International Journal of Innovations in Civil Structures and Materials
Volume1, Issue 01 2025

A CHANCE TO PRESERVE THE ROMANIAN VERNACULAR URBANISTIC HERITAGE IN A NEW AND EXCITING WAY

Aurelian GRUIN[1*], Felicia ENACHE[2], VARGA Ofelia[3]

Department of Civil Engineering,

Research Article

Received:27-02-2025 **Revised:02-03-2025** **Accepted:10-03-2025** **Published:25-03-2025**

Abstract

Protecting Romania's vernacular urban history is the overarching goal of the proposed study, which aims to find creative and practical ways to capitalise on traditional building techniques. Redesigning traditional Romanian housing entities using modern methods, techniques, and tools (e.g., specific design methods and detailing, material mix design, specific material parameters, etc.) is one way to accomplish this goal. An existing model that has been empirically validated over the centuries using construction materials and techniques primarily from rural areas can be reformatted with modern scientific knowledge to create a new model that meets current safety, aesthetic, and quality standards. Depending on the climatic and relief zoning, earthen buildings in Romania were developed differently. These buildings can be vernacular or built with qualified personnel like craftsmen and traditional masons. Many different techniques and technologies are used in their construction, such as load-bearing walls, adobe bricks, mixed wood-earth structures, etc. The traditional housing legacy of Romania can be preserved by optimising these techniques and technologies, finding their weaknesses and engineering solutions to overcome them, and determining relevant fields of application based on their physical, mechanical, and durability characteristics and their evaluated bearing capacity. Nearly half of Romania's population is now relocating to rural regions, including dwellings constructed of earth, which presents a clear potential for the suggested study. Earth, clay, wood, and other traditional building materials are derived from primary natural resources. By utilising these materials, ecological housing concepts can be created that are highly efficient in terms of energy savings, indoor air quality, and resource conservation. This aligns with the industry-wide push for Circular Economy implementation and the general goal of reducing resource consumption.

Keywords*: Earthen building materials; Traditional housing heritage; Conservation; Structural performance; Green buildings*

Introduction

By using vernacular methodology and innovative building materials sourced from main natural resources, green housing ideas may be implemented, leading to improved energy efficiency and occupant health. The use of raw materials including clay, sand, wood, straw, wool, and more, together with improvements to local traditional methods and conceptions, may lead to the development of such materials and processes. Making eco-friendly and long-lasting homes is the primary goal of reevaluating these methods. The design, production, and usage of a wide range of building goods is possible; this includes adobe bricks, structural and non-structural components like walls and floors, and finished constructions with matching finishing elements. In addition to protecting Romania's architectural legacy, this method is in line with national and European initiatives that seek to increase the use of sustainable, environmentally friendly, and non-toxic building supplies. In addition to being sourced from readily available materials, they also have low toxicity and carbon dioxide emissions levels, are highly recyclable, and may be reused for other uses.
A country's or region's "vernacular"

encompasses not only its language and dialects but also its culture and even the architectural forms of its dwellings. The main characteristic that distinguishes vernacular materials from their more conventional counterparts is their availability in the local area [1]. The most ubiquitous of these materials is, without a doubt, earth. Even in the modern day, more than a third of the world's population lives in earthen structures, with developing nations accounting for more than half of that total [2]. This makes it very improbable, both now and in the future, that we will be able to satisfy the infrastructure needs for housing facilities by relying simply on contemporary, industrialised materials like concrete, steel, glass, bricks, and so on. It is also impossible to overlook the negative effects on the environment caused by the manufacturing of these materials. One possible answer is to make use of soil, the most common and plentiful natural resource, which contains a wide variety of materials including loam, clay, sand, silt, and more. Use of new methods, supplementary materials, and continuous study may enhance the structural capacities of a variety of construction techniques, such as mud bricks, adobe bricks, soil blocks, rammed earth, poured earth, and others.

In recent decades, there has been a noticeable upturn in the value and usage of vernacular urban history, which has garnered interest from disciplines as diverse as science, economics, and business on a global scale. Areas ranging from highly developed to moderately developed are all part of this expanding interest. There are a number of reasons why vernacular architecture is gaining popularity. One is that it honours and uses the traditional building knowledge that is associated with earth, wood, and stone. Another is that it considers and adapts to the specific landscape and area in which it is built.

