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Entry

Underground Built Heritage

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Definition

The Underground Built Heritage (UBH) class, introduced at a methodological and theoretical level in 2021, collects cultural assets excavated throughout history from underground that, today, are significant elements of local cultural heritage, having strongly impacted on the "sense of place" of local communities. Those cultural assets have been at the core of several national and international regeneration processes, and, recently, new tools have been developed to support their classification and sustainable reuses. This entry introduces tools for the classification of historical uses of UBH elements and their historical reuses, as well providing guidelines for their sustainable regeneration for the social and economic benefit of local populations based on the analysis of some worldwide case studies.

Keywords: Underground Built Heritage; cultural assets; classification; enhancement; regeneration

1. Introduction

1.1. Historical Background

Many international groups of scholars have been studying caves, cavities, and other underground structures with historical, cultural, and technological value since the 1960s. The Union Internationale de Spéléologie (UIS) [1], the main international body focusing on those elements, was established in 1965, but it was only in 2013 that some representatives from the Italian Committee [2] published a multilingual dictionary to facilitate exchanges among members speaking different languages and introduced a first classification for the objects of their expeditions, inspections, and studies [3]. This first attempt, however, was dedicated to all types of cavities, regardless of whether their origin was natural or artificial, and the Artificial Cavities Commission, part of the Department of Scientific Research within UIS [4], adopted it the way it was. This circumstance had effects on the definition of guidelines for their preservation, classification, and enhancement. This was a critical issue, overall, with reference to the complex of elements of cultural heritage artificially excavated by men through the adoption of the so-called "culture of negative building". This refers to a building technique based on excavation and the subsequent removal of surplus from the underground to give shape to the final buildings, rather than on the adoption of building materials by addition to give shape to the final structures.

1.2. Definition of the Problem

The absence of a generally accepted definition for those assets excavated across the centuries from underground had a significant effect on their classification, monitoring, restoration, and, of course, all of the actions addressed towards their enhancement as elements of cultural heritage. This absence also affected the properties included into the

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UNESCO protected lists, since the correspondent dossiers were also based on reports from inspections by geologists and speleologists that were not adequately supported by specific tools [5,6]. In fact, those properties were inscribed by adopting the most varied terminologies—rock-cut, troglodyte, cave, cavity, gallery, underground building, etc.—creating considerable confusion with reference to their identity.

This limit has become truly crucial in relation to the growing interest in these typologies worldwide and the ever-increasing number of projects dedicated to their regeneration and enhancement. Those actions, instead, require standardized tools, not only for the identification of the assets, but also for the analysis of their historical functions and the definition of the parameters for their reuse. In addition, this limit has proven to be crucial, considering that, very often, these assets are located in very remote areas and are managed by small communities that could benefit from the enhancement processes.

1.3. The Introduction of the Underground Built Heritage Class

In response to this widespread need, the class of Underground Buit Heritage (UBH) was introduced for the very first time in Horizon2020 proposal SC5-21-2017, "Cultural heritage as a driver for sustainable growth: Heritage-led rural regeneration", to refer to the designated cultural heritage selected for local rural regeneration plans [7].

The theoretical definition was provided in 2021 as follows: "Underground Built Heritage (UBH) is the class of elements of cultural heritage encompassing all underground historical artefacts. To classify an artefact as "underground", the elevation of each point of its ceiling should be measured in relation to the Geographical Zero Level (i.e. the zero level is the reference point for measuring positive or negative distance from the sea level at a given geographical point). To qualify for inclusion in this class, the artefacts must have been made using local skills and technologies. If their making involved the transformation of natural caves, this transformation must have been such as to transform the said caves into significant elements of local material and immaterial culture. Based on the application of the concept of "sense of place", the use or reuse of UBH artefacts can be the springboard for local social and economic regeneration actions, with the involvement of local communities" [8].

The UBH class includes elements that have been historically excavated for the management of eight different functions, dealing with some environmental conflicts by maximizing natural sources and opportunities or by social interactions linked to local historical traditions. Sometimes, UBH elements have been realized to manage both. The functions focus on the following: water management, solutions to sanitary issues, the conservation or transformation of food, playing cult rituals, defending people, supporting local economies, and allowing for more convenient and easier transportation and housing.

To date, the adoption of the UBH criteria by the international scientific community, local bodies, and various institutions involved in the enhancement processes for UBH elements has already supported several projects. However, the debate regarding UBH is very active, and the corresponding tools are constantly updated. Successful case studies are very different from one another: some focus on major sites; some focus on minor assets, whose regeneration is expected to impact social, economic, and demographic data; and some are about the adoption of UBH elements in marketing and branding strategies.

