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EARTHEN ARCHITECTURAL HERITAGE IN THE INTERNATIONAL CONTEXT: VALUES, THREATS, CONSERVATION PRINCIPLES AND STRATEGIES

Camilla Mileto and Fernando Vegas
Universidad Politècnica de València

Abstract:
Design/methodology/approach: Earthen built architectural heritage is found widely in all parts of the world, in archaeological sites and monumental and vernacular architecture, which research centres and researchers are increasingly studying and cataloguing. However, despite its richness and historic and cultural values, as well as its many merits in environmental sustainability, sociocultural and socioeconomic terms, the value of this heritage has not been fully recognized in fields with major repercussions in conservation.
Purpose: This research aims to highlight the values, principles and recommendations for conservation in order to establish valid strategies for the conservation of earthen built heritage. This is done following a methodology which uses indirect (bibliography) and direct (case study) sources systematically analysed from different perspectives: the values of earth as a material and of architectural and vernacular heritage; the heritage conservation principles found in international documents; and the analysis of over 3,000 case studies from which good practices in earthen architecture conservation are extracted.
Findings: Finally, these data are cross-referenced to establish the broadest possible strategies to guarantee all aspects to be taken into account in the conservation of earthen built architectural heritage.
Originality/value: The text provides an overview of the different methodologies in order to extract specific strategies applicable to the conservation of this heritage, both locally and globally.

1. Introduction

Earth is the most abundantly accessible material found all over the world. This ubiquitous material, available on site, can be handled directly and different execution techniques used to produce architecture, from the simplest to the most complex. The presence of earthen architecture almost all over the world was already documented in the late 1980s by CRATerre (Houben & Guillaud, 1989: 16). This research then served as the starting point for many other studies which have attempted to document this architecture and its constructive cultures in greater depth, proposing atlases on a global (Vellinga et al., 2007) or continental scale (Correia et al., 2011), as well as studies by geographic region (Correia et al., 2016).

Habitats with earthen architecture can be found almost everywhere in the world (Mileto & Vegas, 2018). Earth has been observed in freestanding dwellings, groups and major monuments throughout history. The imprints of this human history can be found in the most primitive archaeological sites. Among the oldest materials we find the constructions in the excavations of Dja'de el Mughara in Syria (11,000 years old), in Jericho in the West Bank (9,000 years old), and the major discovery of groups of

dwellings in Çatal Höyük (Turkey) dating from 7000 BC. (Fontaine & Anger, 2009: 46). The dissemination of earthen architecture and the different constructive techniques have evolved together with ancient exoduses and cultural developments, colonizations and modern migration. These human movements have resulted in the circulation and marriage of techniques and different forms of use of earth in construction.

The wealth of earthen architecture is also linked to the potential of its execution. Earth offers a variety of colours, granulometries and textures, and a wealth of constructive cultures linked to the different climates and locations. Different studies have attempted to show the different forms of use of earth (Houben & Guillaud, 1989; Mileto et al., 2011), naming the different techniques and variants found in heritage (including: De Hoz et al., 2003; Correia et al., 2011; Mileto & Vegas, 2014; Correia, 2016; Mileto & Vegas, 2017a; etc.): construction through extraction (caves and excavations); monolithic construction (cob, piled earth, rammed earth, poured earth, etc.); construction by pieces (clay lumps, adobes, sod, CEBs, etc.); mixed-technique construction using timber, earth and fibres (half-timber, wattle-and-daub, reeds, etc.) or earth as an auxiliary material (aggregate in different mortars, rendering, coating, etc.). In each of these five groups, the different techniques branch out into endless variants depending on location, materials available, local tradition, climate and environmental needs, etc.

2. Methodology

Earthen built architectural heritage is increasingly studied for its architectural and constructive characteristics. Different studies have highlighted the qualities and limitations of earth as a material, as well as its features. In addition, in terms of conservation there is a wide range of conservation and restoration experiences providing case studies for the assessment of results as regards the criteria, materials and techniques used in these restoration processes. Some documents also provide a general overview of the conservation of earthen architecture, as well as specific manuals. However, despite decades of research, earthen architecture continues to be treated as second- or third-rate heritage by administrations, specialists, crafts and society in general.

This article aims to serve as a rallying cry for earthen built architectural heritage through a process based on the clear identification of the values, threats and risks of this heritage, as well as the conservation principles which should be applied in order to establish strategies covering the conservation of built heritage in the broadest way possible.

