervention, and the integration of archaeological evidence into urban regeneration.

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Revealed Spaces. The Hypogeal Churches of Naples Between Improved Knowledge and New Forms of Expanded Fruition

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Abstract
The search for new forms of use for under-utilised or abandoned ecclesiastical heritage represents one of the main challenges for the culture of conservation, to which is added a further complication, in both physical and perceptive terms, when it comes to the intervention on underground spaces. With respect to this sphere of action, recent experiences, conducted both in Italy and, more specifically, in the Neapolitan context, have proposed a differentiated panorama of solutions and strategies for the valorisation and improvement of the knowledge and use of these structures. Starting with the analysis of these experiments in terms of cultural approaches and operational outcomes, the contribution intends to present the results of an applied research work conducted by the authors in relation to the less-known hypogea of the Congrega dei Bianchi allo Spirito Santo in Naples. This precious and complex space, articulated on several levels, was carefully investigated in historical-evolutionary terms, surveyed with range-based methodology and then analysed in terms of specific constructional features and spatial relationship with the aggregate structures of the urban fabric. This was done to understand its peculiarities, investigate its criticalities and define possible scenarios for extending its use.

Keywords: *hypogeal churches; knowledge; comprehension; revelation; fruition enhancement*

1. Introduction

Within the broader framework of strategies aimed at restoring and exploring new forms of use for the ecclesiastical heritage of historic cities, the regeneration of underground spaces – such as crypts, ossuaries, sacred grounds, and lower churches – presents a particularly challenging design theme. This is primarily due to issues related to their limited accessibility, both physical and perceptual (e.g., the presence of stairs, poor visibility, and restricted dimensions). In this regard, reflecting on recent experiences in Italy – and specifically in Naples – offers an opportunity to assess cultural approaches and functional choices, while also highlighting both the positive outcomes and the recurring critical issues. These issues often concern the risk that new uses and forms of access may perceptually alter the identity and distinctive spatial relationships of these places.

Within this research framework, we developed a multi-scalar strategy for understanding the valuable – yet largely unknown – underground space of the *Congrega dei Bianchi allo Spirito Santo*, selected as an emblematic case from the broader Neapolitan heritage.

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The results of this work are presented here. The cognitive phase began with a bibliographic review focused on the historical and evolutionary development of the structure. This was followed by a detailed range-based architectural survey, aimed at constructing a digital twin – a highly informative three-dimensional model that accurately represents the morpho-chromatic and dimensional characteristics of the hypogeal space, as well as its relationship to the overlying architecture and the surrounding urban fabric.

Based on this data and the interpretation of the structure's construction features, vulnerabilities, and issues related to both physical and cognitive accessibility, the research explored both tangible and intangible strategies for enhancing the perception and use of this sacred space. These strategies, which also aim to foster broader community involvement, contribute to the wider ongoing debate on the conservation and adaptive reuse of underground ecclesiastical heritage.

2. Perceive, understand, participate. Some recent experiences

As highlighted in both national and international disciplinary debates, current conservation strategies face the challenge of improving the inclusiveness and accessibility of cultural heritage. The Faro Convention (2005) – as well as the Italian *Piano Nazionale di Ripresa e Resilienza* – emphasizes the importance of expanding community participation as a means of reinforcing cultural identity. This necessarily entails experimenting with multi-scalar actions aimed at enhancing both the physical and perceptual experience of heritage, requiring a careful balance between conservation imperatives and opportunities for communication. This must be achieved without compromising the authenticity of historical architecture, not only in tangible terms, but also in its intangible and cognitive dimensions (Cetorelli & Guido, 2020; Pollone, 2023). In relation to hypogeal spaces and considering both these cultural objectives and the recurring challenges associated with their physical inaccessibility, several recent initiatives have tested various strategies for enhancement and public engagement. These have generally focused on two main approaches: revelation and valorisation. The first involves opening previously inaccessible spaces to the public; the second includes developing solutions to improve accessibility and understanding, as well as defining digital methods for communicating cultural content that may be otherwise difficult to recognize or physically access.

Among the broad array of recent national initiatives focused on the intangible valorisation of underground heritage, one notable example is the immersive restoration of the frescoes in the rock church of Lama d'Antico in the province of Brindisi (2019). This project is part of a wider movement that promotes the use and appreciation of the religious rock architecture typical of Apulia and Basilicata in Southern Italy.

Another example is the virtual relocation of the frescoes in the underground church of *Santa Maria dei Laici in Gubbio* (2021), coordinated by Giorgio Verdiani, Alexia Charalambous, and Gaia Marsili. Additionally, the conservation of the crypt of the church of Sant'Agnese in Agone in Rome (2022) was followed by an insightful museal intervention. This included the installation of interpretive devices and, most notably, a carefully designed lighting system that *reveals* the decorative elements and historical layers of the site, which also contains the ruins of Diocletian's Stadium.

In continuity with these experiences, the interventions carried out in Naples in recent years have explored the intersection between tangible and intangible approaches, involving both permanent and temporary solutions. Among the former, particular attention has been given to the underground structures in the Sanità district – most notably, the public opening of the Hellenistic Hypogeum of the Cristallini (2022).

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This valorisation initiative followed a rigorous campaign of investigation, digital surveying, and restoration, and incorporates user-friendly methods of engagement, including an audiovisual narrative that conveys the outcomes of the research phase. Regarding temporary – or at least reversible – strategies, the case of the Church of *Santa Maria della Misericordia ai Vergini* is particularly noteworthy. Since 2015, it has hosted the studio of artist Cristian Leperino, where the *Terrasanta* hypogeum has been used for temporary art installations.

These initiatives are especially significant not only for enabling public use of such spaces, but also for fostering strong local community involvement, especially among younger generations, through creative processes and events. Finally, other Neapolitan hypogea have also been sites of temporary enhancement projects, including the crypt of the Church of Santa Luciella, which hosted an art installation by Michele De Lucchi in 2022.

The perceptual strategies and communication methods adopted in these examples – based on expanded accessibility and, more importantly, on the *experiential* involvement of users – demonstrate a commitment to combining intangible and perceptive approaches with more traditional, physical ones. These are carefully calibrated according to the specific characteristics and communicative potential of each heritage site. In many cases, the ethical and cultural value of direct engagement with the material substance of *revealed* architecture is prioritized, deliberately avoiding forms of remote access – even in contexts of difficult physical accessibility.

Nevertheless, the digitalisation processes adopted in some of the projects discussed serve to compensate for inaccessibility through alternative forms of engagement that are truly inclusive. They also offer powerful digital tools for understanding the layered historical transformations of these sites.

3. The hypogeum of the Congrega dei Bianchi allo Spirito Santo in Naples. An experiment of applied research

3.1. The holy space through the centuries

The seat of the *Real Compagnia ed Arciconfraternita dei Bianchi allo Spirito Santo* is located adjacent to the *Basilica dello Spirito Santo*, in an area significantly shaped by the urban transformations that took place during the Spanish Viceroyalty (Colletta 1975; De Fusco 2004). Founded in 1555 – or 1563, according to other sources – the Archconfraternity commissioned the construction of an initial church on the site. This structure was modified in the 1560s to accommodate the construction of the present basilica, which incorporated parts of the earlier building (Rocco di Torrepadula, 2004, pp. 32–33). Rebuilt alongside the basilica between 1580 and 1582 as a single-nave structure, the Oratory included a hypogeal space – likely corresponding to the current vestibule, the first of the three underground rooms visible today. This original space was probably expanded between the 17th and 18th centuries through the enclosure of an area initially used as a courtyard, as suggested by an analysis of historical cartography. This intervention appears to have resulted in the creation of two additional rooms – formally and decoratively distinct from the first – the larger of which was positioned directly beneath the Oratory. In 1729, the building underwent Baroque-style renovations attributed to Ferdinando Sanfelice, Carlo Tucci, and Domenico Punziano, which led to transformations of the altars and decorative schemes. During this same period, the first and second *Terrasanta* (burial spaces) were adorned with exquisite Neapolitan majolica tiles (*riggiole*), crafted by master artisan Gaetano Massa based on a design by Don Muzio Anaclerio (Donatone, 1981, p. 81) (Fig. 1). The decorative program may also have been further enriched by interventions attributed to Mario Gioffredo (Strazzullo, 1955), who, from the mid-

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18th century, was also involved in restoration work on the adjacent basilica. Since then, aside from minor additions, the Oratory and its hypogeal spaces have remained largely unaltered to the present day.



Fig. 1 – *A view over the second Terrasanta from the first one. In detail, the majolica tiles and the burials* (Cera, 2024).

3.2. Knowledge through surveying

The process of understanding the *Congrega dei Bianchi*, in its dual articulation above and below ground, necessarily begins with a meticulous architectural survey campaign. The application of contemporary processes and techniques for the digitisation of architectural heritage enables the collection of a wide range of data, which is essential for a deeper understanding of the specific features of the structures under study.

To investigate the unique spatial configuration of the Bianchi's hypogeal spaces and their relationship with the above-ground Oratory architecture, a comprehensive digitisation campaign was undertaken. This survey represents a significant cognitive advancement within the broader analytical framework, particularly in light of the complete absence of existing graphic documentation attesting to the spatial arrangement and condition of the site. Moreover, the use of active optical sensor-based survey techniques – well-established for applications in underground environments – allows for the acquisition of both quantitative data (e.g., dimensions) and qualitative data, such as colour, materials, and state of preservation.

As is customary, the digitisation process was preceded by a preliminary site inspection, which was essential for gaining an initial understanding of the spatial configuration – particularly complex due to its integration within an urban fabric that limits accessibility. This step also included an assessment of site conditions, which informed the choice of appropriate data acquisition equipment and the planning of scanning positions, with the aim of optimising the efficiency and accuracy of the digital survey. During this phase, several critical issues were identified and grouped into two categories: (i) environmental issues of a general nature and (ii) site-specific issues relating to the hypogeal context. The first category includes factors such as natural lighting conditions – affected by the sun's trajectory during the day – and frequent pedestrian and scooter traffic along *Vico Bianchi allo Spirito Santo*, where the entrances to the *Congrega* are located. Both conditions posed challenges for documenting the external areas. The first issue – natural lighting – was addressed, as detailed later, by adjusting the scanning sequence to ensure well-lit acquisitions for the exterior areas (street, entrances, and semi-porticoed courtyard). The second was mitigated by temporarily restricting access to the area in front of the main entrance façade, with its two monumental portals, during scanning. Site-specific challenges primarily involved the complex spatial configuration and extension of the architectural complex, which is structured over two levels, each subdivided into multiple rooms. Compounding this is the limited and uneven lighting in the hypogeal spaces, some of which are in complete darkness. Due to the planimetric and altimetric complexity of the layout, the survey campaign was divided over two days: the first dedicated to the underground areas and the second to the Oratory floor. The

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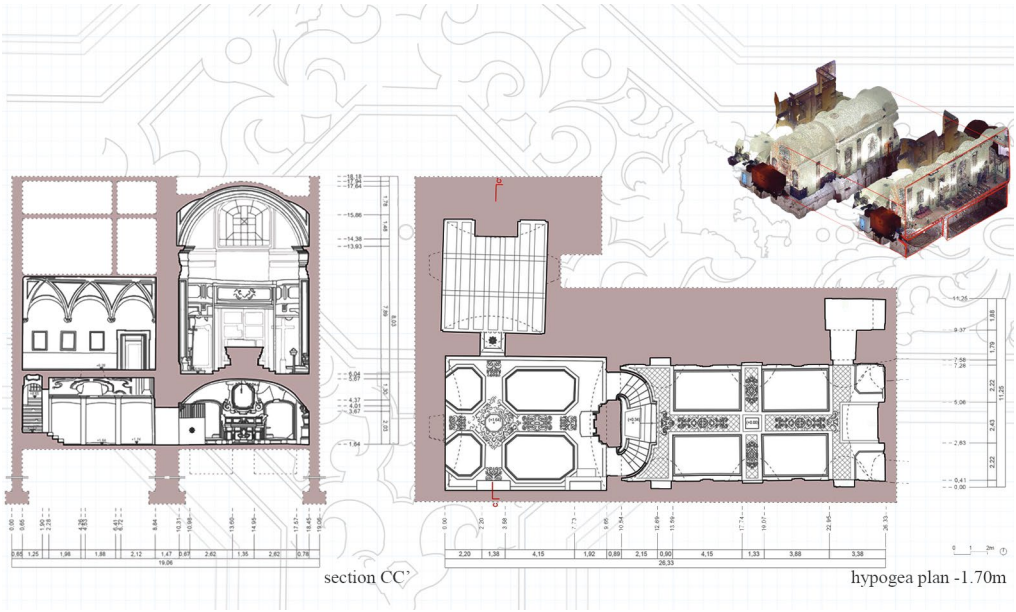


Fig. 2 – *Some bidimensional drawings derived from the TLS point cloud* (Spataro, 2024).

low lighting conditions in the Oratory were resolved using a range-based technique with a terrestrial laser scanner capable of acquiring dimensional data even in the absence of ambient light.

Following this preliminary work, the digitisation phase was carried out using a phase-shift terrestrial laser scanner, the FARO Focus3D S120, selected for its suitability to the spatial dimensions and linear extension of the site – well within the instrument's effective range (up to 100 m without noise). The scanning network was organised along a linear path with stations positioned approximately 7 metres apart. To minimise the need for post-processing and clean-up of the point cloud, no artificial targets were used; instead, scans were aligned during processing using only geometric features. This approach preserved both the geometric and chromatic fidelity of the data, avoiding interference from extraneous architectural elements. As previously mentioned, the colour data were also recorded during acquisition, enabling the identification of potential discolourations, such as those caused by moisture. A total of 41 scans were performed, using a resolution of 1/8 and a quality factor of 4x. The resulting point cloud, roto-translated and registered, consisted of approximately 10 million points. The discrete model achieved a high level of accuracy, with an average alignment error between scans of around 1.6 mm. Clipping boxes were used to generate orthomosaics by sectioning the point cloud along horizontal and vertical planes at different heights, which were then used to produce two-dimensional drawings, including plans and key sections.

The digitisation process thus enabled the detailed architectural documentation of both the hypogeal and above-ground structures, with precise dimensional annotations. Specifically, the hypogeum of the *Congrega dei Bianchi allo Spirito Santo* comprises three interconnected vaulted rooms – each with a barrel vault – arranged in an L-shaped plan. These spaces are situated on staggered levels, with a total height

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difference of approximately 2 metres between the first room – immediately accessible from the staircase – and the final room, which has no exit.

Access to the hypogeum is via a steep, multi-ramped staircase that leads to a vestibule with a square plan measuring 6.20 x 6.20 m. This room features three mirrored niches along the side walls of the stair landing. Opposite the staircase, a short, vaulted corridor leads to the first main hypogeal chamber, which is rotated 90° relative to the vestibule and has a more rectangular layout (9.66 x 8.45 m). This space is more elaborate in terms of decoration, featuring stucco work, a richly decorated marble altar topped with a fresco, and several *terre sante* (holy soils) and sarcophagi – two larger ones centrally placed to guide movement toward the altar, and two smaller ones against the rear wall. On either side of the altar, two lowered elliptical arches provide access, via an 18th-century-style pincer staircase, to the third and final chamber. This room, aligned with the previous one, is the largest and has a more rigid spatial articulation. The side walls are punctuated by niches set within thick masonry, framed by pilasters and topped with a moulded cornice that marks the springing line of the vaulted ceiling. The lunettes above are adorned with motifs representing the rays of the Holy Spirit. The chamber contains six *terre sante*: four rectangular ones arranged in a cruciform layout on the floor, and two smaller polygonal ones near the brick rear wall. These are located beneath two *bocche di lupo* (wolf mouths) that connect with the original entrance façade of the church (Fig. 2).

3.3. Constructive features and state of conservation

The acquisition of detailed surveys and the subsequent production of drawings incorporating accurate orthophotos enabled the analysis of the material and constructional components of the architecture, as well as the interpretation of its state of conservation. The survey revealed masonry predominantly composed of roughly squared blocks of yellow tuff, bonded with lime-based mortar, with limited brickwork inserts attributable to consolidation interventions. The barrel vaults, built using the same material, have an average keystone thickness of approximately 0.4 metres. The laser scanner survey also allowed for the accurate reconstruction of the vault geometries, revealing slight deformations in the three vaults. However, these deviations were interpreted as physiological – typical of aged masonry structures – rather than indicative of structural collapse, thanks to the centimetric accuracy of the data. Nevertheless, monitoring measures have been planned to ensure continued assessment. Rich stucco decorations highlight the geometry of the vaults, the pincer staircase, and the wall surfaces. Majolica tiles featuring floral motifs embellish the bands of paving that outline the perimeter of the tombs.

Although the masonry does not appear to exhibit significant structural instability, it does show signs of deterioration – along with the decorative elements and majolica flooring – primarily due to the underground setting, and more specifically, to high humidity levels. Observable deterioration phenomena include widespread detachment of material, the presence of efflorescence and sub-efflorescence, material loss of varying degrees, biological patinas, and swelling. As is standard in conservation methodology, the diagnostic phase was followed by the development of guidelines aimed at mitigating the causes of damage. Only brief references to this aspect are provided here. The proposed interventions were formulated according to a principle of minimal intervention, with the goal of addressing the identified pathologies while preserving the site's authenticity (Fig. 3).

4. Cultural-aware strategies for the enhancement of fruition

In defining the most suitable strategies for the enhancement of the case study, both the site's potential and its critical issues were prioritised, while also focusing attention on the inherent

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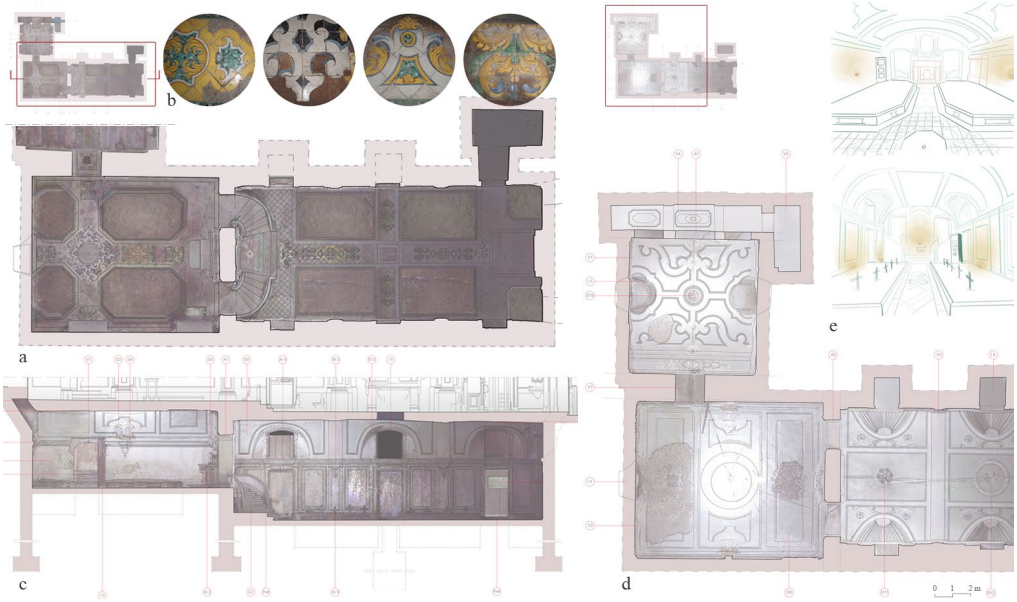


Fig. 3 – *Material-constructive interpretation of the hypogeal spaces: a) plan (excerpt); b) details of the tiled floor; c) longitudinal section; d) hypography (excerpt); e) possible strategies for the expansion of cultural fruition* (Spataro, 2024).

vocations of the hypogea and the Congrega to which they belong. The hypogea of the *Bianchi allo Spirito Santo* are distinguished by their central location within the city's historical fabric, well served by public transport. They are situated near the educational facilities of the Department of Architecture at the University of Naples Federico II and are directly connected to the adjacent *Basilica dello Spirito Santo*. These factors, combined with the morphological characteristics revealed through surveys and in-depth investigations, make the site particularly suited to new functions that would physically and perceptually open the architecture to the wider community. However, the selection of appropriate forms of participatory use must take into account several critical issues identified during the research. These include: the inconspicuous location of the Congrega's entrance in relation to the main thoroughfare, Via Toledo, which currently limits its visibility; and the limited accessibility of the site for certain user groups, especially individuals with reduced mobility, due to the vertical distribution of the complex, accessible only via stairs.

In response to these considerations, the proposed strategy first includes installing directional signage from the main street and at the entrance. Given the impossibility of ensuring physical access to all areas of the Congrega, two distinct routes – differentiated by accessibility level – have been proposed. The first itinerary, fully accessible to users of all mobility levels, is confined to the ground-floor spaces. Within this area, the Oratory is envisioned to host not only religious services but also concerts, graduation ceremonies, and book presentations. The *Sala del Governo* may be adapted for mixed use by the Archconfraternity of the Bianchi and as a study room for students from the nearby Department of Architecture. Accessibility to the ancillary service areas in between will be improved through the addition of ramps and step aids. In

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these accessible spaces, multimedia totems, project panels, and tactile maps will be installed to convey information about the hypogea to users unable to visit them in person. These same spaces will also be part of a second, partially accessible route, which would allow access to the complex via the external ramp and enable direct entry into the church by overcoming existing level changes and steps.

As for the hypogea, physical access will be restricted to the stairways, which – being particularly steep and narrow – do not permit the implementation of barrier-free solutions. Consequently, these spaces will be musealised through temporary exhibitions and an appropriate lighting system. At the same time, in order to convey the complexity of the site's historical stratification and promote broader understanding, compensatory measures are planned. These include the use of the digital 3D model as a narrative tool. Through interactive multimedia totems located on the ground floor, visitors will be able to explore the hypogeal spaces virtually, interacting with the three-dimensional survey model enriched with annotations on the site's construction history and decorative elements. The proposed measures aim to foster a deeper understanding and appreciation of the site, encouraging its enhancement through community engagement and active involvement in the architectural heritage, valued both for its material and immaterial significance.

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Authorship

Although this contribution is the result of joint research by both authors, Valeria Cera is responsible for paragraph 3.2, while Stefania Pollone authored paragraphs 2, 3.1, and 3.3. Paragraphs 1 and 4 were co-written by both authors.

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Solar Cadastre for Heritage Sites: A Geoinformation Tool for Balancing Energy Potential and Conservation Needs

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Topic: T3.2. Intervention and regeneration projects

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Abstract

The commitment of the European Union to achieve climate neutrality by 2050 increases pressures on areas with protected values. Their protected constituents and spatial characteristics may be adversely impacted by placing renewable energy solutions, which requires careful integration of such systems. The quality of heritage sites is essential for maintaining their significance and identity of place. The paper proposes a methodology for incorporating photovoltaic systems in heritage buildings and within heritage settlements while preserving their spatial qualities. This will be achieved within the scope of a solar cadastre, which serves as a framework for assessing, designing, and implementing sustainable energy solutions in the context of heritage conservation. The solar cadastre serves as an interactive geoinformation support for conservators, decision-makers, and investors. It provides digital models assessing solar potential and heritage vulnerability for urban and rural pilot areas. The solar potential model is aggregated using a theoretical potential for solar energy utilisation; technical potential, including physical, technological and regulatory limitations; economic feasibility of placement; and market potential for placement of solar solutions while adhering to all relevant limitations and requirements. The vulnerability model is aggregated from applicable protection regimes for cultural heritage and several models of visibility: from the vicinity of the heritage settlement (silhouette), important observation points (characteristic views and dominants), and public space in the heritage settlement (pedestrian experience). The models are aggregated into an overall visual exposure index. The models of potential and vulnerability allow testing of different solar energy development scenarios in heritage settlement sites, differing by the restrictiveness of development. The scenarios allow us to assess the possible extent of energy interventions on the buildings, including energy refurbishment and solar energy installations, and their impact on heritage, providing the decision-makers with a tool to balance heritage values and energy targets.

Keywords: *energy efficiency; solar energy; solar cadastre; heritage conservation*

1. Introduction

The European Union's commitment to climate neutrality by 2050 (European Commission, 2019) presents challenges for protected cultural and natural heritage sites and requires consideration of environmental, cultural and

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economic aspects. While this ambitious goal envisions a sustainable energy transition with minimal negative environmental impact, integrating renewable energy solutions poses a complexity. In particular, the placement of technologies such as photovoltaic and solar thermal collectors may disrupt the protected elements and spatial characteristics of heritage sites, requiring careful and sensitive integration of such systems. At the same time, the New European Bauhaus (European Commission, 2020) promotes a balanced approach, harmonious, sustainable and inclusive integration of environmental objectives with cultural and spatial preservation.

The installation of solar systems on prominent buildings, specifically at settlement entrances or along important visual corridors, can significantly impact the aesthetic and historical integrity of heritage sites. Cultural heritage buildings possess intrinsic testimonial value and crucially contribute to the broader spatial quality and identity of the place. Acknowledging the importance of maintaining the spatial quality and identity of place within the energy transition pathway, this paper proposes innovative strategies for the balanced installation of solar systems while preserving high-quality spatial compositions.

The approach requires methods for assessing solar potential and heritage vulnerability while safeguarding the local and cultural spatial context. To achieve this, a solar cadastre will be developed as a framework for assessing, designing, and implementing sustainable energy solutions in heritage conservation. By combining the energy potential and vulnerability models into scenarios, the proposed framework will ensure a balance between technological feasibility, cultural heritage protection requirements, and visually acceptable solutions. The outcome will facilitate the aesthetic coexistence of renewable energy solutions and heritage sites in urban and rural contexts.

The proposed solar cadastre is aligned with renewable energy goals and the continuous preservation of heritage sites, reflecting the principles of the transformative initiatives of the European Green Deal and the New European Bauhaus. Furthermore, the solar cadastre as a geoinformation tool provides valuable insights for investors regarding integration possibilities and supports decision-makers in balancing energy transition goals with heritage conservation.

The article's structure outlines the methodological approach, illustrating the functionalities and applications of the solar cadastre, and critically examining its effectiveness and limitations.

1.1. Research objectives

This paper presents a methodology for assessing the suitability of photovoltaic systems on heritage buildings and within heritage settlements in large areas utilising spatial data. The approach seeks to provide information to decision-makers to help balance the implementation of new energy solutions while preserving the cultural significance of heritage sites, thus promoting a sustainable future of heritage settlements. Additionally, the study seeks to critically reflect on the type of information this approach can provide and explore its use in the decision-making process of allowing new infrastructure within heritage sites.

2. Methodology

A solar cadastre serves as a systematic tool for assessing, designing, and implementing sustainable energy solutions within the context of heritage conservation. It includes digital models that evaluate both solar potential and the vulnerability of heritage sites across urban and rural areas. As an interactive geoinformation tool, the solar cadastre supports conservators, decision-makers, and investors in making informed decisions regarding integrating solar systems in culturally significant locations

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(Kokalj et al., 2022). By providing early-stage insights about the potential conflicts and the complexity of installing a solar power system in heritage sites, it facilitates mitigation strategies.

By adopting various assumptions about the possibilities of installing solar power systems, it is possible to assess trade-offs and benefits of various scenarios. This offers important input to policy-makers in broad decisions on renewable energy integration in heritage contexts.

The development of the solar cadastre follows a structured process, from data collection to the generation of multiple Geographic Information System (GIS) models and maps.

The primary modelling components include an assessment of solar potential, which identifies opportunities for solar energy utilisation, and a spatial vulnerability analysis that evaluates the impact of solar power systems on heritage sites.

The methodology and solar cadastre are tested on two pilot sites: one rural and one urban. The urban case study is in Slovenia's second-largest urban area, the Municipality of Maribor, in northeastern Slovenia, while the rural pilot is based in the Municipality of Vipava in southwestern Slovenia. The two areas were selected in consultation with regional offices of the Slovenian Institute for the Protection of Cultural Heritage, as they include different types of heritage protected by various protection regimes.

2.1. Solar potential model

The solar potential model evaluates the feasibility of solar energy utilisation on built structures within heritage sites. It integrates multiple assessment criteria to ensure a sustainable and context-sensitive solar energy deployment while adhering to heritage conservation constraints.

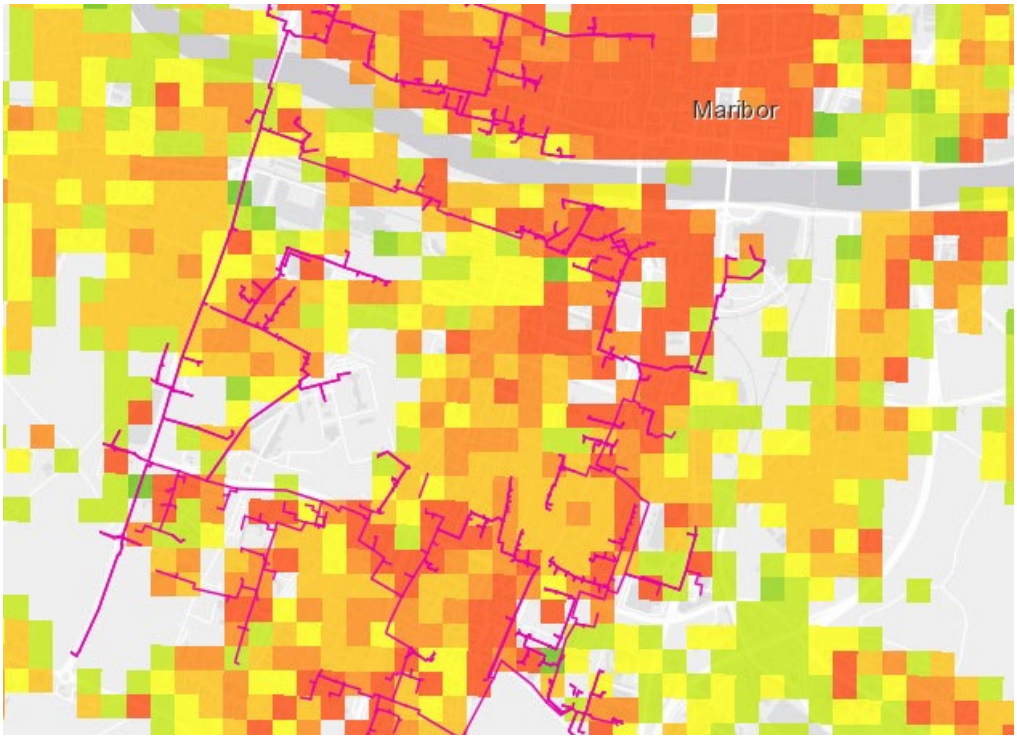


Fig. 1 - *Energy potential for heat consumption of buildings in the Municipality of Maribor* (Stegnar, 2025).

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The model comprises four key components:

1. **Theoretical potential** estimates the maximum possible solar energy that can be harvested from a building's rooftop under ideal conditions. It is determined by calculating the total solar irradiance received on the roof surface without considering physical, regulatory, or spatial constraints. This serves as a baseline for evaluating the upper limits of solar energy production.

2. **Technical potential** refines the theoretical model by integrating physical, technological, and regulatory limitations that impact the installation and efficiency of solar systems. Key considerations include: a) Roof characteristics: structural integrity, slope, orientation, and shading from surrounding buildings or vegetation. b) Technological feasibility: suitability of solar technologies for different roof types in heritage contexts. c) Regulatory constraints: heritage protection requirements that may restrict solar panel placement or impose design limitations. By incorporating these factors, the model provides a more realistic estimate of the solar capacity that can be achieved within heritage settings (Kovač et al., 2019).

3. **Economic feasibility** assesses the financial viability of solar installations by considering: a) Investment costs, including initial expenditures for materials, labour, and installation. b) Operational costs: long-term maintenance and system longevity. c) Return on investment (ROI): projected payback period and overall financial benefits. d) Available incentives such as subsidies, grants, or financial mechanisms supporting solar adoption in heritage areas. This analysis ensures that the proposed solar solutions are technically feasible and economically sustainable.

4. **Market potential** considers real-world implementation conditions, taking into account both technical requirements and regulatory constraints. It evaluates: a) Stakeholder interest, the willingness of property owners and local authorities to adopt solar technology. b) Support mechanisms, like policies or financial incentives promoting energy-efficient refurbishments in cultural heritage sites. c) Compatibility with conservation objectives, ensuring that solar installations enhance rather than detract from the site's historical and aesthetic values.

By systematically analysing these factors, the solar potential model provides a holistic assessment of the viability of solar energy integration in heritage buildings. It serves as a decision-making tool for conservators, architects, planners, and policymakers, offering a data-driven approach to balance renewable energy goals with heritage preservation.

2.2. Vulnerability model

The vulnerability model is aggregated from existing heritage protection regimes, and multiple visual exposure indicators are aggregated into an overall visual exposure index. This model builds on the premise that more restrictive protection regimes and their overlaps indicate a heightened vulnerability of heritage sites (Florio et al., 2016, 2018; Munari et al., 2019).

The cultural heritage protection regimes are sourced from the Ministry of Culture's records (eVRD). They include different levels of protection based on expert studies and legal proclamations, which outline general protection and management guidelines and prescribe the preservation of identified protected values. Furthermore, spatial planning documents must consider preserving heritage features defined in the heritage protection areas, including designated areas of influence (Ministry of Culture, 2011).

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The overall visual exposure index is derived from three different visibility indicators:

a) **Visibility from the vicinity of the heritage** settlement, which indicates how a building contributes to the settlement's silhouette. A more prominently visible individual roof indicates greater significance for the settlement's silhouette. This visibility is calculated by creating a boundary of points around the settlement and calculating the visual exposure of individual roofs from these points.

b) **Visibility from important observation points:** this indicates the importance of the roof for the most characteristic views. This visibility is calculated by identifying significant observation points and calculating the visual exposure of individual roofs from them.

c) **Visibility from public space within the heritage settlement:** this indicates the contribution of a building's roof to the overall spatial experience within the heritage settlement. The more often an individual roof is visible from public space, the more important it is for the pedestrian experience. This visibility is calculated by creating equally spaced points along the centrelines of all public roads and paths in the settlement itself and calculating the visual exposure of individual roofs from them.

The overall visual exposure index shows the extent of buildings' visual exposure. Therefore, structures with higher visibility need to adhere to more stringent criteria for integrating solar systems, to ensure harmonious safeguarding of the heritage settlement's aesthetic and character.