This paper, after the introduction of the UBH approach, analyses some case studies that demonstrate the UBH attitude to interpreting local identitarian issues, common critical issues, and possible solutions as they appear in the recent literature. This paper has been organized in five sections, as follows:

- Introduction to the UBH theoretical approach: Charts for functional classifications, static and dynamic analyses, and possible reuses;

- UBH in the world: Analysis of some famous worldwide case studies;
- Problems and solutions: A definition of the most common critical issues regarding the elements included in the UBH class, and an illustration of the projects that focus on their solution;
- Milestones: The most significant findings from our literary review;
- New challenges.

2. UBH Theoretical Approach

UBH is the class that includes manmade elements historically caved in the underground to manage eight functions, as follows: Water, Sanitary, Food, Burial and Ritual, Defence, Economy, Transport, and Living Space (Figure 1) [8].

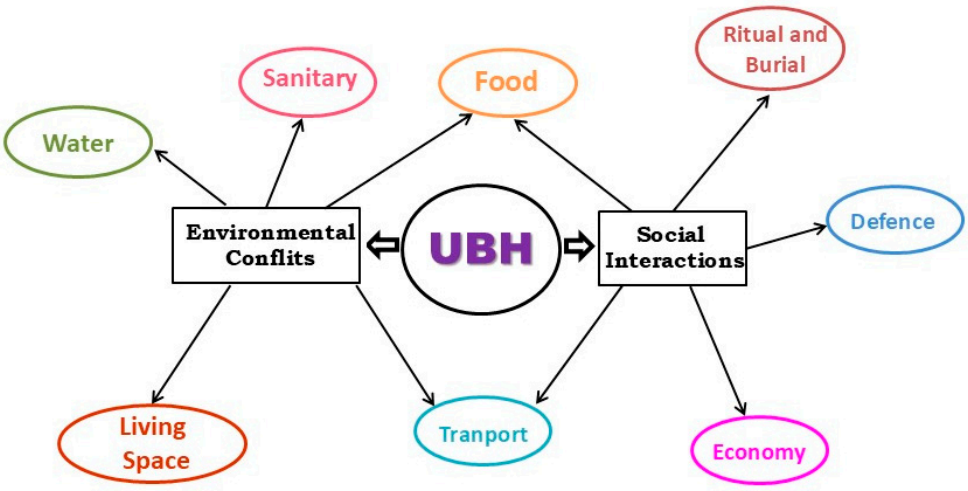


Figure 1. UBH chart.

In detail:

- Three functions to solve environmental conflicts: Adoption as a living space in harsh habitats (Living Space), supporting water management at rural and urban levels (Water), and solving sanitary issues (Sanitary).
- Three functions to solve social interactions: Adoption as spaces for ritual and burials (Ritual and Burial), allowing for escape in case of danger, protecting people or things and providing safety in general (Defence), along with the maximization of local productions with raw material supplies and support of the local economy (Economy).
- Two functions to solve both environmental and social issues: Optimization of transport routes by overcoming obstacles of various natures (Transport), and provision of spaces for food management at family or professional levels (Food).

Examples of possible UBH case studies are listed in Table 1; it shows the great variety of worldwide elements that are suitable for inclusion in different historical periods, from prehistory to contemporary age. For each type, examples are provided in italics.

The UBH approach allows for a dynamic analysis of case studies, also. In fact, both the identification and the study of primary functions and possible historical reuses can be analyzed; this aspect is fundamental with reference to the creation of the storytelling adopted in the correspondent enhancement projects. For example, when studying catacombs, the function connected to its first excavation is Ritual and Burial, but if the cavity, after abandonment, was then adopted to store food and then as a stable recovery in the rural area, passages from one function (Food) to the other (Living Space) can be visualized in the chart, as well by adopting arrows which remark the functional flux. The same dynamic approach can be adopted in all case studies. In the case study of the Second

World War (WWII) shelters in Naples (Italy), for example, the UBH chart allows for the analysis of the transformation of previous canteens (Food), aqueducts (Water), galleries (Transport), and tuff caves (Economy) into shelters for citizens during bombing attacks (Defence) (Figure 2) [9].

Table 1. Examples of case studies for the UBH class.