The methodology used (Figure 1) for this research has resorted to indirect (bibliography) and direct (case studies) sources through a systematic analysis of different perspectives. To do so, an extensive initial bibliographical review was carried out, focusing especially on the identification of the values of earth as a material, as well as on architectural, vernacular and intangible heritage. Secondly, based on international documents for the protection and conservation of cultural heritage it was

possible to identify the principles applicable to earthen built heritage. Thirdly, the research carried out as part of three projects funded by the Spanish government (RES-Tapia, SOS-Tierra and RISK-Terra) has provided an extensive database of case studies (around 3,000 in the Iberian Peninsula) which have been analysed following the criteria (Mileto et al., 2011), materials, intervention techniques, and results (Mileto & Vegas, 2014; Mileto et al., 2017b). This analysis made it possible to identify the problems but also the good intervention and management practices that have made it possible to obtain favorable results in the short and long term. Finally, the combination of the results of the case studies, the identification of the good practices and principles set out in official documents has allowed conservation strategies for earthen built heritage to be outlined.

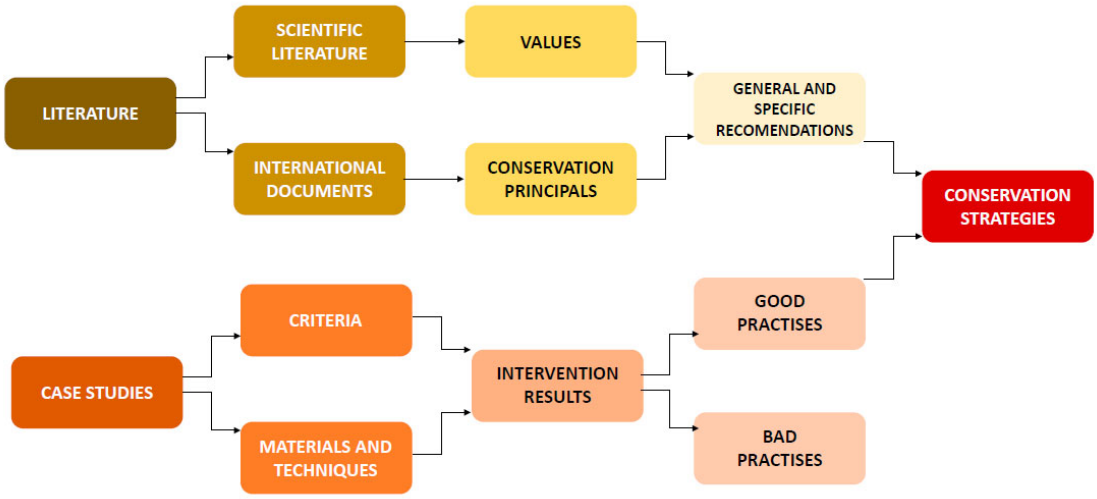

Fig. 1. Methodology used in the research

3. Values, threats, risks and potential of earthen built architectural heritage

3.1. Values

From the 1970s on, different research centres including Forschungslabor für experimentelles Bauen, CRATerre, Auroville Earth Institute, Earth Building Research Forum and Amaco started experimenting with earth as a building material to generate a more economic and sustainable architecture. The research carried out in all these centres has reinforced the values of earth as a material for construction (Houben & Guillaud, 1989; Fontaine & Anger, 2009; Barbeta & Massó, 2015; Balaguer et al., 2019): *financial values* (immediate availability as earth can be found anywhere, it requires no transformation and is therefore easy to transform); and ease of execution, as it is easy to handle and requires no specialist labour; *constructive values* (it displays good resistance, elasticity and adherence; it is fire-proof, chemically stable (and therefore long-lasting), and waterproof in its plastic state. It is also volumetrically stable and easy to work with due to its ductility); *bio-ecological values* (it guarantees a good level of comfort thanks to its capacity for acoustic insulation, while its thermal inertia and permeability allow good transpirability and regulation of steam; it has no radioactive or toxic charge); *environmental values* (it blends well into the site without affecting the

landscape; it guarantees improved energy efficiency thanks to the savings in energy linked to transport, extraction and transformation processes, and building use in heating or air conditioning savings; its complete recyclability leads to minimal waste generation).

In addition, the values identified in built cultural heritage throughout the 20th century have been gradually defined through the ideas of different authors (Mason, 2002) who have highlighted ancient, historic and commemorative values and those of use and novelty (Reigl, 1903); economic, aesthetic, symbolic and informative (Lipe, 1984); aesthetic, historic, scientific and social (Australia ICOMOS, 1999); economic, heritage, prestige and education (Frey, 1997); cultural, educational, economic, recreational, aesthetic (English Heritage, 1997). Some authors (Avrami et al., 2000) suggest grouping all these values into sociocultural aspects linked to architectural heritage as a reflection of a local culture, history, customs and beliefs (historic, cultural, symbolic, social, spiritual, aesthetic values), and socioeconomic values linked to their potential for use at present and the economic development of surroundings, exploiting their resources (economic, functional, development values).