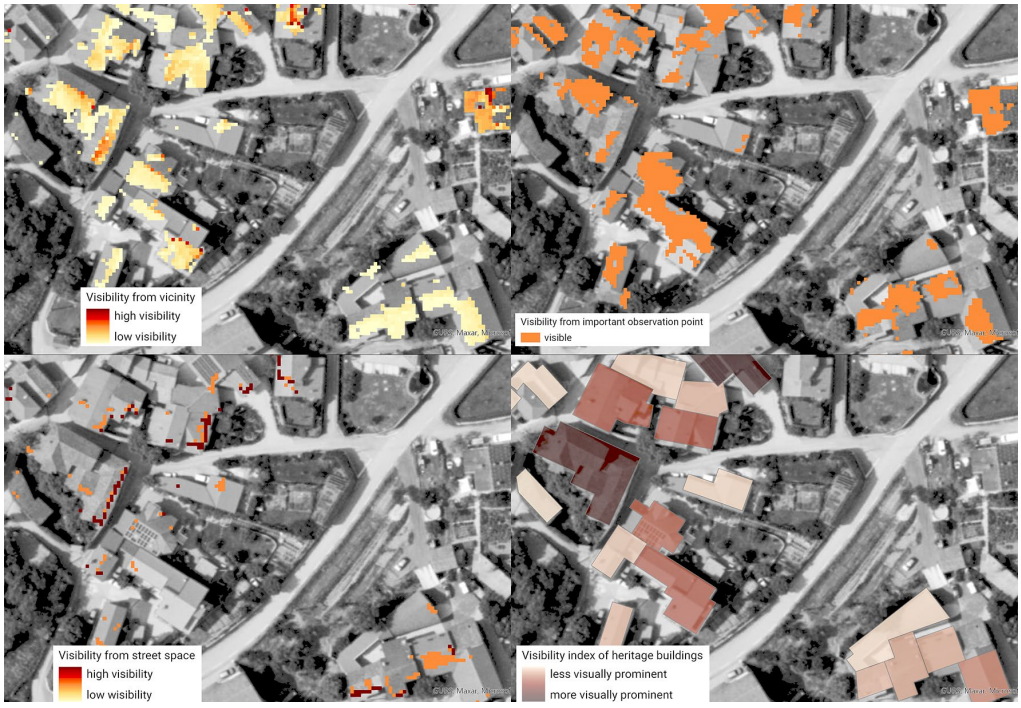


Fig. 2 - *Visibility Models; Lože, Municipality of Vipava* (Bevk, 2025).

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2.3. Solar Cadastre

The solar cadastre functions as an interactive visualisation platform, conveying essential information about solar potential and associated vulnerabilities in the context of cultural heritage. It gives detailed information on the theoretical potential for PV on buildings (power and annual production forecast), energy self-sufficiency level, protection regimes for cultural heritage (obtained publicly available data; Ministry of Culture), visual exposure analysis, including visibility from the vicinity of the heritage settlement, visibility from important observation points, visibility from public space in the heritage settlement, overall visual exposure index; overall vulnerability (visual exposure and protection regimes).

The cadastre has multiple use-cases and primarily serves as a decision-support tool, providing early information on feasibility of energy measures on heritage buildings and information on possible improvements of PV installations. For potential investors, it offers information about the potential conflicts with conservation requirements – the higher the assessed vulnerability of a heritage unit, the greater constraints for PV installation. Solar potential, in this case, helps investors to assess if the additional financial costs of such a system are justifiable. For conservators, the cadastre provides similar information, and allows them to quickly assess which (visual) aspects are more important and to give more informed recommendations to investors on permit documentation requirements. The detailed visual model can help identify less visually prominent roofs, more suitable for PV installation. Finally, the scenarios created based on the models give the decision-makers information about the possible contribution of heritage sites to renewable energy transition and thus provide inputs for creating future policies on heritage conservation to balance the protection of values and energy benefits.

2.4. Scenario development

To assess the feasibility and impact of solar panel installation on cultural heritage buildings, we propose a conceptual framework based on three distinct scenarios. These scenarios explore how different levels of regulatory restrictiveness influence the potential for integrating photovoltaic (PV) systems while considering the role of energy efficiency improvements in enabling or limiting PV deployment. Each scenario reflects a different level of regulatory flexibility, shaping the extent to which heritage buildings can undergo energy refurbishment and solar energy integration.

2.4.1. Scenario 1: Business as Usual (BAU)

This scenario assumes that current trends in energy renovation and solar panel installation in heritage buildings continue without major changes. Decisions remain case specific (by the competent regional offices of the Slovenian Institute for the Protection of Cultural Heritage). Publicly available subsidy databases reveal that, despite existing restrictions, some energy efficiency measures are already being implemented in heritage-protected buildings or areas, including window replacement, external wall insulation, and roof insulation.

However, solar panel installation on heritage buildings remains highly limited, as existing restrictions often prevent visible modifications to rooftops or facades. In cases where PV systems are installed, they are typically small-scale and integrated in a minimally invasive way. This scenario serves as a baseline for evaluating:

a) the current extent of energy refurbishment in heritage areas,

b) the practical limitations of integrating solar energy,

c) the gap between theoretical potential and real-world implementation due to regulatory barriers.

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By maintaining the status quo, this scenario highlights the slow adoption rate of solar technologies in heritage sites and the continued dependence on conventional energy sources in these areas.

2.4.2. Scenario 2: Balanced Intervention

This scenario represents a moderate regulatory approach, allowing for a controlled expansion of both energy efficiency measures and solar panel installations in heritage areas while still maintaining conservation priorities. In this scenario, regulations are adapted to permit carefully selected interventions under strict guidelines, ensuring that:

a) solar panels can be installed if positioned in less visible locations (e.g., inner courtyards, flat or hidden roof surfaces),

b) energy efficiency measures (such as insulation and window replacement) are allowed if they respect traditional materials and aesthetics,

c) building-integrated photovoltaics (BIPV) are promoted, integrating solar technology seamlessly into architectural heritage.

Since building energy efficiency directly affects PV system feasibility, this scenario recognises that improving insulation and reducing energy demand can enable smaller, more feasible PV installations while minimising their visual impact.

This approach allows for a more flexible yet controlled adoption of solar energy solutions, balancing heritage conservation with climate and energy objectives.

2.4.3. Scenario 3: Strict Conservation Approach

This scenario enforces the most restrictive regulatory framework, prohibiting any energy efficiency renovations or solar panel installations on cultural heritage buildings and in areas.

The rationale is to preserve the historical authenticity and architectural integrity of cultural heritage buildings without any modifications that could compromise their historical value. However, this also means that:

a) no insulation improvements or window replacements would be permitted, maintaining high energy demand in these buildings;

b) solar panels would not be allowed, leading to zero renewable energy generation in heritage areas;

c) the national energy savings potential from heritage buildings would be entirely lost, as these buildings would remain dependent on conventional energy sources.

This scenario highlights the trade-offs between heritage conservation and national climate action goals. By restricting all interventions, it becomes possible to quantify the potential energy savings that are permanently lost and assess the impact of these losses on broader sustainability targets.

3. Discussion

By defining these three conceptual scenarios, this framework provides a structured approach for evaluating the potential trade-offs in solar panel integration and energy efficiency measures within heritage sites. This approach provides a foundation for:

- Quantifying how regulatory restrictions affect the adoption of solar technologies.
- Assessing energy savings potential that could be achieved under different policy scenarios.
- Providing policymakers with a structured basis for decision-making in balancing conservation and renewable energy objectives.

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While this paper does not yet present quantitative results, future research will build on this scenario framework to estimate:

a) The potential for solar energy production in heritage sites.

b) The contribution of these areas to national climate targets.

c) The long-term policy implications of different regulatory approaches.

4. Conclusions

The solar cadastre, as a decision-support framework, aims to assist heritage conservators, urban planners, and policymakers in making informed decisions that enable both sustainable energy solutions and the preservation of cultural heritage values in a balanced way.

For conservators, a cadastre identifies which visual aspects are essential to be preserved and helps in providing guidelines to investors on necessary measures for integration.

It helps investors to assess whether the additional financial costs of such system integration are justifiable.

Finally, scenarios allow decision-makers to assess and understand the potential contribution of heritage sites to the renewable energy transition, guiding the development of policies that harmonise renewable energy solutions and heritage conservation.

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The Historic City of Doha in Qatar; Tourism as a Catalyst for a Sustainable Urban Regeneration

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Topic: T3.2. Intervention and regeneration projects

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Abstract

Heritage and tourism have become during the last two decades dynamic areas of development in the world. The idea of heritage is crucial to the critical decision-making process as to how irreplaceable resources are to be utilized by people of the present or conserved for future generations. In view of the importance of 'heritage' to the development of a tourist destination the emphasis on developing appropriate adaptive reuse strategies cannot be overemphasized. In October 1999, the 12th general assembly of the ICOMOS in Mexico stated, that in the context of sustainable development, two interrelated issues need urgent attention, cultural tourism and historic towns and cities. These two issues underscore the fact that historic resources are non-renewable, belonging to all of humanity. Without adequate adaptive reuse actions to ensure a sustainable future for these historic resources, may lead to their complete vanishing. According to the World Tourism Organization, natural and cultural heritage resources are and will remain motivating factors for travel in the near future. According to the experts, people choose travel destinations where they can learn about traditional and distinct cultures in their historic context. This paper focuses on the role of heritage tourism and its implications for urban regeneration in the context of Old Doha. Therefore, in order to use heritage wisely, it will be necessary to position heritage as an essential element of sustainability and resilience in a global environment, giving particular attention to heritage tourism. The research methodology is based on the case study approach. The Souk Waqif urban regeneration project in old Doha will be explored. A thorough onsite investigation will be carried out though observation and formal and informal discussions with the local and global tourists. The findings of this research is to propose an appropriate strategy for cultural heritage tourism in Doha and Qatar.

Keywords: *urban regeneration; resilience; cultural heritage tourism; identity; sustainability*

1. Introduction

Historic urban centres are major economic resources and irreplaceable capital assets. Tourism is considered a major economic generator through earnings of foreign exchange, local employment and government taxation. Countries use tourism in multiple disciplines of educational, commercial, natural and most importantly cultural as the most sought out destination for travellers. It was believed that tourism is a non-consuming industry where visitors gaze places of interest and minimum changes are done to polish the counter effect. However, reality of this industry has proven the opposite, with the growth of tourism activities, social patterns, resources and quality of local identity and urban stability has been disrupted.

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Tourist industries are now well aware of the significant role they play in ensuring a balance between demand and local integrity of tourism destinations. Additionally, in relation to heritage tourism specifically, a high level of coordination is needed between the local planning authorities, archaeologists and tourism stakeholders. It is important to highlight the different strategies and agendas to avoid conflicting results and keeping the local identity and community wellbeing at the forefront (Rodwell, 2002).

Through place marketing, sense of place has become a valuable commodity and cultural heritage has become a potential economic activity. Striving to be competitive within the globalizing economy, many places have tried to increase their distinctiveness and character. In so doing, people created cosmopolitan cultural facilities, shopping festivals, sport facilities, media and conference centres. There are many approaches for the exploitation of culture inside historic cities; these may include funding for facilities of the arts, investment in public spaces, recreation and refurbishment of waterfronts and the regeneration of historic districts.

Globalization exposure and urban development have put cultural heritage areas under the spotlight in both positive and negative contexts. The change in production and consumption characteristics shifted built environments and changed local cultures slowly transforming many local heritage sites to tourist attractions. However, in some cases the intangible values they possess have been undermined, where development planning over rides the conservation of local values. Today, cultural heritage tourism is a rapid growing sector that offers new destinations yet to be discovered globally. With heavy tourist consumption and demand for leisure, hotels, restaurants and other supportive services sprang around these hot spots. Therefore, planning management while considering cultural and community agendas and the conservation responsibility these sites require, has become a major concern to cultural heritage tourism.

In order to accomplish positive economical tourist activities whilst conserving the unique cultural heritage, socio-cultural needs and values these places provide both locally and universally, planners can play a significant role in sustaining heritage hotspots and local cultures. The three focus elements, cultural heritage, tourism and sustainability in planning decisions should all be equally considered and may be related concepts are discussed. Variables for consideration are explored as a means of examining the guiding principles that influence cultural heritage tourism where the author uses a qualitative approach to discuss it from a sustainability perspective. To achieve this, the approach consists of highlighting major points such as definition, significance, categories, challenges and urban context of cultural heritage and tourism.

In many historic cities of the Gulf, numerous irreplaceable historic centres and buildings are being compromised and left to die because local authorities failed to give them enough economic consideration. In Qatar, for instance, Al Zubarah fort, which was listed on the world heritage, list since 2013, has not yet been reused. Since these heritage resources do not generate any income through tourism or any other activities, they will create an additional burden for the local authorities to maintain them. This might consequently lead to future disinterest in conserving them and may result in their further neglect, decay leading to vanishing (Boussaa, 2014, 2015, 2018).

2. Cultural heritage tourism: concept and definition

The United Nations as the legacy of “tangible” artefacts defines cultural heritage and physical structures whether historic towns or single buildings that are valued as a vital physical piece of evidence from the past and “intangible” traditions, knowledge and skills inherited from past generations. The latter hold a significant value in the representation of a specific culture and should be conserved for future generations to

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benefit from. Cultural heritage sites are significant to archaeologists, planners, scientists from multidisciplinary points of interest. They represent a vast area of human history layers, knowledge of early settlements and are considered a vital part of cultural stability as well as a measuring tool for development.

In tourism, while so much is spent on transportation, accommodation and dining, relatively little is spent on conserving the cultural heritage resources on which tourism mainly rely. Economic benefits include creation of jobs and the direct and indirect benefits of visitors' expenditure. In contrast, when tourism is poorly managed it can involve negative impacts on the host communities, such as gentrification and the neglect of local traditions and patterns of life.

With increased knowledge worldwide, many heritage places started to face some sort of tourism activity, which poses a risk of heritage areas deteriorating due to increased tourist activities in or around them. "Heritage tourism" relies predominantly on the physical built elements of past culture as well as the intangible skills and performing arts of the past, which eventually require a physical, secure well managed place to be presented. shown in this template.

3. Cultural heritage tourism: management and authenticity

Management of change is the integration of heritage management into strategic planning. Intangible values cannot be dealt with technically but need strategic assessment, consequently heritage becomes a matter of political consideration and decision-making. Conservation for cultural tourism is not a freezing of time; rather it is the conservation of areas and monuments by linking history of a valuable location to its people and culture.

emphasis lies on the possibility of a transformation, not as a falsification of the past, but as a remake where accessibility of the past and history are maintained. In one sense, this approach is highlighting the past because the contrast makes it the focus. An unsuccessful tourism development approach could lead to diminishing unique cultural heritage assets and death of historic cores. Modern development is more monotonous and homogeneous compared to traditional quarters, as is the scale of modern development that may overwhelm the original compactness of traditional spots thus eliminating the original sense of place and thus possibly discouraging tourism. New building design needs to consider the original identity of the area as well as consider the durability of old street fabric to withstand the increased pressure on them due to growing numbers of visitors as well as transport movement.

It is crucial for the stakeholders to understand conservation from a broader view, the relationship between continuity of the architectural facade and the congruent relationship of old and new. Without this understanding, many regeneration projects have failed to include urban heritage as part of the scheme and have usually resulted in the demolition of old buildings and their replacement by new buildings. The new development creates a new identity to the city and thus loses the significant physical fabric of the city (Boussaa et al, 2021).

Historic areas disrupted by the invasion of office tower blocks and large blocks of shopping complexes altering the existing atmosphere of the area and modern developments such as hotels and service apartments were introduced in the area redevelopment. This could lead to gentrification, thus affecting the cultural stability of the population and attracting less authentic market development. Gentrification is also one of the common cases in fast decision making for cultural tourism, when decayed areas are reinvented without sensitivity to the deep connection its original occupants had to offer in terms of authentic cultural experience. This can develop tourism city centers that lack the social stability in relation to the historical monuments they offer.

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Cultural heritage tourism is a vital part of the tourism industry and is highly dependent on the movement pattern of people in search of diverse authentic experiences; the commitment needs to be towards balancing the needs of three categories: (1) resource, (2) resident, (3) visitor in order to sustain them based on benefits from cultural tourism industry. “Authentic resource is defined by an entire "sense of place"-inclusive of the gateway, the built environment, the landscape, the cuisine and cultural traditions, and the souvenirs to purchase. Therefore, the industry is challenged by rapid development and realization of the true values and traditional lifestyles and industries in the planning and management approach essential for the complex development of heritage-oriented tourism. Planners are held accountable to provide the best argument that favors maximum authentic conservation while claiming clashing benefits of political or stakeholders involved in the growth of tourism industry.

Cultural heritage tourism development requires that both heritage and development speak the same language. Based on that, decision-making is far more than just the site its self, it relies on effective coordination between various political stakeholders, private organizations representatives and NGO’s. Sustainable management and development tourism sectors depend on the collaboration and communication between these multiple players. Mediating organizations work to negotiate appropriate solutions through educational activities, programs related to development policies aiming to raise awareness between tourism industries and multiple actors ranging from transport to hospitality, entertainment and legal networks to minimize negative outcomes about cultural differences (Loulanski, 2006).

Developing tourism products based on historical resources is now a strategic target for many cities in the Gulf, such as Dubai, Doha and Jeddah, which are diversifying their economy away from reliance on oil. One important aspect of the influence of heritage industry on spaces, places, and landscapes is the tendency for historic districts and settings to be re-created, imitated, simulated, and even reinvented according to commercial considerations rather than principles of conservation. This trend may lead many historic areas to position themselves on the market place by changing their historic environment and townscape for the sake of attracting more tourists (Madandola and Boussaa. 2023, Boussaa & Madandola, 2024).

Historic cities in the Gulf endure intensified urban challenges because of a rapid increase in population numbers, urban decisions and economic status. This puts pressure on the government to provide spaces and develop new townships for the population. Newly introduced enterprises mainly focused on central areas of the city where most heritage locations are found as city centres are commonly the oldest part of a city where in most cases they failed to generate harmony with the historic urban fabric. Rapid development schemes included demolishing the old and building the new. However, this has raised concerns of developers versus society perceptions of a place, as well as the level of awareness afforded its original occupants cultural values and connection to heritage physical places (Boussaa et al, 2023).

4. Doha: historical overview

Doha, Qatar's capital and largest urban centre, is home to more than 80% of the country's inhabitants, who reside within either the city or its neighbouring suburbs. Serving as the nation's administrative and economic hub, Doha had a population of 3,069,631individuals as of October 2024 (QSA, 2024). Doha experienced three significant bombardments, leading to the loss of many of its historical structures and districts. Initially, the British ship Vestal attacked the city in 1821. A second bombing occurred in 1841, followed by the destruction of the village in 1847 after a conflict with Bahrain's Al Khalifa near Fuweirat.

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In 1916, Doha was recognized as the capital of the British protectorate in Qatar. The early 20th century saw Qatar's economy heavily reliant on fishing and pearling, with Doha boasting approximately 350 pearling vessels. However, the introduction of Japanese cultured pearls in the 1930s led to a severe economic downturn, plunging Qatar and Doha into poverty.

Before the discovery of oil, Doha was confined to one area called “Al Bidaa”. One hundred years later Al Bidaa expanded to include 9 districts (furjan): Al Hitmi, Al Slata, Al Jasra, Mohamed Bin Jassim, Al Ghanem, Al Asmakh and Al Najada and Abdul Aziz. The total urban area reached 1.5 Km2 and 3 km along the coast, with only a few hundred meters inland. The population reached 20,000 persons, living in irregular and unpaved streets in one to two stories districts until 1950. Although oil was discovered in 1939, its exploitation was halted from 1942 to 1947 due to World War II and the Bahrain embargo. The year 1949 marked a turning point for Qatar, as oil exports and offshore rights payments commenced. Under British guidance, the 1950s witnessed the gradual development of government structures and public services in the country.

In the 1960s, Qatar established new administrative hubs to handle its substantial income. The Government House, which opened in 1969, is now recognized as one of Qatar's most iconic structures. After the British departed, Qatar proclaimed its sovereignty on September 3, 1971. As the capital of the newly independent nation, Doha transformed into a massive construction zone, drawing numerous foreign specialists and laborers who found employment in the building industry.

In the years that followed, Doha experienced an unprecedented boom in property development, global finance, sports, and tourism sectors. This growth is evident in the numerous contemporary skyscrapers, shopping centres, luxury accommodations, and government buildings spread across the city. Additionally, massive projects like the Pearl, an all-encompassing commercial, residential, tourist, and recreational complex situated beyond West Bay, further illustrate this expansion. However, the rapid urban development of Doha and its surrounding metropolitan areas has often come at the cost of Gulf cultural heritage. The extensive groundwork required for these developments has, on many occasions, resulted in the destruction of historically significant sites and structures.



Fig. 1 – *Satellite image of Doha and its historic centers* (Google Earth, 2025).

5. Souk Waqif rehabilitation project

Situated near the Corniche, off Grand Hamad Street, Souk Waqif highlights traditional architecture, crafts, and folk art. This area, which formerly served as a weekend marketplace for Bedouins, has its roots in Doha's early days when it was still a small village. Back then, residents would gather along the banks of the Msheireb (wadi) river to engage in trade.

The term "*Waqif*" in Arabic translates to "standing," referring to the merchants and locals who were forced to conduct their business while standing due to the flooding from Wadi Msheirib. This water would flow on both sides, passing through Al Khrais area of the souk before reaching the corniche.

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Souk Waqif is an expansive network of narrow streets encompassing various specialized areas. These sections offer a diverse range of products, including fragrances, traditional Qatari attire, travel bags, hardware, gardening supplies, camping gear, kitchen utensils, seasonings, local confections, grains, and dried goods. This popular marketplace is famous for its array of conventional clothing, spices, artisanal crafts, and mementos. Additionally, it houses a multitude restaurants featuring international cuisine. Despite its origins dating back to the 1850s, the market has undergone recent renovations to restore its authentic charm. Today, it stands as one of Doha's premier attractions for visitors.

In 2004, the Diwan Amiri's Private Engineering Office initiated a restoration project for Souk Waqif. To start the work, the government acquired privately owned buildings within the souk from their respective owners. A thorough assessment revealed that approximately two-thirds of the structures still maintained their original characteristics, while the remaining one-third had been torn down and substituted with contemporary constructions.

The restoration initiative was grounded in a comprehensive analysis of the market's history and architecture, with the goal of halting the decay of its historic buildings and eliminating recent, unsuitable modifications and extensions. The Private Engineering Office (PEO), tasked with renovating Souk Waqif, sought to retrieve the site's historical essence. To accomplish this goal, recently constructed buildings that did not fit the local aesthetic were torn down. Traditional roofing materials, such as danjal and bamboo with a mixture of clay and straw for insulation, replaced the modern metal sheets. Additionally, time-honoured techniques for protecting structures against extreme heat were reintroduced.



Fig. 2 – *Site plan of Souk Waqif (Courtesy, Private Engineering Office).*

In recent times, Souk Waqif has emerged as a significant center for artistic endeavours, featuring numerous galleries and workshops. The area hosts various art exhibitions and local musical performances during festive periods and special events. Alongside its array of shops, restaurants and hotels, the Souk Waqif Art Center is situated within the dining district. This facility incorporates a diverse selection of small art boutiques and multiple exhibition spaces, all arranged around a long, narrow streets (Sikkas).

Following years of deterioration and abandonment, Souk Waqif has been revitalized as a thriving cultural landmark in central Doha. Heritage-based tourism is a valued pursuit for both travellers and local communities. While this interaction is crucial, it is essential to preserve the unique characteristics and identity of each urban centre and nation. Importantly, the development of heritage tourism should prioritize the local population's interests rather than solely catering to international visitors. This approach should enhance residents' appreciation of their urban heritage, fostering awareness about its preservation, encouraging them to inhabit these historic areas, and ultimately enabling them to transmit this legacy to the present and future generations.

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Fig. 3 – *Aerial view of Souk Waqif; a major tourist attraction in Doha* (Author, 2015).

6. Conclusions

When opting for heritage tourism, a cautious approach is needed regarding a high respect to the local traditions and customs of the host community. Therefore, a strict management of heritage tourism should be established in order to maintain a balance between social and economic needs in old centres. Over-emphasis on the tourist function creates pressures for new services and associated development, sometimes to the detriment of the local population, and can lead to damage significant cultural assets. It is therefore important for the tourism capacity to be carefully managed and controlled in a sustainable manner.

Setting objectives for sustainable tourism is about establishing a sensitive balance between socio-cultural and economic interests, between conservation and development. Restoration of individual monuments without conserving or rehabilitating their historical contexts and economic forces is meaningless. It will eventually deprive the historic city of its "inhabitants" and will result as an open air and lifeless museum. One way to avoid this inclination is to see conservation as part of a much wider development process. The idea that effective action to promote the management and rehabilitation of the surviving historic centres requires the adoption of a holistic policy:

- Heritage tourism as a catalyst for urban regeneration;
- Improvement of neighbourhood amenities: action on housing, public areas and environmental amenities (façades, streets, squares, markets and the wider townscape) which contribute to the feeling of belonging;
- Strengthening of the notion of diversity: upgrading the various central functions (shops, housing, neighbourhood and district amenities) - a balanced mix of functions helps to maintain vitality and harmony;
- Action to promote economic development in old centres through sustainable tourism;

Tourism with environmental concerns is also a key feature of sustainable development policy in a historic area. This implies that development in a historic core should be limited, but not to the point of stifling its economic vitality. Most heritage players recognize that such places cannot revitalize themselves without some kind of intervention. These are meant to regulate and manage the physical and social fabric upon which their local identity and economic success are predicated.

The situation of historic centres in the Gulf is particularly alarming. The historic district is both the content and container, as it were, of heritage. Cultural heritage tourism is an important and desired activity for both visitors and hosts. The challenge to cultural resource managers is to mitigate the amount of damage that visitors can cause to sites. Based on the case of Doha, the following points emerge as principles for an appropriate sustainable tourism in historic areas:

- Comprehensive tourist development plans are essential as the pre-condition for developing any tourist potential;
- It should be a fundamental principle of any tourist development plan that both conservation, in its widest sense, and tourism benefit from it;
- The best long-term interests of people living and working in any host community should be

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the primary determining factor in selecting options for tourist development;

- Educational programs should insist and invite tourists to respect and understand the local way of life, culture, history and religion;
- Adequate management should define the level of acceptable tourism development and provide controls to maintain that level;
- Develop adequate protective measures to keep visitors away from sensitive parts of the resource.

Urban regeneration strategies should envisage discouraging static preservation, which attempts to "fossilize" the past and turn our historic centres and districts into open-air museums. However, housing which is absent at the present remains a major drawback in providing a sustainable life Souk Waqif, while preserving the original identity of the quarter. There is a need to conserve and develop historic areas, to be thriving and bustling with life. To achieve this, sustainable development policies should be introduced through housing, tourism, trade and other economic activities. Cultural heritage tourism in Doha, Jeddah and Dubai is a way of fostering a major incentive for its survival and regeneration.

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The Walls of Philippe Auguste in Paris across the Centuries: General Strategy of Conservation and the Case of Jardins Saint-Paul

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Abstract
The medieval walls of Philippe Auguste in Paris, built in the late 12th century, served both as a defence and symbol of the strategic importance of Paris in medieval Europe. The research was carried out in collaboration between the University of Naples Federico II and the Ecole Nationale Supérieure d'Architecture Paris-Belleville. Three key parts may be identified: the historical evolution of the fortifications of the city of Paris, a proposal for the conservation of the remnants of the walls, and a project for the urban redevelopment of rue des Jardins Saint-Paul. The paper synthetically explains the research methodology through which the urban and topographical development of Paris were traced, the walls were constructed and how they influenced the city's growth. The proposal explores current conservation strategies and innovative approaches that aim at overcoming the major challenge of preserving the remaining sections of the walls. While balancing modern needs with the protection of historical sites, the study seeks to deepen the understanding of Philippe Auguste's walls and suggests practical solutions for their conservation and integration into Paris's modern urban landscape. The work is based on an interdisciplinary approach which combines history, archaeology, architecture, and urban planning and aims at enhancing the city's historical heritage affirming its relevance in the present day.

Keywords: *Paris; medieval walls; conservation; reuse*

1. Visible and invisible: the echoes of medieval history in today's city

Urban walls constitute a central topic in the history of European cities. Usually, they were built over the centuries as a result of progressive urban development strongly affecting the urban fabric. However, they have often constituted an obstacle to a city's growth, generally solved with more or less radical demolition practices.

Such is the case of most Italian cities: after the Unification (1860) walls were systematically destroyed (Sica, 1977; De Seta & Le Goff, 1989; Zucconi, 1989). Even the famous case of Vienna is emblematic, as the route of the fortifications was transformed into the vast avenue system of the Ring. Only in the early 20th century did the first pleas concerning the conservation of the walls and doors of ancient cities arise (Dvořák 1916).

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These simple examples testify how there is no European city that does not bear witness to this process of construction, destruction and –much later– protection and restoration. Paris is for sure a city with a layered history. It stands as a palimpsest where every era has left its mark. Among the numerous elements that have contributed to shaping the urban landscape of the French capital, the medieval walls of Philippe Auguste occupy a prominent place. These fortifications were built at the end of the 12th century (Gagneux & Prouvost, 2004) and served a defensive function. With their consistency, they reflected the strategic and political importance of the city in the medieval European context. Being an economic crossroads, Paris underwent an exponential growth in the Middle Ages. Hence it became the most populated city in Europe. Such an increase in its dimension was made possible thanks to King Philippe Auguste's (1180-1223), politics and works, including the construction of the new fortification (Bergeron, 1989).

These walls represent an important example of medieval military engineering and were the first walls of the city to be built in masonry on a large scale. For such reasons, they represented a significant improvement over the previous Parisian wooden fortifications. Due to their extension (about 5km) (Hayot, 2018), they helped to define Paris' perimeter for centuries. They determined the layout of streets, neighbourhoods, and public spaces within the walls and marked an important evolution in urbanization. Today, these walls have become invisible, as they are buried under layers of modern developments and seem to have been forgotten by the fast pace of contemporary life (Fig.1). Nevertheless, the walls of Philippe Auguste seem to have had a different influence on the city compared to the fortifications built after them: they have been the longest lasting fortifications until they have been incorporated and crystallized within the new urban fabric and transformed into a "secret monument" (De Seta & Le Goff, 1989).

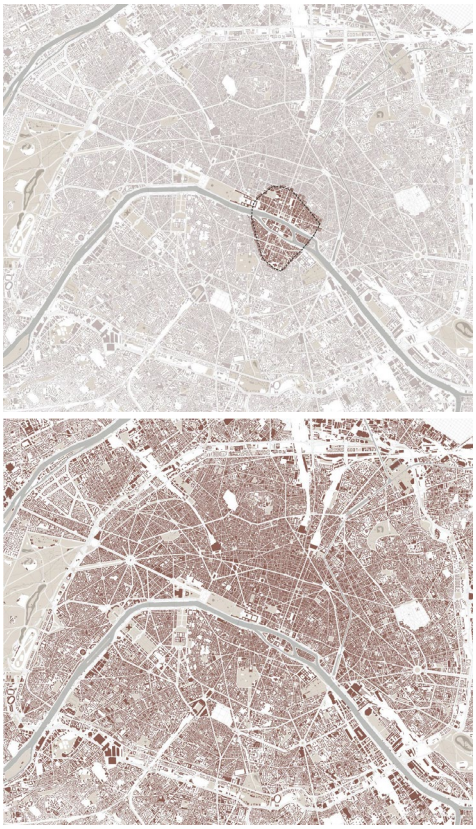


Fig. 1 – *Paris, disappearing of medieval walls* (Polverino &Ruggiero, 2024).

The research entitled "The Walls of Philippe Auguste in Paris across the centuries: general strategy of conservation and the case of Jardins Saint-Paul" was carried out starting from such premises. The study aims to bring back to prominence the medieval ruins, on one hand highlighting them through an urban plan of regeneration of the medieval walls and on the other hand through a conservation project focused on the reuse of its longest fragment.

2. An interdisciplinary approach

The approach used in this research is strongly interdisciplinary and stems from an innovative teaching experience, which involved the joint work of two European universities. More precisely, the research is part of a larger project

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coordinated by the École Nationale Supérieure d'Architecture de Paris-Belleville (ESNA PB), in which the contribution of the Master of Science in "Architecture and Heritage"' of the University of Naples Federico II was grafted. The research was part of a larger project entitled "L'enceinte de Philippe Auguste revisitée", conducted by the UMR AUSser of the ENSA Paris Belleville under a framework agreement with the CNRS. This aimed at enhancing the remains of Philippe Auguste's *enceinte* through a cultural project involving several tools: cartographic drawings, historical and typo-morphological analysis, and new digital tools, such as interactive mapping and 3D modeling of the wall with the support of augmented reality.

The main objective of the project was to facilitate the understanding of the archaeological remains' spatial organisation within the historical and current urban fabric. By interconnecting the visible (existing fabric and remaining wall sections, present-day ground level, current practices, and uses) and the invisible (ancient fabric, original *enceinte* layout, ancient ground levels, past uses) urban components, cartographic representation –both 2D and interactive– and 3D modeling have been implemented as a basis for a reconstruction of the walls using augmented reality where there are no longer visible traces of the ancient *enceinte*.



Fig. 2 – *Paris, Plan de Braun et Hogenberg* (Braun, & Hogenberg, 1572).



Fig. 3 – *Paris, Plan de Quesnel* (Quesnel, 1609).

Various research results have been produced including pedagogical exploitation, in particular within the DSA course 'Heritage and Architecture' of the ENSA Paris-Belleville and as a framework of a Master's thesis in "Architecture and Heritage", illustrated below.

3. A research-based project: an integrated methodological approach

The methodology followed for the research on the walls of Philippe Auguste in Paris is based on an interdisciplinary approach that combines historical, archaeological, and urban analysis.

3.1. Urban growth of Paris through cartography and academic literature

In order to understand the construction process of the medieval walls, the research deals with the study of the origins and the development of the Parisian urban asset. That was conducted through archival research in the main archives and libraries of Paris.

The National Archive of France and the Bibliothèque de l'Institut de France were fundamental for the consultation of documents linked to the realm of Philippe Auguste. A relevant issue of the archival research was the cartographic analysis, from which it was possible to localize precisely the path of the fortification and how it was linked with the urban fabric of Paris.

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Fig. 4 – *Reconstruction of Paris' urban evolution* (Polverino & Ruggiero, 2024).

In particular, *Plan de Braun et Hogenberg* dated 1572 represents the city in 1530 (Fig. 2), *Plan de Saint-Victor* dated 1550, and *Plan de Quesnel* dated 1609 (Fig. 3) were crucial to have a wider vision of the evolution of the city and its fortifications, and to understand the changes of the walls of Philippe Auguste during the centuries. The cartographic research was not limited to the study of the medieval walls but was also extended to all succeeding fortifications of the city of Paris. Such an extension of interest was necessary to understand how the walls have influenced the urban development of the capital up to modern times (Fig. 4) and how they disappeared over time, devoured by the uncontrolled growth of the city. Furthermore, the research includes a detailed study of the academic literature and specialized texts on the walls of Philippe Auguste. These were fundamental for the reconstruction of the history and structure of the rampart.

Literary texts were analysed mainly in the Bibliothèque Nationale de Paris and in the library of the ENSA PB. Main historical and archaeological texts provided an analysis of written sources, allowing for the contextualization of information and comparison with the data collected from the archives. In particular, the works of French historians and archaeologists, which dealt with the construction of the walls, their developments over time, and subsequent restorations, were essential to outline the evolution of the fortifications, and the numerous interventions they have undergone in the centuries following their construction.