Figure 1.	Example of Case study 1	Example of Case study 2
Transport	Historical galleries Cripta Neapolitana (Italy)	Historical metro stations Moscow metro (Russia)
Living space	Troglodyte settlements Matmata (Tunisie)	Underground settlements Göreme (Turkey)
Sanitary	Historical sewers Egout de Paris (France)	Cesspits, drainage systems Middle age pools in Faenza (Italy)
Water	Aqueducts, qanat, foggara Persian Qanat (Iran)	Cisterns, pools Water Stepwells (India)
Food	Traditional food canteens Wine canteens (Moldova)	Seasoning spaces Prosciutto di Parma cells (Italy)
Defence	Escaping galleries Underground war galleries (Vietnam)	Bunkers Cold War bunkers (Russia)
Ritual and Burial	Rock cut churches Rupestrian churches (Italy)	Historical cemeteries, religious caves Buddha Caves (China)
Economy	Extraction mines Historical mines (Japan)	Rural storage spaces Spoegrivier Cave in Namaqualand (Africa)

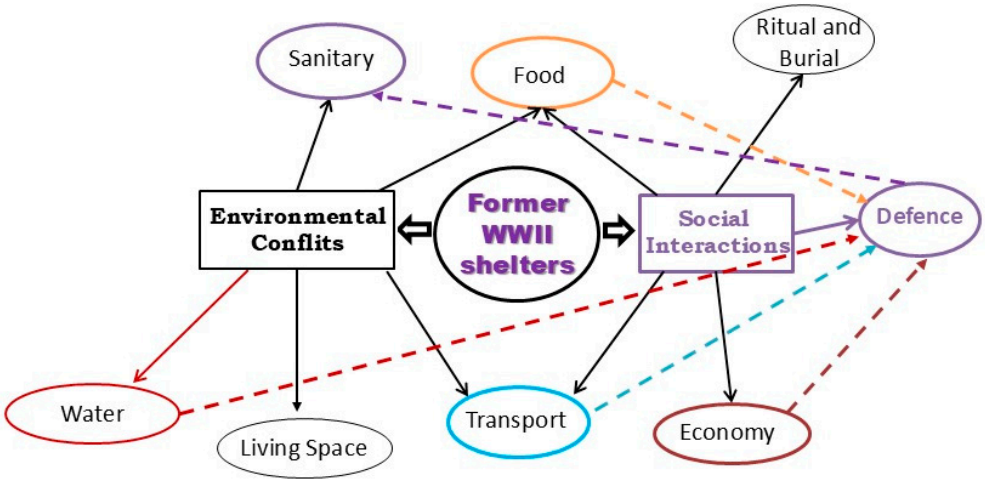


Figure 2. UBH chart: The case study of WWII shelters in Naples (Italy).

Artefacts classified as UBH elements, based on their intangible and tangible values, are very often considered significant elements of local cultural heritage, and eventually they are, at the core, targets of a wide range of contemporary reuses and enhancement actions.

The UBH theoretical approach provides the classification of four different levels of reuses, as follows:

- Re-inventing: This level refers to very rare and unique UBH elements transformed into museums.
- Re-introducing: This level refers to UBH elements adopted again according to their historical functions, but in respect of modern-day safety and sanitary guidelines. In this specific case of reuse, historical processes and technologies should always be accessible to users, also by displaying iconographic material or through the exhibition of various tools or machinery once adopted on the site.

- Re-interpreting: This level refers to UBH elements that, after abandonment, have been eventually adopted for other uses. In this case, new uses and the original functions should offer a diachronic approach to visitors.
- Re-building: This level refers to two very different hypotheses: very vulnerable UBH elements whose musealization strategy is based upon the building of replicas, and the adoption of the historical negative building techniques for new artefacts.

The UBH approach implies the adoption of both the UBH chart for the functional analysis and the selection of the adopted or more suitable level of reuse. Those instruments, together, provide a complete toolkit to support their sustainable enhancement.

Table 2 simulates the adoption of the toolkit for the hypothetical X, Y, Z, and W case studies. In this simulation, case X was originally excavated to be adopted as a burial place during the Roman era, and, by adopting the UBH chart in Figure 1, it can be classified in the correspondent function, Burial and Rituals. After the abandonment of the burial site, those caves were used as Living Space, then transformed into Food canteens and eventually adopted as a bunker during a conflict and classified as Defence. Today, case X, after having been at the core of some project regarding collapse-monitoring and reinforcement, has been re-interpreted: it hosts a permanent exhibition of local traditional carpet production and is a famous tourist attraction. Table 2 allows for the reconstruction of Y and Z case studies as well; in the case of W, instead, a new artefact was built by adopting historical excavation skills and was opened to tourists to preserve the original cave from anthropic impacts.

Table 2. Simulation for the adoption of the UBH toolkit.

Case Study	Primary Function	Historical Transformations	Re-Use
X	Ritual and Burial (rock cut churches)	Living space (stable recovery) Food (seasoning) Defence (bunker)	Re-interpreted (it is now a museum)
Y	Economy (copper mine)	Ritual and Burial (burial site) Food (canteen)	Re-invented (it is now a contemporary art space)
Z	Economy (Stable)	Food (fossa cheese seasoning)	Re-introduced (still in use as a seasoning space for local food specialties)
W			Re-building (a new artefact that replicates a prehistoric cave especially excavated for visitors)

The simulation refers to three very old artefacts—X, Y, and Z—and to a recently rebuilt case study, W. However, the UBH approach can be adopted to any excavated element, regardless of its ancientness, since UBH elements are definitely very different from another. In fact, the main feature of this class is that it includes elements with the most varied architectonic, engineering, and artistic characteristics, excavated in periods ranging from prehistory to the contemporary era, but always interpretating the cultural attitude of the place they belong to. UBH elements only have in common the method of construction, the so called "negative built culture", and the fact that they were made to optimize local natural resources to manage the functions that better reflect and interpret local culture.