To these heritage values we must add the values especially linked to vernacular heritage as the value of integration into the landscape and those of simplicity and immediacy linked to their direct immediate use (Vegas & Mileto, 2011). This is also the case with the values linked to intangible cultural heritage which, according to the "Convention for the safeguarding of the intangible cultural heritage" (2003), covers the uses, representations, expressions, knowledge and techniques (along with the instruments, objects, artefacts and cultural spaces inherent to them) which communities and groups recognize as an integral part of their identity and collective memory (cultural, identitarian, social values, etc.). Some of these heritage values acquire this specific nature when identified in earthen built heritage. This is particularly the case with historic-cultural values linked to the wealth and variety of techniques and forms of execution of earth in construction, which are extremely heterogeneous and diverse. This richness depends mostly on the great adaptability (Cooke, 2010: 24) of earthen architecture in relation to location and climate, to human demands and to architectural and constructive forms.

Currently, the concept of sustainability applied to vernacular architecture has prompted major reflection on the values of vernacular heritage in *environmental* terms (respect for the environment, a suitable location in settings, waste reduction, the salubriousness of materials, the mitigation of natural risks), in *sociocultural* terms (respect for the cultural landscape, the transfer of constructive cultures, the promotion of creativity and social cohesion, the intangible values of identity) and in *socioeconomic* terms (the promotion of local autonomy and activities, the optimization of efforts linked to constructions, lengthening the useful life span of the building, saving on resources) (AA.VV., 2014).

Therefore, the values of vernacular, monumental and intangible architectural heritage of earthen architecture can be summarized as sociocultural, socioeconomic and environmental values, as shown in detail in figure 2.

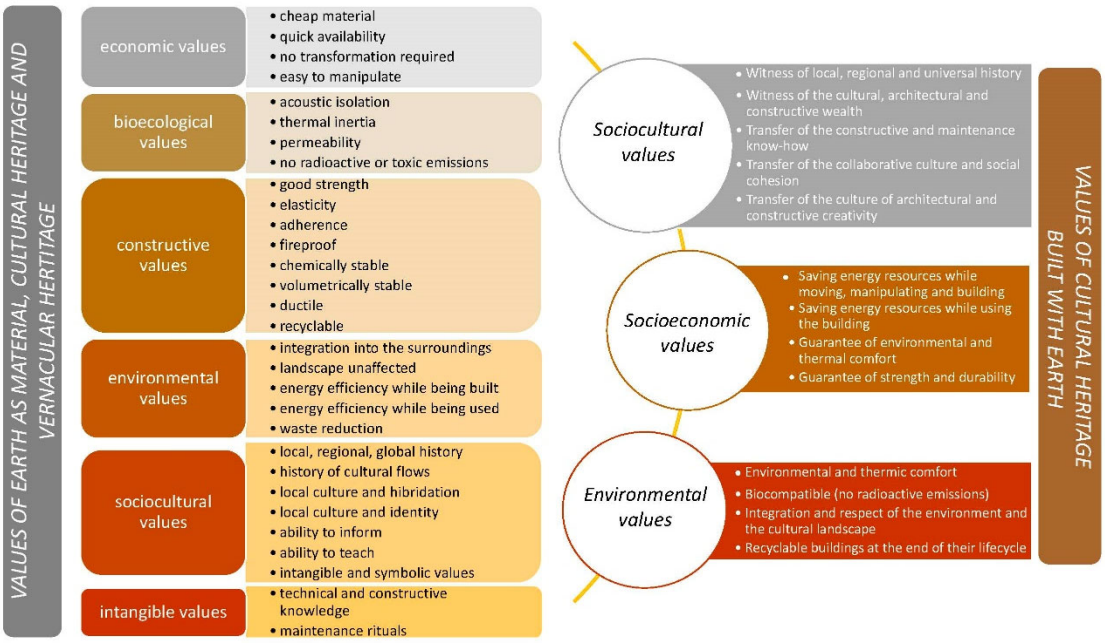

Fig. 2 Values of earthen built heritage

3.2. Weaknesses, threats and risks to earthen built heritage: natural and social factors

The material, constructive and structural weaknesses of earthen architecture are linked to different types of causes or natural threats, both intrinsic and extrinsic. There is extensive literature on the phenomena and causes of degradation (Houben & Guillaud, 1989; Warren, 1999; Keefe, 2005; Bui et al., 2009; Cooke, 2010; Rogiros, 2013; Mileto & Vegas, 2014; Mileto & Vegas, 2017a). Water is without a doubt one of the factors with the greatest impact on the degradation of earthen architectures in its different forms of rain, steam, water by capillarity, ice, etc. Among the atmospheric agents, wind also has a great impact on the erosion of earthen constructions. The growth of microvegetation and macrovegetation and the presence of animals can result in erosion and degradation. Other extrinsic factors to take into account are natural disasters like floods, earthquakes, droughts, etc. which can cause major damage to earthen architecture. There are also weaknesses linked to factors intrinsic to the construction, to the initial design of the building or subsequent additional transformations: excessive size of openings, thrust of the roof, failure of the foundations, occasional shoring up of horizontal structures, insufficient sizing of load-bearing walls, etc. Finally, the anthropic factor linked to the interventions to transform and adapt the building to new forms of use and demands, to the damage caused by tourism and the improper use of the different types of architecture and archaeological sites are also of importance, as are the interventions for repair, maintenance, restoration, etc. These interventions can cause great damage to the building if incompatible materials and techniques are used.