When it comes to public works projects, vernacular architecture has a lot of promise for eco-friendly growth. By encouraging energy efficiency and meeting basic needs at a reasonable price, it is consistent with ecological ideals. This is accomplished by making efficient use of nearby resources, which decreases the need for energy-intensive materials such as cement. Both rural and urban metropolitan regions may lay the groundwork for sustainable urban development by making use of locally accessible resources. This method helps reduce emissions of carbon dioxide, which is in line with European policies that try to combat climate change, save resources, and safeguard the environment.

A complex and contemporary scientific investigation is involved in the use of as a building material, whether for structural reasons, filling, finishing, repair, or consolidation, either alone or in conjunction with materials that are compatible with it in terms of composition and structure. This investigation covers a wide range of topics, including production approaches and tools, mechanical and physical qualities, longevity, structural soundness, aesthetics and design, cost, and the creation of suitable rules within an all-encompassing legal framework. To get the most out of the material and make sure it is used properly in building projects, all of these things are necessary.

Preserving and using the rich and varied legacy of earth-based building continues to garner significant attention on a worldwide scale. Research into, preservation of, and creative promotion of traditional earth architecture's worldwide legacy receives ongoing funding from the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) [3]. Also, well-known scientific organisations and institutes are constantly doing experimental and application research on earth structures; for example, CRAterre in France [4] and "Dachverband Lehm eV" [5] in Germany. The formulation and execution of earth building laws and legislative frameworks at the national and

European levels are greatly impacted by their activity.
This study is part of the NIRD URBAN-INCERC research project PN 23 35 04 01, which will be funded by the Romanian government beginning in 2023. Its main objective is to find new ways to value the traditional technologies of earth-inhabited spaces, a topic that has broad potential applications in both new and existing buildings.

General Context of the Research and Project Structure:
Major Scientific Axes and the Corresponding Objectives

The current global, geo-political, industrial and economic, urban and demographic, scientific, cultural, and environmental context, etc., is dominated by intense concern over environmental degradation, climate change, and future access to natural resources for the next generation in the short, medium, and long term. Therefore, the NIRD URBAN-INCERC research project PN 23 35 04 01 seeks to offer scientific, technical, and applied solutions in the field of national construction infrastructure as part of the European Union (EU), based on the following considerations:

- It is anchored in the field of construction as an essential contributor to the national GDP (the construction industry alone represents 9% of the Romanian GDP without the supporting industries, according to the National Strategy on the Circular Economy (SNEC 2022), considering the 2020 available data);
- It is focused on the irreversible repercussions produced on the environment by the present society and the acute need for a fast change in the development and consumption approaches by the applicative implementation of the Circular Economy (EC) principles at the national level, in accordance with the objectives assumed in SNEC 2022, the National Strategy for Research, Innovation, and Smart Specialization (SNCISI 2022-2027), the Recovery and Resilience Plan for Romania (PNRR), etc.

The general goal of PN 23 35 04 01 is the design and the applicative validation of technological algorithms specific to construction and supporting industries in direct partnership with the entrepreneurial environment, and it is pursued by means of two distinct but complementary research axes, Ax I (i) and Ax II (ii):

(i). *Development of innovative engineering solutions for eco-intelligent construction products by an efficient capitalization of additions generated by local industries;*

(ii). *Innovative assembly of solutions for the conceptual and applied valorization of traditional technology for earthen inhabited space.*

The structure of the project includes 16 distinct phases, assigned alternately to the two directions, considering the conceptual symmetry that generates a synergistic convergence in the final stage. The estimated results are connected to four general objectives (GO) (Fig. 1), associated with the general goal of the project, and established in accordance with the general and specific objectives of SNCISI 2022-2027 and SNEC 2022:

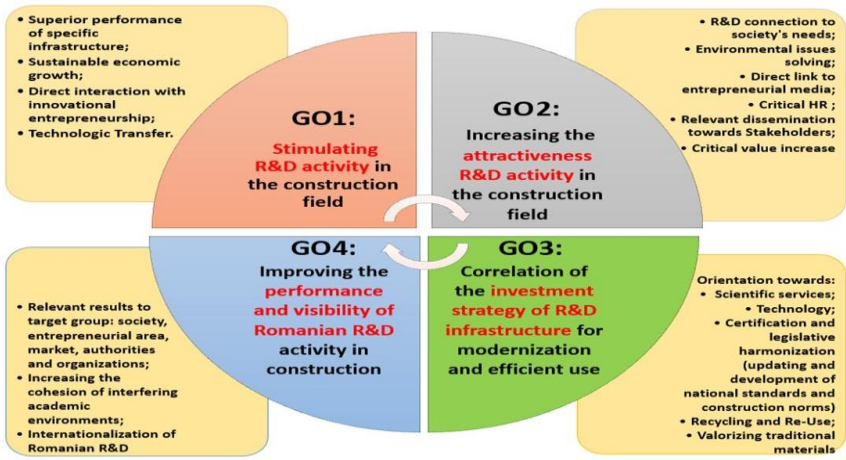


Fig. 1. The 4 general objectives (GOs) of NIRD URBAN-INCERC research project PN 23 35 04 01

a. **GO1 - Stimulating Romanian R&D activity in the construction field by:**
- ✓ Superior performance of specific infrastructure;
- ✓ Sustainable economic growth;
- ✓ Direct interaction with innovational entrepreneurship;
- ✓ Technologic Transfer.

b. **GO2 - Increasing the attractiveness of Romanian R&D activity in the construction field by:**
- ✓ R&D connection to society's needs;
- ✓ Environmental issues solving;
- ✓ Direct link to entrepreneurial media;
- ✓ Critical human resources;
- ✓ Relevant dissemination towards stakeholders;
- ✓ Critical value increase.

c. **GO3 - Correlation between the investment strategy of R&D infrastructure for modernization and its efficient use, considering the orientation towards:**
- ✓ Scientific services;
- ✓ Technology;
- ✓ Certification and legislative harmonisation (updating and development of national standards and construction norms);
- ✓ Recycling and Re-Use;
- ✓ Valuing traditional materials.

d. **GO4 - Improving the performance and visibility of Romanian R&D activity in construction by:**
- ✓ Relevant results for the target group: society, entrepreneurial area, market, authorities, and organisations;
- ✓ Increasing the cohesion of interfering academic environments;
- ✓ Internationalisation of Romanian R&D.

The estimated results aim to offer concrete solutions to the current problems in the construction sector by

developing products and services (materials, elements and structures, processes and technologies, etc.) with superior overall performance and increased energy efficiency. The intelligent and sustainable transition of the Romanian construction infrastructure is also considered, as is implicitly the increase, in the short and medium term, of the degree of implementation of the principles of the Circular Economy (EC) in Romania. A key partner in the scientific approach is represented by the local entrepreneurial media, in order to determine the mobilisation of organisations towards open innovation through concrete and efficient technological transfer of research results, simultaneously with the cohesion of the academic environment in complementary directions of scientific interest.

Research Ax II: New Solutions for Innovative Conceptual-Applicative Valorisation of the Traditional Earth Technologies of Romanian Inhabited Spaces

The second axis of the project is focused on the conceptual and applied valorization of the traditional technologies of earth-inhabited spaces by using modern methods, techniques, and tools with multiple applicability, both on existing buildings as well as for new housing entities [6]. The proposed research is considered in direct relation to all stakeholders, namely the parties interested in the direct or indirect outcomes of the study. Belonging to the internal and external environment with respect to the research core, they include the academic and research media, the entrepreneurs, the users (clients), suppliers, and also the social, economic, and political compounds, local and central authorities, etc. The research intends to cover the whole range of construction products, namely materials, elements, and structures, as well as technologies for production and implementation. Natural clay-based materials are currently experiencing a return to the spotlight due to their very low impact on the environment, considering their complete life cycle, namely the production, application, exploitation/disposal processes, compared to modern materials [7].

The global assessment of the current state regarding the potential of the proposed theme, i.e., the valorization of the traditional technology of creating inhabited space from the earth, involves the analysis of the interior and exterior environment, namely the evaluation of the strengths and weaknesses, the opportunities, and the threats. The scientific research report on the current state of national and international research in the concerned field (internal environment, IE) and also the consulting of the local and regional entrepreneurial environment (designers, executors, experts in the field), the authorities, market analysis, etc. (external environment, EE) will substantiate a SWOT analysis, favouring the synthesis of investigative strategies and a further selection of lines of investigation with high-performance potential in accordance with established objectives of the Ax II.