These circumstances mean that the sources for the analyses of these artefacts are the most varied, and the skills required for their study vary from case to case. Depending on the period of their construction and the environmental and social issues connected to

them, the study of their UBH elements involves varied disciplines, belonging both to the hard and soft sciences: archeology, construction and static engineering, environmental sciences, geology, geography, history—ancient, medieval, modern, and contemporary, but also economic, institutional, technological, environmental, etc.—sociology, mechanical engineering, chemical and physical sciences, demography, and many others. During the reuse process, it is also necessary to adopt the skills of experts in musealization, dissemination, storytelling, virtual installation, architecture, development planning, tourism strategies, and many others. Based on these characteristics, all projects that adopt the UBH class at a theoretical level included multidisciplinary approaches.

In conclusion of this section dedicated to the theoretical approach, we have to say that UBH elements have one more common characteristic: the negative building culture adopted reveals the main characteristics of the place where the UBH is excavated. This aspect will be analyzed in the next section of the entry.

3. UBH Case Studies in the World

UBH class includes both very famous sites, often also inscribed in protected lists, as well as rather unknown and abandoned artefacts.

In both cases, these artefacts can benefit from inclusion in the UBH class. In cases of major cultural assets, UBH guidelines can support the protection of their values and contrast overtourism, while in cases of minor sites, the analysis of the historical functions and the selection of the most suitable reuses can provide elements for their sustainable enhancement.

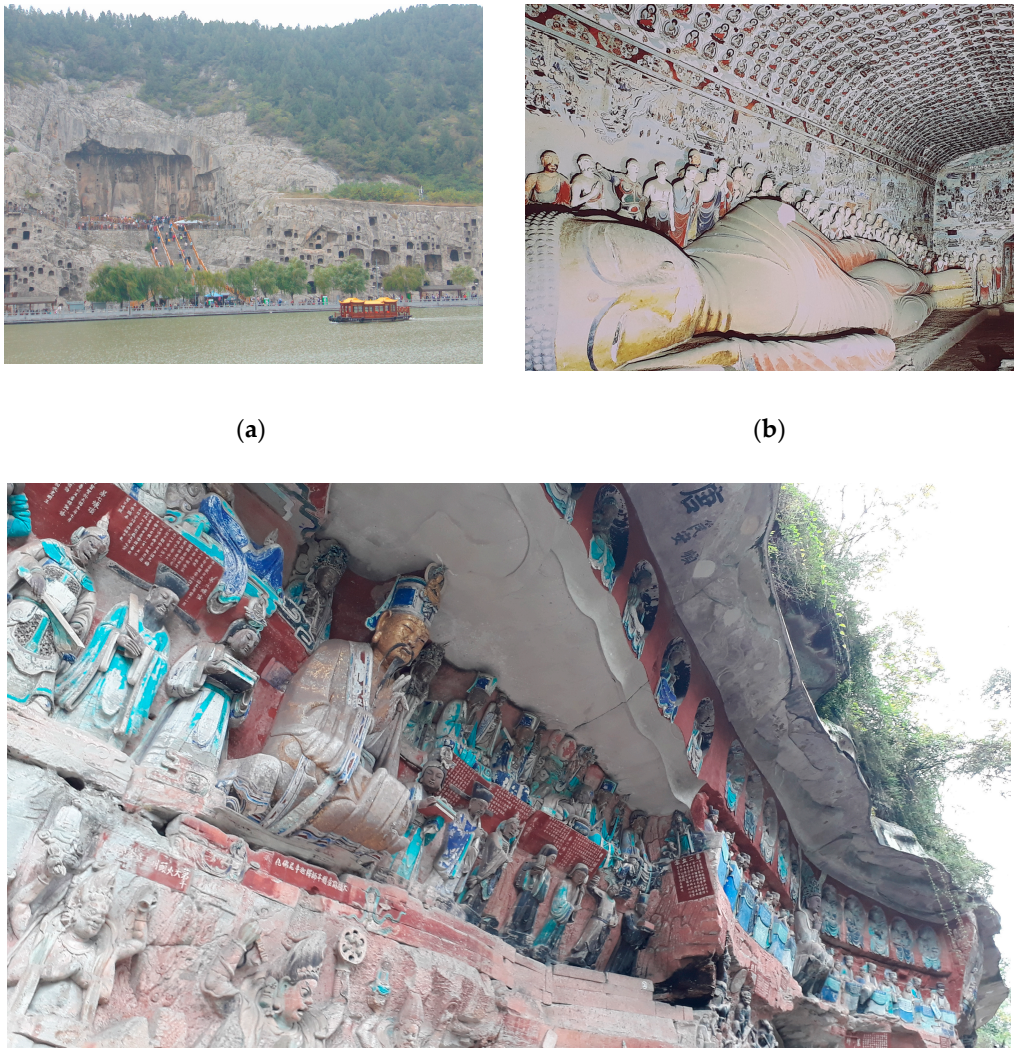
Several UBH sites are inscribed in the UNESCO list of cultural heritage sites [5] or are located within UNESCO geoparks [6]. Sometimes, these properties are significant pieces of art realized by adopting the negative building culture; sometimes, the excavated elements symbolize the strong relationship between local natural resources and skills, very often in connection with social, economic, and cultural issues. It is also very common that UBH elements are those that, more-so than others, focus and interpret what is perceived to be the local character at a global level. The analysis of the descriptions of UNESCO properties belonging to the UBH class can clarify this aspect.