In addition, social threats perhaps constitute the greatest risk factor to this type of architecture (Mileto et al., 2020). The greatest threats are abandonment, social discredit, the loss of crafts, the use of industrial materials, and the pressure of tourist development. Earthen vernacular architecture often suffers greatly due to abandonment or social discredit, both as earthen architecture and vernacular architecture when compared with monumental earthen architecture, which is less at

risk from these factors given the recognition, value and protection attached to its heritage. However, when granted great recognition, both monumental and vernacular architecture are under threat from the pressure of tourist development.

Abandonment as a result of sudden or long-term causes is one of the greatest threats to earthen architecture, especially vernacular architecture. Sudden causes are those linked to catastrophic events such as major earthquakes, floods or tornados (Cameron & Tomka, 1993: 3) which mean that the local population is forced to abandon a place. However, there are more general long-term causes such as the migration of population from the rural setting to the cities, particularly widespread from the mid-20th century. The emigration of the population devoted to agriculture and livestock from a rural setting to cities has led in many villages and regions to the abandonment and degradation of cultural landscapes and their infrastructures (terraces, fields, platforms, canals, mills, etc.), as well as of entire settlements and buildings scattered throughout the territory. Furthermore, even if the population remains in the same place the introduction of machinery for agriculture, livestock, and production of materials and food has brought about the functional obsolescence of many buildings.

The threat of social discredit is the other major threat to the conservation of earthen architecture. Cooke (Cooke, 2010) identifies "vices" affecting the social image of earthen architecture, which is seen as lacking modernity, and is linked to economic poverty rather than being viewed as something positive. The idea of earth as a material far weaker than others has been long-held, whether founded or unfounded, and can be observed from the Sumerian writings where adobe is considered the least firm of baked bricks (Calatrava, 2010: 17) on. The vices identified by Cooke can be grouped into three major factors of social discredit of earthen architecture: association with poverty, backwardness and lack of civilization; association with insalubriousness and illnesses; association with a cheap construction and with a weak material with limited durability.

The social rescue of earthen architecture has been promoted for several decades, but has gained more weight in the last 10-15 years through different actions. Firstly, it has confirmed the validity of earth as a sustainable and biocompatible constructive material. Furthermore, restoration manuals (including: Cornestones Community, 2006; Achenza & Sanna, 2009; Bollini, 2013; Mileto & Vegas, 2017a; Joffroy & Moriset, 2018, etc.) have brought about the culture of restoration rather than replacement. The structural response of earthen architecture to seismic action and the potential for improvement has also been researched by different research teams (Vargas Neumann, 2005; Hurtado Valdez, 2010; Miccoli et al., 2014; Lorenço et al., 2019). In this respect, the Seismic Retrofitting Project headed by the Getty Conservation Institute (United States) has allowed advances in research on the compatible structural reinforcements of earthen heritage buildings under seismic risk (Cancino et al., 2012).

Secondly, the adoption of earth as a material in well-known types of contemporary architecture has been fundamental. This is the case of the first experiments carried out with rammed earth in Domaine de la Terre (Jourda & Parraudin Partenaires, L'Isle-d'Abeau - France, 1984) or with adobe in La Luz Community (Antoine Predock

Architect, Albuquerque – United States, 1967-74) which showed several decades ago that earth, with its different traditional techniques, can be used in contemporary architecture. From the 1990s the number of contemporary architecture projects using earth has increased, as have the award-winning and renowned architects who have used this material for their architectural design, showing its validity in contemporary design. This is the case of the architects who received the Pritzker Architecture Price including Herzog and de Meuron (2001), Glenn Murcutt (2002), Wang Shu (2012), or the multi-award-winning Burkinese architect Francis Keré, as well as many other designs both for large-scale buildings and for individual homes. Despite these efforts and results, there is still a long way to go in terms of raising awareness among the local population on the socioeconomic potential of earthen architecture in new construction and in heritage buildings. In this respect, there have been some exemplary actions for the construction or reconstruction of community dwellings such as the village of Wencun (Wang Shu, 2015) or the reconstruction of the village of Ma'anqiao in China (Mu Jun et alii, 2008), as well as the different projects carried out in collaboration with local communities.