3.2. Reconstruction of the *enceinte* from archives to the site

Along with the study of the texts, an on-site analysis was carried out with a direct survey of the visible ruins. Thanks to three-dimensional survey techniques, the current state of the ruins was documented and compared with historic descriptions. The technique used was photogrammetry, which is based on a sequence of pictures taken on-site, that are merged on the Metashape software to generate a three-dimensional model of the ruins. Starting from the model, graphic reconstructions may be exported.

The analysis involved on-site visits of the medieval wall traces, which are majorly concentrated in the Latin Quarter, the Marais, and in the area of Jardins Saint-Paul. Such visits were guided by the head of the *Fondation Philippe Auguste*, Jean-François Janin, who gave the possibility to have access to mostly hidden towers and fragments of the walls. Through the site visits, significant characteristics of the masonry structures have emerged, most importantly signs of restoration works on the ruins. This gave the possibility to comprehend the different phases of construction and uses of the ruins over the centuries.

3.3. The research output

All the analyses provided a complete overview of the *enceinte* and resulted in a census of the ruins that nowadays are still visible in the city: a detailed inventory of the traces of existing walls has been drawn up, taking into account structures

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still standing as well as fragments of walls embedded in modern buildings or hidden below ground level. This survey included the location and photographic documentation of each section, the indication of the state of conservation, and the recognition of any problems related to their protection. A description of the remains' status of conservation is provided too: possible causes of decay patterns and subsequent changes and alterations are pointed out. Lastly, there is an analysis of the private and public accessibility which examines the ease of access to the site, also considering persons with disabilities' perspective. Through the comparison of the information collected from on-site surveys, historic sources, and archaeological data provided by the *Département d'Histoire de l'Architecture et d'Archéologie de la Ville de Paris* (DHAAP), a detailed map of the ruins was traced. This gives a complete panoramic of the medieval heritage of Paris and suggests potential areas for future conservation actions. Thanks to the census containing information on the state of conservation and the accessibility to the site, a regeneration project of the medieval wall was designed. This constitutes one of the principal outcomes of the research project.

4. From knowledge to design process

4.1. General strategy for urban conservation

The strategy envisioned draws a new route that gives the possibility to read the city differently. This is as part of a general strategy of conservation which gives the opportunity to enhance the preserved fragments and highlight the synergy between past and present that has formed the urban fabric of Paris.

The general strategy is focused, firstly, on the idea of highlighting the trace of the walls in the centre of the city. In this regard, its passage in the urban plot is underlined with the change in the urban flooring. As a result, a line with a different material is traced only where the walls were placed. This will give the consciousness of the frontier between the inside and outside of the fortified city. The starting point of the path is placed in the area of Jardins Saint-Paul, where the longest fragment of curtain framed by two towers is kept. To facilitate and promote slow mobility, it will be mainly cyclo-pedestrian. The cycling path will follow as much as possible the trace of the fortification, but it will be based on the direction of the current bike lanes (Fig. 5). The path will go through open areas. Moreover, whenever there had been a tower in the original structure of the fortification, a wooden pavilion will be constructed in the void it has left and its design will resemble demolished towers. Such reconstructions will be recognizable being made with wood, a clearly distinguishable material far from the original stone towers.

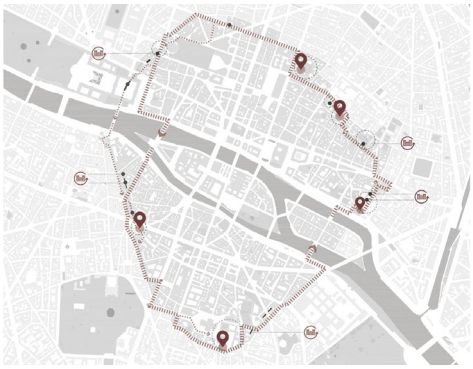


Fig. 5 – Paris, general strategy of walls conservation (Polverino & Ruggiero, 2024).



Fig. 6 – Paris, view of Jardins Saint-Paul (Laurent, 2012).

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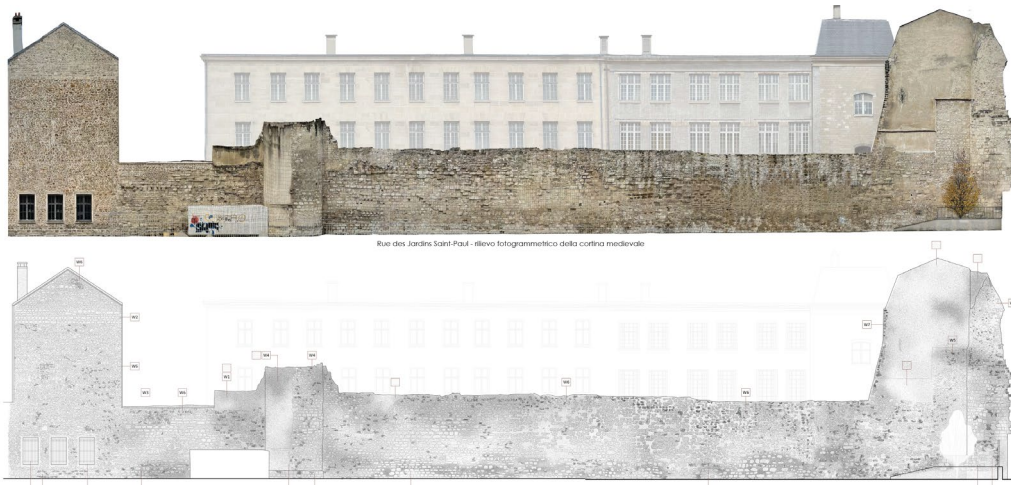


Fig. 7 – *Paris, the walls in Jardins Saint-Paul, materic survey* (Polverino & Ruggiero, 2024).

In addition, these new volumes will be reversible as they will host informative temporary pavilions where visitors can attend projections and interactive expositions. Contents will be focused on the medieval history of the city and specifically on the walls of Philippe Auguste.

All these urban spaces placed along the path of the fortification provide for the same typology of interventions that consist in the restoration of all the fragments which show decay phenomena caused by a lack of maintenance and by the exposition to the atmospheric agents. All these actions are aimed at unifying all the fragments still present in the urban fabric of the city in a way that now seems casual but that in the past created a unique ordered system where all the ruins had their precise position.

4.2. Reuse of the urban voids through the conservation of the ruins

The project for the area of Jardins Saint-Paul (Fig. 6) begins with the restoration of the wall fragment and the two towers that frame it. The methods employed adhere to current restoration principles, particularly conservative for the architectural surfaces. Based on the analysis of degradation, the restoration work planned for this wall fragment consists of pre-consolidation, cleaning, consolidation, and protection of the Lutetian limestone and lime mortars that compose the rampart. All along the length of the wall, a Soft Capping intervention on the coverage will preserve the state of its future conservation. This intervention provides for the inclusion of a box with a humpback profile consisting of a layer of grass and soft herbaceous plants (Fig. 7).

4.3. Jardins Saint-Paul: new archaeological route

Part of the conservation project for the medieval wall fragment includes the reorganization of the site. The aim is to preserve the area in its current essence, avoiding the introduction of new buildings that would recreate a situation that history has sought to eliminate. Thus, the objective is to maintain the urban void, while restoring its historical boundaries and offering this space back to the community. As a starting point for the broader conservation strategy, the project addresses particularly the relationship between the modern additions and the ancient fragments. The elongated rectangle forming the empty lot is bordered on the west side by the medieval wall which constitutes the focal point of the project.

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The east side, instead, is currently demarcated by a low wall topped with a railing. These two boundaries serve as tangible traces of the Jardins' historical evolution: the archaeological fragment recalls its historical role as an open space outside the walls, while the eastern boundary reflects the historical condition of the area as a congested and closed environment.

Hence, the new design of the area is generated by the interaction between the space and its context, the intersection of these two boundaries, and the geometry characterizing the buildings that once occupied the site. A grid emerges from these historical geometries, dictating the layout of the spaces within the area (Fig. 8). The entrance to the new park is located at the southern end of the lot, on rue de l'Avé Marie.

To the left, the exhibition path begins within a wooden tower positioned in the original location of a now-destroyed tower, marking its historical presence. Inside the tower, an interactive exhibit allows visitors to explore the history of the city's medieval walls. Continuing along the wall, visitors can descend to a lower level, two meters below the current ground level, revealing the original medieval basement and offering a view of the foundations of the ruins. Adjacent to the remaining towers, two large, stepped terraces provide a vantage point for viewing Philippe's walls and serve as spaces for sitting and experiencing the site (Fig. 9).

On the current ground level, the other tangible element is the new wall, which re-establishes the historical boundary of the lot. This line creates a permeable boundary, maintaining a continuous relationship with the exterior through the thoughtful arrangement of solid and void elements that define thresholds, openings, and viewpoints between the interior and the exterior. At the same time, it creates opportunities for exhibition within its structure (Fig. 10). Through light and precise interventions based on the generative grid, a flexible space is defined within these boundaries, serving the city's needs.



Fig. 8 – *Project masterplan* (Polverino & Ruggiero, 2024)

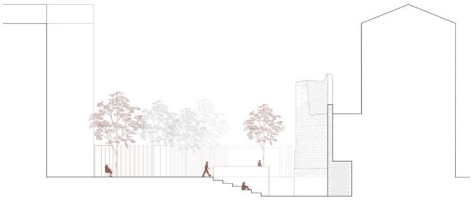


Fig. 9 – *Section on the stepped terrace* (Polverino & Ruggiero, 2024)



Fig. 10 – *Project view* (Polverino & Ruggiero, 2024)

5. Conclusions and results

The walls of Philippe Auguste are among the most studied fortifications in Paris and are crucial indeed to understand the city's historical and urban development. Built in the Middle Ages with innovative techniques, they were the first

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fortifications designed with specific military features. The research and the project emphasize that these walls are not mere relics but vital components of Paris's cultural identity, shaping its modern urban structure. Through in-depth historical analyses, the study shows how to reconstruct their materiality, their use, and their integration into today's city. A conservation strategy is proposed to protect the remnants and make them accessible, including a new city path to tell their story. The redevelopment project of rue des Jardins Saint-Paul illustrates how surrounding spaces can be adapted, restoring wall remnants, and creating public spaces that encourage interaction and connection to other historical sites. In conclusion, the walls of Philippe Auguste stand as living vestiges of Parisian heritage, imbued with a dynamic presence that calls for both preservation and reinvention. Far from being mere relics of the past, they weave a subtle yet powerful dialogue between history and modernity, inviting their seamless integration into the contemporary urban fabric. As silent witnesses to the city's transformations, they enrich the collective memory while offering new avenues of exploration, captivating both residents and visitors in an ever-evolving narrative of Paris.

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Guidelines to Support the Sustainable Conservation of Cultural Heritage Buildings in Slovenia

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Abstract

Cultural heritage holds a constitutional status in Slovenia, immovable cultural heritage being its vital part. The most extensive categories of the Register of cultural heritage are buildings and settlements. In accordance with the principles of revitalizing and adapting heritage buildings to contemporary requirements with the aim of their sustainable conservation, energy renovation is also included in the integral approach. Such approach must adhere to cultural protection conditions and include measures that do not threaten the protected values. Energy renovation should be coordinated with other technical measures to meet the essential requirements for buildings. To support these efforts, the national Guidelines for energy renovation of cultural heritage buildings were introduced in 2016 as a manual that supports the conservators' decisions and informs building owners and renovation contractors about the specifics of the approach to designing and implementing measures. At the end of 2023, the national research project V5-2358 (DEDIS) began, focused to provide an update of the guidelines. The additions will include refreshed chapters on the relevant national and European legislation, characteristics and regulation of cultural heritage protection, necessary preliminary investigations of the condition of buildings, and, as the main part, technical measures of renovation and their interdependence, with a special focus on the installation and use of renewable energy sources. The guidelines will consider the experiences of successful renovation projects and the results of an extensive interaction with key stakeholders through interviews and online surveys. The paper presents the preparatory activities leading to conceptualisation of the refined purpose, goals and content of the renewed guidelines.

Keywords: *guidelines; sustainable conservation; integral approach; cultural heritage buildings*

1. Introduction

Slovenia has 30,965 units of cultural heritage listed in the national Register of cultural heritage, including 8,082 are monuments of local significance and 343 monuments of national significance (Ministrstvo za kulturo Republike Slovenije, 2025). Buildings and settlements constitute a significant part of the national cultural assets. Given that many of these

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buildings are publicly owned, they fall under the mandatory 3% annual energy renovation rate, as required by the Article 7 of the Energy Efficiency Directive, EED (Directive (EU) 2023/1791, 2023). Additionally, these buildings are addressed also in the revised Energy Performance of Buildings Directive, EPBD (Directive (EU) 2024/1275, 2024).

The status of cultural heritage in Slovenia is not solely determined by the age of buildings. Rather, it is based on various criteria, including their authors/architects, architectural and artistic value, building methods and materials used, typical of a certain historical period. Further defining characteristic also include the buildings' originality, rarity or uniqueness. The special significance of the building can also arise from other historical and even political circumstances.

Cultural heritage buildings are tangible witnesses to national history, culture, art and technology, as well as broader societal developments over longer or shorter periods of time. A special protection regime applies to them, designed to prevent interventions that would compromise their historical identity and values. However, these buildings, like all others, are preserved mainly by their continuous use. We must regularly maintain, repair and, where feasible, upgrade them. Only by doing so we can achieve their sustainability for future generations.

Energy renovation, when aligned with cultural protection requirements represents a legitimate, logical and professionally appropriate element of the integrated conservation of cultural heritage buildings. Such strategy has multifaceted environmental, social, economic and cultural benefits. Enhancing energy efficiency improves living comfort while reducing operating costs, fostering a more positive perception and engagement among owners and users. As part of a comprehensive or wider renovation, it helps to reduce the building's vulnerability and improves its resilience, enabling it to withstand the challenges of changing circumstances in nature and society.

This is a coherent set of measures designed to address existing problems and circumstances, and to achieve favourable effects that endure over time. However, numerous challenges are inherent in this process. Buildings that have successfully defied many adversities for decades or centuries and managed to preserve at least some of their cultural and historical characteristics, can be irreversibly deprived of the values that define them as heritage in an instant by inappropriate interventions.

2. Objectives: identifying the gaps

In energy renovation projects, the technical profession deals primarily with measurable or quantitative indicators, such as energy use for building operation, CO_2 emissions and the share of renewable energy sources (RES), while the cultural protection profession primarily focuses on qualitative indicators that describe cultural and historical characteristics or protected values of the building.

Furthermore, on the one hand we have the aspect of needs and wishes of building owners and users, and principles of good management, and on the other hand, we also have the formal requirements set by common European and national laws.

Here we perceive several gaps, the filling of which is the key to an all-round successful and comprehensively managed and implemented renovation project. Technical experts generally do not have the knowledge that would enable them to accurately identify important building features that limit or eliminate certain renovation measures.

On the other hand, cultural heritage protection experts are often not familiar with technical innovations, e.g. materials, products and systems that may enable solving known problems in a way that does not threaten protected values.

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The key guide of any building renovation must be its integrity, of course within the framework of what is possible and justified. In most cases, we design a varied set of measures that, due to technical, logistical, financial and other challenges, are implemented only once during the life of the building.

Within the administrative, technical, environmental and economic framework, we want to ensure the long-term fulfilment of essential requirements, the reduction of energy use and the reduction of negative impacts on the environment, and the improvement of living and working comfort. All the above can have a significant impact on reducing maintenance and operating costs and increasing the building's market value.

Another common weak point is the availability of financial resources, i.e. the possibility of cultural heritage buildings to equally apply for co-financing sources for comprehensive energy renovation. In the past, public tenders did not differentiate between building statuses, which meant that cultural heritage buildings could not reach the entry threshold expressed by the achieved energy indicators after energy renovation or the physical extent of the required measures.

In 2016, the national Guidelines for energy renovation of cultural heritage buildings (in further text: Guidelines) (Ministrstvo za infrastrukturo Republike Slovenije & Ministrstvo za kulturo Republike Slovenije, 2016) were introduced to address these gaps.

The content is based on the following two main principles:

1. In accordance with the principles of good management, the energy renovation of a cultural heritage building must also include other reasonable measures to improve the condition of the building (e.g. static renovation, fire protection, etc.).
2. The energy renovation of a cultural heritage building must seek an appropriate balance between the preservation of protected values and the energy efficiency of buildings.

As the primary criterion of acceptability of the measures their impact on the protected values and cultural-historical characteristics of the building was determined, not the contribution to the improvement of the building's energy indicators.

A specific definition of a comprehensive energy renovation of cultural heritage buildings was presented in the Guidelines. Buildings that have recognizable building elements or are protected as cultural heritage usually cannot be comprehensively renovated without a negative impact on the protected values. Therefore, with this term we denote the specialty of a comprehensive energy renovation, from which all those measures that would unacceptably change the character or appearance of the building are excluded. The extent of the comprehensive energy renovation therefore depends on the architectural and historical importance of the building, which must be considered.

Simply put, a comprehensive energy renovation of cultural heritage buildings only includes energy efficiency measures permitted by cultural protection conditions and confirmed by a cultural protection consent. This definition enables cultural heritage buildings to qualify for co-financing of their energy renovation.

The Guidelines were put into practical use shortly after publication. They are taken into consideration in energy renovation projects, cited as a reference in various tender documents and referred to in many national strategic documents. After almost a decade since their introduction, the time has come to review and refresh the content. At the end of 2023, the national research project V5-2358 (DEDIS) began, focusing on providing an update of the Guidelines.

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3. Methodology

3.1. Starting points

Since the publication of the Guidelines in 2016, the number of projects of energy renovation of cultural heritage buildings has been constantly growing. One of the main reasons lies in the easier access to co-financing sources, both for the private (subsidies from the national Eco Fund) and public (cohesion fund) sector, which has been enabled by the definition of the comprehensive energy renovation, written in the Guidelines. Also, successfully implemented projects serve as good practice examples and foster further similar initiatives.

The Guidelines consist of several chapters, from description of the legal framework and building typologies, presentation of preparatory investigations, clarification of technical measures with their impacts and possible interactions, to explanation of renovation outcomes reflected in indoor climate and comfort.

Nevertheless, the legislative changes and technical progress (new materials, products and technologies) bring forward the need for an upgrade of the Guidelines. Not only this, more extensive introduction of RES like solar collectors and photovoltaics opens several fields that need more attention. In particular, this is true for their electric and fire safety, and responsible positioning both on heritage buildings and within heritage settlements.

3.2. Analysis of the national framework related to energy efficiency of buildings

Cultural heritage buildings are specifically treated in national strategic and legislative documents on energy efficiency and renovation of buildings. The first step was to study them for implications on the cultural heritage buildings to include their main accents into the updated Guidelines.

Performing desk research by collating and examining said relevant information helped to gain insights into the national legislative framework, which was crucial to understand the overall context and identify current demands and limitations related to energy renovation of cultural heritage buildings.

The review of legislation was directed from the more general to the more specific, i.e. from national strategies and action plans, through laws to regulations. The most important highlights are presented in the Results chapter.

3.3. Obtaining feedback from the stakeholders

The work on updating the Guidelines continued with collection of practical experience of implemented renovation projects and survey among the recent thematic written sources. The main preparatory activity was dedicated to obtaining feedback to the existing Guidelines and related information from cultural heritage professionals and representatives of local communities. This was done through interviews and online surveys.

With the first target group – employees of the regional units of the Institute for the Protection of Cultural Heritage of Slovenia (IPCHS), the interest focused on the experience from the practical use of the Guidelines, suggestions for content amendments, and relation and approach to use of RES technologies. From the second target group – the municipalities, we gained information about RES technologies on cultural heritage buildings and in heritage settlements in the context of local urban planning policies.

Interviews were held at all seven regional units of the IPCHS, all together 48 employees were present (from 3 to 9 employees per interview to ensure the presence of various experts, e.g. architects, conservators). A questionnaire was developed, divided into ten thematic sections and consisting of thirty questions. The questionnaire was also sent to the IPCHS units in advance by invitation, which allowed the employees to

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familiarise themselves with the questions. The interviews were semi-structured, with the conversation following the flow of the questions, but with the possibility of sub-questions or additional explanations. Interviews were held in person at each regional unit.

The survey included 89 municipalities, among them seven city municipalities, with a higher representation of those more actively engaged in the protection of architectural and settlement heritage. Most respondents were professionals working in departments related to environment and spatial planning, urbanism, and energy consulting, while in some cases (e.g. small municipalities) responses were provided by mayors or directors of municipal administrations. The survey was conducted with the "1ka" online survey tool.

4. Results and discussion

4.1. The national legislative framework

The National Energy Efficiency Action Plan 2017–2020 (Ministrstvo za infrastrukturo Republike Slovenije, 2015) mentions essential support in the transfer of knowledge and experience in the field of energy renovation of cultural heritage buildings, which is the task of the governmental Project Office for energy renovation of buildings. The office plays a key supporting role in the project "Energy renovation of buildings in state and municipal ownership" as part of the Operational Programme for the implementation of European cohesion policy. The Guidelines are an integral part of the documentation published by the office in support of the comprehensive energy renovation of public buildings.

The Operational programme of measures to reduce greenhouse gas emissions until 2020 (Ministrstvo za okolje, prostor in energijo Republike Slovenije, 2014) envisages the creation of a completely new measure, a support scheme for the renovation of building cultural heritage. The full scope of the instrument includes development of renovation criteria, demonstration projects, development and deployment of technologies, financial support scheme and provision of targeted funds.

The National Energy and Climate Action Plan 2020 (Vlada Republike Slovenije, 2020) states that when placing solar power plants, restrictions and protection regimes of cultural heritage are to be considered. When renovating cultural heritage buildings, in addition to sectoral legislation, recommendations such as the Guidelines shall be consulted. A part of the cohesion funds should be allocated specifically to this group of publicly and privately owned buildings, and special public tenders should be created for the co-financing of their renovation measures.

The Long-term energy renovation strategy for 2050 (Vlada Republike Slovenije, 2021) brings two proposals aimed at strengthening the supporting environment for the integrated conservation of cultural heritage. The first proposal includes a review and revision of the Guidelines. The second proposal is to introduce changes in the field of local fiscal legislation so that local communities would be given greater autonomy in the creation of fiscal revenues and their management.

The Act on Energy Efficiency (Zakon o učinkoviti rabi energije, 2020) mentions cultural heritage in two places. The protection of cultural heritage shall be considered when determining the methods of promotion and the amount of incentives for energy efficiency measures. Public sector entities must establish an energy management system that includes goals from the fields of energy efficiency and RES, and measures to achieve them. This obligation also applies to energy managers of cultural heritage buildings.

The most important novelty concerns the right and duty to possess an energy performance certificate. Until the adoption of this act, buildings that are protected in accordance with

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the regulations on the protection of cultural heritage were listed among the exceptions. A cultural heritage building now does not need an energy certificate only if it is used for ritual purposes or religious activities (sacral heritage).

The Building Act (Gradbeni zakon, 2021) permits deviations from essential and other requirements (e.g. due to special requirements for the protection of cultural heritage), but they must not threaten the safety of the facility, the life and health of people, neighbouring properties or the environment.

The Recovery and Resilience Plan (Ministrstvo za finance Republike Slovenije, 2021) draws attention to the definition of the comprehensive energy renovation of cultural heritage buildings from the respective Guidelines and emphasises that potential cultural protection requirements for renovation shall be considered.

The Rules on efficient use of energy in buildings (Pravilnik o učinkoviti rabi energije v stavbah, 2022) and the corresponding Technical Guideline TSG-1-004: 2022 Energy Efficiency of Buildings (Ministrstvo za okolje in prostor, 2022) explain that exemptions may be applied to cultural heritage buildings in accordance with the Building Act and the provisions of the Rules.

The latter separate cultural heritage into two groups. Cultural heritage that is not used for other purposes is exempted from the application of this regulation. For all other cultural heritage buildings, the rules apply, but to a limited extent depending on the cultural protection conditions and approval by the IPCHS.

4.2. Interviews with stakeholders

Interviews conducted at regional units of the IPCHS reveal a predominately negative perception among experts regarding the installation of photovoltaic (PV) devices on buildings and sites of cultural heritage significance. The key arguments or objections include the degradation of the historical structures, interventions in the original material substance, potential threats to structural stability, and increased fire risks. Despite some proposals for integrated PV solutions that would be less visually invasive, the prevailing professional stance remains that the installation of PV devices on cultural heritage buildings is generally unacceptable, except in cases where alternative energy solutions are not feasible (e.g., mountain huts without grid connections).

Additionally, issues have been identified in the approval processes, as many PV installations are carried out without prior heritage conservation assessments. Discussions on future developments highlights the necessity of stricter regulations, enhanced oversight, and the promotion of alternative approaches, such as community solar power plants and the placement of PV devices in degraded areas or on industrial buildings.

4.3. Online survey

The online survey conducted among municipalities provides insight into local perspectives on the integration of PV devices in cultural heritage areas.

The survey results indicate a diversity of opinions on the placement of PV devices in cultural heritage areas – most respondents acknowledge that PV devices impact the appearance of settlements, and nearly one third express the view that PV should not be installed in cultural heritage areas. Nevertheless, 42 municipalities have already implemented PV devices on public buildings, most commonly on schools, sports facilities, and utility buildings.

The analysis of municipal spatial planning acts reveals that only 38 municipalities include provisions on PV devices, with even fewer specifically addressing regulations for cultural heritage buildings. Most municipalities do not record significant interest from residents in installing PV devices in such areas, nor do they frequently consult with the IPCHS.

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The results highlight the need for better information dissemination and adjustments to spatial planning acts that would enable the harmonized development of RES while preserving cultural heritage.

The feedback obtained from stakeholders to our inquiry about the structure and content of the existing Guidelines was overwhelmingly positive. Many useful suggestions about possible additions to the topics were collected, which will help the updated document to stay in line both with the national cultural protection doctrine and national strategic orientations, thus maintaining its relevance and applicability in the future.

5. Conclusions

Energy renovation measures can rarely be conceived and implemented following the "copy-paste" approach, where past examples serve as direct templates for intervention. Today, when inter- and multidisciplinary approach is the key principle of successful projects, guidelines and similar tools combining and presenting knowledge from different fields are essential for supporting informed decision-making.

The updated Guidelines will continue to assist decision-makers in fulfilling the fundamental goal, which is finding the balance between preserving historical values and enhancing the energy efficiency of cultural heritage buildings.

For individual renovation measures, the ranking system places preservation of protected features ahead of improving energy performance indicators.

One of the important outcomes of the use of the Guidelines visible in practice has been the improvement of communication and collaboration among the cultural protection professionals, architects and engineers, building managers and users. The Guidelines help the stakeholders to better understand specific legal and technical boundary conditions, gain missing knowledge and differentiate between technical and economic feasibility of renovation measures, and limitations of the cultural heritage protection regulations.

The Guidelines also help dispel the common misconception that the sole purpose of energy renovation is to improve energy indicators.

Positive effects can be achieved on several levels with a reasonable and verified set of measures that are carried out during energy renovation: elimination of damage and defects on the building envelope, solution of various building physics challenges, reduction of energy consumption costs and environment emissions, extension of regular maintenance intervals, reduction of temperature asymmetry and rise of surface temperatures in rooms, easier regulation of internal microclimatic conditions and the like.

The current Slovenian legislative and strategic framework based on EPBD and EED recognizes the importance and sensitivity of cultural heritage buildings. The updated Guidelines for their energy renovation, scheduled for publication in late 2025, will represent a useful and necessary addition to this framework, securing the sustainable conservation of cultural heritage buildings and their appropriate adaptation to the needs of future generations.

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Implementation of an Innovative Model of the Comprehensive Energy Renovation Project of a Cultural Heritage Building in Ljubljana, Slovenia

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Abstract

Renovation of a building requires a comprehensive and targeted approach to managing the process from conceptual design to implementation and future use. Cultural heritage buildings are subject to specific legalities and restrictions in accordance with the conservation regime. The complexity of such a renovation process requires special knowledge and competence of the stakeholders involved. The key is constant and coordinated cooperation among the designer, the cultural heritage protection authority, the investor, the users, the supervisor and the contractor. This rationale inspired the creation of a model of the comprehensive energy renovation process, balancing heritage conservation with energy efficiency through nine key elements and quality guidelines, developed within the LIFE IP CARE4CLIMATE project. The model includes detailed steps of the renovation with quality guidelines for the conceptual design, inspection of the building's condition, financial planning, comparison of variant renovation measures, energy performance analysis and investigation of several other aspects, for instance fire and electric safety, earthquake resistance and the quality of the indoor environment. The model includes support to the investor in the preparation of tenders, contractor selection, supervision, and building management and monitoring plan. This innovative model has been successfully implemented in renovation of several heritage buildings in Slovenia. A more detailed description of its implementation in practice is presented on an award-winning renovation project of heritage building in Ljubljana, Slovenia.

Keywords: *comprehensive renovation; process model; cultural heritage buildings; best practice*

1. Introduction

Building management and maintenance are essential elements to ensure the good physical condition of any building, aiming to extend its lifespan and preserve its property value. This applies particularly to cultural heritage buildings. When renovating them, we must take special care to follow the basic principle of protecting and preserving the values of cultural heritage, as we are committed to safeguarding such buildings for both present and future generations.

Specific rules and restrictions apply to the renovation of heritage buildings. These define the permitted interventions that must be strictly

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adhered during renovation. The renovation should be comprehensive, as only this will enable the continued existence and enrichment of the cultural heritage.

The main principle for the renovation of heritage buildings is to achieve an acceptable balance between permissible measures in compliance with the protection regime and technical measures in line with the construction regulation. It is important to consider reasonable life cycle costs of renovation and the financial capacity of the investor as well as additional sources of financing, e.g. loans and subsidies.

2. Objectives

The objective of this paper is to present an innovative model developed for the comprehensive energy renovation process of cultural heritage buildings (residential and public) with nine key elements and embedded quality guidelines, and to illustrate its practical application in an award-winning multi-apartment building in Ljubljana, Slovenia.

2.1. National legislation

Cultural heritage is a constitutional category in Slovenia (Ustava Republike Slovenije (RS), 1991). We thus recognise its important role among the values that shape our country and statehood. Policies and regulations for the protection of cultural heritage are formulated in accordance with constitutional provisions.

Thematic directives and international guidelines have been adopted at the EU level, setting out the principles of integrated heritage conservation.

The umbrella act is the Cultural Heritage Protection Act (Zakon o varstvu kulturne dediščine, 2008), which stipulates that any interference with cultural heritage must first be subject to cultural protection conditions and then to cultural protection consent, balancing the reasons for interventions with the reasons for preserving the heritage in its existing form.

Any intervention must comply with the Spatial Planning Act (Zakon o urejanju prostora, 2022) and the municipal spatial implementation acts. The renovation must also comply with the essential requirements of the Building Act (Gradbeni zakon, 2022), insofar as they do not conflict with permissible interventions from the point of view of cultural heritage.

Guidelines for energy renovation of cultural heritage buildings (Ministrstvo za infrastrukturo RS in Ministrstvo za kulturo RS, 2016), which are currently being updated within the national targeted research project CRP V5-2358 (DEDIS), set out the basic principles for renovation. The guidelines emphasize finding solutions that respect heritage values while improving energy performance.

The 2050 Long-Term Strategy for the Energy Renovation of Buildings (Dolgoročna strategija energetske prenove stavb do leta 2050, 2021) sets out policies and approaches to decarbonise the national building stock by 2050 and outlines measures to support the set goals.

2.2. Technical aspects

The positive effects of the renovation can be achieved at several levels through sensible and professionally tested measures with solutions in cooperation with the heritage service: restoration of damage and defects in the structure and building envelope, moisture remediation and other building physics problems, reduction of energy costs and emissions to the environment, extension of regular maintenance intervals, etc. Achieving these benefits requires careful consideration of alternative solutions and selecting those most compatible with preserving the building's heritage values.

2.3. Challenges and needs

In practice, a protocol for steering a heritage renovation project is needed to follow the necessary quality assurance and thus consider heritage protection rules, technical legislation,

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comply with financing preconditions and finally reach the heritage building condition needed for future use. The development of a heritage building renovation quality assurance was subject to the LIFE IP CARE4CLIMATE project and upgrading of the national certification scheme Quality Label in Buildings and Construction (Building and Civil Engineering Institute ZRMK, Ljubljana, (GI ZRMK) 2010).

3. Methodology

The development of the Heritage Building Renovation model (HBR model) took place in several steps. It started at the theoretical level, with the study of policies, strategic and implementing acts, followed by research on end-users' and homeowners' needs in building renovation through consultations, and study of experience in developing and managing renovation projects.

The HBR model initially included more detailed renovation process steps during the planning and implementation phase. In pre-testing the HBR model on renovation projects in practice, it turned out that the model needed to be extended from conceptual design to implementation and monitoring, as well as to additional trainings for investors needed for better understanding the trade-offs between heritage protection and building renovation. The main obstacle proved to be in the financing of renovations - ranging from the large scale of the works required to the high labour cost caused by the lack of suitably qualified contractor' staff. The methodology of the heritage renovation approach defined in the HBR model has been demonstrated and verified on the case study of an award-winning multi-apartment building in Ljubljana, Slovenia, presented in more detail in Chapter 5.

4. Results

The elaborated HBR model contains nine key quality elements designed to ensure a high-quality outcome in the comprehensive renovation of heritage buildings. A schematic representation of the HBR model is shown in Fig. 1.

4.1. Quality Elements (QE)

Nine Quality Elements (QE 1-9) are presented and described below:

QE 1 - Preparation of the project brief with conceptual design. It involves the development of a detailed content and scope of work. Included is digitalisation of original plans with measurement control and a review of the actual state of the building. Digitalisation of plans is the

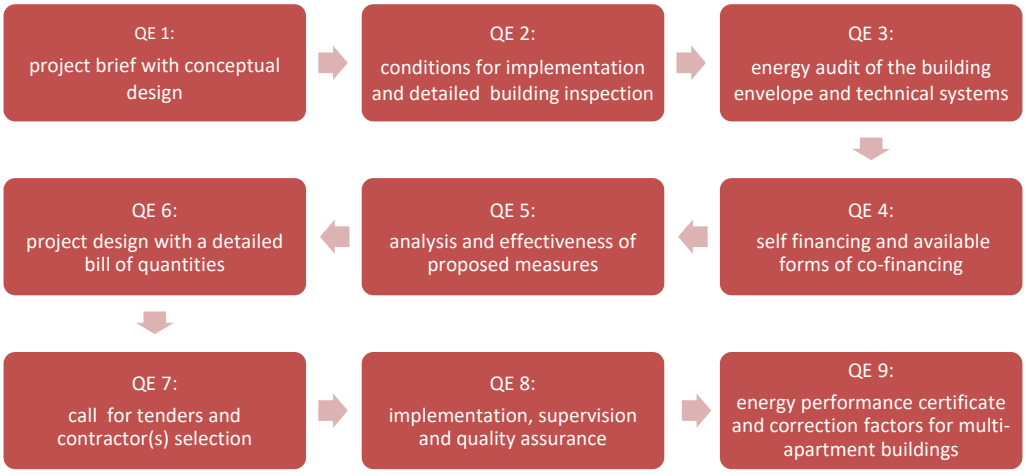


Fig. 1 – *Schematic representation of the project flow HBR model* (GI ZRMK, 2021).