In India, a country where religion and mysticism are tangible elements in a climate of widespread tolerance, a place where millennial history dialogues with modernity, and where it is recognized worldwide to have a very strong, original, and identitarian artistic production, the descriptions of UBH elements interpret these attitudes. In fact, the Ajanta caves are "considered masterpieces of Buddhist religious art" because they "have had a considerable artistic influence" [10], the Elephanta caves [11] "emerged from a long artistic tradition, but demonstrate refreshing innovation", and the Ellora caves "illustrate the spirit of tolerance that was characteristic of ancient India" [12].

In China, where the tradition of excavated religious grotto originates, inscribed UBH properties focus on the historical roots of the country's international trade and on its typical lifestyle. Longmen Grottos "illustrate the perfection of a long-established art form which was to play a highly significant role in the cultural evolution in this region of Asia" and "the high cultural level and sophisticated society of Tang Dynasty China" [13] (Figure 3a). The Mogao Caves, instead, focus on the international trade traditions, being "situated at a strategic point along the Silk Route" [14] (Figure 3b), while the Dazu Rock Carvings (Figure 3c) are a tribute to the local lifestyle because of "their rich diversity of subject matter, both secular and religious, and the light that they shed on everyday life in China during this period (from the 9th to the 13th century)" [15].

When overcoming natural obstacles was the key for local development, UBH elements interpret this aspect. In the case of the Iranian property The Persian Qanat, the inscription in the list of the network of underground water tunnels and pools in the desert is a tangible

tribute to the millennial challenge of water management in desertic areas, since they "provide exceptional testimony to cultural traditions and civilizations in desert areas with an arid climate" [16].



(**a**) (**b**)

(**c**)

Figure 3. Chinese Budish rock cut caves: Longmen (**a**), Mogao (**b**), Dazu (**c**).

In economic history leader countries such as Japan, Germany, and the UK, UBH elements celebrate their leadership. In Japan, while Iwami Ginzan Silver Mine "pioneered the development of silver mines in pre-Modern Asia" [17], the sites of Japan's Meiji industrial revolution: Iron and Steel, Shipbuilding, and Coal Mining, reflects the national pride of entering the global market as a latecomer in industrialization and "bears testimony to the rapid industrialization of the country from the middle of the 19th century to the early 20th century, through the development of the iron and steel industry, shipbuilding and coal mining" [18]. The Blaenavon Industrial Landscape in the UK "is (the) evidence of the pre-eminence of South Wales as the world's major producer of iron and coal in the 19th century" [19] and celebrates the leading role of the UK during the Industrial Revolution. In Germany, the Zollverein Coal Mine Industrial Complex in Essen, Germany, focuses on their pride for their role in the industrial sector of the country; it "constitutes remarkable material evidence of the evolution and decline of an essential industry over the past 150 years" [20].

UBH very often enlightens the passage from nomadism to sedentary life or the strategic roles as a gateway between different cultures. Petra in Jordan interprets the nomadic history of the country and its role as "an important crossroads between Arabia, Egypt and Syria-Phoenicia" [21], while Göreme National Park and the Rock Sites of Cappadocia in Turkey "provide unique evidence of Byzantine art in the post-Iconoclastic period" [22], and Rock-Hewn Churches, Lalibela, Ethiopia, is "a 'New Jerusalem', after Muslim conquests halted Christian pilgrimages to the holy Land" [23].

