

## ORIGINAL ARTICLE

## Troglodyte settlements on the Loess Plateau of China: Challenges to sustainable tourism-oriented development

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## Abstract

Troglodytism is one of the most representative cultural expressions of geo-architecture. On the Loess Plateau of China, several significant examples of this approach to urban development can be found. Sometimes abandoned, sometimes still inhabited, cave settlements are precious examples of living heritage in rural and internal areas, which are at the risk of disappearance. Tourism is one of the strategies to revitalize these settlements, but it might be both an opportunity and a risk. A balance between conservation and development must be found, and a paradigm change is needed. Chinese cases can serve as a reference for solutions for this type of cave heritage, on which a debate has only recently begun at a global scale. This study introduces the classification of cave settlements based on the Underground Built Heritage theoretical approach. Chinese cases in Shanxi and Shaanxi provinces are illustrated on a comparative level. Tourism-oriented reuse and enhancement practices are analyzed and discussed in the context of national and international scenarios. In addition, criticalities and opportunities for the future are illustrated.

**Keywords:** Troglodyte settlements; Yaodong cave dwellings; Rural and remote areas; Underground Built Heritage; Tourism; Sustainable development

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## 1. Introduction

Troglodytism has been one of the most widespread practices of living in the world for thousands of years. This method of approaching the territory is peculiar to the desert and semi-arid regions, with easily accessible natural cavities or easily excavated soil, generally on plateaus and in karst-fluvial areas. Many typologies have been tested and perfected from place to place, resulting in an extraordinary variety of features, thus defining a cultural landscape with a strong identity.

In the Loess Plateau area of northern-central China, this traditional building practice constitutes a broad phenomenon (Knapp, 2000; Wang, 2016; Fan, 2019; Zhang *et al.*, 2021). Especially between the Yellow River and the middle and lower reaches of the Yangtze River, where there are primarily plains, gullies, rivers, and lakes, underground spaces were used to fortify villages, store water and food, or for burial functions since

the Bronze Age. Troglodytism has remained as the basis of urban experience and lifestyle to this day. Yaodong, literally “cave house,” is a distinctive symbol of the folk culture in remote and rural areas, from both the tangible and intangible points of view (Liu, 2014; Varriale & Genovese, 2021, Li *et al.*, 2021).

Unfortunately, many folk settlements are at the risk of disappearance. Multiple natural and anthropogenic factors depress their survival and/or development, it is even tough to generalize the phenomenon. These geo-architectures are fragile and affected by climatic and environmental conditions that heavily impact their conservation (Feng, 2011; Li & Sun, 2013; Han & Li, 2014; Fan, 2019; Zhang *et al.*, 2021). Furthermore, vernacular villages are “vulnerable in the face of pressure including urban, rural development, infrastructural development, tourism or changes in agricultural practices” (“Silk Roads,” 2014). Since the 1990s, various government initiatives have been promoted for rural development to avoid some of these risks. Initiatives have also been launched for the protection of traditional villages and their landscape, thus changing the conception of cultural heritage within the country, and strengthening Chinese historical and cultural identity (Li, 2009; Wang, 2016; Zhang *et al.*, 2016; Liu, 2014; Wang *et al.*, 2021). In this context, tourism has entered as a practice for economic development. As highlighted during pre-COVID time, some yaodong villages with a poor farming-based economy faced the challenge of conversion into tourist attractions so as not to lose their vitality (Varriale *et al.*, 2019; Genovese *et al.*, 2021). Other villages or small towns have already invested in tourist development, having been promoted as tourist destinations at the national or international level.

Tourism is both an opportunity and a risk. On the one hand, it could be the driver for heritage-led economic development, thus straightening local communities’ sense of identity. On the other hand, the mirage of short-term economic interest and tourist pressure may drive local policies toward unsustainable solutions in terms of physical conservation, urban regeneration, livability, loss of authenticity, and a sense of place. A balance between conservation and development must be found, and a paradigm change is needed, which considers the peculiarities of the yaodong settlements. It is a matter of rural heritage in remote areas and underground settlements developed with peculiar logic. From this perspective, the study of Chinese cases can offer solutions in this cultural heritage category – that of the underground settlements in a rural context – on which a debate has only recently begun globally.

This study introduces a general survey of a series of reuse strategies for tourism in some Chinese cave settlements.

Fourteen cases were selected based on predefined criteria to offer the widest range of typologies and functions. The research is based on the classification of the cave heritage introduced with the Underground Built Heritage (UBH) theoretical approach (Varriale, 2021). This work is still an ongoing part of a broader comparative research between Western and Eastern countries, aimed at identifying elements supporting the creation of a general framework of heritage-led strategies for developing sustainable troglodyte settlements in rural areas (Genovese *et al.*, 2019).