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basis for creating the conceptual design, the key document for obtaining cultural protection and other conditions, as well as for creating a BIM model for building management.

QE 2 - Conditions for implementation and detailed general survey of the building's condition. The actual conditions and possibilities for implementation are checked. A detailed general survey of the building's condition is carried out, such as design features, cracks and other deformations in the structure and terrain, the state of fire and electrical safety, the condition of the roof, façade, windows, doors and protected heritage elements. This is crucial for understanding the building's specific heritage values and vulnerabilities.

QE 3 - Energy audit of the building envelope and building technical systems. An extended or simplified energy audit of the building envelope (floors, walls, ceiling or roof), building technical systems (heating, cooling, ventilation, lighting), and indoor conditions (e.g., presence of mould, daylighting, air quality) is carried out.

QE 4 - Financing and other forms of co-financing. An analysis is made of the feasibility of measures based on financial capabilities of the investor and possible sources of co-financing and the availability of loans and other financing mechanisms.

QE 5 - Analysis and effectiveness of proposed measures. A detailed analysis with calculations of the effectiveness of alternative measures and assessment of their impact on aspects of sustainable construction is prepared. In the case of a cultural heritage building, cooperation with the competent conservator is essential. Different technical solutions (e.g., thermal insulation, texture and colour of the plaster) should be evaluated, choosing those that most effectively combine energy efficiency with the preservation of heritage features. Renovation is always preferred over replacement where technically feasible and appropriate from the conservation perspective.

QE 6 - Project design. The project design is prepared with detailed specifications, which include restoration works and a detailed bill of quantities. The planned measures are coordinated and approved by the competent authority, which gives cultural heritage conditions and consent to the project implementation.

QE 7 - Call for tenders and contractor(s) selection. The tender for the selection of the service provider(s). Contains clear and transparent criteria based on technical and technological aspects, the desired level of quality, and the financial statement of the bidders.

QE 8 – Implementation, supervision and quality assurance. A quality assurance protocol is crucial during the implementation phase. In addition to construction supervision, the conservation service also oversees the work. The supervision ensures that all work is carried out in accordance with the accepted construction and heritage standards.

QE 9 - Energy performance certificate and heat billing correction factors for multi-apartment buildings. After the completion of all work, an energy performance certificate of the building is issued at the request of the clients. This is otherwise mandatory under the Act on Energy Efficiency (Zakon o učinkoviti rabi energije, 2020), and applies when selling or renting out, even for cultural heritage buildings other than sacral. If the renovation involves a multi-apartment or other building connected to district heating or another common heating source, correction factors are calculated to ensure fair sharing of heating costs.

4.2. Monitoring

It is recommended to monitor the effects of the energy measures implemented for at least two years after the renovation. Every renovation requires a comprehensive and timely insight into the project, its implementation and monitoring of the effects of the measures, which can also be

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carried out gradually or in steps. This means that necessary structural reinforcements and consolidations are carried out first to increase the strength, stability and seismic resistance of the building. Measures to eliminate and prevent moisture (e.g., roof leaks, preventing capillary moisture from rising) also have a high priority. In the next step, an energy renovation of the building envelope is undertaken, and in the final step, measures on the building technical systems are implemented.

5. Discussion – case study verification

The principles of heritage conservation and adherence to the HBR model were verified in the energy renovation of several buildings. Here, the case of a two-story workers' multi-apartment building from 1922 at Einspielerjeva 25 (E25) in Ljubljana, Slovenia, is presented. The project took place from late 2021 and was completed in the spring of 2024. Monitoring will continue until 2027.

5.1. Description of the building

The building E 25 (Fig. 2) has an irregular shape, divided into three parts with three entrances with staircases, and 16 apartments. On the ground and the first floor there are two-room apartments with an eat-in kitchen and sanitary facilities. In the attic, which has a wooden gable roof, there are two original one-room apartments, and larger apartments built after 1970. The building is traditionally built with old-format brick, known as the “Austrian” format.

The basement is located under the central part of the building. Above it is a massive ceiling made of steel beams and brick arches, while the rest of the floors have wooden ceilings. The windows have already been replaced and some of them are equipped with shutters in different shapes, colour shades and designs.

The roof was covered with brick roof tiles a few years ago, except two small sections on the central attic are covered with the original metal.

Most of the apartments are heated via district heating, some use a gas boiler. Ventilation is natural, through window openings. Individual external units of air conditioning devices were randomly mounted on the façade. Mould appeared on the interior walls in several spaces.

On the north side, there is a green area separated from the road by a fence and trees, and on the south side, there are parking spaces and the alley.



Fig. 2 – *View on the north, main façade before renovation* (GI ZRMK, 2021).

The building has gradually become disorganised and externally neglected due to haphazard interventions, and its installations urgently need renovation.

5.2. Renovation – the HBR model application

The spatial acts indicate that the building is listed in the cultural heritage register as part of the settlement heritage. This designation means its external appearance, including specific façade elements, contributes significantly to the character of the area and requires protection. The key renovation processes are presented in more detail below, summarized in the planning, implementation, and financing chapter.

5.2.1. Planning Process (QE 1 – QE 6)

The first step, a discussion and on-site inspection of the building were conducted with the investors (the building manager and homeowners) to identify their goals and capabilities. Based on this, a conceptual project has been designed with defined goals, content, and scope of the

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renovation. The original plans were obtained from the Archives of the RS (Fig. 3). This was followed by the digitalisation of the plans with on-site measurement control (QE 1).

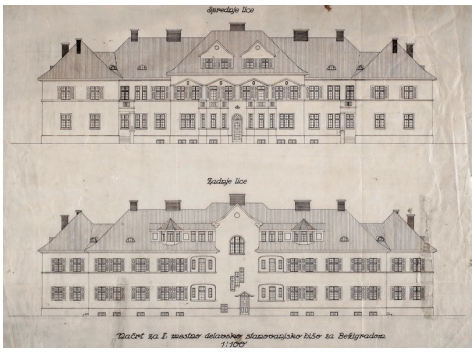


Fig. 3 – *The original plan of the north and south façades* (Arhiv RS).

Simultaneously, a detailed survey of the actual condition and living conditions in the building was conducted (QE 2), along with a simplified energy audit. Measures were planned for the building envelope and technical building systems related to cooling and air conditioning. This was done in close and dynamic cooperation with the conservation service, investors, and the building manager (QE 3). In parallel, possible sources of financing were examined (QE 4). Variant renovation solutions were evaluated, particularly concerning the acceptable thickness of the external thermal insulation and shutter design to ensure the preservation of its original proportions and detailing (QE 5).

Due to the protection regime, which aims to preserve the building's external appearance (a primary heritage value), and considering previous solutions, a slightly smaller thickness of thermal insulation (10 cm) was deemed permissible on the façade. This contrasted with the thicker layers (16 cm) required by the Rules on the efficient use of energy in buildings at that time, U<0.20 W/(m²K), (Pravilnik o učinkoviti rabi energije v stavbah, 2010) and Eco Fund's tender conditions for the allocation of non-refundable financial incentives. This decision, made in close consultation with the conservation service, represents the key aspect of balancing heritage protection with energy efficiency goals.

The protected elements on the façade, which exhibit one of the most important heritage values, were coordinated with the conservation service. Cornices, ornaments, medallions, originally rendered in stamped plaster were meticulously replicated in the same form using the chosen thermal insulation material, which was then finished with a final layer (several samples of different granulation, composition, textures and colours).

As noted in Section 5.1, most of original windows had already been replaced haphazardly over time. Therefore, the intervention focused on improving the overall coherence and energy performance of the existing windows. This involved unifying the appearance with replacement of authentic wooden shutters throughout the building. In this project, the focus was on the new shutters and reinforcing existing dormer windows to improve their structure and image, giving the building a uniform appearance.

An installation of outdoor air conditioning units in exposed locations was not allowed. The openings for the ventilation system on the south façade and the proposed ventilation method in the window reveals on the north, street-facing façade (appearance protected) were unified.

The interior of the building is not protected, so thermal insulation was added to the basement ceiling and above the staircase entrance in the central part (14 cm), and in the common attic area and under the roof by the eaves (26 cm), in accordance with the requirements of the mentioned Eco Fund tender.

Two small parts of the attics received a new metal (zinc-copper-titanium (Zn-Cu-Ti)) roofing. The metal flashings at the roof eaves, gutters, rainwater pipes (Zn-Cu-Ti) and the snow guards (metal) were replaced with original material. The terraces were thermally insulated and waterproofed and unified railings were added to protect external appearance (QE 6).

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5.2.2. Implementation (QE 7 – QE 8)

The tender for the selection of the contractor was conducted at the level of the Municipality of Ljubljana (MOL) (QE 7). The implemented measures on the building envelope were accompanied by other vital interventions, such as creating an opening for stairs to the loft from common areas, reinforcing dormers windows, unifying the railings of subsequently constructed terraces in the attics, and improving fire safety. In addition to the regulations in this area, the guidelines for Fire Protection in Cultural Heritage Buildings (The Confederation of Fire Protection Associations Europe, 2013) were also considered for fire safety.

In addition to installing fire barriers at the height of ceiling structures and near parking areas along the façade and entrances, it was necessary to install fire doors in the basement, dividing the building into three fire sectors. The relocation of the gas boiler flue from the *façade* to above the roof was carried out, and obstacles on the staircases were removed for safe evacuation in case of fire or other emergencies. The renovation also included the electrification of basement areas and the modernization of common electrical installations on the staircases, as well as the illumination of building entrances (Fig. 4).



Fig. 4 – *Depiction of the renovated north, main façade.* (GI ZRMK, 2024).

The quality assessment and control during implementation involved regular site visits by the MOL and GI ZRMK supervisor, designer, and heritage conservator to ensure adherence to the approved plans and heritage protection conditions and consent, particularly regarding the repetition of the façade details using appropriately shaped insulation material (QE 8).

An energy performance certificate and heat billing correction factors were produced (QE 9).

5.2.3. Financing of the renovation

The renovation of E25 was financed by the owners' resources previously collected in the reserve fund (obligatory monthly contribution), a factoring loan, the Ljubljana – My City (MOL. Ljubljana - moje mesto) mechanism covering 25 %, by Eco Fund, Slovenian Environmental Public Fund (Eko sklad, js), subsidy for thermal insulation (20 %), and partially from the owners' own funds.

6. Conclusion

An energy renovation of a cultural heritage building is a unique challenge and an opportunity to revive and preserve the building structure and its protected values post-renovation. The success of the renovation largely depends on the implementation of the quality assurance in the process of project conception, planning and detailed design, preparation of the tender and selection of the contractor, implementation of the works, monitoring and control, as well as the support to end-users in the post-occupancy phase. The HBR model conceived on this base, with nine quality elements supporting heritage building renovation, has been verified on several case study buildings in Slovenia.

The HBR is adaptable to all types of heritage buildings, although specific technical solutions and heritage constraints would naturally vary. A holistic approach is emphasised, as heritage conservation and energy efficiency often require interconnected solutions; partial interventions might compromise structural integrity, heritage values, further use or its existence. The HBR model, with its adaptations, is suitable for renovating also non-protected buildings. The E25 renovation project in Ljubljana received the Successfully Completed Renovation Award 2024

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by the expert committee of the School of Renovation, demonstrating the effectiveness of the applied methodology in the HBR model (https://solaprenove.si/priznanja/).

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Rural Settlements as Cultural Heritage: Guidelines for Renovating and Building Houses in the Municipality of Cerknica, Slovenia

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Abstract

Contemporary development of the Slovenian countryside increasingly reflects uncritical adoption of global trends, characterized by generic designs, nontraditional forms, and modern materials. Although modernization itself is not inherently problematic, such practices have led to the degradation of significant cultural landscapes as well as rural and urban settlements, many of which are protected as cultural heritage. This article emphasizes the potential of informed planning and awareness-raising initiatives to counteract these trends. By educating the public as well as architects about the importance of preserving locally distinctive urban planning principles and architectural typologies, it is possible to positively influence both the renovation of heritage structures and the construction of new buildings. This study focuses on the development of guidelines for the Municipality of Cerknica in Slovenia. These guidelines promote the conservation and enhancement of specific village typologies and traditional architectural elements that have largely survived due to cultural protection measures. However, these heritage assets remain vulnerable to inappropriate renovation and intrusive modification. The guidelines provide detailed information to property owners, architects, and contractors, outlining typical architectural features through comprehensive descriptions, drawings, and photos of exemplary cases. They were developed based on an extensive literature review, field research, and interviews with key stakeholders, including representatives of cultural heritage protection services. To maximize their impact, the guidelines are disseminated both online and in print, accompanied by additional outreach activities such as local events and newsletters to further engage the community and promote adherence to support the preservation of spatial qualities and identity.

Keywords: *regional architecture; residential buildings; conservation of village typology; rural settlements*

1. Introduction

Contemporary spatial development is characterized by complex challenges, such as climate change adaptation, transition to green energy, and digitalization. These processes drive the transformation of urban and rural areas and necessitate adjustments in spatial planning. However, in many remote areas the demographic shifts followed by out-migration and the abandonment of farming remain the main driver of change, indirectly shaping the character and identity of the landscape. In contrast, in recent decades suburbanization and periurbanization,

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mainly driven by the construction of individual housing in the form of dispersed settlements, have significantly impacted both the settlements and the surrounding landscape, particularly near towns and freeway access points. In the Slovenian context, these processes are described in detail in reports on Slovenia's spatial development (e.g. Bizjak et al., 2021).

In Slovenia, strategic spatial development documents such as the recently adopted *Resolution on Spatial Development* (ReSPR50, 2023) explicitly recognize that contemporary spatial development trends are diverging from the principles of planned, efficient, economical, and high-quality spatial development. These trends are altering spatial identity and eroding its key elements (Švigelj et al., 2023). The key challenge is therefore to effectively translate the guidelines for preserving the distinctiveness of settlements and landscapes outlined in strategic spatial documents into practice at the local level and within sectoral policies.

Preserving the distinctiveness of settlements and landscapes is becoming increasingly significant in this context because it contributes to maintaining the quality of the living environment and fostering a stronger sense of place. The conservation of cultural heritage is a key aspect of this effort, particularly in protecting architecturally distinctive buildings and cohesive urban morphological units that contribute to the regional identity of both settlements and the surrounding landscape.

This article presents research carried out to produce the expert bases for the municipal spatial plan of the Municipality of Cerknica. This is an example of the aforementioned translation of strategic guidelines on paper into local documents and awareness-raising campaigns. The research focused on:

- Urban design guidelines for the major settlements in the municipality,
- Guidelines for designing residential buildings in large settlements and characteristic landscape areas, and
- General guidelines for designing non-residential buildings (including farm structures and simple buildings).

The Municipality of Cerknica is located in south-central Slovenia and has an area of 241 km². In 2024, its population was approximately 12,000, corresponding to a population density of forty-nine residents per km² (SiStat, 2024). Cerknica is the largest town in the municipality and an inter-municipal center with administrative, educational, cultural, and other social functions. The historic center of Cerknica developed in the sixteenth century on a hillside along Cerkniščica Creek, and it was the largest fortified settlement in Slovenia. Cerknica (both the town and the municipality) is well connected to the freeway and railway network, which links it to smaller towns such as Rakek and Unec. The municipality, however, is best known for the intermittent lake and cultural landscape of the Cerknica Karst Field, which lies to the south and is protected as a nature park 'Notranjska Regional Park'. The flatland to the south, covered in marshes and meadows, contrasts with the hilly northern part of the municipality, covered in woods and scattered villages. Some villages there function as local centers with basic services such as grocery stores, schools, and churches.

2. Cultural heritage: the Slovenian context and the main characteristics of the research area

In Slovenia, cultural heritage is classified into registered immovable cultural heritage, heritage conservation sites, cultural monuments of local significance, and cultural monuments of national significance (Zakon, 2008).

There are nine categories of cultural heritage (Pravilnik, 2010): archaeological sites, buildings, parks and gardens, buildings with parks and

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gardens, memorial buildings and sites, other buildings and installations, settlements and parts thereof, cultural landscapes, and other. This article focuses on two categories: settlements and parts thereof, and buildings, regardless of their classification (e.g., as registered cultural heritage sites or cultural monuments of local or national significance). The Municipality of Cerknica has 210 registered cultural heritage units (Ministrstvo, 2025), including:

- Five settlements or parts of settlements (the villages of Dolenje Jezero, Otok, Žerovnica, and Begunje pri Cerknici, and the historic center of Cerknica);
- One hundred eight buildings, including houses, farms, mills, and churches;
- Eleven cultural landscape areas, including the intermittent lake area and lines of trees along major roads;
- Memorial buildings and sites (e.g., chapel shrines), and other structures (e.g., wells).

Over the past decades, the development of this region has been relatively limited due to its geographical remoteness and insufficient resources compared to other parts of Slovenia. New construction and infrastructure growth have primarily been concentrated in designated development zones within the municipal center and the town of Rakek, which has a rail connection. The construction of the freeway in 1972, followed by further expansion in the 1980s and 1990s, facilitated additional development (e.g., the industrial zone near Cerknica). However, rural settlements, historically reliant on agriculture, experienced minimal growth, with limited new construction and renovation. Consequently, the traditional spatial structure of these villages has remained largely intact and is now recognized as a distinctive feature of the region's cultural landscape. There have been some renovations of individual buildings that can serve as exemplary best practices. However, many buildings with cultural heritage status suffer from neglect, deterioration, or inappropriate renovations, posing a challenge for heritage preservation efforts.

3. Architectural typology

Traditional settlements and buildings in Slovenia have distinct design characteristics influenced by regionally available materials, building techniques, and construction adapted to the climate. Consequently, Slovenia has been divided into fourteen architectural regions, which have been further subdivided into architectural landscapes (Fister et al., 1993). Koblar et al. (2023) explain the process of defining boundaries between these units. The units are based on historical vernacular architecture types and settlement patterns, as well as historical development and dialects rather than on administrative or geographical boundaries. The Municipality of Cerknica belongs to the Inner Carniola–Brkini architectural region, which comprises six architectural landscapes, including the Planina–Cerknica and Bloke landscapes in the Municipality of Cerknica. Each has developed a unique spatial identity shaped by geographical, cultural, historical, and socioeconomic factors; the use of local materials, builders' knowledge, and adherence to regional characteristics have contributed to the establishment of consistent architectural principles (Fister et al., 1993).

3.1. Urban development characteristics: villages

The lowland areas of the municipality are characterized by ribbon villages (e.g., Dolenja Vas, Begunje pri Cerknici, and Žerovnica), and clustered settlements are typical on hillsides (e.g., Unec, Cerknica's historical center, and Sveti Vid). Ribbon villages are characterized by farms with buildings (houses and outbuildings) arranged along an axis perpendicular to the road. The layout of these villages reflects the formation of the settlement and linear land division (Mušič, 1947; Fister et al., 1993; Gantar & Goršič, 2024).

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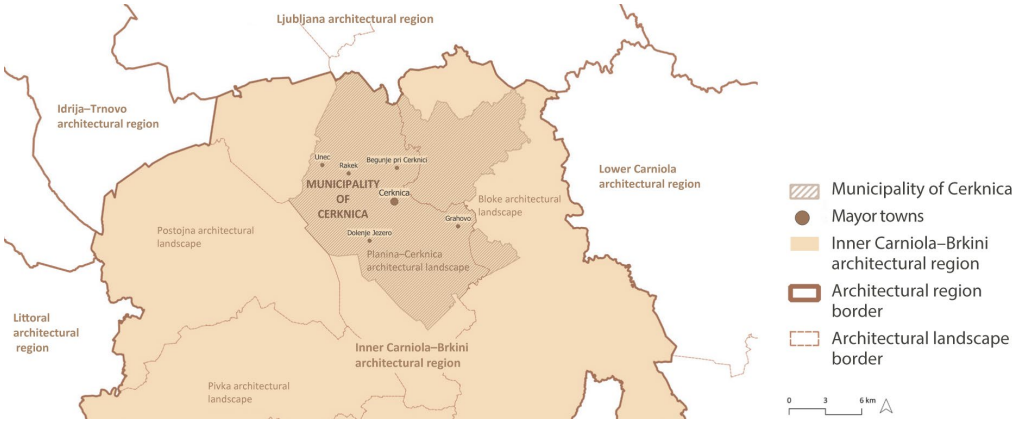


Fig. 1 – *Architectural regions and landscapes in the Municipality of Cerknica* (Kmetič based on Fister et al., 1993).

3.2. Architectural types and significant features

The most characteristic traditional house type in the municipality is the Inner Carniolan house. It has a rectangular shape and a symmetrical steep gable roof. Some variations include facades with five bays and a dormer above the entrance. Houses with this layout were primarily found closer to Logatec, but individual examples can be seen across a wider area.

A distinctive architectural feature of the region is the wooden hayrack—specifically the double hayrack, known as a *toplar* in Slovenian. Its regional character, shaped by functionality and climatic conditions, is defined by very steep roofs and austere closed gable ends, typically divided into two sections. In many cases, all sides of the hayrack are enclosed. Some examples also feature large masonry pillars. Another significant element of built heritage in the Cerknica area was granaries, but only a few remain today.



Fig. 2 – *Typical village layout: Žerovnica* (K. Gantar, 2024).

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Fig. 3 – *Example of a traditional house type* (Goršič, 2024).

These buildings were typically masonry structures with a single room, and they either had a basement or several stories. The region was also historically rich in mills and sawmills, particularly along Cerkniščica Creek and its tributaries. However, beginning in the 1960s, most of these structures fell into disrepair, and only a few have survived (ZVKDS OE Ljubljana, 2023).

4. Methods

The research focused on assessing the state of built cultural heritage, its connection with or significance for spatial identity, and the perception of cultural heritage, architecturally significant buildings, and their relevance for spatial identity. Based on this assessment, the subsequent steps were aimed at preparing materials and dissemination activities to foster the preservation and proper renovation of cultural heritage and other typical architectural structures to support the spatial identity of the area.

1. Analytical phase:

- Analysis of available materials, spatial data, and specialized literature (e.g., the Spatial Plan of the Municipality of Cerknica, the Spatial Development Strategy of Slovenia 2050, etc.);
- Detailed on-site spatial analysis.

2. Conceptual phase:

- Focus groups with specialist stakeholders (e.g., architects and the cultural heritage protection service);
- Conceptual design of a handbook/guidelines;
- Presentation of preliminary findings to stakeholders.

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3. Final phase:

- Presentation of expert bases and handbook/guidelines for representatives of the municipality;
- Dissemination of informative materials (an information leaflet and two articles in a local newspaper).

5. Results and discussion

5.1. Insights gained from the analytical phase

The spatial data analysis and the subsequent on-site analysis provided valuable insights into the state of individual settlements, their relation to highly valuable landscapes, as well as the establishment of local and regional significance based on architectural features and the importance of these features for regional spatial identity.

Spatial analysis was conducted for five major towns and one specific protected village. On-site visits were made to all the towns and villages, as well as to individual farms.

5.2. Information from focus groups

Focus groups were conducted with four groups of participants: local architects, cultural heritage specialists and conservators, employees at the municipal spatial planning department, and the administrative unit staff (who grant building permits). Based on similar questions, which were slightly adapted to each group, insights were gained into the recognition of architecturally typical buildings and settlement forms in the municipality as well as the specific architectural elements, materials, and forms that are valuable and need to be protected and (re)presented.

In addition, important information was obtained on "disturbing" elements, poor-quality renovation, and new construction that has an adverse effect on spatial identity. Important differences were observed in the perception of the relationship between protection and allowing the introduction of new forms and foreign influences such as international design and generic building forms (e.g., very modern houses with flat roofs).

5.3. Results and feedback from the municipal administration

The results were synthesized through careful integration of information, photographic materials to illustrate best practices, and drawings to propose appropriate and inappropriate solutions. They were submitted to the municipal office in the form of a) expert bases—a compendium of detailed analyses and guidelines for individual settlements; and b) a manual or guidelines for renovating and building houses in the Municipality of Cerknica intended for owners, developers, architects, and builders.



Fig. 4 – *The information leaflet*: *Construction and Renovation in the Municipality of Cerknica* (Gantar et al., 2024).

Dissemination activities included a presentation to stakeholders, an information leaflet, and expert articles published in a local newspaper discussing

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the most important architectural elements and their preservation or interpretation in new construction. There was positive feedback, especially on the manual, which was printed as a booklet and is available for free (with a limited print run) at administrative units, the municipal office, and local libraries; a .pdf version is also available online and can be downloaded for free from the municipality's website.

6. Conclusion

The analytical work performed revealed a good state of cultural heritage and preserved architectural identity in most settlements, which, together with the distinctive landscape of the intermittent lake and its surroundings, form a specific and valuable place. There is also a strong sense of place evident among all the stakeholder groups, and individuals that were met on field trips.

The results, synthesized from fieldwork, GIS, and cabinet analysis, as well as a participatory process with various stakeholder groups, will only be effective if properly communicated and disseminated to relevant stakeholders. Preserving architectural identity and the quality of the living environment requires stakeholders to first recognize its value rather than uncritically reproduce generic designs.

Furthermore, comprehensive understanding of the typical architecture and settlement types extends beyond municipal spatial planning regulations. There is an urgent need to include this knowledge in the educational system and especially the architecture and urban planning programs at the university, where it has been increasingly (if not intentionally) neglected over the past decades.

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Between the Protection of the Urban Landscape and Cultural Tourism: Risks and Opportunities for the Painted Architecture of the Historic Center of Malaga (Spain)

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Abstract

The cultural legacy of the painted architecture constitutes an identity and unique urban landscape for the city of Malaga. However, it is currently highly modified and subjected to the demands of contemporary dynamics, especially in the face of uncontrolled tourism that affects the changes generated by the aggressive real estate dynamics in its historic centre. The vulnerability of this heritage is so great that it is doomed to disappear unless joint action is taken, and this type of research and knowledge is a manifestation of the implementation of strategies and opportunities that demonstrate its high heritage potential. The conservation of mural paintings, their effect on the colour planes, didactics and the incorporation of new technologies into the discourse of cultural tourism are the elements that constitute the axes on which our research is based. In this work, we present the technical work carried out for the cataloguing of the mural paintings in the historic centre of Malaga, an essential point of reference in all methodological processes of knowledge, treatment and enhancement of cultural assets. Our discourse also proposes, as an opportunity for the planning of a model for the development of cultural tourism, the incorporation of new technologies to add to the high degree of technification acquired by conservation and restoration in recent years, both in terms of scientific instrumentation and increasingly precise and sophisticated analyses.

Keywords: *mural painting; Malaga; catalogue; heritage; urban landscape; tourism*

1. Introduction. The mural paintings of Málaga in the definition and evaluation of the cultural landscape of the Baroque city

Painted architecture constitutes an urban landscape that has been modified over the centuries, at the same time as new planning and management instruments have been approved, such as the General Urban Development Plans and the Special Protection Plans, which have made it possible to guarantee its continued existence to the present day.

Starting from the concept of immovable heritage, we consider it necessary to transfer this extension not only to the buildings themselves, but also to:

> "Any elements that can be considered consubstantial with the buildings and form part of them or their surroundings or have formed part of them, even if they can be separated and form a perfect whole that can

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be easily applied to other constructions or to uses other than their original one" (Law 16/1985, art. 14.1).

Looking at the figure of the catalogue, we should point out that it is a complementary instrument of the Urban Planning Law 7/2021, of 1 December, in article 72, developed in terms of its purpose, preparation or registration in articles 95 and 112 of its Regulations, the first of which states that "the purpose of the catalogues is to complement the determinations of the general and detailed urban planning instruments relating to the conservation, protection, enhancement and improvement of elements of historical, cultural, urban, architectural, natural or landscape heritage".

Therefore, based on the following shared reflection as a working principle in the exercise of heritage protection, we understand cultural valuation as the origin of a working methodology that is progressively shaped and whose objective is to organize the processes of knowledge, reflection and characterisation of immovable heritage in order to establish criteria for action that guarantee compatibility between the safeguarding of heritage values and social function (Castellano et al., p. 37). These values have been forged as a result of continuous learning processes whose definitions may change over time, giving rise to great diversity in both the definitions of heritage resources and the associated values (Jokilehto, 2016).

However, the gradual disappearance of buildings belonging to the baroque period in Malaga, whose facades even include 'hidden' paintings, ornamental elements and other decorative resources, puts this unique pictorial heritage of Malaga at serious risk of irreparable loss. The protection of the urban landscape inherited from the baroque city is therefore a necessary exercise, the lack of knowledge of which is posing serious conservation risks and, consequently, the loss of heritage.

Taking into account the definition of the concept of value described by Jokilehto, we can say that values are fundamentally the product of human action, based on parameters found in the relevant socio-cultural and physical contexts. They are therefore the product of learning processes and need to be renewed by each generation of individuals. They are therefore not static, but subject to change over time and cultural times. In fact, values are not physically in heritage objects but associated with them through their recognition. Consequently, when approaching a place or a historical object it is necessary to start by assessing its current value, and in order to have a broader recognition, it will also be necessary to appreciate its history and becoming in time and its cultural context in the past, comparing it with other similar attributes and approaching a more recent heritage construction, that is, characterising it patrimonially.

In this way, cultural heritage values can be identified as layers of perceptions, associated with different aspects or attributes of the heritage resource (Castellano et al., 2024). In 2005, the Council of Europe adopted the Council of Europe Framework Convention on the Value of Cultural Heritage for Society, the so-called Faro Convention. This Convention defined the concept of heritage community, as a key element in the exercise of identifying and adjudicating values: "A heritage community consists of people who value specific aspects of cultural heritage that they wish, within the framework of public action, to maintain and pass on to future generations".

As a result, it is the community that is responsible for generating shared values associated with a particular heritage resource, be it an urban area or a cultural landscape. In this way, our efforts are aimed precisely in this direction, at giving a voice to the identity heritage of the city of Malaga, highlighting and recovering, through heritage protection, the value of the painted architecture of the Baroque city as a heritage resource and its projection into the contemporary city.

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This being our context of work in relation to heritage protection, we should mention how, from the 1990s to the present day, the historic center of the city of Malaga has needed time to recover its 18th-century painted architecture for collective memory and to value it as the unique cultural legacy that it is. At the end of the 20th century, the deterioration of both religious and civil buildings was evident, revealing a decadent city, then elegant and modern as a result of the industrial prosperity experienced in the 19th century. This inherited image of a modern city lacking in colour, in keeping with nineteenth-century aesthetic taste, was revealing the vestiges of eighteenth-century Malaga, where the constant loss of more modern plastering gave a glimpse of colored ornaments on the city's facades. (Fig. 1).



Fig. 1 – *Santiago church mural paintings, Málaga* (Royo, 2024).

With regard to the recovery of old coatings and their chromatism, interest in their protection arose in the aforementioned chronological framework, with pioneering interventions in Andalusian cities such as Cadiz and Seville, and particularly in the case of Granada with the facade rehabilitation programme in the Carrera del Darro by the architect Gárate Rojas (Gárate Rojas, 1996). In the case of the city of Malaga, the protection of relevant buildings, which prevented their destruction and therefore their paintings, although not their deterioration, was thanks to the General Municipal Development Plan of 1997 (BOJA of 26 July 1997) and the Special Plan for the Protection and Interior Reform of the Historic Centre of Malaga (PEPRI, 1992).

Other important milestones in the recovery of the paintings were the project entitled Plan del Color del Centro Histórico de Málaga (1996) by the architect Joan Casadevall or the research projects (1996 and 2000-2003) under the direction of Dr. Rosario Camacho where the painted architectures were inventoried and studied with a historical and artistic approach (Camacho Martínez, 2010).

In this context, the current General Urban Development Plan of Malaga (PGOU, 2013) includes in Title XII (art. 12.4.12) a list of 192 properties registered in the so-called 'Historic City' area and which have or are likely to contain 'Painted Architectures' that must undergo a specially regulated intervention for any licence for new construction, rehabilitation or demolition. Between 2021 and 2023, the Catalogue of Mural Paintings of Malaga was drawn up, revising, adapting and completing the list of mural paintings (art. 12.4.12), resulting in a selection and scanning of certain Malaga facades as a preventive conservation measure (Royo, 2023).

In the field of conservation of exterior painted architecture and its inclusion in colour plans, Barcelona was a pioneer with its slogan Posat guapa, which transformed a very different reality, thanks to Joan Casadevall and his team, who came to Andalusia. They were followed by Granada, and especially Malaga, whose General Urban Development Plan (2011) has given them specific treatment.

In general, progress was slow, with the exception of specific restoration or rehabilitation interventions that would support an element of this type. However, we do not recognise an interest in internationalising this cultural legacy

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which, due to its idiosyncrasy, makes it a unique opportunity to get to know Malaga's cultural heritage. For example, no two painted facades are the same, in order to stand out and become a brand of its own that would resize the cultural tourism image of Andalusian cities (Fig. 2).



Fig. 2 – *Mural paintings in Gaona Street, Málaga* (Royo, 2024).

2. Working context. Risks and opportunities of cultural tourism in historic cities in the 21st century

Among the new latent threats in historic centers are urban pressure and tourism as risk factors. The thin and delicate line that separates tourist enjoyment from heritage conservation generates a series of obscure and negative issues associated with phenomena such as the overtourism process of heritage or the loss of identity in historic cities (Fig. 3).

With regard to the role of colour in the process of heritage recovery in historic centres, it is known that the cultural legacy of painted facades is represented in a wide area of central, northern and southern Europe. An approach to the different territorial areas of Italy, Spain and Central Europe shows the importance of the integration of these painted architectures, making them part of the historical construction of their urban image. However, with few exceptions, urban regeneration plans do not show much interest in this cultural heritage. The recovery and conservation of these spaces should be carried out with the understanding and preservation of the principles that underlie the very image of the city.

This fact allows us to establish a scientific methodology of systematic studies of architectural and urban colour in order to establish the most appropriate conservation and treatment criteria for each case. In this way, we propose to maintain the unique characteristics of the urban environment, especially in areas of heritage interest such as historic city centres.

This methodology of colour studies for their integration into protection plans has only been applied in a few Spanish cities such as Barcelona, Malaga and Valencia, among others. In the case of Malaga, the actions carried out by the Archaeology Service of the Urban Planning Department stand out for the amount of work carried out to safeguard this heritage, and for its capacity to take on work that was hitherto pioneering even in terms of methodology, initially using the methodology of the Archaeological Risk Charter for facades with mural paintings.



Fig. 3 – *Tourists in the historic centre next to the Church of Santiago in Malaga, with mural paintings on its exterior* (Royo, 2024).

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However, many buildings with mural paintings on the facade correspond to popular domestic architecture that does not have architectural protection, and in some cases, their state of conservation is ruinous. Hence the need to promote preventive actions and new approaches to the protection also of those paintings identified in the interior of dwellings, establishing, when necessary, the carrying out of subsidiary actions among buildings declared to be in ruins.

3. The project. The protection of Malaga's mural paintings as a challenge for the protection of urban heritage

The conservation of mural paintings, their influence on colour plans, as well as didactics and new technologies incorporated into cultural tourism are the backbone of our work, the result of the project carried out by the research group of the University of Seville HUM1050 in collaboration with the 360 BIM Architecture studio.