Internal Environment (IE) Evaluation – Current Relevant Issues

Considering the established objectives of the project and the estimated results, the documentation study focuses on a pertinent national and international consultation of the norms, regulations, designing standards, raw materials or composite materials, the cast-in-place technologies, etc., in the earthen housing entities field, the component materials, the execution technologies, together with the profile studies carried out by the academic or related research environment worldwide.

a. Integrating the general principle of vernacular constructions into the concept of

Sustainable Development

The proposed research approach is designed by integrating the general principle of vernacular construction into the concept of Sustainable Development. Sustainable architecture has often been associated with technology and energy performance as important factors in achieving comfortable living standards. However, nowadays, design approaches focus mainly on the objective of energy efficiency, which limits the definition of sustainability and does not consider the specifics of the place or relevant cultural and regional aspects. There is a powerful need to pay more attention to the social and cultural components of local specificity in order to develop solutions that increase the sense of belonging and encourage the formation of communities with common interests [8–10]. This can be achieved by exploiting the specific knowledge of the local community in the development of sustainable architecture solutions, with the aim of achieving a balance between energy efficiency and cultural and regional appropriateness.

Vernacular construction techniques, influenced by local traditions, serve as adaptable responses to the unique environmental conditions of a particular area. Traditional buildings are designed to fulfil a wide range of physical and spiritual needs while harmoniously blending with the surrounding communities [11, 12]. The notion of being indigenous to a specific place encompasses a complex relationship with the environment and a diverse range of customs. These elements collectively establish a shared foundation of values that shape the cultural practices of a community. When approaching architecture from a sustainability standpoint, it becomes evident that a comprehensive understanding of the local context is crucial, spanning from the national level down to the local level [13–15]. This entails recognising, considering, and preserving all relevant aspects specific to the area. In this context, the current theoretical study delves into scientific documentation regarding innovative *Eco-Clay materials* used in construction products and earthen structures, both at the regional, national, and international levels. *To effectively integrate these constructions within the framework of sustainability, it is imperative to account for cultural aspects and local heritage.* This necessitates a deep understanding of the unique conditions of the location, including its historical, political, and social context, as well as the construction techniques employed and contemporary advancements in the utilisation of traditional materials.

b. The balance challenge: Meeting design requirements vs Meeting economic efficiency criteria for Romanian earthen housing entities

In traditional constructions, including those made of earth, there is often a conflict between two seemingly contradictory criteria:

I. Meeting design requirements: This involves ensuring the safety and functionality of the structure. It encompasses aspects such as strength and stability under normal and extreme loading conditions, as well as meeting architectural, thermal, acoustic, and waterproofing requirements.

II. Meeting economic efficiency criteria: This pertains to creating a housing entity with minimal financial resources. Economic considerations can influence the choice of structural systems, non-structural components, and materials used throughout the construction process.

Balancing these two criteria is a challenge for the current study. While it is essential to meet design requirements for a safe and functional structure, there

is also a need to minimise costs and optimise resource utilization. This may lead to strategic decisions regarding the choice of construction systems, materials, and components, aiming to achieve an economical outcome without compromising the overall integrity and performance of the structure. Finding the right balance between meeting design requirements and achieving economic efficiency often requires careful evaluation, planning, and consideration of various factors, such as local availability of materials, construction techniques, local building regulations, and the specific needs and resources of the project.

c. The lack of regulations for the design and execution of earthen constructions on a national, European, and even global level with respect to structurally relevant criteria On a national, European, and even global scale, the lack of a unified guiding and regulatory system for earthen constructions has been identified. This system should encompass design, execution, and quality control criteria to ensure the safe utilisation of such constructions, taking into account the specificities and applicability of the region in which they are situated, like seismic action or durability issues, etc.

Upon reviewing the norms and regulations pertaining to the construction of houses using compacted, rammed, or poured earth, particularly in seismically active areas, it is evident that most of these documents serve as instructional publications, providing construction specifications to be followed. Two notable papers [16, 17], together with the NZS 4297:2020 standard (engineering design of earth buildings), were identified as sources that include formulas for seismic design. Other publications refer to additional papers to obtain more detailed information on seismic design, such as the NZS 4203:1992 (Engineering Design of Earth Buildings) referenced in NZS 4297:2020.