UBH also interprets some historical social issues: in the USA, Mesa Verde National Park represents a tribute to the pre-Columbian era and a reconciliation sign with its "great concentration of ancestral Pueblo Indian dwellings" [24].

UBH strongly characterizes UNESCO geoparks as well: each one of the 213 properties inscribed "uses its geological heritage, in connection with all other aspects of the area's natural and cultural heritage, to enhance awareness and understanding of key issues facing society, such as using our earth's resources sustainably, mitigating the effects of climate change and reducing natural hazard-related risks. They represent the interaction between local natural resources and their inhabitants and give shape to the unique landscapes to which they belong" [6].

But if the sites belonging to the UBH class registered in UNESCO lists interpret the main characteristics of their countries, minor UBH sites allow us to explore lesser-known aspects of the relationship between aboveground space, socioeconomic development, and underground potentialities. All those features can be profitably adopted in their enhancement projects.

This is the case for the emery mines on the island of Naxos in Greece, which draw attention to the strategic, and almost unknown, role that that country had in terms of military supplies during the WWII [25]. In Moscow (Russia), metro stations recall various aspects of socialism having been adopted for the communication of social values during the regime [26] (Figure 4a), while underground bunkers, which were built to face possible attacks by the USA during the Cold War, are, today, symbols of that controversial historical period [27] (Figure 4b).

(**a**) (**b**)

Figure 4. Celebration of socialist values in Moscow metro stations (**a**); Cold War bunker in Moscow (**b**).

This list includes Moldavian cellars, impressive underground tuff caves then adopted for the seasoning and protection of wines, both resulting from local production, the most significant in eastern Europe, and from private collections as well [28] (Figure 5). These UBH artefacts are unique in that area, and their existence has historically been at the core of controversies, often being degenerated. As an effect of the political independence of Moldova, wine cellars became one of the most significant symbols of national identity, and today they are very famous tourist attractions.

Figure 5. Moldavian wine cellars.

Indian stepwells, spectacular UBH architectures built for water management, were closed during the colonial period to prevent political meetings by locals, and are considered to be a symbol of the social, political, and economic control carried out by the British during the colonial period. Today, most of them are famous tourist attractions [29]. Many issues regarding the history of African colonies can be analyzed by studying the history of mines in Congo, Zimbabwe, and South Africa [30,31], but their potential in terms of cultural heritage is mostly unexploited yet. For Namibian case studies, some comparative analyses have already been carried out to support the development of local eco-museums [32].

The examples given above demonstrate how UBH elements are gateways both with reference to the most characterizing issues of the countries they belong to and also with less-known aspects that have great potential.

Even if several UBH assets are today famous touristic attractions, not all UBH elements are adequately enhanced. Several common problems must be taken into consideration and solved in order to continue the dedicated projects. In the next section, these issues will be examined, and some projects addressed toward their solution will be listed.

4. Problems and Solutions

Since the introduction of the UBH class, to date, in addition to having stimulated the interest of many scholars around the world, it has been adopted for the classification of case studies in many financed projects, supporting local and urban regeneration processes and stimulating international cooperative actions.

Based on the initial results of academic studies and regeneration projects already carried out, the most common critical issues connected to the enhancement of UBH elements are as follows:

- Vulnerability: UBH elements are always at risk of collapse, and their enhancement must consider their vulnerability (Figure 6a,b). Consolidations are very often required before opening them to the public, and constant monitoring actions must be taken to prevent possible damage to visitors and/or cultural assets.

(**a**) (**b**)

Figure 6. Collapses in troglodyte villages: Gravina (Italy) (**a**), Göreme (**b**).

- Location in inner areas: Very often, UBH elements are in rural areas that are at risk of abandonment, have low income rates, and are affected by a decreasing population. In such areas, UBH enhancement projects must deal with problems around accessibility and lack of services. However, this aspect can also be an opportunity for inclusion in cultural itineraries or to stimulate and support rural regeneration projects with potential impacts on demographic and socioeconomic issues.
- Overtourism: UBH elements are very attractive, but, very often, as an effect of their enhancement processes, their integrity is not adequately preserved, and tangible and intangible values are at risk. A typical example of overtourism is troglodytic villages. In the Sassi of Matera [33], Göreme and Matmata (Figure 7), for example, the pressure on the cultural resource is so strong that everything has been shaped to meet the desire of an "immersive experience" in troglodytic lifestyle by tourists. Villages were progressively abandoned by local inhabitants, tangible and intangible values were lost, and traditional rock caved spaces were transformed into caved hotels, caved restaurants, caved shops, etc. Moreover, troglodyte spaces were replicated, and fake troglodytic structures impacted the original landscape.

(**a**) (**b**)

Figure 7. Strong impact for the Star Wars Hotel (**a**) and the fake troglodyte hotel in Matmata (Tunisia) (**b**).