Since the end of the 20th century, a strategy of approaching cultural heritage has been considered not so much as an isolated object or set of objects, but as a continuous complex reality in which action is taken on plots of land with diffuse limits.

This intervention methodology forces us to work on the generation of knowledge and transversal views, from different disciplines that add and contribute to the complex heritage fact with which we work. For all of the above reasons, from the beginning of the work of drafting the Catalogue, it was proposed as a fundamental principle to draft a preliminary research phase, capable of providing the necessary knowledge to address the future intervention on a set of real estate assets that represent a series of unique values whose importance and uniqueness make the work we are dealing with significant. (Fig. 4).



Fig. 4 – *Mural paintings church of San Agustín, Málaga* (Royo, 2023).

Technical and scientific research assumes the methodology of the heritage project, including in a collaborative and coordinated manner the work and research from different disciplines, still in progress and to which this cataloguing project is incorporated. In this way, the methodology is the result of multidisciplinary work and includes different sections that address the following tasks: knowledge based on research and field work, valuation of the assets, diagnosis, definition of criteria (for protection, intervention and/or restoration) and a working framework for the proposals set out.

The research carried out was also aimed not only at defining the instrument for the protection and preservation of the mural paintings of the 'Historic City', but also at limiting the risk of loss of this unique heritage and establishing a systematic knowledge of the mural paintings already recovered. In this context, the following specific objectives are proposed:

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- To catalogue individually the properties with facades with recovered mural paintings.
- To make an inventory of the buildings which, although not recovered, leave visible pictorial remains which make them susceptible to protection.
- Inventory newly located buildings that are likely to contain mural paintings as they present formal elements characteristic of this period (ceramic gutters, balcony ironwork, etc.) on their facades.
- Exclude the properties in which it has been found that the paintings do not exist and should therefore be removed from the list.
- Select the most relevant and suitable facades for 3D scanning.

The Catalogue of Mural Paintings of Malaga (2023) represents an advance in terms of precision in the classification of properties with respect to the list of mural paintings (art. 12.4.12). The catalogue includes a list of buildings with recovered wall paintings and those likely to contain them. The latter buildings are included because possible remains of paintings can be seen or because they present elements characteristic of buildings from the Baroque period. In this way, the proposed list presents a reasoned classification, divided into five groups: A. Buildings with mural painting on facades. Intervened, B. Buildings with mural painting on facades. Not Intervened: visible or tastings carried out, C. Paintings removed and restored not on the original facade, D. Susceptible and E. Out of catalogue.

The catalogue is in itself a conservation tool that contributes to preserving the identity of the city. In addition to this, there is another complementary instrument that provides a still photo of the mural paintings, by means of a 3D survey of 13 facades from among the 73 buildings listed as buildings with mural paintings on intervened facades (group A). The selection of these buildings is based on the following criteria: relevance of the ornamental repertoire (Constitución, Plza. 13-14 or Consulado del Mar, Montepío de Viñeros), relevance of the building



Fig. 5 – *Taking of scanning points Arco de la Cabeza, cl. 2, Virgen de las Penas, Plza. 5* (360BIM, 2021).

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(Convento de Santo Domingo, Iglesia de San Felipe Neri), stylistic variety of the mural paintings (Carretería, cl. 23 corner Postigo de Arance cl. o Carretería, cl. 42 corner Puerta de Antequera), accessibility (Arco de la Cabeza, cl.2- Virgen de las Penas, Plza.5) and opportunity (Fresca, cl.8).

In the practical case of Malaga and the digitized facades, the methodology used has opted to work with the Leica-RTC360-3D Reality Capture Solution laser, capable of allowing scanning at 2,000,000 points per second and advanced HDR image system, in the creation of 3D point clouds in colour, allowing its completion in less than 2 minutes, a range of up to 130m and an accuracy of 1mm at 10m. with 3 HDR 360 cameras that generate a combined image of 345MPx (Fig. 5).

For the captures, at least three positions of the building were taken to achieve an accuracy of 1mm. The point cloud created by the laser scanning made it possible to generate a BIM model of the current state of conservation (a process known as Scan to BIM). This model (Fig.6) has been used to establish the current state and the main dimensions of the paintings and elements to be analysed, which would be difficult to obtain by other means.

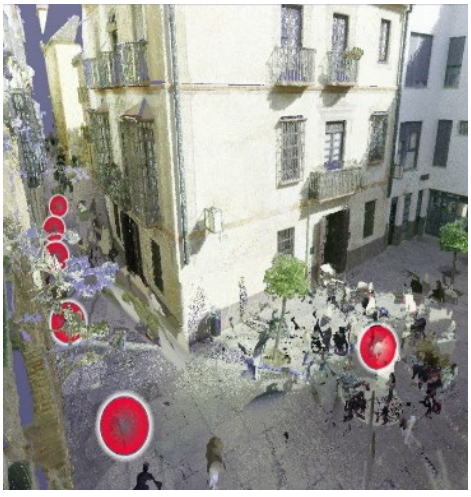


Fig. 6 – *Example of scanning process* (360BIM, 2021).

4. Conclusions

The conservation and recovery of architectural heritage is a priority for heritage management, a sign of identity and added value for future cultural proposals in terms of sustainability.

The incorporation of new technologies plays an increasingly relevant role in the intervention work, being an essential reference in all methodological processes of knowledge, treatment and enhancement of cultural assets, given the high degree of technology acquired by conservation and restoration in recent years, both in terms of scientific instrumentation and increasingly precise and sophisticated analysis.

There is still much work to be done, especially when it comes to including both aspects of heritage conservation in the same experience. In relation to the degree of innovation of the work presented, it is important to point out that never before have studies like the one we present been carried out in the specific case of mural painting in the city of Malaga, where, in addition to the pathologies obtained, a complete knowledge and approach to the state of conservation of the property in its urban context and its landscape could be collected and identified.

The evolution of the historic center of the city of Malaga, the changes brought about by urban planning, changes in aesthetic tastes over the centuries, health needs at certain times and climatic events have had a significant effect on the conservation of the mural paintings on the façades of buildings dating from the 18th century and belonging to the Modern Age, and have meant an increasing risk to their conservation. Preserving this type of heritage requires conservation policies backed by specific conservation plans. In the case of Malaga, the instrument tendered is the Catalogue of Mural Paintings of Malaga (2023), as a measure for the conservation, protection and improvement of the architectural heritage.

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Within this context, the company 360BIM has scanned the facades that, according to defined criteria, have been proposed as significant and representative of the architectural pictorial panorama in order to capture not only the essence of the past but also to contribute to the digital conservation of this unique heritage. This is an important step forward in documenting and recording the current state of conservation of the buildings, being a document of great relevance for the study, monitoring and evolution of deterioration and facilitating future assessments of the state of conservation. Although the field of cultural heritage is full of intentions related to digital approaches and community engagement, there is still much work to be done, especially when it comes to including both aspects of heritage conservation in the same experience and recognition of the community's heritage value (Royo, 2022).

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Cultural Agrarian Landscapes: the case of the Valencian Citrus Fields as a GIAHS candidate (Spain)

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Abstract

The concept of cultural landscape has garnered significant interest in heritage studies, valued particularly for its ability to enhance citizens' quality of life. In an increasingly homogeneous world, agrarian landscapes are at risk of disappearing, as urban dynamics and socio-economic pressures lead to the abandonment of small-scale farming activities, dispersed habitats, and traditional knowledge. This increases their vulnerability and threatens the loss of landscape diversity that has historically characterized the Valencian territory. Orange cultivation in Ribera Alta (Valencian Community) has shaped a distinctive landscape closely tied to Valencian identity. This paper presents a diagnostic assessment to evaluate its potential designation as a Globally Important Agricultural Heritage System (GIAHS) by the Food and Agriculture Organization of the United Nations (FAO). The GIAHS designation would serve as a strategic tool for enhancing the value of this cultural agrarian landscape and preserving its tangible and intangible heritage.

Keywords: *cultural landscape; agricultural heritage system; architecture; preservation; GIAHS; Valencia*

1. Introduction

The Valencian territory boasts a rich landscape, shaped over time by the cultures that have passed through it (Hermosilla Pla, 2017). In recent decades, the survival of landscapes has been affected by the expansion of urban areas and current socio-economic circumstances, leading to the abandonment of small-scale agricultural activities, scattered rural habitats, traditional knowledge and the deterioration of associated heritage assets. In this regard, the concept of heritage, increasingly moving away from being perceived as a mere passive monument, has proven to be a powerful catalyst for the economic and social development of a territory.

The figure of landscape, defined as the expression of the interactions between natural and cultural processes (UNESCO, 1992; Rivera Blanco, 2010; Cárcamo, 2024), gains special significance when understood as part of a territorial system, as it has the potential to improve the quality of life of local populations, strengthen social cohesion, and reinforce a sense of belonging (Hermosilla Pla, 2017). In 2005, the Food and Agriculture Organization of the United Nations (FAO) proposed a management strategy

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through the Globally Important Agricultural Heritage System (GIAHS) designation for the agro-cultural landscapes. These landscapes not only represent tangible manifestations of specific agricultural practices but also embody ways of life, traditions, and identities that have left their imprint on the territory through architectural and ethnological heritage. The GIAHS designation is an effective tool for valuing both tangible and intangible heritage. Additionally, these landscapes offer a range of solutions to contemporary challenges, aligning with the Sustainable Development Goals of the 2030 Agenda (Koohafkan & Altieri, 2011).

The Valencian landscape of Ribera Alta refers to a complex system where different components interact (agricultural matrix, historical structures, local stakeholders, farmers, etc.). This agrarian system, based on citrus cultivation, has shaped the current dynamic landscape, which is increasingly threatened by socio-economic conditions that could lead to its disappearance. The citrus landscape extends in the Valencian region along the coastal plain of the Gulf of Valencia, from La Plana in the north to La Safor in the south, although its origins are primarily traced to Ribera Alta (Fig. 1), particularly to Alzira and Carcaixent (Besó Ros, 2015).

2. Objectives, methodology and study area

The main objective of this work is to assess the potential of this Ribera Alta landscape as a candidate for the FAO's GIAHS designation, as well as to provide a series of future recommendations for initiating the nomination process, thereby highlighting the potential of this framework as a tool for the valorization of agricultural landscapes (Arnés et al., 2020). The study area is located south of the Júcar River, where the land borders the historic irrigation area of l'*Horta de València*. It is a historically peri-urban agricultural zone that forms part of four municipalities in Ribera Alta: Alzira, Carcaixent, Polinyà del Xúquer, and Corberà. This geographical area covers a total of 7,319 hectares dedicated to citrus cultivation (Generalitat Valenciana, 2022).

Our methodology followed the approach outlined in the *National Plan for Cultural Landscapes* approved by the Spanish Ministry of Education, Culture, and Sports in 2012. This plan draws on precedents such as the World Heritage Convention (UNESCO, 1992) and the European Landscape Convention (Council of Europe, 2000), which marked a turning point in the recognition and consolidation of cultural landscapes.



Fig. 1 – *Overview of* Els Horts de Tarongers *landscape in La Ribera Alta from the San Blas viewpoint (Carcaixent)* (Lozano Muñoz, 2024).

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The starting point of this research was a previous inventory of *Els Horts de Tarongers* (Besó Ros, 2015). Due to the extensive geographical area and the number of existing heritage assets, a subsequent selection was made of those examples located in Ribera Alta. This area represents the quintessential landscape of orange groves, having preserved its genuine characteristics, and is therefore proposed as the study area for a future GIAHS nomination. The general inventory of *Els Horts* includes a total of 822 orchards, of which 532 heritage assets belong to the study area (Lozano Muñoz, 2024).

3. The cultural landscape of *Els Horts de Tarongers*

During the 18th century, Valencian agriculture underwent an intensification process aimed at increasing production, leveraging existing hydraulic infrastructures to expand irrigated areas. However, by the middle century, traditional irrigation systems had reached their limit, leading to the transformation of the surrounding drylands. It was in this context, in the mid-19th century, that Carcaixent and Alzira turned their attention to citrus farming, particularly orange cultivation. The expansion of this crop was made possible by the convergence of several factors: agricultural advancements stemming from the Industrial Revolution, and improvements in transportation infrastructure, which enabled the transformation of citrus-growing communities. The emergence of an agrarian elite within the bourgeoisie played a decisive role, as they were responsible for disseminating technological advancements throughout the production chain (Besó Ros, 2015). Valencian agricultural history is marked by continuous technological and human innovation. Through trial and error, farmers optimized citrus cultivation, and unlike other regions where agricultural development led to a break with tradition, Valencia sought to merge agronomic tradition with the technological advancements of the Industrial Revolution fostering social cohesion and ensuring the success of the agricultural model. The impact of orange cultivation extends beyond economics, as it has also had a profound cultural and symbolic influence. Its presence in the Valencian agricultural landscape has been appreciated not only for its productivity but also for its aesthetic value, making it a symbol of identity for Valencians, both regionally and internationally.

This situation gave rise to an agrarian system characterized by the construction of agricultural estates featuring distinctive architectural and ethnological elements, known as *horts de tarongers* (Fig. 2). These estates are easily identifiable and can be found along the Valencian littoral plain.

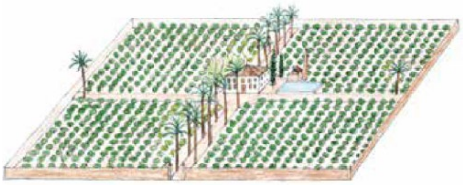


Fig. 2 – *Representative drawing of the ideal bourgeois orchard type, consolidated by the late 19th century* (Besó Ros, 2012).



Fig. 3 – *Hort del Castell (Alzira)* (Besó Ros, 2015).

The house is the key reference point around which the orchard elements are arranged. Together with the *balsa* (irrigation ponds) and the waterwheel or motorized pump, it constitutes the essential set of components that define the traditional orange orchards. The house itself follows the architectural typology of the scattered rural settlements in Valencia. However, due to

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the background of its owners, urban elements such as promenades, gardens, and even the emulation of architectural styles such as Art Nouveau or Gothic Revival were incorporated into the rural environment (Fig. 3). This resulted in a unique architectural heritage, reflecting the aspirations of the bourgeoisie to associate themselves with this landscape (Besó Ros, 2015).

4. Diagnostic analysis for GIAHS

The historical review underlines the heritage value of this orchard landscape, demonstrating that *Els Horts de Tarongers* are the result of:

- A landscape shaped by citrus farming, with significant environmental values.
- An agricultural system based on citrus cultivation, primarily oranges, which evolved through the experimentation of Valencian farmers into a resilient system capable of withstanding historical challenges. It has been preserved to this day through the traditional knowledge of the communities linked to it.
- The expansion of this groundwater-based agricultural system, resulting in a cultural landscape with architectural and hydraulic infrastructure that are key to the region's collective identity.
- An orange-growing culture that has inspired various artistic expressions and remains a strong part of communities' identity.

Based on a detailed analysis of the heritage assets (Lozano Muñoz, 2024), we examined the current situation of these landscapes in order to assess the viability of a future GIAHS candidacy, identifying the strengths to preserve and the weaknesses to address. The diagnostic main results are presented below, structured according to the FAO's criteria for GIAHS designation: a) food security and livelihoods; b) agrobiodiversity; c) local and traditional knowledge systems; d) culture, value systems, and social organizations; and e) landscape (FAO, 2022).

4.1. Food and livelihood security

The orange orchard system in Ribera Alta is a key source of economic livelihood. Its structure (Fig. 4), based on small-scale holdings (Hermosilla, Pla & Membrado-Tena, 2018), has contributed to preserving the traditional morphology of the territory, while also enabling a fairer distribution of land and wealth (Asociación de Productores de Cítricos Ecológicos de Minifundio Histórico de la Ribera Alta del Río Júcar, 2021). However, the decreasing profitability of orange cultivation has led to the abandonment of many orchards, directly affecting both the landscape and the preservation of traditional architecture. In this context, the GIAHS designation emerges as a tool to revitalize this agricultural system by highlighting its uniqueness and supporting its sustainable continuity.



Fig. 4 – *Subdivision of the property in an orchard (Alzira)* (de los Dolores, 2023).

4.2. Agrobiodiversity

This agricultural landscape has preserved local citrus varieties that have evolved and adapted to the specific environmental conditions of the territory, offering not only remarkable biological value but also creating a rich visual and olfactory landscape. Farmers and agricultural technicians actively contribute to maintaining agrobiodiversity and the system's resilience. In contrast, monoculture and a limited number of varieties increase vulnerability to pests, climate variability, and market pressures.

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Through the cultivation of diverse citrus varieties, Valencian farmers not only extend the harvest season but also strengthen the system's capacity to adapt to climatic, economic, and health-related variables.

4.3. Local and traditional knowledge systems

The first published manuals on citrus farming were written by Valencian authors, who pioneered several cultivation techniques that are still in use today. These have supported a productive model that is both efficient and ecologically integrated. From the morphology of plots to water infrastructures (irrigation ponds, pumps, wells), every component reflects an accumulated traditional knowledge that has shaped the landscape.

The loss of this knowledge—due to the aging agricultural population and lack of generational replacement—threatens not only the productive system but also the cultural dimension of the landscape. A GIAHS nomination would support the documentation, protection, and transmission of this knowledge as part of the region's living heritage.

4.4. Culture, value systems, and social organizations

Orange orchards have transcended their productive function to become a symbol of Valencian identity. This landscape has inspired artists, writers, and painters, consolidating its presence in the collective imagination. A clear example is found in the literary works of Vicente Blasco Ibáñez (1867- 1928) and the paintings of Joaquín Sorolla (1863-1923) (Fig. 5), which reflect the cultural significance of the Valencian citrus landscape as Viana Arroyo (1999) stated.

Some municipalities in Ribera Alta have shown their desire to reconnect with this landscape, much as they did in the 19th century. For example, Carcaixent has incorporated orange in its tourism identity, as reflected in the ceramic panel at the town entrance, which proclaims it as *Bressol de la Taronja* (Cradle of the Orange). Additionally, the local population has historically identified as heirs to the orange-growing tradition, showcasing their architecture through guided tours and marketing their harvest using traditional methods, such as in *Hort de Ribera*.

The organization of gastronomic fairs and cultural events related to citrus farming further strengthens society's connection to the agricultural landscape, promoting the consumption of local products and raising awareness of their value. One example is the *Carcaixent Modernist Fair*, which has already held ten editions, showcasing various historical buildings that reflect the urban regeneration brought about by the golden age of orange cultivation in these towns.



Fig. 5 – *Entre naranjos* (Sorolla, 1903; Museo Nacional de Bellas Artes de Cuba).

4.5. Landscape

The Ribera Alta landscape is characterized by the integration of natural and built elements, such as bourgeois villas associated with the orchards. This fusion of natural and cultural heritage creates high-value spaces, many of which are still preserved.

Land use and ownership models shaped the architectural typologies of this landscape. Some properties belonged to bourgeois families who used them as summer residences (Fig. 6). Within this typology, the architectural character of the historical orange grove is most clearly defined, incorporating ornamental and structural elements from the urban context into the rural landscape.

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Fig. 6 – *Villa Ángeles (Alzira)* (Besó Ros, 2015).

Another identified typology consists of modest homes built by caretakers or smallholders who settled in the orchards to better manage the crops. In Carcaixent, we cand find the so-called *casas d'hortet* (Fig. 6), modest structures inhabited by families who, with the spread of orange cultivation, sought to generate economic return from the orchard through family labor.

These buildings often reflect hereditary divisions of land, whereas larger or medium landowners could leave entire groves to their descendants. The subdivision of land among multiple families led to the formation of clustered housing units.

Even in the simpler structures, there is a clear effort to maintain aesthetic coherence, reflecting a desire to be linked to the citrus landscape not only as a sign of status but also as an expression of deep-rooted local identity.

The morphology of the orchards is closely linked to water extraction methods which have given rise to interesting elements of ethnographic heritage, many of which are still in use today. Initial citrus cultivation expanded into easily irrigable lands, but as it spread to more challenging terrains, like barren hillsides, traditional wooden waterwheels were replaced with iron ones capable of greater water lifting capacity. This expansion, driven by advances in agronomic practices and improvements in transport infrastructures, led to an increase in isolated buildings within the orchards, contributing to the consolidation of a true cultural landscape.

In addition, other irrigation elements like ponds and canals are key features of this landscape. Originally built with masonry and lime mortar, these structures are essential for understanding the historical relationship with water. Beyond their technical role, they also contribute to the sensory experience of the landscape, evoking the concept of the Valencian productive garden, which merges Christian and Islamic cultural influences. Fountains, spouts, and artificial ponds highlight water as both a resource and a symbolic element.



Fig. 7 – *Hort del Castell and its surrounding environment (Alzira)* (Besó Ros, 2015).

Visually, the orange trees—typically three to four meters tall—limit panoramic views unless observed from elevated points. This is particularly evident in Ribera Alta, where many orchards are enclosed by masonry walls. As a result, vertical elements such as date palms or steam pump chimneys serve as visual landmarks that break the landscape's horizontal rhythm. Also, balconies and porticoed terraces are frequently found in this type of architecture, as they not only provide an expensive panoramic view of the surrounding landscape -which offered aesthetic pleasure to the owners- but also served to underscore their integration into it. In some cases, *miramar* towers were constructed, further accentuating the bourgeois character of these buldings (Fig. 7).

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5. The landscape preservation

The low profitability of the orchards directly affects the sustainability of the agricultural system and the preservation of architectural heritage. Many farmers cannot afford the upkeep of traditional structures, and part-time farming has led to the replacement of historic agricultural systems with modern alternatives.One of the core principles of heritage conservation is awareness-raising initiatives. While orange fruits are highly valued in Valencia, there is a notable lack of public recognition regarding this type of cultural landscape.

Urban sprawl (Fig. 8) and agricultural abandonment (Morrell Monzó & Garófano Gómez, 2022) further threaten the landscape, creating abrupt transitions between urban and rural areas and disrupting both the original spatial context and the visual perception of the orchards.



Fig. 8 – *View of the Hort de San Fernando, located next to a hostel from the Domus hotel chain (Carcaixent)* (Lozano Muñoz, 2024).

To preserve this cultural landscape, it would be advisable to conduct detailed studies of its cultural assets, incorporating architectural and ethnological features into public protection catalogs, and promoting the restoration of orchards at risk. At the same time, initiatives to raise awareness of this unique architectural identity should be encouraged. Open House events and agrotourism visits, as already implemented in some local orchards, could serve as valuable tools to reconnect the public with this heritage.

6. Conclusions

The evaluation of an cultural agrarian heritage landscape is becoming increasingly important in a globalized world that threatens landscape diversity. This work has identified, on the one hand, positive aspects to preserve and promote the Valencian cultural landscape of *Els Horts de Tarongers* as a GIAHS designation. There are numerous tangible and intangible assets associated with Valencian society in this landscape, which have shaped collective memory and identity both internationally and at the regional level. This study also highlights that the landscape is a living environment, playing a fundamental role in local community cohesion and enhancing quality of life. This identity has particularly endured in certain municipalities of Ribera Alta, as a Carcaixent and Alzira. Despite the difficulty of finding landscapes that have remained unchanged in the face of contemporary challenges, no radical transformation has occurred in this pilot territory (Fig. 9), as modern elements have not overtaken traditional ones.

As a final thought it should be noted that in this territory the landscape is a cultural synthesis that should not be viewed solely from the perspective of resource extraction. Shaped by traditional farming systems, it also has the potential to add value to agricultural production through quality differentiation and environmentally respectful practices. However, for such a system to be truly sustainable, it must offer farmers the possibility of earning a living from it as their primary occupation.

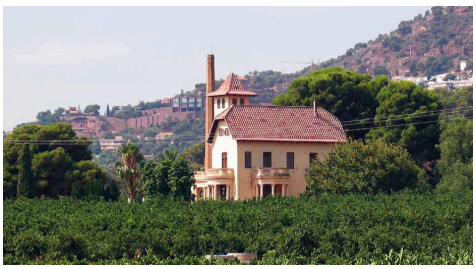


Fig. 9 – *Alquería de Pinós (Sagunto)* (Lozano Muñoz, 2024).

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International recognition would distinguish this agricultural system and attract niche markets that value orange cultivation as a strategy to promote local, ecological, and traditional trade. This, in turn, would ensure the preservation of this verdant Valencian landscape.

Nevertheless, some weaknesses have been reported that must be addressed and this study represents the first step on the roadmap for a future candidacy.

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From Village to Sky: Analysis of the Historical Evolution and Heritage of Benidorm (Alicante, Spain)

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Abstract

From the 1960s onwards, Benidorm (Alicante, Spain) established itself as an international tourist destination after undergoing an accelerated urban transformation that has presented challenges and opportunities for the preservation of its cultural and architectural heritage. Although its historical roots date back to the 14th century, the growth of tourism in the 20th century and the proliferation of skyscrapers have generated an urban landscape characterized by a striking contrast between its traditional and contemporary heritage. This study seeks to understand this complex urban evolution and its impact on Benidorm's cultural identity through historical analysis and its traditional and modern heritage features. Firstly, a historical study is carried out through the compilation of writings, plans, and photographs documented up to the present day and a detailed analysis of the urban evolution of the town, considering factors such as economic development, urban policies, and the transformation of land use. This is followed by a qualitative analysis of traditional heritage, which includes historic buildings and urban elements of cultural value, and modern heritage, represented by skyscrapers and other contemporary constructions that have redefined the city's urban profile. The study highlights how both types of heritage, although sometimes perceived in tension, are now an integral part of Benidorm's identity. This analysis seeks to contribute to the definition of strategies to balance the conservation of traditional heritage with the valorization of modern constructions, promoting a sustainable and respectful approach to the cultural and architectural richness of the city.

Keywords: *Benidorm; history; evolution; heritage; skyscrapers*

1. Introduction

Benidorm is undoubtedly one of the most emblematic cities on the Spanish Mediterranean coast. The transformation from a small fishing village to a tourism giant has been as incredible as it has been controversial. Today, the town faces a complex dilemma: How can tourism development be balanced with the preservation of our historical and cultural identity? The massification of tourism and the growth of infrastructures bring with them unquestionable economic opportunities, but also a challenge for the conservation of its heritage, in line with the ICOMOS International Charter on Cultural Tourism (2022), which emphasizes the

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importance of balancing tourism development with the preservation of cultural heritage. There have been many occasions on which the city's historical heritage has been enhanced since the beginning of the 21st century.

However, the imposition of coexistence with climate-driven tourist interest and the city's own eccentricity, linked to leisure and entertainment tourism, has meant that the balance between heritage and novelty is not always balanced.

2. Methodology

The aim of this article is to analyse the historical and urbanistic evolution that has developed in the municipality of Benidorm, identifying its main changes over the centuries in order to understand its current layout. The aim is to analyse whether these changes have been beneficial for the town from a sustainable perspective.

First, a compilation of historical sources is carried out, namely: archival documents of the competent authorities in the different periods of the town of Benidorm; interviews with local descendants of historical figures, such as the son of the mayor Pedro Zaragoza Orts; visits to historical records; analysis of the documentation provided by the Department of Heritage and 20th century plans provided by the Department of Urban Planning; study of the different current urban and political plans; and collection of readings and testimonies of various Benidorm protagonists over the last 70 years.

Subsequently, an analysis is made of the typological differences collected between the dwellings of the early and mid-20th century and those developed after the great tourist boom that began in the 1960s, highlighting the Assets of Cultural Interest that appear in the inventory of Benidorm's Heritage, with the aim of finding a balance between the old heritage and the contemporary style with skyscrapers in the city. Finally, an understanding between contemporary and historical architecture is sought, creating strategies that enhance sustainability between the variety of cultural and architectural heritage typologies in Mediterranean tourist towns.

3. Evolutionary analysis of Benidorm

The town that is now Benidorm also originated, like many of the Spanish villages in the Mediterranean area. However, there was a turning point in the 1950s, which radically changed the vision of *pueblo* to begin its transformation into the contemporary city.

3.1. Historical origins

3.1.1. Until the 14th century

The Roman fort of Tossal de la Cala has been the subject of reinterpretation (Bayo Fuentes et al., 2021) and, subsequently, of a villa founded by the Muslims. From them comes the current etymology of "Benidorm'. Originates from the Arabic word 'beni', which means 'sons of' and has been used by many other villages in the Valencian Community. The words following 'beni' referred to the name of the clan that inhabited the place.

Despite this, the fact is that the name 'Benidorm' does not appear in the documentation before the Christian conquest of Xarq al-Andalus by King James I of Aragon, nor does it appear during the reconquest. This is recorded in the chancellery records of James I the Conqueror and Peter the Great.

The First Town Charter of Benidorm, granted on 8 May 1325 by the feudal lord Bernat de Sarrià, marked the official foundation of the town, which, in this year (2025), celebrates its 700th anniversary. This document established the rights and duties of the first settlers, with the aim of repopulating and strengthening the territory after the Christian conquest of the region.

Among its provisions, the Charter guaranteed land to the new inhabitants and regulated economic activity (especially fishing and agriculture).

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3.1.2. From the 14th to the 20th century

After the first Town Charter, the town, made up of several fishing and farming families, was settled for approximately 100 years, but in the 15th century, Benidorm was depopulated due to the pirate attacks that ravaged the town and its castle.

It was not until the 17th century that, thanks to the improvement of coastal defences and the progress of fishing, Benidorm was once again consolidated. Due to the great expansion of the almadraba fishing technique, its population increased progressively and by the end of the 19th century it had almost 4,000 inhabitants (Fig. 1). This figure dropped to 3,000 inhabitants during the crisis caused by the loss of the last overseas colonies, which generated the emigration of the population to Cuba, Barcelona or Cadiz at the beginning of the 20th century (Fig. 2). All demographic data are from population censuses extracted from the Instituto Nacional de Estadística - Series históricas de población.

Around 1925, the first villas were built in the area of Playa de Levante (Fig. 3). In the 1950s, however, the first steps towards a real transformation were taken (Fig. 5).



Fig. 1 – *The Poniente beach and Benidorm in the background. Except for the road on the left, the rest of the landscape was quite like that of 1834* (Soler, 1894).



Fig. 2 – *Playa de Levante in 1910* (Municipal Archive of Benidorm).



Fig. 3 – *Playa de Levante in approximately 1930* (Municipal Archive of Benidorm).

On the one hand, in 1952, the Almadraba del Racó de l'Oix (translated as smelly corner) was closed due to low yields, which was traumatic for many families dependent on it; but, on the other hand, in 1956 the Town Council approved the town's urban development plan with the aim of creating a town designed for tourist leisure.

According to the article *De la caña de pescar a la sombrilla* (Ordoñez Sánchez & Rovira Mateu, 2013), an article provided by the University of Alicante: “These were years of progressive growth due to the change in the legal economic system, which abandoned the primary sector (fishing and agriculture) and opted for the tertiary sector (tourist services)” (Translated by authors).

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3.2 The tourism boom (1960s)

This great change can practically be attributed to Pedro Zaragoza Orts[1]. The idea of attracting tourism to a town like Benidorm by conceiving a General Urban Development Plan as if it were the capital of the country itself might have sounded crazy in that context.

Benidorm had no more than 3,000 inhabitants and its urban fabric, the historic quarter, did not exceed 12 hectares of land occupation, coinciding to a large extent with the current historic quarter (Fig. 4).

Mayor Pedro Zaragoza created the new urban footprint, extending the occupation of the territory along the entire coastline (Fig. 6).

The plans designed in 1955 opted to divide plots in a reticular way in the Levante area and in a freer way in the Poniente part (Fig. 8). In this way it could effectively take advantage of the geography that enriches and characterises Benidorm.

In addition to its geography, it is located in an environment protected by three natural barriers to the north, east, and west, with the coast facing south. Being located in the upper half of the planet, the hottest climate approaches from the south, so that Benidorm enjoys good weather for most of the year (Fig. 7).

In the process of growth of the city from the PGOU onwards, several milestones were proposed that put Benidorm on the map in a touristic way (all promoted by Mayor Pedro Zaragoza), which had great national and international popularity thanks to their media repercussion.



Fig. 4 – *Aerial photograph of Benidorm in 1938. A similar urban layout remained until the 1950s* (Municipal Archive of Benidorm).



Fig. 5 – *Aerial photograph of Benidorm in 1955* (Municipal Archive of Benidorm).

[1] Pedro Zaragoza Orts (1922-2008). Mayor of Benidorm during the Spanish Franco era between 1950 and 1966. He is considered one of the visionaries who turned Benidorm into the media and tourist town it is today.

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Fig. 6 – *Aerial photograph of Benidorm, Levante area, the land has already been divided into plots and the main avenues have been laid out, although they are not yet asphalted. End of the 50s* (Municipal Archive of Benidorm).

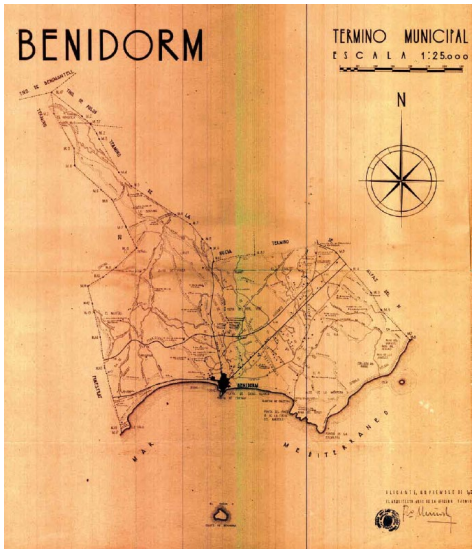


Fig. 7 – *Plan of the limits of Benidorm in 1955. The only residential occupation at the time is the black spot in the southern area* (Municipal Archive of Benidorm).



Fig. 8 – *Plan of the PGOU of Benidorm in 1955* (Municipal Archive of Benidorm).

Some of these historical milestones, such as the Bikini decree in 1953, the Spanish Song Festival in 1959, or the modification of the General Plan for the free height in 1963, were consolidated as a key link in the history of Benidorm.

The latter was a decisive factor in the urban development of the city. It freed up the height limit without changing the size of the plots; all the buildings on the beaches were left free-standing and overlooking the sea, without creating screens, which promoted a model of intensive land occupation, avoiding sprawl. It meant savings in energy and travel.

The new building height had a significant impact on Benidorm's economy. The accommodation capacity multiplied, allowing the town to receive a greater number of tourists and residents, generating employment in the construction sector, the hotel and catering trade, commerce, and tourist services.

4. Heritage analysis in Benidorm

4.1. Traditional heritage

4.1.1. Pre-20th century

In Benidorm, there are three Assets of Cultural Interest listed in the General Inventory of Valencian Cultural Heritage.

Firstly, the site of Tossal de la Cala, whose first bibliographical references date back to 1853, when the cartographer Federico de Botella y de Hornos indicated that there were ruins of a Roman settlement at the top of La Cala.

It was not until a century later that archaeological remains from the Iberian period were found, excavated between 1944 and 1951.

According to the first excavators, it was a settlement from the 2nd and 1st centuries BC, although research in 2013 showed that it was in fact a Roman fort from the 1st century BC, the remains of which can still be visited (Fig. 9).