## 2. Literature review: Analysis of the global scenario

The conservation and sustainable development of folk villages in rural and remote areas, along with the management of underground spaces both in rural and urban contexts, has become a global issue today. Troglodyte villages are a peculiar kind of heritage, as each settlement is an expression of climate, geomorphology, geography, technical culture, belief, economics, politics, and so on. (Wang, 2016, vol. 4). Thus, the number, variety, and potential of troglodyte villages still need to be fully investigated and explored.

Rarely, an adequate understanding of the high potential and value, both tangible and intangible, of underground settlements, as well as calibrated protection and management actions, have determined the success of some cases. This was witnessed by the inclusion in the World Heritage List of cases such as the “Göreme National Park and the Rock Sites of Cappadocia,” Turkey, in 1985; “The Sassi and the Park of the Rupestrian Churches of Matera,” Italy, in 1993, and the “Cultural Landscape of Maymand” Iran, in 2023.

Based on these successful cases, the attention and appreciation for underground cultural heritage have gradually spread. Today, based on 1157 assets included in the UNESCO List, 175 cultural and mixed sites bear the word “rock” and 108 have the word “cave,” that is, approximately 15 percent and 9% of the total. As a result, all over the world, old mines, temple grottoes and rocky sanctuaries, underground wineries, underground military sites, and cave settlements. The list can continue, – are recovered and musealized, becoming points of interest for tourism (Edwards & i Coit, 1996; Varriale, 2019; Pace & Salvarani, 2021; Varriale *et al.*, 2022).

In the past few years, such geo-architectures have been equipped to become tourist attractions and accommodations, particularly in Europe and the Middle East. Only sometimes these structures were created as living spaces. Frequently, they were transformed and reused for tourism purposes. On a macro scale, it has also

happened in many urban contexts. The tourism market has stimulated local policies toward adopting practices to make places attractive to tourism. However, the mirage of short-term economic interests related to tourism has pushed both private owners and local policymakers toward unsustainable solutions in terms of physical conservation, quality of life – that is, availability of services for residents, overcrowding, pollution, and safeguarding the sense of place and cultural memory.

In this perspective, the international community pushes toward models for sustainable development and responsible tourism, respectful of livability and place identity, as recommended by Agenda 2030 for Sustainable Development (Agenda 2030; “Tourism in the 2030 Agenda,” n.d.) and the ICOMOS International Charter for Cultural Heritage Tourism 2022 (ICOMOS, 2022). The UNESCO Commission is also proceeding in this direction in evaluating sites with living heritage connotations to be included in the Cultural Heritage List. It has recently been demonstrated by the nomination of the Iranian case – above-mentioned – and by the submission of new candidatures, such as for the candidacy of “Cave dwellings and the world of ksour in southern Tunisia,” in 2020. Nonetheless, each country is approaching the conservation, recovery, and enhancement intervention efforts in these settlements on the basis of what it deems most relevant to the interests of the country itself (i.e., social, economic, etc.).

### 3. Methodology

The present study introduces a preliminary overview of a series of reuse strategies for tourism in some Chinese cave settlements within the context of an ongoing project. The research was based on the design of various cases and employed both quantitative and qualitative methods of data collection. Documentation and information were collected during the on-site visits of the corresponding phases of the project since 2018 before the COVID-19 outbreak had started. The methodology adopted in this paper was organized into five different stages, according to the theoretical approach employed as follows:

- (i). Adoption of UBH approach to Chinese cultural heritage;
- (ii). Selection of Chinese yaodong as case studies;
- (iii). Selection and adoption of significant data for the analysis of case studies;
- (iv). Analysis of results from the comparative study;
- (v). Discussion of results: Contextualization of Chinese troglodyte settlements in the national and international scenarios and opportunities for the future.

Concerning stage one, the UBH (Varriale, 2021) theoretical approach is taken as a reference. It provides

parameters for the classification of all elements included in the class and allows both static and dynamic analysis of all cases, introducing several criteria also to evaluate historical reuses that can be considered within dedicated enhancement processes.

With reference to the second methodological step, we decided to focus on Chinese yaodong as an expression of the UBH class – Living Space. Case studies were selected based on the following criteria:

- (i) Availability of the widest variety of typologies: a single village or clusters of interdependent villages in a contiguous area with historical functions, such as rural, commercial, and military/fortified;
- (ii) Selection according to different levels of reuse and enhancement;
- (iii) Inspection of all case studies considered during on-site visits.

Regarding the third methodological step, the parameters considered were as follows: name, GPS coordinates, province, county, date, typology of settlement, typology of geo-architecture, architectural quality, inhabited or not, prevailing economy, historical/cultural/natural connections in or around the settlement, infrastructural connections, level of protection, enhancement policies, tourism development, promotion, brief description, year of visit, sitography, and references. Then, a systematization of data was done to allow for subsequent comparative analysis. Parameters considered were as follows: settlement typology, presence of historic remains in or around the settlement, level of protection of each site, and type of tourism development. With reference to the fourth step, a comparative analysis of case studies was carried out.