Based on these most common issues, several projects have been financed to face and solve them, and, in general, to support the sustainable development of UBH elements for the social and economic benefit of local populations.

First, Cost Action 18110 "Underground Built Heritage as a catalyzer for Community Valorisation" was funded [34]. The project, led by the CNR and involving over thirty countries—partly or entirely considered part of Europe—was part of the European Cooperation in Science and Technology programme supporting research and innovation networks in the period 2019–2023 [35]. The aim of the project was to promote "balanced and sustainable approaches to conservation, reuse and enhancement of underground space in urban and rural areas for regeneration policies. It has pursued the dissemination of knowledge on underground culture and assistance for local communities' decision-making with adequate cultural, scientific and technical knowledge of the underground-built environment from many different aspects" [34]. Results from the project have been published in five books, which collected papers from participants on the projects. The first introduces all case studies under analysis and the theoretical approaches adopted [36]; the second analyses the case study of La Union in Spain [37]; the third reports on the second training school [38]; the fourth is about the case study of the Fontanelle Cemetery in Naples [39]; and the fifth focuses on the underground settlements in Cappadocia [40]. A Special Issue of the journal *Sustainability* from MDPI was launched and collected thirteen articles [41].

The Bilateral project, "Damage assessment and conservation of underground space as valuable resources for human activities and uses in Italy and Japan", between the CNR and the Japanese Society for Promotion of Sciences—JSPS (2018–2019/2020–2021), focused on UBH elements. It was financed twice, and consisted of a joint study and an experiment on the UBH approach for the management of some common critical features in the reuse and enhancement of several case studies in Japan and Italy [42].

The project "Reinventing Industrial Museums for a new image of Italy" (ReMusIt), still current, adopts the UBH chart for the classification of the following case studies: the abandoned mines of Carbonia and Agordo in Italy. The project's challenge, which focuses on the sector of work and industry museums and on the interpretative and communicative models of these museums, is the identification of good practices to enhance their cultural, social, and economic impact in the territories of reference in the digital age. ReMusIt is based on synergic interdisciplinary research activities, thanks to the participation of experts in museology, urban history, economic history, sociology, geo-heritage, cultural tourism, computer science, and digital communication [43].

Alongside these projects, a series of still-running activities, both at academic and institutional levels, focus on rural and urban regeneration based on the enhancement of UBH assets. To support the exploitation of those potentialities, and also by adopting the UBH chart, an institutional research line was established within the National Research Council of Italy (CNR): "Underground Space for Territories Knowledge and Enhancement" [44].

To date, many results from the above-mentioned projects have been published. Milestones from UBH case studies, innovative adoptions of the UBH chart, and multidisciplinary studies about UBH assets are listed in the next section.

5. Milestones

The UBH chart has been adopted to analyze several case studies and has strongly impacted on the enhancement of the correspondent elements.

In the case of the monastery of Ayia Napa (Cyprus) and the Saint Helena chapel in the Holy Sepulchre in Jerusalem, the UBH chart supported the interpretation historic graffiti and their role as additional agents for the sustainable development, valorization, and promotion of the site [45].

Underground Built Heritage (UBH) is also considered a unique cultural and tourist resource, often with diverse values for tourists and local communities. The case studies of Petrovaradian Fortress Military Galleries (Serbia), the Srebrna Góra Fortress (Poland),

Roman City (Bulgaria), Göreme (Turkey), and Bunk'art (Albania) demonstrate how minor touristic destinations can benefit from inclusion in the class [46].

At a theoretical level, "data supported the hypothesis that the sustainability of a UBH enhancement project is only guaranteed by its survival over time and that the correspondent decision-making process must be bottom-up, i.e., promoted and developed by the actors of the territory—communities and stakeholders—who share a strategic objective and that two practices are encouraged: the first is aimed at enhancing the UBH for the territory itself and involves the application of design thinking, the second, in the interest of the economic agents, is aimed at promoting the territory externally—promoting sustainable tourism—through the application of audience development" [47].

It was also underlined, based on case studies from Warsaw (Poland) and Volos (Greece), how local "UBH and its fringe serve as a facilitator of communal identity to mobilize community care towards social and economic development with less involvement from the state and the market actors" [48].

Based on a single case study, the theoretical concept has been integrated: "ground, as a body incised by natural and human actions (European Landscape Convention), carries *stories*, going beyond quantitative values. As in a text, it holds the keys to understand what it covers or hides. In its thickness, it shelters *implicit projects*. Understanding its complexity requires a physical and perceptual commitment, challenging the body in space: dimensions gradually forgotten by Environmental Sciences. As a *threshold*, Underground-Built-Heritage represents the reverse of the emerged world: hollow space, both generator and mirror of open space (cities, landscapes)". More, "based on the focus on physical and mental relationships between visible and invisible, the *Three Countries Park* was the place selected to test how UBH can rebuild common links for fragmented environments becoming a vector of new territorial coherence linking the physical and mental perceptions of people" [49].