Moreover, earthen architecture, among other vernacular architectures, is linked to constructive knowledge and ancient crafts. This constructive knowledge is the heritage of master builders, of the building crafts, and of the population. The phenomenon of construction industrialization has drastically reduced the demand for traditional constructions and therefore of the population which held this knowledge. This vertiginous drop in demand has often caused the dismantling of the chain of transmission of knowledge. From the last third of the 20th century the recovery of traditional trades which arose in the field of bioarchitecture and the restoration and retrofitting of heritage have been reflected in the activity of different institutions (including: CRATerre, Auroville Earth Institute, Proterra, University of Cagliari, etc.). There are fewer initiatives linked to the restoration of earthen built heritage, but it is worth noting the programmes offered internationally by the Getty Conservation Institute (United States) or the initiatives from Spanish centres including the CIAT – UPM, the UPV group led by the authors of this text, and the Tierra group from the Universidad de Valladolid.

4. Principles and strategies for conservation

4.1. The definition of principles through international documents (figure3)

Earthen architecture constitutes an extensive heritage covering archaeological, monumental and vernacular assets and tangible and intangible assets. In this respect, the general principles applied to architectural, archaeological, landscape, vernacular or intangible heritage can also be applied to this extensive heritage. These general principles for the protection and intervention of heritage have been progressively defined in a series of international and European documents: the *Athens Charter* (1931), the *Venice Charter* (1964), the *Convention concerning the Protection of the World Cultural and Natural Heritage* (UNESCO, *Paris Charter*, 1972), the *European Charter of the Architectural Heritage* (*Declaration of Amsterdam*, 1975), the *Convention for the Protection of the Architectural Heritage of Europe* (Granada, 1985), the *European Convention on the Protection of the Architectural Heritage of Europe*

(Valetta, 1992), the *Nara Document on Authenticity* (ICOMOS, Nara, 1994), and the *Burra Charter* (ICOMOS, Australia, 1999).

All these documents progressively expanded the concept of monument firstly to that of assets of cultural interest and, subsequently, to that of cultural heritage, a concept which covers all aspects of tangible and intangible culture. The Venice Charter in 1964 already recognized the conservation and restoration of heritage as a discipline covering diverse sciences, while subsequent documents established the need for cross-disciplinary work. From 1931 there was a progressive establishment of conservation principles (integratory action extended to construction, use, significance and relationships) which could be summarized as: the need for safeguarding, conservation and correct management of heritage; the need for an extensive and detailed study prior to any type of decision covering all the material, cultural and significant aspects of heritage; respect for all the values of heritage avoiding emphasizing some over others; the use of traditional materials and techniques in conservation processes, and if necessary, the use of new materials and techniques with guaranteed results; the need to maintain its heritage use or otherwise to introduce a use that is compatible with the heritage itself; respect for all phases as evidence of all moments in history; the legibility of the interventions while always respecting the harmony of the whole.

In addition, the major international documents in the field of vernacular heritage, traditional constructive techniques and intangible heritage include: the *Recommendation on the Safeguarding of Traditional Culture and Folklore* (UNESCO, 1989), the *Charter on the Built Vernacular Heritage* (ICOMOS, 1999), the *Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage* (ICOMOS, 2003) and *Convention for the Safeguarding of the Intangible Cultural Heritage* (UNESCO, 2003). The *Charter on the Built Vernacular Heritage* (ICOMOS, 1999) stresses the particular vulnerability of this type of heritage due to progressive cultural homogenization, mass introduction of industrial materials, and subsequent loss of knowledge of traditional constructive materials and techniques. This document calls for the need to respect the cultural identity linked to community, cultural values, traditional nature, and the relationship with the landscape. These aspects also coincide with the proposals of the *Convention for the Safeguarding of Intangible Cultural Heritage* (UNESCO, 2003).

The use of traditional materials and techniques in the conservation and restoration of heritage over the use of new materials has been the focus of debate for decades. The use in restoration of new materials, such as concrete, is admitted in the 1931 Athens Charter, and is limited to necessary cases in the 1964 Venice Charter. In the meantime, based on the 1985 Granada Convention it became necessary to favour the application and development of traditional techniques in the conservation of heritage, a principle which is increasingly consolidated. In the *Charter on the Built Vernacular Heritage* (ICOMOS, 1999) the conservation of traditional materials and techniques was considered essential so that there was a call for actions for education and dissemination for trades, the community and society. The use of traditional or innovative techniques was also enthusiastically recovered in the *Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage* (ICOMOS,

2003), reinforcing the principles of compatibility, reversibility, minimum intervention and respect for cultural values. Architecture is closely linked to its natural surroundings as built with the *earth* of the place.

In terms of the reflection on the principles and criteria to be used in conservation and restoration it should be noted that, since the early 1970s, ICOMOS (later ICOMOS-ISCEAH), as well as ICCROM, CRAterre-ENSAG and the Getty Conservation Institute, have periodically organized conferences on earthen built heritage, the first of which was held in Yazd in 1972 and the most recent in Lyon in 2016. On occasion, these meetings have served to develop recommendations which are of interest in highlighting issues crucial to the conservation of earthen built heritage.