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On the other hand, there are also two fortified towers of noble foundation from the second half of the 14th century, Torre Morales and another from the 15th century, Torre Punta de Cavall, created for strategic reasons to defend against the continuous coastal attacks by pirates. The towers are made of irregular masonry plastered with lime mortar.

Both are still standing today, although in the Punta de Cavall Tower, only the solid section of the base remains standing up to a height of approximately 7 m (Fig. 10). It is likely that the watchmen's quarters were located on top of it, as has been documented in other neighbouring towers.

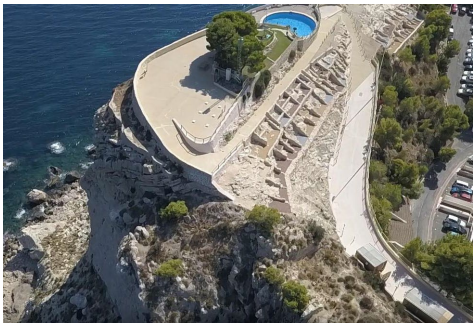


Fig. 9 – *Current aerial photograph of Benidorm, archaeological site in the Tossal de la Cala* (Municipal Archive of Benidorm).



Fig. 10 – *Current aerial photograph of the Punta de Cavall Tower* (Municipal Archive of Benidorm).

4.1.2. Historical centre of the 20th century

The housing typology of the early 20th century in Benidorm responds to the local materials and traditional techniques of the area. Consequently, masonry load-bearing walls, sloping roofs with Arabic tiles, tiled floors, and wooden carpentry are common. In the past, these houses housed rural communities whose economic base was based on agriculture and fishing.

These houses were usually structured around a courtyard, although over time, these houses evolved by adapting their form to their function. They stopped needing the courtyard as a corral due to the rise of commerce during the 20th century and inserted the bathroom inside the house for reasons of health and comfort, thanks to the arrival of drinking water.

After studying various traditional dwellings within the historic centre of Benidorm, the outline of a plan of a dwelling has been drawn, which encompasses the generalities of this typology at the end of the 19th century (Fig. 11).

Few of these dwellings remain today (Fig. 12), as after the tourist expansion of the 1960s, they were rebuilt in the style of the period. The change from traditional materials to the new industry in order to achieve greater height in the buildings was significant and a turning point in the way of building in Benidorm.

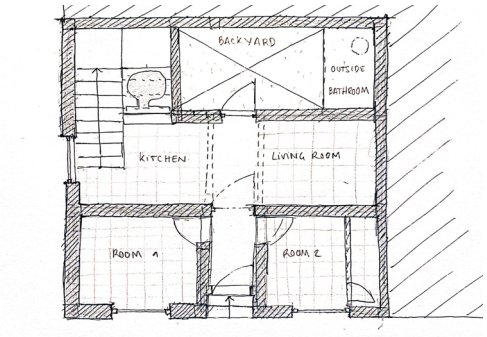


Fig. 12 – Plan of a traditional 19th and 20th century house in Benidorm, this particular plan corresponds to the house at 41 La Palma Street. (Piqueres Martínez, 2025).

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Fig. 11 – *Photograph from the 1940s of a street looking towards the castle and the island* (Municipal Archive of Benidorm).

4.2. The contemporary city

The implementation of the PGOU in 1957 allowed a greater development in the height of buildings, favouring that a large part of the traditional dwellings was transformed or replaced by buildings of 4 or 5 floors in height, with industrial materials and techniques. At the same time, urban planning contributed to the construction of taller buildings in the expansion areas. In a first phase, they reached about 10 storeys using different solutions of reinforced concrete arcades or metal structures.

However, as the buildings grew in height and exceeded 20 storeys, deformability and stresses increased dramatically, and other structural systems had to be used. Thus, it was necessary to add transverse concrete screens covering the full height of the building, generally located between dwellings and braced with waffle slabs. The addition of these elements configures a cantilever that receives all the wind acting perpendicularly to the main façades, thus making it possible to reach greater heights.

According to the archives of the Pedro Zaragoza Orts Chair, the first two skyscrapers were erected in 1963. The architect Aliena Goiti designed the Frontalmar building, a 15-storey metal structure in the style of American skyscrapers. The second was the work of the architect Guardiola Gaya; the Coblanca-1 tower, almost 100 metres high and 27 floors. Benidorm began to be a laboratory for modern architecture and urban planning.

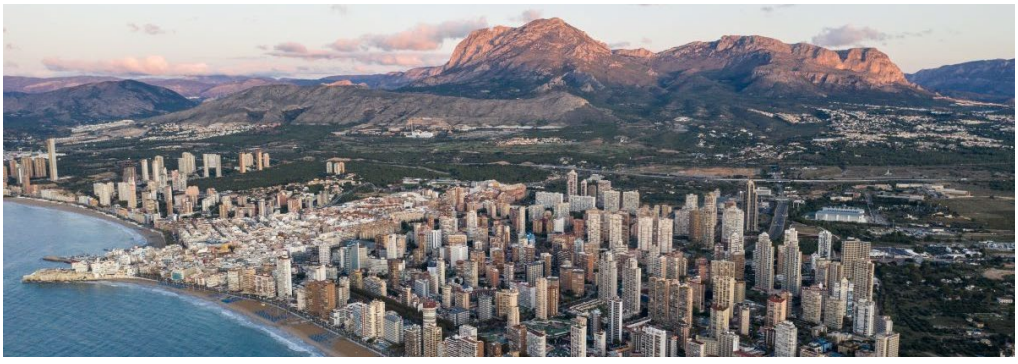


Fig. 13 – Aerial photograph from the east of Benidorm today (VisitBenidorm).

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With the aim of boosting the residential and tourist yield of the buildings, during the 1980s, housing of approximately 60m2 was developed, initially designed for temporary accommodation. Subsequently, more high-rise typologies were developed with larger dwellings, the residential buildings. As a result, there are now more than 150 high-rise buildings with more than 20 storeys throughout the town, which form the most prominent feature of the urban landscape.

5. Urban growth and tourism model

According to his book *Así será Benidorm*, the urban development promoted by Pedro Zaragoza was based on the premise that by building in height it was possible to occupy a smaller surface area, achieving that at present 60% of the municipal territory corresponds to protected unbuildable land. In this way, it was possible to make high tourist yields compatible with land protection. This concentrated urban planning model has also allowed the development of a sustainable mobility model, making it possible to easily get around the city on foot, by bicycle, or by public transport. In this sense, Benidorm has been recognised by the European Commission as a European Green Pioneer of Smart Tourism 2025, which distinguishes cities that stand out in terms of sustainability, innovation, and accessibility in the field of tourism.

Despite the urban and territorial advantages of the model developed by Pedro Zaragoza, it is also necessary to point out the effect it has had on traditional heritage. On the one hand, it is possible to debate the heritage value that skyscrapers have or will have. However, it is also necessary to recover, promote, and disseminate the value of the traditional and archaeological heritage that is still preserved. It is necessary to establish a new legal framework that guarantees the effective conservation of Benidorm's identity, understood as a combination of a traditional fishing village with a Mediterranean tourist destination characterised by high-rise buildings.

6. Conclusions

Benidorm's evolution is a testimony of the capacity for adaptation and transformation of a town with deep historical roots. It has been able to reinvent itself and prosper thanks to the tourist boom, without forgetting its cultural and architectural heritage. However, this uncontrolled growth also poses crucial challenges: the need to balance modernity with the preservation of its identity. To move towards sustainable development, it is imperative that urban policies integrate strategies that safeguard traditional heritage while encouraging architectural innovations that respond to contemporary demands.

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Marginality versus Resilience. Opportunities of Inner Areas' Territorial Heritage: the Case of Valle del Giovenco-Valle Roveto

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Abstract

The Italian territory is characterized by a widespread system of rural historical sites, which bear witness to unique settlement processes and socio-cultural models linked to a predominantly agro-pastoral economy. Today, this heritage is marked by conditions of marginalization and fragility. Rural historical sites contribute to forming a "territorial heritage", a set of cultural and natural, tangible and intangible resources that can be enhanced through sustainable regeneration interventions. In the current debate, regeneration is primarily associated with urban contexts, but it is crucial to adapt this concept to small rural centers by adopting a resilience-based approach. The research is funded by the Territorial Cohesion Agency and focuses on the municipalities of the "Valle del Giovenco – Valle Roveto" inner area, identified by the National Strategy for Inner Areas (SNAI). The objective is to develop an assessment tool for resilience parameters to support local administrations in managing existing built heritage, guiding strategies and actions for a sustainable and resilient regeneration of small centers in inner areas. As part of the adopted methodology, this paper illustrates the territorial, natural and built, heritage of this area and the tools used for surveying it. The aim is to identify the potential resources of the territory and define regeneration strategies capable of mitigating existing critical issues, in line with the planning instruments already in place or under development.

Keywords: *territorial heritage; inner areas; rural settlements; heritage mapping; rural regeneration*

1. Introduction

A vast network of rural historical sites, that attest to distinct settlement processes and sociocultural patterns associated with a primarily agro-pastoral economy, define the Italian territorial palimpsest. Today, this heritage is largely affected by marginalization and fragility, whose symptoms manifest in a concurrent and interrelated manner: limited accessibility, lack or progressive reduction of essential services, demographic decline, population aging, economic impoverishment, depopulation, and abandonment, often accelerated by disastrous events such as earthquakes and landslides.

Despite these weaknesses, rural historical sites contribute to forming a "territorial heritage", understood as a "more or less coherent and interconnected set of historical, cultural, and natural heritages, both tangible and intangible, which create a sense of belonging and networks of relationships that link places and social formations" (Gambino, 2011, p.133).

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This heritage represents an activatable potential through sustainable regeneration interventions, not only to define new, adequate, and effective economic processes based on its enhancement but also to provide a viable response to the crisis of high-density housing models. Considering territorial capital means "shifting attention to the system of resources that defines the identity and potential of a territory, fostering development processes" (Camagni, 2008).

The concept of regeneration has become central in the academic debate. However, literature analysis shows that this term is predominantly associated with urban contexts (De Rossi & Mascino, 2020). Nevertheless, to address the challenges of shrinkage and marginalization, a new interpretation of the concept is necessary for small rural centers. The regeneration of these territories requires a resilience-based approach. Initially, resilience was used to describe the capacity of an area affected by a natural disaster to react and recover. Over time, its meaning has expanded to encompass long-term shocks and phenomena such as depopulation and territorial marginalization (Faggian, 2020).

In Italy, two national-level instruments are currently active for the regeneration of these territories. The National Strategy for Inner Areas (SNAI) combines two development trajectories with the goal of "reversing demographic trends, population aging, and territorial abandonment by attempting to balance disparities between central and marginal areas" (Mamì, 2024). Alongside this, the National Recovery and Resilience Plan (PNRR) has allocated significant resources for the regeneration of small centers, implementing targeted interventions to counteract marginalization and promote territorial enhancement (MiC, 2021).

The analysis of current practices confirms the need to define more clearly the concept of regeneration when applied to a widespread system of rural historical sites. It is essential to understand which strategies to adopt to foster an effective regenerative process, capable of strengthening the resilience of these places and ensuring their enhancement and sustainability.

This research, funded by the Territorial Cohesion Agency, addresses these issues. Its general objective is the enhancement of the territorial system of some small villages within the Valle del Giovenco–Valle Roveto Inner Area, adopting sustainable development models capable of increasing attractiveness, creating new employment spaces, and ensuring greater levels of social inclusion. Through the definition of an assessment tool for resilience parameters to support local government decision-making, this research aims to evaluate the existing built heritage and guide strategies and actions for a resilient and sustainable regeneration of small centers in inner areas.

The contribution presents the territorial, natural and built, heritage of the Valle del Giovenco – Valle Roveto Inner Area and the tools adopted for surveying it, essential for identifying the potential resources of the territory and defining regenerative strategies capable of mitigating existing criticalities, in coherence with the programming instruments planned or already in place. The paper is structured into four main sections. The first section describes the case study, identifying its critical issues and vulnerabilities. The second section outlines the methodology used for analyzing active programs in the area, while the third focuses on the territorial heritage and the tools for cataloging it. Finally, the fourth section explores the potential opportunities offered by this heritage, emphasizing the need for targeted interventions capable of ensuring resilience and long-term sustainability.

2. The case study

The Valle del Giovenco - Valle Roveto Inner Area (IA), established in 2014 within the framework of the SNAI is one of the five project areas of the Abruzzo Region. The SNAI

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identified municipalities experiencing socio-economic distress due to depopulation, lack of attractiveness, limited accessibility, and deficiencies in essential services (MUVAL, 2014). The area is located in the southwestern part of the Province of L'Aquila, bordering the Lazio Region (Fig. 1). It comprises 13 municipalities that, from a morphological perspective, belong to three valley systems: Valle del Giovenco, Vallelonga, and Valle Roveto. The total population of the area amounts to 19,084 inhabitants[1]. The entire territory has undergone significant transformations, primarily due to the drainage of Lake Fucino between 1875 and 1910 and the earthquake that struck the Marsica area in 1915.

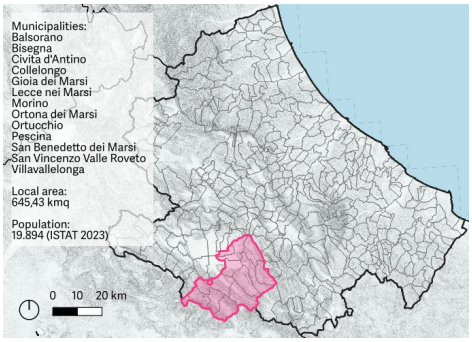


Fig. 1 – *Location of the Inner Area* (Authors, 2025).

From a demographic perspective, the area has experienced a continuous population decline since the 1960s. Between 2011 and 2023, the population decreased by 25%. Economically, while agriculture is highly intensive in the Fucino Plain, it has not achieved full development or a high level of specialization within the IA. Agricultural enterprises in the area are generally small in scale, and linkages between tourism, local production, and livestock farming remain weak (SNAI, 2021). These economic challenges are further exacerbated by an inadequate local mobility system.

The secondary road network is in critical condition in terms of maintenance and hydrogeological safety, while public transport services connecting the numerous settlements to the main hubs of Avezzano and Sora are insufficient.

3. Active strategies in the area

A prerequisite for developing new strategies to revitalize the IA was the analysis of the active planning instruments in the territory to identify existing strategies and interventions while simultaneously assessing their coherence (Fig. 2). This comparison was conducted using coherence matrices, which are valuable for evaluating the degree of compatibility or potential discrepancies among different initiatives (Fig. 3).

The first instrument analyzed was the Valle del Giovenco – Valle Roveto Inner Area Strategy, which aims to establish a renewed "mountain governance" model by promoting a new local development approach focused on tourism and agriculture, alongside the enhancement of essential services (education, healthcare and social services, and mobility).

These elements are considered fundamental prerequisites for improving the quality of life of local communities. The strategy also envisions reconnecting the three valleys through the creation of a cycling and pedestrian route, thereby rediscovering and enhancing their unique cultural and environmental characteristics (SNAI, 2021).

The study area, in addition to being a project area under the SNAI falls within the Marsica Local Action Group (GAL), an instrument promoted by the European Union to develop plans and programs aimed at improving the socio-economic conditions of rural communities.

[1] ISTAT data from 2023.

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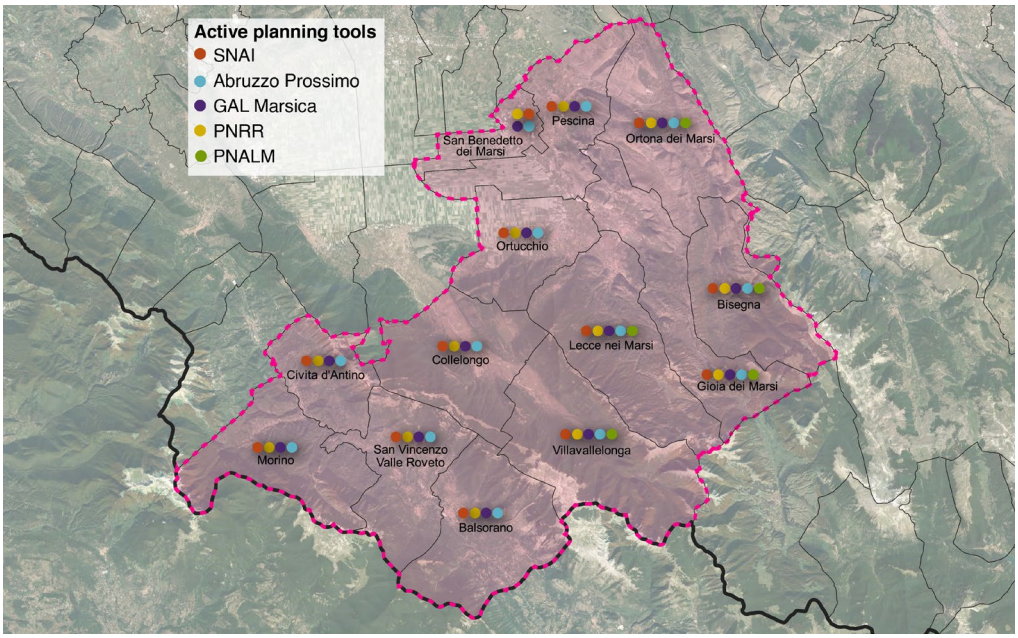


Fig. 2 – *Active planning tools* (Authors, 2025).

The GAL has formulated a new Local Development Strategy (SSL) for the 2023–2027 founding period, focusing on two thematic areas: agricultural and agri-food supply chains, and socio-cultural, tourism, and recreational services. The objective of the strategy is to improve the organization of tourism in the area, enhance traditional agri-food systems, and increase the territory's attractiveness (GAL Marsica, 2023).

On the territory, the National Recovery and Resilience Plan (PNRR) is also in operation, with the vast majority of planned interventions focusing on the digitalization of public administrations and the energy efficiency of public buildings. Five municipalities within the IA are included in the Lazio, Abruzzo, and Molise National Park (PNALM), established under the framework of the law on protected areas. The park's management plan outlines strategies to achieve seven specific objectives, including the enhancement and preservation of historical and architectural heritage, as well as the promotion of agricultural and pastoral activities. An analysis of all active programs in the area reveals a lack of a unified vision regarding strategies and interventions, which are primarily concentrated in the tourism sector. This highlights the need for an operational tool that can better guide local administrations in directing funds towards effective regenerative strategies.

4. The territorial heritage

The IA Valle del Giovenco – Valle Roveto possesses a rich territorial heritage that has never been fully cataloged. Information regarding the built and natural heritage of the entire area has been collected, classified, and subsequently georeferenced using the open-source software QGIS, which enables the visualization and analysis of spatial data. The built heritage has been categorized into the following groups: small villages, scattered rural settlements, towers, castles, buildings, churches, archaeological remains, and abandoned mines. Natural elements, on the other hand, have been classified into parks, nature reserves, geosites, and water bodies.

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		Strategic axes											
		Interventions on the built environment	Conservation and enhancement of heritage	Mobility and Infrastructures	Digitalization	Agricolture	Enterprise and Work	Tourism	Energy	Research	Education	Social inclusion	Social and Health services
Planning Tools	Valle del Giovenco - Valle Roveto Inner Area Strategy			■		■	■	■					■
	Local Development Strategy (GAL Marsica)			■		■	■	■				■	
	National Recovery and Resilience Plan	■	■		■	■	■	■	■	■	■	■	■
	Piano del Parco Nazionale d'Abruzzo Lazio e Molise		■					■		■	■		
	Regional Strategy (Abruzzo Prossimo)			■	■			■	■			■	

Fig. 3 – Cohesion matrix between strategies (Authors, 2025).

The cataloguing of built heritage was carried out through the development of analytical sheets, which contain all the essential information, such as the type of settlement and prevalent building type.

A future objective is to update these records by integrating any regeneration interventions that have been implemented (Fig. 4). The sheets were subsequently uploaded to QGIS and linked to geographical data, creating an accessible and easily consultable database of the entire built heritage of the Valle del Giovenco – Valle Roveto Inner Area.

The built environment underwent significant transformations following the 1915 earthquake. As a result, alongside medieval-origin towers, castles, and villages, a new urban fabric emerged, constructed using materials and techniques that diverged from the local building tradition. The settlements have been classified based on the post-1915 earthquake reconstruction into three categories (Verazzo, 2022): settlements heavily damaged and reconstructed in their original location; settlements rebuilt adjacent to the pre-existing urban fabric and settlements reconstructed at a distance from the pre-existing urban fabric.

An example of this process is the village of Sperone, which was relocated twice from its original site. Sperone Vecchio was a medieval settlement situated approximately 1,220 meters above sea level on the slopes of Monte Serrone.

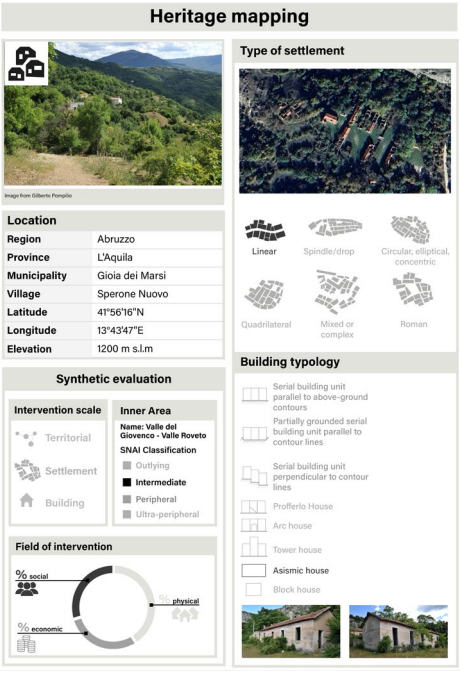


Fig. 4 – *Analytic sheet of Sperone Nuovo* (Authors, 2025)

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Fig. 5 – *Sperone Nuovo* (Chiappanuvoli, 2019).

The 1915 earthquake caused severe damage to the settlement, and during the reconstruction phase, authorities decided not to rebuild the ruins but to relocate the village further downhill, giving rise to Sperone Nuovo, characterized by one-story residential units (Fig. 5). By the late 1950s, due to inadequate hygienic conditions, further relocation was planned, leading to the establishment of Borgo Sperone, 11 km away and closer to the newly developed settlement of Gioia dei Marsi. The relocation of all inhabitants was completed in 1971. The new center is characterized by buildings typical of social housing (Galandini, 2022).

Another distinctive feature of the built environment in this area is the presence of abandoned bauxite mines, which were active from 1903 to 1930 and represented the largest aluminum production site in Italy. These mines have been recognized among the twenty mining sites of historical, cultural, and natural significance in the Abruzzo Region. They are primarily concentrated in the municipality of Lecce nei Marsi.

Regarding natural heritage, the AI Valle del Giovenco – Valle Roveto includes a Special Protection Area (ZPS), as part of its territory falls within the Lazio, Abruzzo, and Molise National Park (PNALM). Within the park, the ancient beech forests have been recognized as UNESCO World Heritage Sites. These forests, home to the oldest beech trees in Europe, include Val Cervara in Villavallelonga, Moricento in Lecce nei Marsi, Coppo del Morto and Coppo del Principe in Pescasseroli, and Cacciagrande in Opi. The Zompo lo Schioppo Regional Nature Reserve is located in the municipality of Morino. This protected area serves as a crucial ecological corridor between the PNALM and the Lazio Regional Park. Additionally, the area features an extensive network of trails and walking paths. The map in the next page provides an overview of the IA's complete built and natural heritage (Fig. 6).

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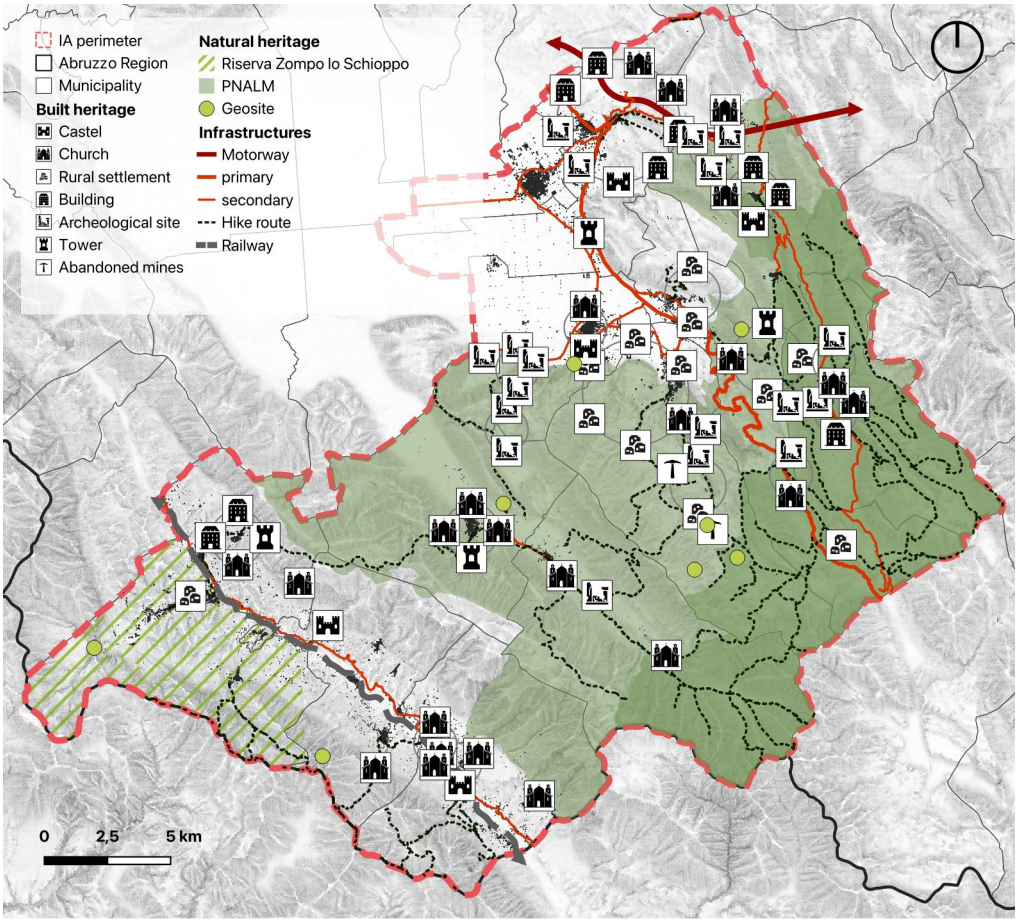


Fig. 6 – *Map of the territorial heritage* (Authors, 2025).

5. The opportunities of this heritage

The territorial heritage can support the local economy not only through the more conventional tourism sector but also through "more sophisticated and intangible channels, including local identity, social cohesion, interregional competitiveness, the attraction of private investment and talent, and the creation of new job opportunities" (Boniotti & Cerisola, 2024). The presence of numerous widespread rural settlements in the AI Valle del Giovenco – Valle Roveto, such as the village of Sperone, represents a significant opportunity for territorial development. Through appropriate restoration and regeneration initiatives, it is possible to encourage the establishment of agricultural and artisanal start-ups, as well as activities that promote biodiversity, ecotourism, and landscape conservation. Another potential solution is the creation of Renewable Energy Communities (CERs), which, based on the principle of energy self-sufficiency, could stimulate the local economy and foster the sustainable development of these areas.

Another opportunity lies in the abandoned mining sites, which could be repurposed for tourism through the creation of an ecomuseum or a thematic park showcasing the region's mining

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history and its territorial transformations. Integrating these sites into the existing network of trails, routes, and mountain huts would enhance their accessibility and attractiveness, fostering the revitalization of the local economy.

6. Conclusion

The Italian territory is characterized by a widespread system of rural historical sites, often affected by fragility and marginalization. To address these challenges, it is essential to adopt a resilient approach and activate regeneration processes that enhance the existing territorial heritage. The aim of the research is to define a flexible operational tool based on the characteristics of the investigated heritage, capable of providing predictive and postdictive assessments to support policies, programs, and projects for sustainable regeneration. This tool will be tailored to the unique settlement patterns of rural centers, which are a defining feature of Italy's inner areas. This contribution has presented the case study on which the tool will be validated as the research progresses: the Valle del Giovenco – Valle Roveto Inner Area. Identified as a project area by the National Strategy for Inner Areas (SNAI), this region boasts a rich natural and built heritage, which, if properly enhanced, can stimulate the local economy and reverse current trends of decline and marginalization.

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Transformation of Historic Areas of Spa Towns under Urbanization Pressure: The Case Study of Bukovička Spa (Aranđelovac, Serbia)

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Abstract

Cultural and natural heritage plays a significant role in the unique characteristics of historic areas, particularly the elements that comprise their structure and identity. Rapid urbanization has led to negative consequences in historical places and requires new approaches to urban planning. Bukovička Spa was chosen as a case study to analyze the threats and opportunities in historic areas of spa towns. Through a chronological review of urban plans and documents, we observe several aspects of urban pressure on historical centres, including changes in forms of urban landscapes, functions, and significance focusing on social and cultural transformations. Based on the result, we suggest a new approach to tourism development plans for historical spa towns by integrating cultural and natural heritage. By contrast to large-scale privatization projects, the new approach, as an integral part of the tourism development plan, contributes to a more objective perception of the cultural and natural heritage and emphasizes the importance of urban planning in preserving historic areas of spa towns.

Keywords: *cultural tourism; nature tourism; urban impact; historic urban landscape*

1. Introduction

Historic areas in spa towns play a vital role in sustainable tourism, as they often hold cultural and architectural significance that enhances the visitor experience. These areas, which typically showcase unique historical features and heritage, are protected by the laws and regulations established in each country to preserve their identity and value for future generations. Spa towns' distinctive features significantly influence their structural layout and overall identity, impacting both the built environment and the use of natural spaces.

The history of spa tourism in Serbia begins in the second half of the 19th and the first decades of the 20th century. Architect Emilijan Josimović transferred the idea of increasing green areas from Belgrade to other cities in Serbia. The development of the spa town was affected by the primary social needs and cultural policy implemented in the fragmented Serbian national state. Along with the struggle for freedom from Turkish rule, in the Serbian culture of the second half of the last century, oriental construction practices changed in favour of European methods (Kadijević, 1998). Following the European methods, tourism study emphasizes a holistic approach that seeks to enhance the beneficial aspects of tourism while actively mitigating its adverse impacts. This approach relies on comprehensive research into

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new urbanities, focusing on the dynamic interactions between built environments and natural ecosystems (Hough, 2002). For successful sustainable planning, it is essential to incorporate various elements: preserving architectural monuments that reflect cultural heritage (Kuzović, 2015), safeguarding natural resources to maintain ecological balance (Anguluri & Narayanan, 2017), and occupying a usable element of nature as a public good (Čaldarović & Šarinić, 2010). Leask and Yeomen have classified cultural heritage into three categories: built, natural, and living (Leask & Yeoman, 1999).

According to Cross, the sustainability of heritage tourism is a process of cultural and natural elements, including tourism potential in cultural heritage areas (Du Cros, 2001). The new discourses of sustainability underscore the essential for sustainable tourism, preserving and protecting historic areas at cultural and natural sites (Faganel & Trnavčevič, 2012). Recent research indicates that adopting a multidimensional approach can significantly improve the integration of urban landscapes by focusing on three key dimensions: form, function, and significance (García-Hernández et al., 2017). Emphasizing and appreciating the cultural elements of these landscapes can promote meaningful dialogue and interaction between rural and urban communities (Fabi et al., 2021).

This study aims to investigate how specific tourism-related processes affect the preservation of historic urban landscapes. Aranđelovac, like other spa towns in Serbia, is facing increasing urban pressure. During the socialist era, the national government carried out large-scale development projects in the spa area, including extensive housing estates and industrial enterprises. In 1989, the local government acknowledged the importance of the historic area by enacting a decree that designated it as a cultural heritage site. Following the EU candidate status, the spa area became under state natural protection. As outlined in the Decree on the Proclamation of Natural Monument, the "Park of Bukovička Spa" is officially recognized as a protected spatial, cultural, and historical unit (Službeni glasnik Republike Srbije, 2011). It is renowned as one of the oldest and most preserved spa parks from the 19th century in the Republic of Serbia. Another privatization has significantly influenced urban development, leading to a chaotic environment characterized by a diminished role of the state and increased arbitrary governance under market conditions (Stanilov, 2007). Transferring responsibility from the national to the local level often favours the interests of private investors over protecting the public space (Petrović, 2009). In 2015, the Decree on the Proclamation of Natural Monument reduced the protected area in favour of private investors (Službeni glasnik Republike Srbije, 2015).

2. Materials and methods

2.1. Case study

Aranđelovac is a town in central Serbia with a population of 24,309 residents. The oldest part of the town, known as the "old bazaar," emerged with the settlement of peasants, merchants, and artisans near Risovača Cave on the right bank of the Kubršnica River. This area featured trade and craft shops, inns, and taverns along the main street. At the same time, the town expanded towards a spa situated at the foothills of the Bukulja Mountains. In the second half of the 19th century, it was a spa town where members of the Serbian dynasties came to spend their summers. The construction of the "Staro Zdanje" and "Novo Zdanje" residents of the Serbian dynasties and the steam bath, as well as the arrangement and maintenance of the park, led to a significant improvement of life in the spa town. Based on observation, Bukovicka Spa became the best spa in Serbia until the First World War.

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During the 20th century, it was a popular tourist destination known for its natural healing mineral water and historic city centre, which attract visitors seeking wellness and cultural heritage. Although the spa town continues to be a tourist destination, large-scale privatization projects have significantly transformed the historical area of the spa town. Nowadays, urban experts have begun to express concern for the sustainable urban development of this tourism success and control over its negative aspects.

2.2. Objectives and research methodology

This paper emphasizes the essential role of urban planning in preserving natural and cultural identities. It addresses the object of study, which includes the historic urban landscape and the transformations caused by urban pressures. The methodologies used in this research were content analysis, case studies, and comparative analysis.

Bukovička Spa in Serbia was chosen as a case study to analyze the threats and opportunities in developing historic areas of spa towns. The paper examines the urban impact on tourist historic centres using various criteria, including built, natural, and living elements, focusing on two specific contexts: historical and post-industrial. Additionally, this research investigated the effects of urban pressure on tourist historical centres in three aspects: the forms of historic urban landscapes, their functions, and the significance attributed to social and cultural transformations.

Firstly, the research assessed how tourism planning influences the physical forms of historic urban landscapes, including the transformation of the forms and deterioration of the heritage brought about by increased urban pressure. Secondly, the study analyzed the various functions of these historic areas, investigating how tourism planning modifies their land use in urban planning from cultural hubs to industrial and conference centres. Lastly, the research delved into the meanings ascribed to these urban spaces through the lens of social and cultural changes, exploring how perceptions and narratives surrounding these areas shift in response to tourism, affecting local identity and community values. This comprehensive approach highlights the multifaceted relationship between tourism and urban heritage, offering a deeper understanding of its implications.