To achieve the above-mentioned objectives, new technologies for UBH investigation have been introduced. It is the case of Mobile Mapping Systems (MMSs), tested in Camerano Caves (Italy), they revealed the potential of this new technological approach in mapping UBH assets to speed up acquisition times [50].

Due to the peculiarities of UBH elements, some guidelines have been introduced for a "culturally sensitive management" of different scenarios in the respect of the existing value systems of local communities, such as the awareness of the decision-makers in the UBH connected value systems [51].

The state of the art in the tourist sector reveals how UBH elements "have become an attractive tourist destination for an increasing number of visitors. This flow of visitors has made sustainability a major issue, that is, the way in which tourism development ensures economic benefits for host communities and respects local identity without compromising the environmental resources" [52].

In fact, as it has emerged, in the case studies of some salt mines, now transformed into very popular touristic destinations (Wieliczka in Poland, Campina de Cima in Portugal, and Turda in Romania), that, despite the positive impact related to their protection as cultural and industrial heritage, there are also "some negative aspects related to increasing costs of their maintenance and adaptation of salt mines to new functions and to meet the tourism needs" [53].

The UBH class been can also be adopted to support branding and marketing strategies for selected local connected productions. The grotto cheese case study demonstrates how climatic and environmental features of seasoning caves strongly characterize some niche productions. Based on these premises, research has focused on the profitability of the adoption of UBH artefacts within the marketing strategies dedicated to those food

specialties and, also, their potential role in supporting rural regeneration plans in the Italian countryside [54].

WWII bunkers in Naples were selected to test if and how the adoption of the UBH chart can provide the collection and the classification of intangible values for the enhancement of tangible elements of local heritage. In that case, former refugees were interviewed based on licenced structured and unstructured questionaries, and their testimonies allowed for the collection of data both regarding personal memories and historical events. Results were then analyzed and classified to be adopted, in the future, for the storytelling adopted in the enhancement processes [55].

The UBH toolkit has also supported the comparative analysis of elements included from different countries. In the cases of Italy, China, and Japan, several analogies were found (Figure 8), and the results from the study are not only expected to have effects on the exchange of good practices from one county to the other, but also on the implementation of mutual touristic fluxes [56].

(**a**) (**b**) (**c**)

Figure 8. UBH case studies in China (**a**), Italy (**b**), and Japan (**c**).

6. New Challenges for UBH

The adoption of the UBH chart has already been experienced in several scenarios, but its potential has not yet been fully exploited. The Sicily region in Italy can be considered a 'hub' for UBH, since the chart has been already adopted for a variegated number of case studies involving territorial governance at several levels.

Based on more than 20 memorandums of understanding between the Institute for Studies on the Mediterranean (ISMed) from CNR [57] and the municipality hosting UBH elements, the approach "thinking deep" was adopted to strengthen the territorial cohesion of very heterogeneous districts, impact several socio-demographic issues, and promote cooperation among different municipalities. For example, in the case of the territory managed by the local support body for the economic and social development of the Eolie islands and some areas of the Northern coast of Sicily, the Local Action Group (GAL) Tirreno Eolie [58] historical extraction caves have been analyzed by adopting the UBH approach. This adoption resulted in the definition of guidelines to support the enhancement of the strong linkage between the territory with its geological stratifications.

In the inner area of the island, instead, the municipality of Sperlinga—a small troglodyte village resulting from the reuse of an abandoned necropolis—as an effect of the adoption of the UBH toolkit, invested in the preservation of its tangible and intangible values and sustainable tourism [59]. In Sperlinga, there is the emerging promulgation of the Municipal Regulation of urban Decor and furniture of Sperlinga (RDS) [60], which includes the UBH chart, to introduce an innovative approach for the protection and enhancement of the troglodyte village.

In Lercara Friddi, the UBH approach was adopted for the analysis of abandoned sulphur mines within the activities of the GAL Metropoli Est [61]. In this case, the introduction

of this methodology provided innovative elements that can support the inclusion of the mine in local regional routes of abandoned mines.

In conclusion, the introduction of the UBH class, its theoretical charts for the reconstruction of historical functions, and its definitions of the most appropriate reuses is the perfect example of an innovative approach for the sustainable enhancement of selected cultural assets. The UBH approach can implement already-running processes, addressed to big touristic attractors and minor assets, for the benefit of the communities they belong to as well. The UBH approach also demonstrates how profitable the adoption of a multidisciplinary approach can be, both with reference to the preservation and the enhancement of the homogeneous elements of cultural heritage.

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