Moreover, the design guidance provided in NZS 4297:2020 is considered useful by Australian standards. Regarding the IS 13827:1993 standard (Engineering design of earth buildings), it references the IS 1893 Part 1:2002 standard (Engineering design of earth buildings) for seismic design, while the ASTM E2392-M10 standard (Standard Guide for Design of Earthen Wall Building Systems) specifies the need to perform seismic design according to ASCE 7.

Although seismic design is not explicitly mentioned in NBC 204:2015 (Guidelines for earthquake-resistant building construction: earthen buildings), it is covered by the Nepali NBC 105:1994 (2007) code (Seismic design of buildings in Nepal), which, in turn, recommends its application along with the Indian Standard IS 4326:1976 (Code of Practice for Design and Construction of Earthquake-Resistant Buildings).

As observed, the design of structures constructed with compacted or poured earth requires consulting various documents from different countries to address seismic considerations. In Europe, a potential solution to this issue would involve the development of a unified code similar to Eurocode 8, Part 1 (General Rules), seismic actions, and rules for buildings. This standard provides specific design criteria for different building materials such as steel, concrete, and masonry, offering detailed guidance on design calculations to ensure structures can withstand seismic forces.

The lack of comprehensive understanding of the structural behaviour of earthen constructions is the primary reason why existing regulations (standards, codes, and instructions) are often adapted from masonry regulations, leading to compatibility and adequacy challenges. It can be concluded that the design methods for earth construction have not been extensively researched,

correlated, and unified in the form of clear regulations that are widely accepted, implemented, and legislated at the national or European level, specifically considering their relevance to the case of Romania. Addressing this gap would require dedicated research efforts and the formulation of specific regulations tailored to the unique characteristics of earth construction, ensuring the safety and reliability of such structures, especially in seismic regions.

d. ***Brief review of the vernacular urban heritage of the Romanian space***

Traditional houses were built to last for generations, often using locally sourced materials that are sustainable and adaptable to the local climate and environment. These materials are generally durable, energy-efficient, and have a low environmental impact. As a result, traditional houses tend to blend into the surrounding landscape, reflecting local culture and architectural styles [18–20].

In Romania, there exists a construction system that has been documented on our territory since the Neolithic period. This system involved constructing house walls using a wooden frame and closing elements made of reeds and yellow clay [21]. Initially, the pillars of the building's skeleton were embedded in the ground. However, as time progressed, they were secured to wooden slats supported by a foundation of river boulders. This foundation was elevated above the level of the surrounding land, indicating that the lifespan of the construction extended beyond that of the embedded part in the earth, which naturally degraded over time. This technological advancement was made possible by the implementation of a new beam joining system, which enhanced the overall strength and durability of the building. A short overview of the typology of traditional Romanian houses and their evolution is presented in figure 2, according to the studies of traditional architecture towards conservation and valorization by the means of typification (*Locuința Sătească din România, ICCPDC, 1989)* [21].