3. Results and Discussion

3.1. Form of historic urban landscape

3.1.1. Spa parterre

As a result of analysis, the form of the historic centre outlines a structure consisting of a spa parterre with an irregular trapezoidal shape and two dominant axes (Fig. 1).

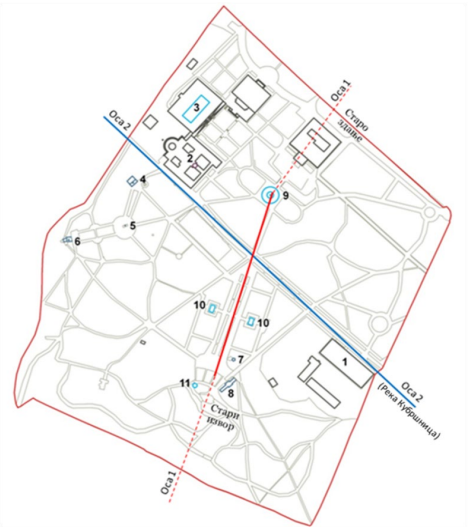


Fig. 1 – *Historic spa area with dominant axes and mineral resources (1:2500) (1) Building of exploitation of mineral water (2) Special Hospital of Rehabilitation (3) Open Swimming pool (4) Source of Mineral Water "Talpara" (5) Source of Mineral Water (6) Source of Mineral Water (7) Source of Mineral Water (8) Pavilion "Biveta" (9) Central Fountain (10) Fountain (11) Decorative fountain* (Milovanović, 2024).

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To illustrate:

- Axis 1 (red) represents the primary path that extends north-south from the residence, passing over the central fountain and leading to the pavilion enhanced with rows of maple trees and vibrant flowers;
- Axis 2 (blue) runs east-west at the entrance with the most prominent linear feature, easily identified by the row of pine trees that line it;

Examining the spa parterre, we can identify two distinct parts: the lower and the upper. The lower part features a cultivated area with level terrain centred on a water fountain adorned with flowers and sculptures. This harmonious blend of water elements, blooming plants, and artistic features contributes to a cohesive and visually appealing spa unit. Moreover, the varied terrain, highlighted by elements such as cascades and slopes in the upper part, enhances the prominence of its unique characteristics.

3.1.2. Spa parterre points

In this paper, the analysis adopts a cultural tourism perspective grounded in the territorial paradigm based on the geography-based hypothesis proposed by geographer Max Sorre. This hypothesis articulates a spatial division theory and introduces the concept of singular points (Rossi, 1984). In our case, the parterre points are highlighted through architectural elements, while elevated points provide excellent viewpoints, offering unique perspectives on the surrounding landscape. Notable examples of these higher elevation points that serve as both viewpoints and singular points include:

- The top of the stairs at the residence to the hospital, above which a mountain rises in the background;
- View from the residence towards the axis 1;
- View from the west entrance towards the path of pines, axis 2;

The concept of singular points also highlights the source of healing mineral water, which becomes an integral feature of the spa parterre, made evident through specific architectural elements.

3.1.3. Built and natural form

An analysis of the physical structure and natural forms highlights the design of the elevated stage above the parterre, which serves as a venue for cultural events and activities while offering panoramic views along axis 1. Surrounding the stage, a tall tree with a dendriform shape provides shade, contributing to the inviting atmosphere of the area. Among the most remarkable examples of dendriform trees are the ancient plane trees, one of which has been integrated into the auditorium (Fig. 2).

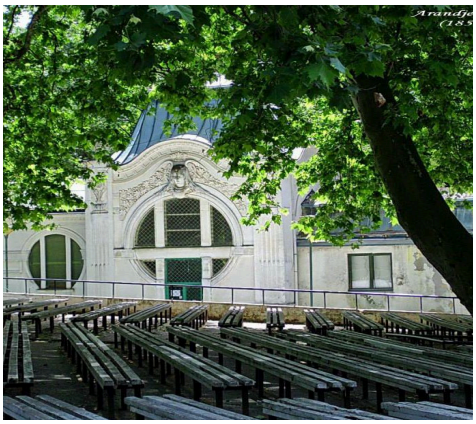


Fig. 2 – *Open scene with pavilion. Example of integration of cultural and natural heritage* (Baština i budućnost – Aranđelovac 1859, 2005).

The combination of physical structure and natural form creates a visually pleasing experience. Artist elements, such as sculpture, alongside the architectural features, significantly enhance the overall design of the area. This historic urban landscape has transformed into a unique open-air museum in Serbia, established by local and international artists during the "Marble and Sounds" event.

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3.2. Post-industrial transformation of the forms and deterioration of the heritage

Industry development led to the migration of the rural population to Arandjelovac and its surrounding areas, marking the beginning of the spa town's urbanization. Furthermore, the development of traffic was an essential condition for the growth of Aranđelovac from a craft trade centre to a regional industrial centre.

According to urban planning, the appearance of work zones directly close to the spa park led to a dispute over the correctness of the selected location. The expansion of road infrastructure has contributed to a decline in the railway network. As industrialization advanced, improvements in housing planning occurred alongside the installation of a pipeline in the river, which led to the disappearance of the river and several mineral water sources. Simultaneously, a transformation occurred within the spa town, where modern residential buildings replaced the old, single-story homes of the traditional Balkan style.

During the industrial period, the national government implemented large-scale development projects in historic areas, such as housing estates and industrial enterprises (Milanović, 2003). The nationalization of many cultural and natural heritage sites and the trend towards privatization in 2000 has complicated local governments' ability to regulate land use. Observations indicate that delegating responsibility to local authorities often prioritizes the interests of private investors over the protection of public spaces.

In 2015, in response to the growing influence of private capital in a market-oriented environment, a decision was made to reduce the protected historic spa area to facilitate the construction of private apartments (Table 1).

Table 1 – *Protected cultural-historical and natural unit* (Milovanović, 2025).

Unit	Cultural-historical (ha)	Natural (ha)
1989	21.67	-
2011	21.67	21.67
2015	18.79	18.79

Table 2 – *Protected cultural heritage* (Milovanović, 2025).

Building	1989	2015
"Staro zdanje"	+	-
"Šumadija"	+	-
"Biveta"	+	+
Hospital	+	+
Open swimming pool	+	- (destroyed)



Fig. 3 – *The plan of protected historic spa area (white - non-protected private land, green - protected public land) (1:2000) (1) Residence "Staro zdanje" (2) Hotel "Šumadija" (3) Pavilion "Biveta" (4) Hospital (5) Open swimming pool)* (Službeni glasnik opštine Aranđelovac, 2021).

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Table 3 – *Land use change in master plan* (Milovanović, 2025).

Land use	Historic area (ha)	%	Change (+/-)
Public			
Health services	0.64	2.95	+0.32
Green path	0.05	0.23	-0.05
Traffic & Car parking	/	/	+0.19
Culture services	1.37	6.32	+0.15
Greenery	17.34	80.03	-2.18
Water	0.07	0.32	/
Private			
Apartments	2.20	10.15	+1.30

Prioritizing the interests of private investors, the local government revised the master plan, redefined a part of public space into private property (Fig. 3), and updated urban parameters. These changes in land use planning have led to a transition from health tourism to congress tourism, consequently diminishing the importance of the spa's natural resources. The main negative impact of the revised master plan is the deterioration of the historic urban landscape, including transformation in land parcelling, land use, and cultural and natural heritage (Table 2).



Fig. 4 – *3D rendering of new planned apartments in the historic area. Large-scale development project on the site of a destroyed protected cultural heriage (open swimming pool)* (Atelje AL, 2021).

As a result of the revised master plan, the growth of apartments in historic areas influences the loss of public cultural and natural sites (Table 3). Moreover, the growth of car parking and traffic is highly problematic. Implemented large-scale development projects led to a decline in historic urban landscapes and cultural landmarks and contributed to the depletion of natural resources (Fig. 4).

3.3. Socioeconomic and cultural transformation

An analysis of the social and cultural dynamics of the spa town observed several positive impacts on the historical area. Due to the social structure of the historic spa town, many affluent merchants have constructed villas and summer houses around Bukovička Spa, where they spend their vacations with family and guests.

The spa has become a popular gathering place for the intellectual and cultural elite from the capital during the summer months. Another positive impact is related to gastronomy. The mineral water was not used exclusively as medicine. During this period, the distinctive feature was cakes made with water from a mineral spring. An addendum to a Serbian newspaper noted that many guests were drinking water not for medicinal purposes but alongside wine (Petrović, 2011). Despite the shifting from a spa town to an industrial city, since 1966, the international contemporary cultural scene in the historic centre has been held, including events like the Sculpture Symposia “Beli Venčac”. This event symbolizes the town’s cultural transformation and has significant identity value. Due to the economic structure of the historic spa town, the connection between the spa town and its rural surroundings is evident in activities. On one hand, the townspeople gained financially by renting rooms to spa guests.

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On the other, the rural residents benefited from selling food and agricultural products to these guests, who also served as lessors (Petrović, 2011). To illustrate, Joel Martin Halpern described how the rural population is tied to the town and highlighted the market day and the fair as one of the recognizable forms. Within them, the places where they take place accurately determined activities from commerce to entertainment (Halpern, 2006). As a result of the post-industrial period, economic activity changed structurally and adapted to new needs in new socioeconomic situations. The threats in historic areas are evident, including commercial homogenization, the disappearance of traditional local traders, a diminished connection with the cyclical aspects of local agriculture, and the growth of the tourist rental property business.

4. Conclusion

Historic areas of the spa town are facing significant challenges due to urban pressure from rapid urbanization. This rapid development threatens the unique historical urban landscape. The threats affect multiple dimensions of this landscape, including its formal, socio-economic, and symbolic aspects. However, the level of impact varies depending on the specific context analyzed.

First, the progress of the historic spa town can be attributed to the principle of social development inertia, meaning that changes occurred naturally over time. Based on the result, the historic area has shaped social spaces and established functional relationships between public and private spheres. The social dynamics of the historic spa town led to the emergence of a new urban typology, such as urban villas, pavilions, and open scenes, as the unique blend of social interaction and architectural design that characterized the spa tourism development. Moreover, the case study carried out in this research reveals that cultural elements of historic urban landscapes can promote meaningful dialogue and interaction between rural and urban communities. Traditional gastronomy and activities such as market days and fairs have symbolized one of the recognizable forms.

Second, the post-industrial period has led to large-scale privatization projects that often prioritize the interests of private investors over the protection of public spaces. As a result, the spa area, known for its rich cultural and natural heritage, has experienced a significant loss of urban historic landscapes and cultural landmarks due to growing tourist apartment development. Due to the growth of tourism as a business opportunity, urban planning regulations have lost control measures. Despite the historic town, the revised master plan of the spa town did not recognize cultural and natural heritage as the unique characteristics of the urban form, particularly in terms of its structure and identity. Land use planning has led to a transition from health tourism to congress tourism, diminishing the importance of natural resources. In contrast to historic towns, the model of large privatization projects increases the violent invasion of tourism rental properties (tourist monoculture) and the loss of residents' finances by renting out rooms to spa guests. However, one of the positive impacts relies on the international contemporary cultural scene in historic areas symbolizing significant identity value.

In summary, the sustainable development of spa tourism relies on a direct cause-and-effect relationship among the built, natural, and living elements. Integrating cultural and natural heritage into tourism development plans enhances the dynamism and appeal of spa areas for tourists and the local community. The proposed model of heritage tourism involves a balance between building and natural elements, including the tourism potential of cultural heritage sites. Incorporating nature as a public good in urban planning indicates a multidimensional approach to the spa master

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plan can significantly improve the integration of urban landscapes by focusing on form, function, and significance. The success of sustainable tourism depends on the quality of the natural and cultural landscapes within the spa town.

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Approximation to the Concept of 15mC in the Historic Centre of Valencia (Spain): Demographics, Economy, Housing and Emblematic Establishments

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Topic: T3.5. Proximity economy and traditional commerce in historic contexts

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Abstract

In the last decade, but especially since the COVID-19 pandemic, several cities around the world such as Paris, Melbourne, Shanghai and Ottawa or Madrid and Barcelona in Spain, are adopting urban replanning models to offer basic services to residents within a maximum radius of 15 minutes. This model of smart city, recently launched by Franco-Colombian urban planner Carlos Moreno, advocates a polycentric, multi-service and functional city in which every citizen can access the six priority urban functions to guarantee their quality of life: housing, work, local commerce, healthcare, sociability and public space. Ensuring these urban functions also allows us to move closer to achieving the SDGs of the 2030 Agenda. The research presented here addresses the study of Valencia and in particular its historic centre from the perspective of a smart city or 15-minute city. The first part presents the methodology used to analyse whether or not these functions for urban life are fulfilled based on the most recent publications. Secondly, the databases offered by the Statistics Office of the Valencia City Council are analysed and interpreted to compare the data obtained with some existing works that grant the city of Valencia a fulfillment of more than 90%.

Keywords: *15 minute city; Valencia; historic centre; urban planning*

1. Introduction

In 2016, French-Colombian architect and urbanist Carlos Moreno introduced the concept of the 15-minute city as a new tool for rethinking urban planning and improving quality of life. However, it was not until 2021, following the COVID-19 pandemic, that this concept gained traction, as the enforced paralisation of everyday life had provided time to reflect on the way of life in 21st-century cities. Urbanism in the 20th century was partly conceived following the precepts of the Athens Charter, where Le Corbusier prioritised criteria such as zoning, speed, and distance, the result of longer trips by private vehicle between home and workplace, greatly increasing both time invested and

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pollution. The main aim of the 15-minute city is to allow pedestrian access to basic surfaces. It focuses on recovering an urban life of proximity abandoning "endured mobility in favour of chosen mobility". The 15-minute city must be polycentric and have no exclusive areas (segregation). Instead, it should have a mix of both uses and people, adapting neighbourhoods to functionality rather than the other way around (utilitarianism), finding new uses for existing infrastructures and buildings, and applying them differently within a single space.

2. Objectives and methodology

The main objective is to present an initial diagnosis of Valencia and its historic centre, establishing a correlation between three urban phenomena: proximity commerce, demographics, and the boom in tourism. According to its current administrative division, the historic centre is made up of six neighbourhoods: La Seu (1), La Xerea (2), El Carmen (3), El Pilar (4), El Mercat (5), and Sant Francesc (6) (Fig. 1).

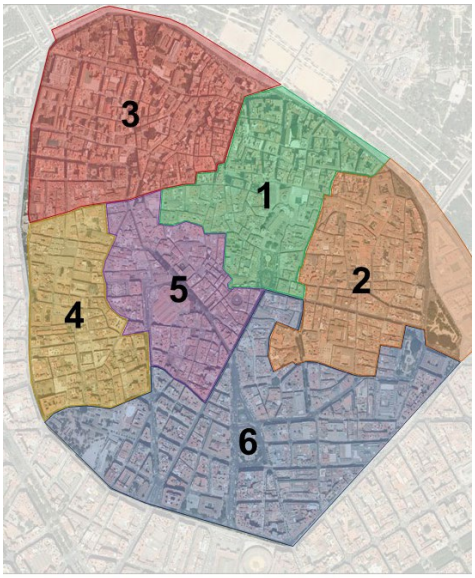


Fig. 1 – N*eighbourhoods of the historic centre. Drawn up by the authors on a Google Maps orthophoto.*

Demographic and housing stock data were obtained to determine their relationship and effect on historic commerce and local economy. The figures were taken from the databases of the Statistics Office of Valencia City Council. The information relating to Accommodation for Tourist Use was taken from the census of tourist apartments of the Generalitat Valenciana and the data obtained from the Spanish Statistical Office.

As regards proximity economy, a particularly specific case was selected, that of the 'emblematic establishment' as recorded in the protection catalogue of the Special Protection Plan for the Historic City Centre (PEP Ciutat Vella, the local name for the historic centre), passed in 2020. With the participation of students from the higher vocational courses in Sales Management and Commercial Spaces, and Tourism Guide, Information and Assistance of the *Escuelas de Artesanos*, a survey was carried out in 10 of the 49 emblematic establishments. This provided information on their situation in the current social, tourist and economic context.

3. Demographic data

According to the most recent census, carried out in December 2024, Valencia has a population of 830,606 inhabitants (Table 1). The municipality covers a surface area of 55 km^2, equivalent to a density of 15,000 inhab/km^2, if the districts of Huerta Sur, Norte and Oeste are excluded. As these are the largest districts, with scattered housing, they would alter the interpretation of data for the city centre. The nucleus of the historic centre, with 30,002 inhabitants, has a slightly higher density, with 17,752 inhab/km^2. Although there is no consensus on the advisable range for an optimum population density, it could be said to currently vary between 12,000 inhab/km^2 and 35,000 hab/km^2.

Moreover, the data analysed show that among the residents of the historic centre, 46% are Valencian. This represents an alarming decrease compared to the figures from 2002 (57%) and

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2011 (53%). According to the tendency forecasts, considering these data (expanded in Table 2), in the year 2035 around 35% of residents in the historic centre will be Valencian unless this situation comes to halt. This is an alarming drop in autochthonous population, who in recent years have been driven out of their usual residence, in most cases due to the effects of touristification and the transformation of historic centres into multicultural commercial centres.

In recent decades the increase in the number of foreign residents in the city has been exponential. In 2002 the city had 738,441 residents, only 4% of them foreign. By 2011 (792,054 inhabitants) this proportion had increased three-fold, exceeding 12%, and in 2024 (830,606 inhabitants) foreign population accounted for 25%, also making up 30% (of the 30,002 inhabitants) in the historic centre (Table 2).

Table 1 – *Evolution of population from 1991 to 2024.*

Urban zone	1991	2002	2011	2024
Valencia	752,909	738,441	792,054	830,606
Historic Centre	27,010	24,478	25,854	30,002
La Seu	2,589	2,538	2,831	3,245
La Xerea	4,057	3,838	3,843	4,137
El Carmen	6,338	5,670	6,258	7,161
El Pilar	4,430	3,796	4,217	5,352
El Mercat	3,297	3,196	3,438	4,034
Sant Francesc	6,299	5,510	5,267	6,073

Table 2 – *Evolution of population born in Valencia and foreign population (between parentheses)* .

Urban zone	2002	2011	2024
Valencia	439,034 (30,863)	427,709 (102,154)	420,174 (206,992)
Historic Centre	14,053 (1,809)	13,819 (4,054)	13,645 (9,417)
La Seu	1,381 (179)	1,412 (487)	1,397 (918)
La Xerea	2,188 (253)	2,109 (533)	2,141 (812)
El Carmen	3,362 (421)	3,410 (421)	3,210 (2,012)
El Pilar	1,958 (319)	2,061 (784)	2,132 (1,739)
El Mercat	1,726 (347)	1,759 (638)	1,722 (1,223)
Sant Francesc	3,438 (290)	3,068 (570)	3,043 (1,372)

This is simply the boom of a process which began in the 1990s, with the implementation of urban policies focusing on attracting international tourists and investors to create an appealing image for the city to satisfy the tourist gaze (Fioravati, 2022; Judd, 2003). Some authors hold that under an anthropological interpretation, tourism creates a media-based image to the point where it erases imagery, heritage, identities, and collective memories (Palou & Mancinelli, 2016). Others even talk about the implementation of urban-tourist branding operations at the service of real estate business (Santamarina & del Mármol, 2017). In any case, it cannot be denied that the social fabric of the historic centre is being forced to move, leaving historic centres, a phenomenon for which Cocola (2018) establishes three different closely linked forms: residential, commercial, and identity-based.

According to the OECD report Tourism Trends and Policies, the alteration and reduction of the social fabric of historic neighbourhoods as a result of uncontrolled tourism is leading to problems such as increased housing prices, affecting community life and access to proximity basic services. At the turn of the century (from the 20th to the 21st), the average price per square metre in the city of Valencia was approximately 1,000€, compared to the 2,849€ currently quoted, according to data from the Idealista real estate portal for the month of January 2025. Since January 2016, when the average price per square metre was at its lowest level this century (slightly higher than 1,300€), there has been an interannual increase of between 1 and 4% (only interrupted during the COVID-19 period). In 2022 this figure exceeded 12% and in October 2024 it was 20% higher than the previous year. An added difficulty is the loss of purchasing power among the population for the same period. The calculation tool of the Spanish Statistical Office (INE) allows the comparison of the CPI rates observed since the euro entered circulation. A salary of 1,000€ in the year 2001 currently corresponds to a value of 1,730€.

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In other words, the loss of purchasing power observed in Spain over the last two decades has been 73%. To sum up, while urban fabric in the last two decades has seen a decrease of around 11%, the number of foreign residents has increased by over 20%. In parallel, housing prices have increased by over 300% while purchasing power has decreased by 75% since 2001. It is undeniable that the conjunction of these economic and social phenomena reflects a reduction of quality of life.

4. Residential versus touristic

The 830,606 people living in the city account for a housing stock made up of 418,232 dwellings, of which almost 5% (19,453) can be found in the historic centre. Throughout the municipality over 20% of these dwellings lie empty or are second homes, and this figure increases to over 40% in the historic centre.

An INE census of accommodation for tourist use shows a total of 1,278 dwellings dedicated to tourist accommodation rentals, with a capacity for 5,128 people. These figures do not match those provided by Generalitat Valenciana, recording dwellings with official licences: 1,484 dwellings, capable of accommodating around 6,000 people in the historic centre. In neighbourhoods like El Mercat, tourist accommodation accounts for 18.3% of almost all housing stock, with a further 12.7% in La Seu, and almost 10% in El Carmen.

4.1. Effects on economy and commerce

According to a survey carried out by Exceltur in May 2022 in tourist neighbourhoods from six Spanish cities, including Valencia, 77.7% of residents in tourist neighbourhoods stated that accommodation for tourist use had increased the price of housing, while 68.4% reported that it had disturbed life in the neighbourhood to the point that usual residents were being driven out. In response to this phenomenon, many neighbourhood groups and collectives from the historic centre have organised protest movements, especially since 2017. With cries of "*Ciutat Vella no está en venta*" [Ciutat Vella is not for sale] they demand new strategies to fight touristification (Fioravanti, 2022). These initiatives are similar to others seen in Barcelona, Madrid, Paris, Berlin, Venice, San Francisco and Rio de Janeiro. As a result, local identity elements are lost and commercial spaces for residents are transformed into an uninspired offer of convenience and food stores geared towards tourism.

The new Special Protection Plan for the Historic City Centre (PEP Ciutat Vella), which came into force in early 2020, offers a stable regulatory framework for the entire historic centre for the first time. As stated above, there is a catalogue of 49 historic commercial establishments known as 'emblematic establishments', some of which have been in operation for over 150 years. They were included in the catalogue either because their activity has been uninterrupted over generations, or because the premises have conserved the typology, original furniture or other heritage elements contemplated in its 49 fiches. It is alarming that almost half of these emblematic establishments have closed in the space of barely five years, despite being protected.

5. Survey of emblematic establishments

It was observed that 12 of the 49 emblematic establishments listed in the Protection Plan have now disappeared. Out of the 37 remaining, 10 were selected based on the availability of the different groups of students and opening hours. The survey was not conducted among the 27 remaining establishments but enquiries were made to identify which ones remain open to the public, with a view to carrying out the survey there in the near future. The type of activity is varied, both overall and in the selected sample. There are antique bookshops, shops selling artisanal fans, fabric shops, sewing machines, wicker products and basketry, goldsmiths, Valencian traditional costume, etc.

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The size of the sample is representative as it complies with the concept of saturation for a qualitative survey and has enabled sufficient data to be collected and most of the responses obtained are repeated.

Respondents were asked about specific issues which help to characterise their business: age of establishment, opening hours, and volume of sales depending on timetable. They were also asked about the situation and trends of historic establishments in recent years, their relationship to tourism and whether they receive any kind of grant or subsidy as owners of an emblematic establishment. The most significant results of the survey are presented below.

5.1. Age of the business

Of the respondents surveyed, four have been in business since the 1950s (and are the third or fourth generation since the founders) and another two since the 1910s. All preserve the original furniture and design. In addition, one establishment dates back to the last third of the 19th century. The three remaining establishments are dedicated to new activity.

5.2. Webpage and use of social media

Only four of the shopowners surveyed have an active webpage. A further three have social media profiles, mostly Instagram, although they confess that they do not use them much. The three remaining have no webpage or social media. Most of them feel that they have not adapted to the digital world.

5.3. Sales volume

No consumption pattern could be established to determine a greater or smaller volume of sales or the characterisation of a typical client profile. In any case, a lower volume of sales is observed in artisanal commercial establishments offering more specialist products. According to most interviewees, a higher volume of sales is observed between 12:00 and 14:00 and between 18:30 and closing time.

5.4. Relationship of historic commercial establishments and tourism

Those surveyed confess that tourism is overwhelmingly destroying the artisanal and traditional commercial establishments of the historic centre due to tourist pressure: high cost of rentals, a lack of younger generations, and fiscal pressure.

Another phenomenon worrying shopowners is that, up until ten or fifteen years ago, numerous proximity shops could be found alongside their own establishments, but these have now been replaced by bicycle rental franchises, vending machines, luggage lockers, souvenir shops, and even tourist accommodation. This is the case of Confecciones La Purísima on calle Bolsería, closed in 2020. According to one interviewed "there are no grocers or bakers […], the oldest artisanal baker in the city closed on 24th October 2023". This was a reference to Horno de San Nicolás, which until October 2023 had been run by Ramón Chirillach, who claimed that at the age of 70 he was "unable to cope with the situation". This is not an isolated case. In the last ten years, more than twenty historic commercial establishments have closed permanently.

6. Discussion

Demographic data show that the number of inhabitants in the historic centre has seen a slight recovery in recent years, increasing from 24,478 inhabitants in 2002 to 30,002 in 2024. However, this increase does not make up for the number of neighbours who have been displaced by an influx of new foreign residents. While in the last two decades over 10% of Valencians have moved away, new foreign residents who have settled in the historic centre now account for over 20%.

The ability to preserve the social fabric of historic centres has been highlighted in recent publications (Ayala & Vázquez, 2024). Terms such as tourism gentrification have been the subject of numerous studies since Gotham (2005) first coined the term. Although touristification

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and gentrification are different phenomena there is widespread agreement that uncontrolled tourism leads to gentrification (Judd & Fainstein, 1999). As Santos, Blanco, Romero & Navarro (2023) hold, the urban regeneration policies aiming to satisfy the needs of tourists are moving away from their original objective, regeneration. Since 2005, different lines of research have opened up on the effects of urban touristification. Some examples are the influence of residential developments, urban tourism and the role played by second homes.

Making historic centres nuclei for second homes and tourist accommodation can be a major hindrance to maintaining the social fabric and traditional commerce in historic centres. As can be deduced from Exceltur's ReviTUR project, between 2010 and 2019, the number of residential properties which were lost to tourist rentals reached levels which greatly complicate the quality of life of residents. This is not a case of adapting the existence of accommodation for tourist use to their minimum expression, but of adapting the number of these found in each zone to its capacity to welcome tourists and the balanced distribution by neighbourhoods. Priority should also be given to those which can generate employment, honouring commitment to contribute fiscally and coexist with the neighbours.

This is the opposite of what is happening: a significant increase in hotel capacity and luxury accommodation for tourist use to the detriment of residential developments. Examples of this are the recent inaugurations of luxury hotels such as Hotel Corona and Axel Hotel in Casa Vella in the neighbourhood of El Carmen; or the forthcoming opening of the Palace of the Eixarchs as a four-star hotel beside the Mercado Central (Fig. 2).

This last example is particularly relevant as it was taken to court by the neighbourhood association *Amics del Carme*, filing a lawsuit against the rehabilitation of the historic palace to transform it into a large luxury hotel and twenty-five tourist apartments among a great number of lots, which had been proposed for the construction of residential buildings to house forty-two apartments in multi-family blocks. Furthermore, the rehabilitation of Casa Vella, a 17th-century residential building, included the transformation of an abandoned block of multi-family dwellings into luxury tourist apartments (Fig. 3).



Fig. 2 – *Former palace of the Eixarchs family. Future luxury hotel.*



Fig. 3 – *Current Axel Hotel in Casa Vella.*

In this regard, it is particularly striking that almost 40% of dwellings in the historic centre are empty or used as second homes. If in addition, the problem of accommodation for tourist use, elitist hotel offer, and the increased price in residential rentals is considered, the situation is far from improving. The data obtained speak volumes, but the recent opinion poll conducted by CIS shows that housing is one of the most worrying issues for the Spanish population, ranking it in third place.

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A recent study carried out by the Research Group in Mobility, Transport and Territory (GEMOTT) of the University of Barcelona has analysed four Spanish cities – Barcelona, Palma de Mallorca, Granada and Valencia but, this study did not incorporate the housing function. Why has the GEMOTT report failed to include the housing function? This report, "*La proximidad en las ciudades españolas. La ciudad de los 15 minutos*" ["Proximity in Spanish cities. The 15-minute city"], focuses on the time duration detailed in the introduction. It analyses the amount of time needed to reach the necessary destinations and services, and appears to assume that, in the study of city nuclei, the housing function simply exists. In any case, the report is an excellent tool to be used as a starting point for drawing up new urban policies and encouraging decision-making from administrations to improve urban life. Furthermore, the portal www.movactiva.es offers maps classified by indicators for mobility including walkability, bicycle accessibility, urban vitality, and green areas. The good results of the GEMOTT report for the historic centre of Valencia may be due to the number of varied services and their proximity to each other, rather than the typology, nature, and target public. It should also be borne in mind that the longest routes on foot take around twenty minutes so that physical proximity is in itself guaranteed. The results obtained following the survey make alarm bells ring for conservation. The most common problem is the creation of a very specific product, aimed at an equally specific client. Most of these are approaching retirement, cannot cope with high tax and rental costs, and the next generation will not take the businesses on. Moreover, new forms of consumption and socialisation seem to have overwhelmed traditional, artisan, and local businesses. Nevertheless, it is not only external factors which are causing their gradual disappearance. Their specific nature, the absence of a younger generation, and lack of financial assistance, despite their status as emblematic, force them to close.

6. Conclusions

The results, obtained from the statistical data provided by Valencia City Council, show that despite the increased number of inhabitants in both the historic centre and the city overall in the last two decades, there has been a reduction in the number of residents born in Valencia. Since 2002 the population has increased by almost 100,000 inhabitants However, in the same period, the number of foreign residents has increased almost seven-fold. In addition, over these two decades, the number of Valencian inhabitants has progressively dropped by 5% throughout the city (with occasional exceptions) in every neighbourhood of the historic centre.

This loss of autochthonous social fabric in favour of foreign population linked to tourism involves a series of issues which are difficult to combat: the increase in housing prices and the disappearance of proximity traditional commerce. Between 1999 and 2001 the price per square metre was around 1,000€ and by January 2025 this figure had reached 2,800€. This increase is mainly the result of the increased volume of tourist rentals which in the different neighbourhoods of the historic centre accounts for 10 to 18% of residential housing stock.

As a result of the higher number of foreign residents linked to tourism and the reduction of the social fabric, proximity commerce in the historic centre has been transformed. In addition to the closure of traditional or artisan establishments offering what were considered everyday basic products and services, there has been an increase in the number of franchises aimed at satisfying the tourist experience. In short, what is happening is that the historic centre of Valencia is being emptied out, despite the fact that objective figures indicate an increase of 5,000 inhabitants. These temporary residents or second-home residents, mostly foreigners with high purchasing power, erase the local identity and drive away locals who have been rooted there for generations.

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The importance of these results lies in the new line of research, never seen before in Valencia, which they open up: the study of the historic centre from the perspective of 15 minute cities. However, the limitations of an approximative study such as this should be taken into account, despite the interesting readings and interpretations it offers. While statistical data have always been available, they have not been used for this purpose, and it would be interesting in future to carry out studies which are not limited to being "approximations".

Some studies examine this line of research, for example for the cases of Malaga (Santos, 2023) and Palma de Mallorca (González, 2020). Furthermore, the GEMOTT report mentioned earlier is an interesting tool in terms of the percentage of residents who have everyday basic services and urban destinations within their reach. But, what type of resident? At what price? Although the results cannot be called into question, this report is perhaps lacking in the characterisation of both services and residents, and also fails to include the situation of housing as a basic element for improving the quality of life in urban environments. A more holistic methodological approach can be found in the "*Guías hacia ciudades de 15 minutos y territorio de 45 minutos*" [Guides towards 15-minute cities and 45-minute territories] published for Madrid and Malaga by the Fundación Foro NESI (New Economy and Social Innovation). To conclude, the tourism gentrification of the historic centre has been taking place at an alarming rate over the last two decades, and this should be countered by good planning and urban policy actions based on rigorous multidisciplinary technical studies.

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Vernacular Terraces for Sustainable Urban Ecosystems in Two Cities in the Andes

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Abstract

Urban areas in South America are facing a pressing issue due to the combined threats of climate change and unsustainable territorial occupation. International organizations and technical literature have proposed urban agriculture and green corridors with native crops as potential solutions for sustainable urban areas and climate change adaptation. However, implementing these solutions is challenging, particularly in cities in the Andes hills, where critical conditions include steep slopes, water stress, and high social vulnerability. The urgency of this situation is apparent. The alternatives for creating sustainable urban ecosystems (SUE) must be accompanied by social, legal, and physical measures that allow for the sustainable management of the projects. Special considerations must be given to historical and patrimonial aspects of the cultural landscape. This paper aims to explore alternatives for SUE in the hills of Andean cities based on the vernacular terrace systems in the Andes from an interdisciplinary perspective. A key aspect is recovering traditional knowledge of hill occupation with land terraces and vernacular dry-stone retaining walls. The study focuses on two cities located in the Peruvian Andes. First, the paper discusses the state-of-the-art in urban ecosystems for climate adaptation. Then, prioritized areas are identified using a spatial diagnosis and analysis of parameters related to geomorphology, natural hazards, socioeconomic vulnerabilities, urban infrastructure, urban development regulation and government capacities. Some preliminary alternatives for SUE and the measures to ensure their feasibility are presented. It is an interdisciplinary project, and the results show that some options exist to improve and protect the environment and the population at risk.

Keywords: *urban green spaces; vernacular terraces; climate change adaptation; hills; green corridors*

1. Introduction

Urban areas in South America face significant challenges due to climate-related threats such as extreme rainfall, landslides, and food shortages (Castellanos et al., 2022). This situation could be particularly critical in the sprawling, segregated, and informal urban areas on the hills of large cities (Fernández de Córdova et al., 2021, Moya

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et al., 2024). Over 50% of Latin America's population lives in areas highly vulnerable to climate change (Novillo Rameix, 2018).

International organizations and researchers emphasize several efficient strategies for urban adaptation to climate change. Nature-based solutions, such as vegetation and soil reforestation, green corridors and urban agriculture, are highlighted as flexible, multi-functional approaches that simultaneously address multiple climate hazards and provide ecosystem services (Rey, 2021).

Implementing these urban green spaces in the Andean context could be challenging, mainly because of critical conditions such as steep slopes, water stress, and high social vulnerability. Governments and international organizations have noted that incorporating cultural components and recovering cultural landscapes (such as vernacular terraces and community involvement) in environmental management planning is a key challenge. In this task, the role of architecture and urbanism is to design and build appropriate habitats for different groups, incorporating ancestral knowledge and strengthening the development of new sustainable and innovative realities in both urban and rural areas.