The first two meetings, held in Yazd in 1972 and 1976, set the bases for the definition and conservation of earthen built heritage. The issue of the need to develop specific scientific research was broached at the conference organized by US-ICOMOS and ICCROM in Santa Fe (New Mexico, US) in 1977. On this occasion, calls were being made for using compatible materials in interventions, their legibility and conservation of the different stages of the building, the protection of buildings with provisional structures while carrying out the indispensable studies prior to intervention and, finally, the importance of using traditional materials and techniques for conservation and maintenance. The term "earthen architecture" was used for the first time in Ankara in 1980. In Lima, in 1983, emphasis was placed on the need to implement specific training programmes at all levels, a point which was also taken up in Rome in 1987 where an intensive study programme for the conservation of earthen architecture was approved, and was to be verified biannually within the Craterre-ENSAG framework. For the tenth conference, held in Mali (2008), a series of recommendations were presented for the conservation of earthen architecture, including: the incorporation of tangible and intangible heritage into conservation; local and traditional knowledge providing guidelines for conservation; the need for conservation to go hand-in-hand with local community; the need for traditional and scientific knowledge and that derived from practice to play a role in the intervention; the need for a meeting point based on sustainable development for conservation and progress; monitoring and maintenance are key to conservation; the need for dissemination of knowledge to respect traditional mechanisms using all sorts of contemporary devices for dissemination; training which must incorporate theory and practice. The world conference Terra Lyon 2016 (held in Lyon, France) brought about the *Lyon Declaration* and the *Recommendations*. The first document affirms the universal nature of earthen architecture as local heritage which can promote sustainable development in keeping with the objectives set out in the 2030 Agenda. In the document of *Recommendations*, the general political and institutional recommendations geared towards the new earthen architecture, also include specific recommendations on its heritage and conservation. Among these it is worth highlighting: the development of studies on vernacular constructive cultures, their constructive intelligence structural behaviour, socioeconomic logic and environmental behaviour; study of its hygrothermal behaviour; promotion of research on the use of organic consolidating elements; restoring and updating rather than building new buildings; promoting the education and training of specialists.

In addition, through the World Heritage Earthen Architecture Programme (WHEAP), UNESCO has promoted the creation of an Inventory of Earthen Architecture (2012). This inventory lists the 150 earthen built heritage UNESCO sites among the total 962 sites declared by UNESCO in 2012, although by 2018 180 sites (out of the total of 1,073) had been identified as earthen heritage by UNESCO. On the 40th anniversary of the *Convention concerning the Protection of the World Cultural and Natural Heritage* (Paris Charter, 1972), the *UNESCO International Colloquium on the Conservation of World Heritage Earthen Architecture* was organized within the framework of the *World Heritage Earthen Architecture Programme* (WHEAP) in Paris in 2012. The document of Declaration (Paris, December 2012) for the conference recommends: the implementation of exemplary projects to contribute to social and economic development and to help the community identify with the asset, to improve conditions and quality of life, as well as the preservation of the varied tradition and construction of local cultures; the development of methodological approaches linking contemporary management systems with traditional and local knowledge, which can incorporate the intangible values into social practices of territorial development, favouring the role of earthen architecture in environmental sustainability and economic and social development processes; the development of examples of good practices to be used by professionals as reference to improve communication, dissemination and raising awareness at all levels; the completion of strategic plans, with all countries assigning resources; the greater protection and assessment of risks at earthen heritage sites before, during and after armed conflicts or disasters, as well as the use of applicable technologies for the rapid assessment of problems on the ground and the development of suitable responses.

In Spain, in addition to the national and regional heritage laws, it is worth highlighting the activity of the Spanish Cultural Heritage Institute (IPCE) which, through its National Plans, aims to regulate the principles, criteria and procedures to be used in the protection, cataloguing and conservation of Spanish cultural heritage. Among all the plans most closely linked to earthen architecture in its different forms we find: the National Plan for Defensive Architecture, the National Plan for Traditional Architecture, the National Plan for Cultural Landscape and the National Plan to Safeguard Intangible Heritage. In fact, in view of the interest prompted by earthen architecture as heritage in recent years, in 2017 the Spanish Cultural Heritage Institute (IPCE) published the book "*The COREMANS project: Intervention criteria for earthen architecture*", edited and coordinated by the authors of this article and drawn up by a multi-disciplinary team for use as a tool for drawing up plans and for conservation work carried out in Spain. As well as providing a general overview of earthen architecture as Spanish heritage, the book details the criteria, techniques and modalities for the conservation, restoration, structural consolidation and maintenance of this heritage.