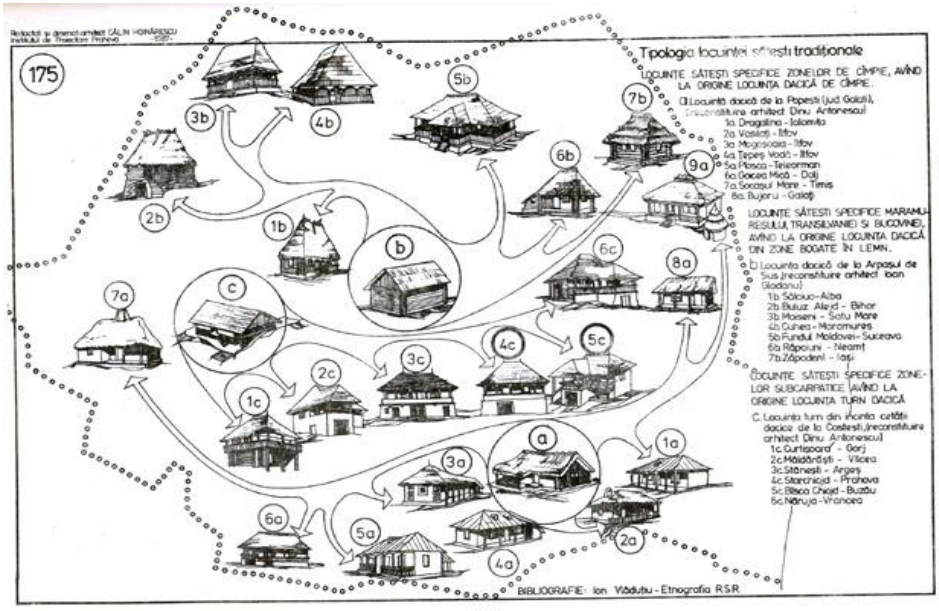


Fig. 2. Short overview of the typology of traditional Romanian houses and their evolution [21]



Fig. 3. Types of traditional Romanian houses: a) Romanian traditional household; b) Traditional Romanian household with vegetable materials for roofing; c) Traditional Romanian one-story house; d) Temporary housing (summer) in the Danube Delta (https://romaniadacia.wordpress.com/2015/08/07/the-romanian-peasant-and-agriculture/) The construction system utilising wood, reed panels, and yellow clay adhesive was employed in our country from the Neolithic era until the mid-20th century. This system evolved over time, was influenced by regional factors and specificities, and adapted to the needs and resources available to the local population, as depicted in figures 3 and 4. Initially, wicker panels glued to clay were used. However, as the system progressed, a broader range of infill materials came into use, such as wooden boards sealed with clay, wood, unburnt clay bricks, and more recently, fired bricks.



Fig. 4. Types of traditional Romanian houses: a) Traditional household with clay walls and woven reeds fence;
b) Current Romanian household, in Chilia Veche;
c) Current Romanian household, in the Danube Delta; d) Traditional Romanian household (Baia Mare Ethnography and Folklore Museum) (https://www.facebook.com/MuzeulSatuluiBM/)

The evolution of the construction system, as depicted in figures 3 and 4, exemplifies the adaptability of traditional building techniques to changing cultural, environmental, and technological influences. Throughout the years, these techniques have responded to various factors, ensuring their continued relevance and usage in diverse regions. By embracing these adaptations, people have been provided with sustainable and cost-effective housing options that have stood the test of time. This evolution not only preserves the cultural heritage of the communities but also showcases the ingenuity and resourcefulness of traditional builders in creating practical and enduring dwellings.

Conclusions

In light of the topic's persistent potential and research prospects, this study provides a worldwide perspective on contemporary options for creative conservation of Romania's vernacular urbanistic legacy. The physical-mechanical and architectural-aesthetic compatibility of natural materials with the mostly traditional rural house stock suggests a substantial possibility of rising demand for these materials in the near, medium, and far future. Sustainable community development in rural and urban areas may be achieved via the use of traditional and vernacular building methods, including wood, rammed earth, clay, burned brick, and clay. The inherent ecological and aesthetic aspects of these building systems are due to their ability to adapt to the local temperature and topography, making use of readily accessible natural materials like soil and wood. Because they are built using local skill and labour, they have a little effect on the environment, making them socially attractive. They also help people feel more connected to the community. Not only are these buildings practical from a financial standpoint, but they also help boost local economies by involving residents in building them. This means that a large percentage of the population can afford them. Because of their distinct character and allure, these historic structures may also serve as tourist magnets.

The first study to compare rammed earth and poured earth wall components aimed to find general improvements in both methods to point the way for further research on the subject [49]. Academic and research media, entrepreneurs, users (clients), suppliers, social, economic, and political compounds, and local and central authorities are all stakeholders with a direct or indirect interest in the study's outcomes. Figure 10 shows that first theoretical and experimental conclusions point to positive results, which support continuing the study in line with scientific directions for the valorisation of vernacular earth products for construction: materials, elements, and structures, Eco-Clay technologies.

References

[1] In the International Journal of Architecture and Urbanism, volume 5, issue 2, pages 148–160, in the year 2021, N. Siregar identifies the technical features of Malay Deli traditional houses as defining characteristics of vernacular architecture.
Building with Earth by G. Minke, p. 2. A Guide to Sustainable Building Design and Construction, 2005, Birkhäuser: Publishers for Architecture in Basel, Berlin, and Boston.