This study aims to study the feasibility of urban green spaces in hills for climate change adaptation based on the Andean vernacular terraces with an interdisciplinary approach (Fig. 1). A key aspect is recovering traditional knowledge of hill occupation with land terraces and vernacular dry-stone retaining walls.

2. Method

Physical and sociological variables are evaluated in a qualitative analysis using a participatory approach to determine the feasibility of the urban terrace system in the metropolitan area of the Andes region. Two study cases are analyzed to identify and characterize the territory where the terrace system may be implemented. Quantitative and qualitative information from satellite and official data is spatialized and systematized in GIS. The slopes were calculated using a digital elevation model (DEM) from the Shuttle Radar Topography Mission (SRTM). The variables are validated in workshops and interviews with key actors (academic researchers, related public officials and municipal officials, and related associations).



Fig. 1 – *Vernacular Terraces System in Central Andes rural areas.*

3. Vernacular terraces system in the Central Andes Hills

The vernacular terrace system in the Central Andes (called Andenes) is composed of a massive infrastructure of almost horizontal platforms on inclined slopes supported by dry stone walls (known as “pircas”), irrigation and drainage infrastructure, soil and vegetal cover, and the management system supported by the know-how and community work (Kendall and Rodríguez, 2015). The altitudinal differences of the platforms allow the diversity of microclimates to be taken advantage of over short distances. Therefore, diversified agriculture is produced, and a unique landscape is formed. (Aparicio, 2022; Kendall & Rodriguez, 2005)

Various authors value the terrace system in terms of food security, controlling soil erosion and landslides, and cultural heritage (dating back more than 5,000 years to the beginning of the 16th century, in the pre-Hispanic period) and have acknowledged the importance of its

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recovery, rehabilitation and expansion (Kendall & Rodríguez, 2015). The Andean region's seismic activity threatens the stability of the terrace system. A recent study concluded that the current stone-cutting technique and terrace layout quality are notoriously inferior to those used in the past during the pre-Hispanic period. Fortunately, the terraces' seismic capacity could be improved by arranging the stone blocks (Ita et al. 2024), which maintains the original vernacular features of the terraces (such as using local materials, elementary tools, and the community's workforce) and its low cost and environmental impact. However, based on seismic risk analysis, using vernacular terraces is recommended only for non-residential purposes, such as green corridors or urban agriculture.

4. Ecosystem services of urban green spaces

Urban ecosystems are complex systems characterized by interactions between social, economic, and environmental variables (Alberti, 2005). Urban green spaces are relevant for climate change adaptation in metropolitan areas because they may provide various types of ecosystem services (Nowak & Mcpherson, 1993; Defilippi et al., 2019), such as the dissipation of atmospheric pollution and the regulation of the thermal effect derived from heat islands (Gómez et al., 2016), regulation of relative air humidity and air circulation patterns in public spaces (Zavala et al., 2016). Furthermore, resilience can be considered an ecosystem service, but no consensus exists in the international literature.

The inter-scalar and environmental impact of green initiatives (such as those associated with pollutants in urban areas, loss of existing vegetation and soil profiles, and disruption of hydrological processes, Deng et al. 2021) must be addressed. Furthermore, special considerations must be considered to preserve the cultural and vernacular practices and local know-how. In the Andean region, the specific features of peri-urban (poorly structured, with urbanized peripheral spaces or border spaces predominating residential activity) and rur-urban area (rural territory with some residential and industrial components) should be considered in determining the ecosystem services and the possible interventions (Folch, 2003). Some interventions for urban green spaces in the Andes are described below.

4.1. Medellin city

The study “Reinhabit the Hillside. Operations in risk areas and precarious settlements in Medellín” (Echeverry et al., 2012) recommended actions to redirect rainwater and increase green coverage, relocation of population in high-risk areas, and soil stabilization by retaining walls complemented with minor agriculture aimed at improving soil stability, to subsequently build houses on the new terraces. The study proposes using communication, participation, and community education to change rural areas' imaginaries.

4.2. Lima city

The Boca de Sapo eco-touristic sustainable Park project consists of the installation of a technical irrigation system and the landscape design for risk mitigation purposes in an area between Loma de Amancaes and the Pacífic Ocean in the district of Carabayllo in Lima-Peru. The native species, such as Tara, Molle, Huaranuay and Mimosa, were selected for their low water demand (Tejada, 2018) (Fig 2).



Fig. 2 – *Eco-Touristic Sustainable Park Boca de Sapo in Lima* (Tejada, 2018).

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4.3. Arequipa city

The agricultural terraces in Arequipa (Fig. 3) exemplify the skill of pre-Hispanic cultures in transforming a harsh, arid valley into a fertile and productive landscape. Indigenous populations enhanced agricultural production and safeguarded soil integrity and sustainable water management by creating intricate irrigation systems and terracing on the Andean hillsides. (Zeballos-Velarde, 2024). Community cooperation facilitated the construction, maintenance, and administration of the terraces and irrigation canals, fostering a shared identity focused on agricultural techniques. The legacy of communal effort and competence is preserved in modern local traditions, where ancestral wisdom persists in informing and guiding agricultural practices. In 2000, UNESCO designated the historic center of Arequipa a World Heritage Site, acknowledging its adjacent terraced landscapes.



Fig. 3 – *Agricultural terraces in Arequipa City-Peru.*

5. LADERA terrace system

LADERA, a terrace system for urban green spaces, is proposed to adapt to climate change in sustainable urban ecosystems. It consists of terraces supported by traditional dry-stone walls called *pircas, which are* made with local materials and native crops. The pircas are low-rise walls made up of blocks of uncarved rock, joined together without mortar that supports the backfill, composed of soil and rock blocks obtained from the same place by cutting the slope using wooden props, picks and bars (Ita et al., 2024) (Fig. 4). The typical cross-section of the *pircas* has two faces joined by "through stones" (stone blocks that occupy the entire width of the wall) and the effect of the overlap of the trace stones.

Based on previous numerical analysis and experimental testing, it is recommended that the *pircas* height should be less than 1.5 m, and the through-stones separation should be 375 mm in the vertical direction and 1 m in the horizontal direction (Ita et al., 2024). Following the vernacular technique, the backfill is soil substrate, with layers of different sizes of stones that ensure the permeability and drainage of suitable agricultural soil (Aparicio, 2022; Kendall & Rodríguez, 2015).

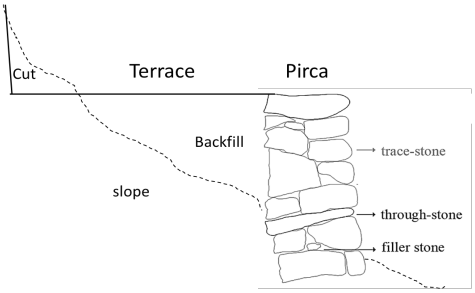


Fig. 4 – *Terrace Cross-Section.*

6. Spatial analysis

The spatial analysis considers physical and geographical factors, such as geomorphology, altitude and microclimates, multi-hazards and ecosystems. These factors determine the conditions of the territory that would ensure an acceptable structural and agricultural performance of the terrace system LADERA. The analysis also considers cultural and social factors, such as urban connectivity (roads and transportation) and urban regulations (urban areas and environmental protection areas). These factors are related to the feasibility of integrating LADERA with existing public spaces to generate a sustainable urban ecosystem articulated with the regulated protection areas, fragile ecosystems, and existing green spaces.

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6.1. Geomorphology and topography

The study focuses on the slope and the type of soil. The ancestral constructions in the Central Andes are located on moderate to very steep slopes, ranging from 15-75% (Agrorural, 2021; Kendall & Rodríguez, 2015). In line with current regulations in the region, this study considers flat terrain if the slope is less than 20%. For acceptable structural performance, the terrace width can vary from 2 m to 8 m for 100% and 20% slopes, respectively (Table 1). These values were estimated considering a maximum height of 1.5 m and an optimized cutting and filling construction process (which minimizes debris).

From 50% to 75% slope, urban agriculture or green corridors are feasible since most crops require at least a width between 3 m and 4 m. The optimum slope value is 35% or less. Slope values greater than 75% are not feasible. Sand and dunes should be avoided for the LADERA location. Local quarries of sandstone, bluestone, granite, limestone, basalt and schist can be used in the *pirca* construction.

Table 1 – *Acceptable Terrace dimensions.*

Hill Slope	Width (m)	Feasibility
75-100%	2.0-2.5	unfeasible
50-75%	2.5-3.5	feasible
35-50%	4.0-5.5	good
20-35%	6.0-8.0	optimum

6.2. Natural hazards

The central Andes have recurring events such as landslides due to rain (whether occasional or seasonal), called *Huaycos*, and falling rocks due to erosion by winds, humidity, precipitation, and earthquakes. The proposed terrace system LADERA could mitigate the risks of *Huaycos,* rock falls, and soil erosion (Aparicio, 2022). Moreover, it stabilizes the terrace system (Ita et al., 2024). Building LADERA in hazardous zones could avoid informal occupation. In this way, hazardous zones should be prioritized in climate change adaptation planning.

6.3. Altitude, microclimates and ecosystems

The Central Andes region is very diverse. Altitude and sunlight define microclimates in the hillsides. From 500 to 2500 meters above sea level, it is classified as having a temperate climate, and the coastal area is arid but with dense fog, depending on the proximity to the sea. It has a temperate climate with seasonal precipitation from 2500 to 3500 meters above sea level.

Although the climate is prone to agriculture, water scarcity is challenging. It requires nature-based technologies and access to regulated irrigation in areas with seasonal precipitation. This research identifies the dense fog areas as an option for water collection. In general, zones with the possibility of water collection should be well-considered.

Although many vernacular terraces are 3000-4500 meters above sea level (Agrorural, 2021; Aparicio, 2022), the authors consider 3000 meters above sea level or less optimum for current standard agriculture practices.

6.4. Connectivity and public spaces

The degree of connectivity is evaluated in terms of the existence of road infrastructure and public transportation services. At the metropolitan level, connectivity is related to the accessibility of the terrace system and how it can be integrated into the network of existing public spaces and green areas. Poorly connected areas may not be the optimum location for LADERA.

6.5. Urban services and facilities

Urban services (such as water, drainage and energy services) and facilities (such as schools, health centers, and sports centers) would facilitate LADERA integration with the network of public spaces. The existence, scale and quality of services and urban equipment are highly recommended for implementing the LADERA terrace system.

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The proximity to urban areas and water treatment plants is well-weighted because they could provide treated gray water for irrigation. Special considerations must be given to protecting the historical and patrimonial aspects of the cultural landscape and integrating the urban green spaces with them.

7. Case study

In the Peruvian Andes, 93% of the growth of cities between 2001 – 2018 corresponds to urban informality (MVCS, 2021). Lima, the capital city of Peru and Arequipa, the second largest city, are analyzed to determine the areas in which the LADERA proposal is feasible. Both have peri-urban and rural-urban areas on hills. Due to urban sprawl, Lima city could incorporate adaptation climate change strategies in their new urban areas. In Arequipa, terraces are widely used for agricultural and recreational purposes in urban and rural-urban areas.

7.1. Lima

In Lima, recent urban expansion is characterized by a continuous and narrow strip, mainly located in the first foothills of the Andes (north, center, and southeast). These newer human settlements are concentrated in ravines and along linear edges. The *huaycos* and the rock falls are the main hazards in these areas. The zone known as *Lomo de Corvina,* located in the south of the city, is a dune with soft soils.

Approximately 139 km² of the urban area has 20%-35% slopes (Fig. 5). These areas have been occupied since 1980 and are low-to-medium developed (CONURB, 2016). The most frequent ecosystem is the coastal hills, with an average altitude of 500 m. According to the spatial variables, vernacular terraces in public spaces can be promoted if urban services and transportation infrastructure are improved. Slope range, 35%-50%, corresponds to 61 km². These areas have recently been occupied, and usually, the residents have no legal property on the land (Background in Fig 6). The LADERA proposal can be used as an opportunity to rearrange and as a work program for residents. There is 11 km² of urban area with a slope range of 50%- 75%. No residential use should be permitted according to the regulation. In this case, resettlement programs should be executed. Furthermore, almost 1000 Km² are at risk of informal occupation, most in moderate-slope hills (20%—50%).

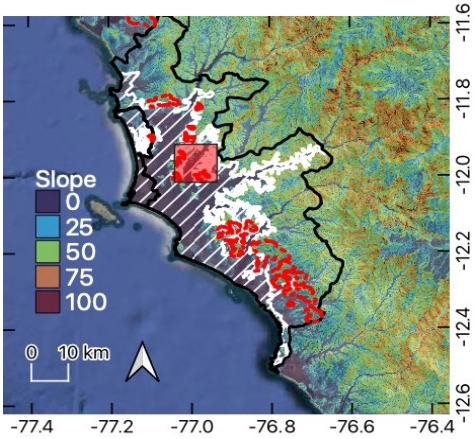


Fig 5 – *Lima's topography.*


Fig 6 – *Urban occupation of the hills* (Municipalidad de San Juan de Lurigancho, n.d.)

Zones in eventual vegetation coastal hills ecosystems that can provide valuable ecosystem services should be protected (Fig. 7). Unfortunately, the perception of the potential of hillsides as providers of ecosystem services for climate change adaptation is low among the local authorities and officials.

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Fig 7 – *Ecosystems in Lima City* (Andina).

7.2. Arequipa

Terrace areas are well-connected to urban services and equipment and are popular tourist attractions. Considering the existing terraces as cultural heritage, raising awareness about the ecosystem services they may provide is proposed. In January 2025, local actors (officials from the Municipality of Arequipa, the Planning Institute, the National Institute of Civil Defense, the Ministry of Culture and the National University of Arequipa) participated in a collaborative workshop. They noted the need to include this aspect in urban development plans. The agricultural function, the hydraulic network, and the relationship between productive activity and residents were identified as factors that protect the terraces against urban and real estate pressures. However, deteriorated terraces have been replaced or repaired by adding reinforced concrete elements, threatening the legacy of the vernacular terraces and landscape. A training program on vernacular terraces should be implemented.

8. Conclusions

This work shows that using a terrace system for climate change adaptation in the Central Andes based on vernacular techniques is feasible from a metropolitan level. Lima hills in the peripheral areas meet the physical conditions for implementing the LADERA terrace system as a peri-urban edge, consolidating a network of public spaces and mitigating rockfall and soil erosion. However, due to water scarcity, agricultural activity is limited. LADERA might be used to protect fragile ecosystems from informal occupation. The Culture and National Heritage authorities must commit to a program to repair and maintain the terraces in Arequipa while preserving traditional construction techniques. Future studies will include analyzing the proposal's impact and more detailed studies to corroborate the results at the medium and local levels.

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The Archaeological Site of *Abella* Castle (Avella, Campania, Italy): History, Conservation and Accessibility

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Abstract
The castle of ancient Abella*, a significant example of Lombard architecture, extends over approximately 21,000 square meters within the municipality of Avella, Campania — an area of relevant historical, archaeological, and landscape significance. Built in several phases, starting from the 7th century, and definitively abandoned by the mid-17th century, the castle now stands in a state of ruin, while it is harmoniously integrated in the surrounding landscape and enhances its evocative scenic appeal. Despite its deterioration, key architectural features remain discernible, including the double fortification walls, sections of the ancient* donjon*, and a tower dating back to the Angevin period. Over the past two decades, several restoration efforts have been undertaken with various outcomes. However, the site remains largely underutilized due to persistent maintenance challenges, uncontrolled vegetation growth, and limited accessibility. Within this framework, this research proposes a comprehensive project aimed at enhancing the archaeological site through the consolidation and restoration of the castle and its defensive structures. Additionally, the introduction of new structures, to be carefully integrated, and walkways, is envisioned to establish an accessible and inclusive visitor route. Drawing on archival sources, the study also examines both the ancient and more recent history of the site, along with past restoration efforts. Ultimately, it envisions a project proposal which explores different and potential uses of the area, aiming both to the preservation of the site and the improvement of its accessibility, while enhancing its cultural and historical value.*

Keywords: *Avella; castle; restoration; accessibility; archaeology*

1. Introduction

Abella is an ancient city whose first settlement dates back to the late 13th century BC, and it is strategically located at the crossroads of the Samnite and Campanian regions. While some ancient sources attribute its foundation to the Greeks, archaeological evidence suggests a notable Samnite influence. *Abella* was integrated in the Roman world in the late 4th century BC and later became part of the Regio I under the administrative rule of the emperor Augustus (Cinquantaquattro et al., 2003). During the Roman age, the city thrived, with the establishment of a regular road network, an amphitheatre, and a defensive wall, which was renovated in the 2nd century AD. Although

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Fig. 1 – *The hill of the castle of Abella* (Mazzei & Polcari, 2024)

documentation from the later phases of the city's history is limited, it is known that the settlement remained active at least until the 5th century. From the 6th century onwards, during the Lombard period, *Abella* began to decline, particularly following the catastrophic eruption of Vesuvius, known as the Pollena eruption. This decline prompted the establishment of a new urban centre on the hill where the castle now stands. The castle, representing a prominent evidence of Middle Ages, is a significant historical, cultural, and architectural landmark. Positioned strategically on the northern hill of the *Clanis* River, the castle has been used with various functions over the centuries, which have changed in response to the region's political, social, and economic transformations. However, the site's evolution, alongside previous restoration efforts, has contributed to the progressive deterioration of its structures, resulting in the loss of some of the original features and underscoring the need for specific interventions to preserve and enhance the complex.

In light of its compromised state of conservation and the risk of further deterioration, this research aims to identify the most effective strategies for the restoration and adaptive revitalization of *Abella* castle. The study considers both the historical and architectural significance of the site, alongside the requirements for its sustainable, contemporary use. The restoration approach which has been proposed in this research goes beyond mere preservation, as it envisions the transformation of the castle into a dynamic and accessible space able to suit the needs of a broader audience.

2. The castle and its history

Abella castle (Fig. 1), built in the 7th century, is a prime example of the widespread phenomenon of Lombard "encastellation" in the Irpinia region (Coppola & Muollo, 2016). Following the Lombard conquest, Abella became a frontier settlement, because of its proximity to the Duchy of Naples and Capua, which were areas ruled by the Byzantines (Coppola & Megna, 2011). The earliest documented references addressing the

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presence of a fortification in Abella date to the 9th century, when the city was frequently targeted by Saracen attacks (Iannelli, 1989). In fact, it was during this period that the first elliptical inner defensive wall should have been constructed. In the 12th century, the arrival of the Normans in Italy led to transfer the ownership of Abella castle to a new feudal lord, who was a member of the Mosca family (Luciano & Petillo, 1985). During this period, the complex was enlarged with the construction of the donjon and the expansion of the inhabited area, which required the extension of the defensive walls. The following Angevin period brought further modifications, including the addition of a circular tower with a truncated conical base, attached to the existing fortress. Since 1432, Avella came under the rule of the Counts of Nola, namely the Orsini family (Cordella, 2007). This period was marked by a series of devastating earthquakes, notably those of 1456 and 1466, which caused extensive damage to the castle. In 1534, the Colonna family took control of Abella, and the castle was transformed from a military fortress into a noble residence (Luciano & Petillo, 1985). This change in function led to a shift in settlement patterns, leading the population that lived on the castle's hill to move elsewhere. The situation worsened following the eruption of Mount Vesuvius in 1631, which buried Abella under a thick layer of ash. This natural disaster accelerated the gradual dismantling of the castle's structures, as building materials were repurposed for construction in the expanding town of Abella, ultimately leading to the site's definitive abandonment (Cinquantaquattro et al., 2003) (Fig. 2).

3. Recent restoration interventions on the castle

The restoration of *Abella* castle is grounded on extensive research delving into available documentary sources, with particular attention to previous restoration efforts. This phase has proven crucial in understanding the evolving interest in the castle, which has seen increasing efforts for its preservation since 1984. Over the years, several projects have reflected a shift in restoration philosophy, evolving from more invasive operations to approaches prioritizing the castle's authenticity. The first major proposal for a conservative restoration was presented in 1984

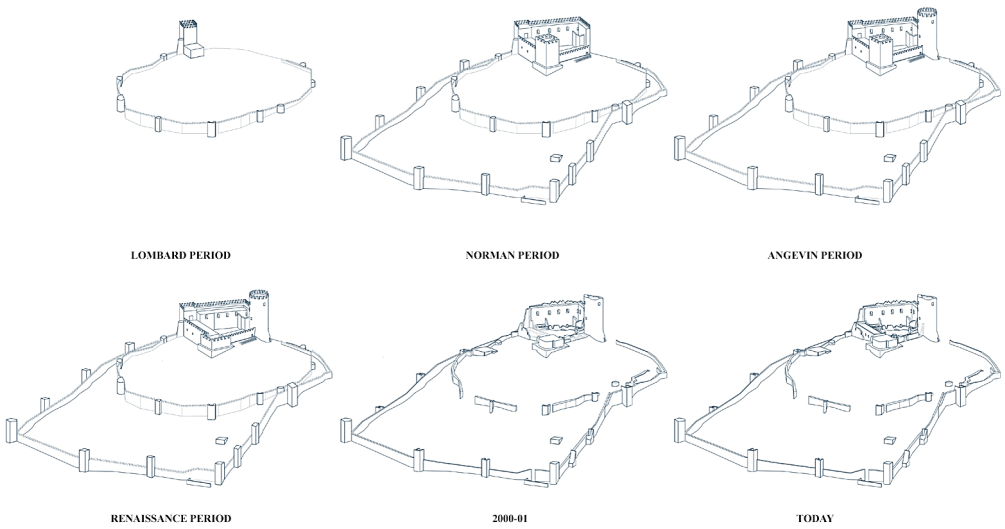


Fig. 2 – *Hypothetical reconstructions of the fortified system from the Lombard period to the present-day palimpsest. (Cinquantaquattro et al.,2003; Florio et al., 2017)* (Mazzei & Polcari, 2024).

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by Pietro Luciano and Francesco Petillo (Luciano & Petillo, 1985). This project envisioned the creation of theatrical structures within the castle walls, although these elements were never constructed. Nonetheless, some consolidation work was carried out, including interventions on the Angevin tower, consistently with the restoration practices of that time. For instance, these involved the installation of so-called "*cappottine armate*"[1] on the vaults and the addition of new metal flooring[2]. In 1989, the project was revisited and expanded, introducing previously unplanned interventions, such as concrete injections to reinforce the walls. During this period, the idea of installing a spiral staircase to provide access to the tower was conceived and partially realized, resulting in the construction of roof structures and balconies[3]. In 1998, Petillo proposed a new project aimed at creating an archaeological park at the castle, addressing the themes of previous proposals while incorporating a visitor pathway with parapets along the patrol walkway and openings in the drawbridge. The most significant and comprehensive restoration of the castle took place between 2004 and 2010, as part of the Integrated Territorial Plan[4]. Promoted by Giuseppe Mollo and Gaetano Barba, this initiative was prompted by the castle's deteriorated condition, which had worsened after archaeological excavations conducted in 2000-2001. These excavations revealed the remains of the "cavallerizza", which were partially reconstructed by using materials similar to the original ones, with the addition of brick *voussoirs*. Pointed wooden arches were introduced within the reconstructed structure, probably striving to evoke the original shape of the building. While the intent was admirable, the results have been somewhat uncertain. Inside the new stables, an elevated steel and wood walkway was installed to facilitate the access to the building. Concurrently, inner pathways within the castle walls were reinforced through naturalistic engineering techniques, and similar consolidation efforts were made for the defensive walls and the keep[5].

3.1. Analysis of current conditions

Following the historical and documentary analysis, a photogrammetric survey of the site has been conducted. This survey has enabled a detailed mapping of the structures, providing a comprehensive assessment of the conservation status of the wall surfaces and identifying areas requiring urgent intervention. The photogrammetric survey has been carried out in multiple phases: after an initial planning stage, several data collection campaigns have been conducted by using a drone. The collected data have been then processed to generate a high-resolution, textured three-dimensional model of the castle (Fig. 3), along with rectified elevation images. These data have been used as the basis for the restoration project, allowing for specific interventions tailored to the exact needs of every critical area.

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[1] This system involves the application of a reinforced external layer, made of durable materials such as reinforced concrete or metal mesh and steel wires, which is placed over the existing vault, connected with the inner surface.

[2] Petillo F. (1984). Progetto di consolidamento del castello, 20/12/1984, perizia 30/09/1987, Soprintendenza di Avellino: Faldone 19a-19p.

[3] Petillo F. (1989). Progetto di consolidamento e restauro del castello medievale, variante al terzo lotto esecutivo, perizia 24/10/1989, Soprintendenza di Avellino: Faldone 19a-19p.

[4] Petillo F. (1998). Parco archeologico del Castello di Avella, progetto definitivo esecutivo, 08/09/1998, Soprintendenza di Avellino: Faldone 19a-19p.

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Fig. 3 – Texturized model (Mazzei & Polcari, 2024).

This approach ensures that all conservation efforts have been guided by a clear analysis of the site's existing conditions. Despite the various restoration initiatives undertaken since 1984, the castle remains in a heterogeneous state of conservation. The Norman defensive walls, which span approximately 510 meters, are partially well preserved, whereas the turrets are in more compromised conditions. The inner Lombard masonry is also partially preserved, with some towers still visible, which, however, are significantly deteriorated. The castle's façades are a complex stratification of medieval, Renaissance, and modern restoration operations, reflecting the site's long and intricate history. These façades bear evidence of conservation efforts aimed at preserving the castle's authenticity while integrating newer construction techniques, as exemplified by the restoration of the stables.

4. Conservation and enhancement of the castle

The restoration project for the castle follows a methodological approach which integrates structural consolidation with the introduction of new architectural elements, aiming to achieve a balance between conservation and adaptive reuse (Fig. 6). The primary objective is preserving the integrity of existing materials and preventing further deterioration, while incorporating contemporary solutions to meet functional and accessibility requirements. Despite previous restoration efforts, several critical issues persist, including inadequate maintenance, the invasive growth of vegetation, and, most notably, limited access to some areas, such as the Angevin tower, which significantly reduces the site's usability. The project therefore aims to restore and enhance the fortification, reconfiguring parts of the castle to ensure both functionality and accessibility for a broader audience. In this context, the reconstruction of lost connecting elements, such as the square tower adjacent to the *donjon*, stands as an opportunity to improve accessibility. A notable precedent for this approach is the reconstruction of the fourth tower at Saliceto castle (Piedmont)[6], where a newly designed volume –though contemporary in style– recreates part of the lost structure while integrating vertical circulation systems and public facilities (Arenghi & Pane, 2016). The structural consolidation strategy is based on a series of specific interventions (Musso, 2013) aimed at ensuring the stability and integrity of architectural surfaces. The project is organized around three key areas of intervention, guided by the principles of minimal intervention and reversibility, with a focus on both conservation and adaptive reuse of the site:

- Access to the tower: currently inaccessible, the tower –one of the castle's central features– will be repurposed as a panoramic viewpoint, offering visitors a sweeping view of the surrounding landscape.
- Stables: rebuilt in 2006 but without a specific function, the stables will be adapted to accommodate small events and temporary exhibitions.
- Inner pathways: the pathways running along the defensive walls, currently obstructed by overgrown vegetation and inadequate maintenance, will be restored to improve accessibility and facilitate circulation of visitors.

[6] Armellino & Poggio-Architetti Associati, 2008, Cuneo.

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4.1. Scope I – Vertical connection inside the tower

The intervention addresses three key challenges: the difference in elevation between the entrance gate and the castle's courtyard; the access to the Angevin tower through the newly reconstructed vestibule; and the vertical connection inside the tower, which has been explored through two different design scenarios.

To overcome the first challenge, a new ramp will be introduced to connect the entrance with the courtyard, serving a dual function: improving accessibility while simultaneously enhancing the historical significance of the ancient Eastern Gate.

Additionally, the project includes the reconstruction of a vestibule (Florio et al., 2017) over the remains of the original structure. Historically, this element served as a transitional space between the castle's exterior and interior spaces. The aim is not only to restore a lost architectural feature but also to provide visitors with a more immersive experience while perceiving a continuous historical narrative. The new vestibule will feature a lightweight steel staircase to bridge the difference in height between the remaining walls, alongside a spiral staircase providing access to the tower's entrance.

After the reconstruction of the vestibule, the next phase involves completing the tower's vertical connection system. This intervention is part of a broader series of proposals started in 1984, aimed at facilitating access to the intermediate metal floors installed in 1988 through the addition of a spiral staircase.

However, due to the complexity of structural assessments and the need to meet accessibility requirements, two alternative design scenarios have been developed, each one of them reflecting a distinct approach within contemporary restoration principles.

Scenario A. (Figs. 4 & 7) The first design proposal aligns with a more conservative approach while integrating functional elements to enhance the site's usability. Upon ascending the spiral staircase in the vestibule, visitors would directly enter the tower, where a second staircase provides access to the intermediate floors. This solution ensures accessibility while maintaining a delicate balance between modern interventions and the preservation of the site's historical integrity.

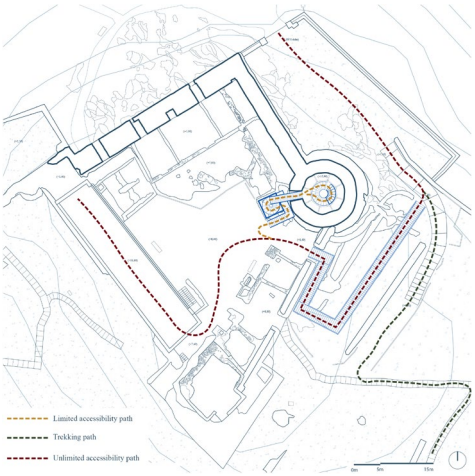


Fig. 4 – *Study of accessibility, Scenario A* (Mazzei & Polcari, 2024)

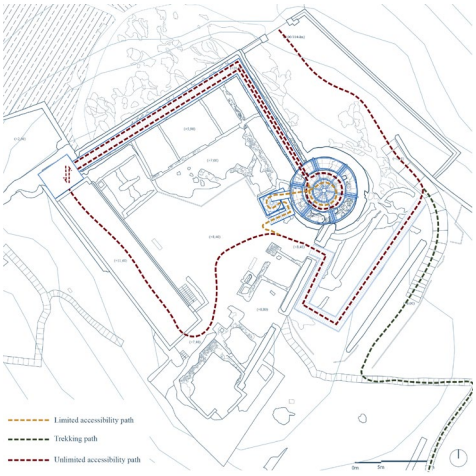


Fig. 5 – *Study of accessibility, Scenario B* (Mazzei & Polcari, 2024)

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Scenario B. (Fig. 5 & Fig. 8) This approach prioritizes accessibility and inclusivity, ensuring the site is fully accessible even to people with disabilities, without compromising its historical authenticity. The primary modification addresses the inner staircase of the tower, which, unlike the proposal of the previous scenario, is not attached to the existing roof but is instead supported by a newly designed wooden structure. Upon reaching the upper levels, the staircase is connected to a newly created pathway leading to the walkway. Accessibility is further improved through the installation of two lifts, located inside a newly constructed tower, which is positioned on the same site where one of the original Lombard towers of the inner wall once stood.

4.2. Scope II - Stables

Following the interventions carried out as part of the Integrated Territorial Plan from 2004 to 2010, the stables currently remain an underutilized space, and are primarily used as a mere passageway. Previous restoration efforts have compromised the space's adaptability by introducing wooden arches, which were intended to evoke the ancient vaults but now appear both visually intrusive and structurally unnecessary to support the upper floor.

Furthermore, the wooden platform obscures significant historical elements that should instead be emphasized. The project involves the removal of wooden arches and other non-functional elements, as well as the replacement of the metal parapet to enhance accessibility, aligning with the principles of Universal Design (Arenghi, 2007; Ministero per i Beni e le Attività Culturali, 2011). The space will feature an extended platform supported by new structural elements, incorporating glass panels to enable visitors to observe the ancient drinking troughs which are located below. Additionally, the presence of the original vault will be referenced through suspended wooden slats, re-evoking the structure's historical shape in a sophisticated way.

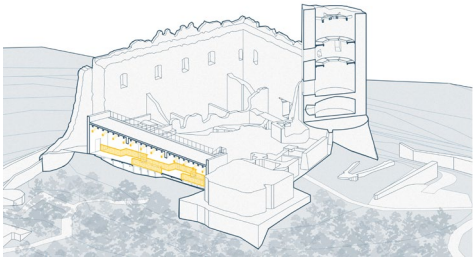


Fig. 6 – *Axonometric cross-section of existing condition* (Mazzei & Polcari, 2024).

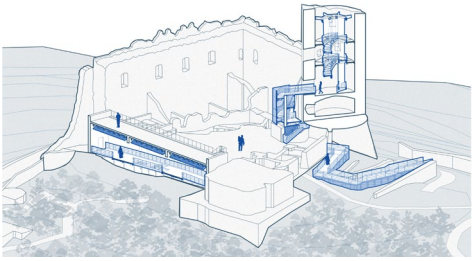


Fig. 7 – *Axonometric section, Scenario A* (Mazzei & Polcari, 2024).

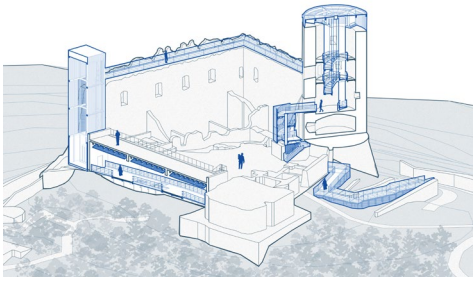


Fig. 8 – *Axonometric section, Scenario B* (Mazzei & Polcari, 2024).

4.3. Scope III – Inner paths

The intervention focuses on the restoration and enhancement of existing pathways, which are currently obstructed by overgrown vegetation. The paths are categorized into three types: iron, natural stone and wood. The proposal includes cleaning, restoration, and replacement of deteriorated materials to improve the overall accessibility. In particular, the wooden paths will undergo significant modifications, replacing the existing gravel infill with a granulated resin walking surface.

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This solution will ensure a more compact surface while minimizing permeability to invasive vegetation. To optimize the circulation of visitors, the project introduces distinct routes configurations: a circular path and a linear path.

5. Conclusions

The restoration of castles and archaeological parks in a ruined state stands as a crucial challenge for the preservation of historical heritage, as these sites embody a cultural memory that must be both protected and enhanced (Foramitti, 2008; Bevilacqua & Ulivieri, 2023). The conservation of such sites extends beyond the mere physical restoration of structures, as it offers an opportunity to reclaim their cultural and social relevance by reintegrating them into the contemporary landscape. In this context, the castle of *Abella* serves as a particularly relevant case study, where the fragmented archaeological remains, despite their substantial gaps, allow for contemporary interventions that, while primarily preserving the ancient structures, also seek to enhance the experience of visitors. The project has paid particular attention to the improvement of accessibility, the reinforcement of structures and the site's usability, and all the proposals for such operations have been supported by thorough archival and bibliographical research. This approach to archaeological heritage, while firmly rooted in conservation principles, also emphasizes the integration of structures and facilities designed to enrich the experience of visitors.

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