4.2. General and specific recommendations derived from international documents (figure 3)

A series of general recommendations can be gleaned for application to earthen built heritage conservation. Firstly, earthen architecture uses local materials following constructive traditions that are thousands of years old and linked not only to material

aspects but also to cultural aspects relating the occupation of the territory, community life, rituals, transmission of knowledge, etc. The study of these processes helps to understand and respect them in the intervention phase. The heritage conservation and restoration process must be the result of scientific research, local culture and tradition and the experience of similar work completed previously. Furthermore, there is already extensive experience in earthen architecture, especially in Spain (Mileto & Vegas, 2014; Mileto et al., 2019).

It is not always possible or convenient to use traditional techniques for conservation and consolidation actions, but it is important to ensure that the materials and techniques used are compatible with the building in terms of materials and structure and socially compatible with the surroundings and community. In this respect it would be advisable to use local materials and techniques in restoration processes or take into account the local context. During the restoration processes it would be advisable to maintain the diversity of techniques avoiding any concession to globalized intervention techniques. Furthermore, it is advisable to resort to local crafts in order to favour their maintenance through the restoration, in turn benefitting the local economy and the development of skills within the community. It is important to involve the community in the process through participatory training and dissemination processes in order to establish a connection of awareness, appropriation and valorization with the asset or the complex being restored.

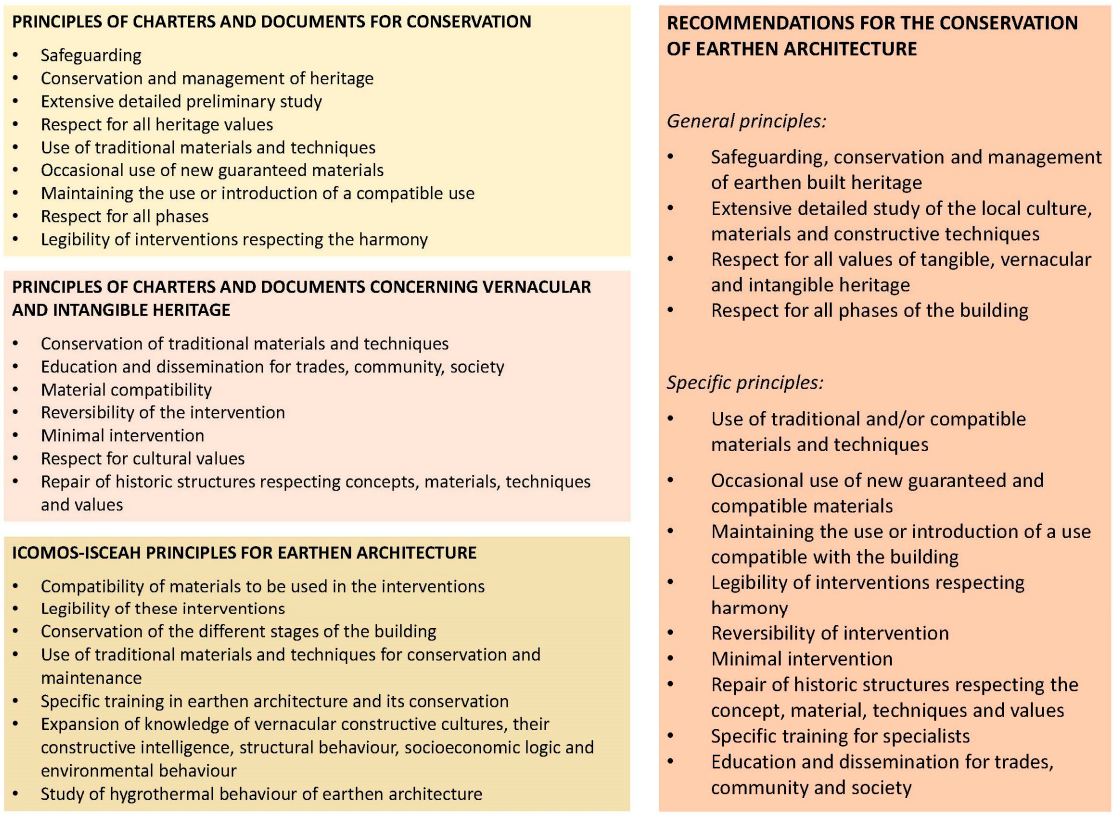

Fig. 3 Principles and recommendations for the conservation of earthen built architectural heritage