World Heritage Centre, Paris,

France, 2005, p. 3 of the Vienna Memorandum on World Heritage and Contemporary Architecture—Managing the Historic Urban Landscape, UNESCO. [4] CRATerre: Traité de Construction en Terre, Éditions Parenthèses, Marseille, France, 2006, written by H. Houben and H. Guillaud, is accessible online at http://whc.unesco.org/en/activities/48.

The Lehmbau Regeln, Begriffe, Baustoffe, and Bauteile, Third Edition, 2009, published by the Dachverband Lehm e.V. with Weimar as his editor. A.I. Petrisor, O.C. Popescu, A.V. Tache, and I.C.A. Sandu, Unmanned Aerial Vehicle (UAV) options for cultural asset preservation and management [6]. International Journal of Conservation Science, volume 9, issue 4, pages 795–804, case study: the Halmyris archaeological site. The authors of the article "Land cover and use changes focused on the urbanisation processes in Romania" (A.I. Petrisor, I. Ianoş, and C. Talanga, 2010, pp. 765-771 in the Environmental Engineering & Management Journal, volume 9, issue 6). [8] In the International Journal of Conservation Science, volume 10, issue 4, pages 689–700, V. Luca, O. Corbu, I. Sandu, and I. Bucur present Rimetea, a traditional Romanian hamlet, with the DOI: 10.30638/eemj.2010.102.

The effectiveness of biodiversity protection within the Romanian Carpathian convention area was evaluated using geographical measures (A.I. Petrisor, L.E. Petrisor, 2017; Present Environment and Sustainable Development, 1, 35–43).

As stated in the 2016 publication by the Rural Group of OAR, H. Răcășan, C. űuteu, and M. Gingirof authored the Architecture Guide for the Local Specificity of the Rural Area - the Hills of Cluj. Energy Procedia, 6, 2011, pp. 228-235, DOI: 10.1016/j.egypro.2011.05.026, by T.A. Aziz and I.M. Shawket, proposes a new approach to improving slum regions in developing nations via the use of vernacular trends in order to accomplish sustainable housing construction.

12 M. Cherry and A. Green, "Vernacular Architecture at 50: Towards the study of buildings in Context," in 50(1), 2019, pages 1–17, Vernacular Architecture. Publication date: 10.1080/03055477.2019.1663471.

“Difficulties in achieving social sustainability in a biosphere reserve” (International Journal of Conservation Science, 7(1), 2016, pp. 123–136), written by A.I. Petrisor, R. Petre, and V. Meiţă. [14] In Landscape and Urban Planning, volumes 83(1), 2007, pages 62–69, C. Tweed and M. Sutherland discuss the relationship between built cultural heritage and sustainable urban growth. Article DOI: 10.1016/j.landurbplan.2007.05.008.

Towards the Sustainable Development of Protected Areas: The Possibilities of Integrated Valuation of Built Heritage Changes, by A. Mlinkauskiene and I. Grazuleviciute-Vileniske, published in 2010 by Advanced Construction, pages 61–67. Reference: [16] Guidelines for Earthquake Resistant Non-Engineered Construction by A.S. Arya, T. Boen, and Y. Ishiyama, published by UNESCO in 2014 with the ISBN 9789230000325. An method towards earthquake risk prediction in poor countries: non-engineered building (A.S. Arya,

2000, pp. 187–208, Bulletin of the New Zealand Society for Earthquake Engineering, 33(3)). The spatial patterns of traditional Romanian houses provide a roadmap to national specificity (G. Mitrache, 2012, pp. 1665-1668, Applied Mechanics and Materials, 174-177). [19] A. Mitrache, "The Cula House—A Specific Case Study," Applied Mechanics and Materials, 174-177, 2012, pp. 1635-1638, DOI: 10.4028/www.scientific.net/AMM.174-177.1665. The article "Construction Techniques and Detailing for Romanian Paiantă Houses: An Engineering Perspective" was published in the journal Sustainability in 2023 and can be found at DOI: 10.4028/www.scientific.net/AMM.174-177.1635. Retrieved from the Internet: 10.3390/su15021344.