4.3. Strategies for the conservation of earthen built heritage (figure 4)

The analysis of case studies among the three research projects funded by the Spanish government (REStapia - La restauración de la arquitectura de tapia en la Península Ibérica. Criterios, técnicas, resultados y perspectivas", 2011-2013; "SOStierra - La restauración y rehabilitación de arquitectura tradicional de arquitectura tradicional de tierra en la Península Ibérica. Líneas guía y herramientas para una intervención sostenible", 2015-2018; and "RISK-Terra - La arquitectura de tierra en la Península Ibérica: estudio de los riesgos naturales, sociales y antrópicos y estrategias de intervención e incremento de la resiliencia", 2019-22) has highlighted the good practices in the interventions carried out in the Iberian Peninsula since 1980 (Mileto et al., 2019). The almost 3,000 cases analysed for interventions in earthen built monumental and vernacular heritage (Mileto et al., 2019) were assessed taking into consideration the criteria used (Mileto et al., 2011b), the materials and intervention techniques, and the results obtained following a period of time passed after the intervention (Mileto et al., 2017b). The high number of cases analysed, combined with the wide range of constructive techniques (adobe, rammed earth, half-timber) and of materials and intervention techniques used (traditional and industrial) makes it possible to form reflections and strategies which, supported by scientific literature and international documents, can be generalized for application in other locations outside the geography studied. Following this methodology, a series of strategies was proposed and grouped into six major blocks:

1. KNOWLEDGE: based on the premise that what is not known cannot be valued and what is not valued cannot be conserved, the first step necessary for conservation is always knowledge. The aim in this case is to ensure knowledge of the heritage object, earthen architecture, its characteristics (materials, techniques, types of buildings, etc.), and its values (material, social, cultural and economic). This knowledge is acquired through scientific research in the fields of history, culture, society, anthropology, material, construction technology, structure, etc. This research progressively expands the knowledge of earthen built heritage assets, both locally and globally, also favouring their localization, identification and cataloguing.

2. VALORIZATION: in order for society to value earthen built heritage it is essential to carry out the relevant research, while ensuring that the value of earthen heritage is not limited to the field of academia but is expanded to society as a whole. To do so it is necessary to set up educational activities designed for the society of the future (children and young adults) and for society in general in order to encourage people to identify these assets as their own heritage and to value them as part of local culture. Finally, the results of scientific research help to dispel myths, especially regarding the negative aspects of earthen architecture, as seen previously, by demonstrating the efficiency of earthen architecture on a structural level, its energy features, its aesthetic validity, etc.

3. PROTECTION: knowledge and valorization of heritage are not enough to ensure its safeguarding. As a result the heritage laws worldwide establish protection mechanisms through the cataloguing, appointment, planning, etc. Different tools for urban

protection are used in the protection of surroundings (natural and cultural landscape), settlement or architecture in question. These protection tools require administrations sensitive to the issue to be promoted and qualified specialists to draw these up. However, they require a mature society to embrace and respect them so that social dialogue, dissemination and raising awareness must always be carried out in parallel with protection.

4. CONSERVATION: as seen in the section dedicated to conservation principles, the conservation of earthen architecture falls within the field of conservation and must respect the relevant principles. However, earthen architecture also requires specific knowledge, especially when proposing techniques and materials compatible with those in place. Thus, specific research is needed to focus on good practices for intervention, management and maintenance, as well as suitable specialization for specialists, craftsmen and companies taking part in the conservation work.

5. TRAINING: given the need for conservation projects and works to be executed by qualified specialists and craftsmen the relevant specific training should be guaranteed, either at university and postgraduate level or with practical training courses. Specific training is also advised for the specialists from the administrations in charge of the management, protection and maintenance of earthen architecture. Manuals are tools which can help in the transmission of traditional knowledge, in the handling of compatible materials and techniques and in the positive or negative results of interventions.

6. INNOVATION: innovation in the field of earthen architecture has been developed in terms of materials and techniques as well as in the use of earth in the design of contemporary architecture following local constructive tradition. As seen above, this tradition-based innovation process contributes to the valorization of the heritage architecture, considered the basis for learning for innovation as well as for the setting in which the new architecture is to be inserted. This innovation is based on scientific research in design as well as the technical aspects and also requires materials and crafts for construction.

Fig. 4 Strategies for the conservation of earthen built architectural heritage

5. Conclusion

Given the direct relationship between earthen architecture and the surrounding landscape, the use of local materials and trades represents a heritage linked to local culture. However, earthen architecture is found throughout almost all parts of the world, with the exception of the North and South Poles, as its basic material is the most readily available worldwide. Earthen built heritage is therefore strictly local heritage, but on a global scope it also currently transmits historic, cultural environmental, social and economic values especially linked to the much-coveted sustainability in architecture. Nevertheless, earthen built heritage does not yet enjoy the levels of protection and conservation it deserves. This article has aimed to highlight the values found in earthen built architectural heritage, as well as the principles and strategies for its conservation. The strategies proposed attempt to cover this heritage from the perspectives of technique, theory of conservation, management and protection, training and teaching, dissemination and awareness, and innovation, based on the understanding that all these factors must work together like cogs which allow the correct operation of the machine. These cogs can individually be smaller or larger, faster or slower, but none of them can stop as otherwise the entire machine would grind to a halt.

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