The fifth phase consisted of the discussion of results. The analysis considers the level of tourism-oriented reuses adopted in China. It is based on the UBH reuses scale, which has been recently updated, encompassing interpretation, protection, abandonment, reuse, and rebuilding. Results are contextualized in the scenario of interventions for the conservation and revitalization of rural heritage and then in the international one.

#### 3.1. Adoption of UBH approach to Chinese cultural heritage

The UBH (Varriale, 2021) theoretical approach is taken as a reference for the study and classification of troglodyte contexts. It considers the elements of cultural heritage that can be included in the newborn homonym class, providing several instruments for the functional classification, and the static and dynamic analysis of all those artifacts coherent with the given definition while introducing several criteria for their reuse and the evaluation of

connected enhancement process as well. Thus, all typologies considered are expressions of the local and national history and culture, potentially leading to both heritage-led economic development and the straightening of the places' identity.

This method has been utilized and refined during several ongoing projects; thus, some categories were re-elaborated and/or modified concerning the already published methodology. At this stage, the method provides a functional analysis (Figure 1).

The functional classification points out eight UBH functions – sanitary, water, living space, religion, defense, economy, food, and transport, each connected to the underground management of correspondent environmental conflicts, social interactions, or both.

The methodology can also be adapted to study historical reuses, both from one function to another and about different uses within the same function.

At a theoretical level, concerning the current situation after dismissing the UBH elements regarding their primary function, the protocol defines four possible alternatives: interpretation, protection, abandonment, and reuse. A fifth hypothesis, that is, re-building, refers to the construction of new UBH elements by adopting the same technology for the construction of UBH elements.

- (i). Interpretation: it refers to UBH elements at the core of enhancement projects.
- (ii). Protection: it refers to UBH elements included in protected areas but not exploited as cultural heritage elements.
- (iii). Abandonment: it refers to abandoned elements of UBH.

- (iv). Reuse: it refers to UBH elements that have been dismissed regarding their primary function but reused within another function.
- (v). Re-building: it refers to new cave elements built following the historical techniques adopted for the construction of UBH, responding to the same functions as the new ones.

In China, interpretation, protection, abandonment, reuse, and re-building were all adopted from case to case regarding different elements included in the UBH class.

### 3.2. Selection of Chinese yaodong as case studies

The present study was based on field research carried out in the pre-COVID period. The latest data collection was conducted between 2017 and 2018.

Initially, the research focused on an overview of the most representative Chinese elements from the UBH class (Figure 2). The religious function, Buddhist caves, rupestrian churches, and necropolis were classified. The defense and escape tunnels were listed. The economic and historical mines were studied. The food preparation and historical granaries were considered. For sanitary, we focused on historical sewers. For the water study, we selected buried channels. Finally, for living space, cave villages known as yaodong were studied.

Yaodong forms, while showing common elements, reveal the broad range of housing-type solutions. Each has emerged from specific environmental and social conditions characteristic of the plateau area at different times in the past (Golany, 1992; Knapp, 2000; Wang, 2016).

In general, a yaodong is an artificial cave created by excavating the earth and transformed into a living space

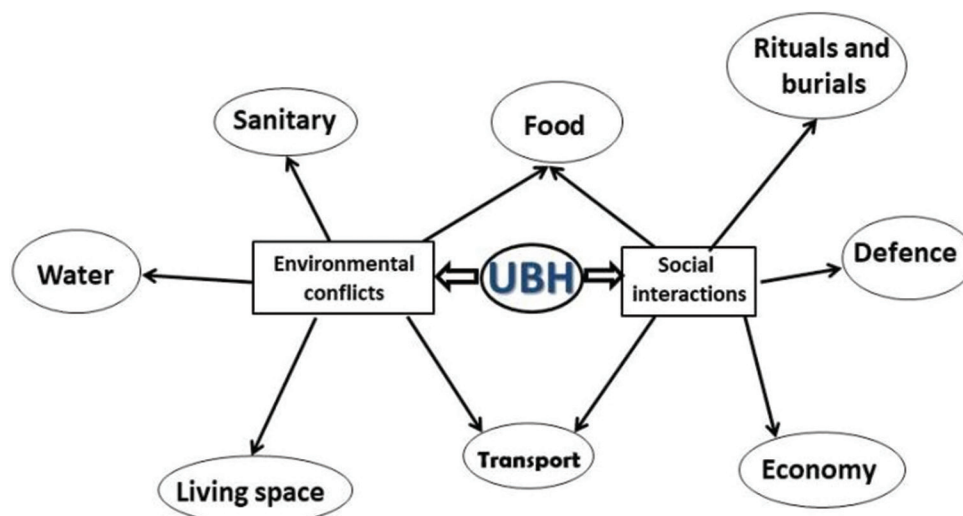


Figure 1. The Underground Built Heritage chart. Source: Diagram by Roberta Varriale

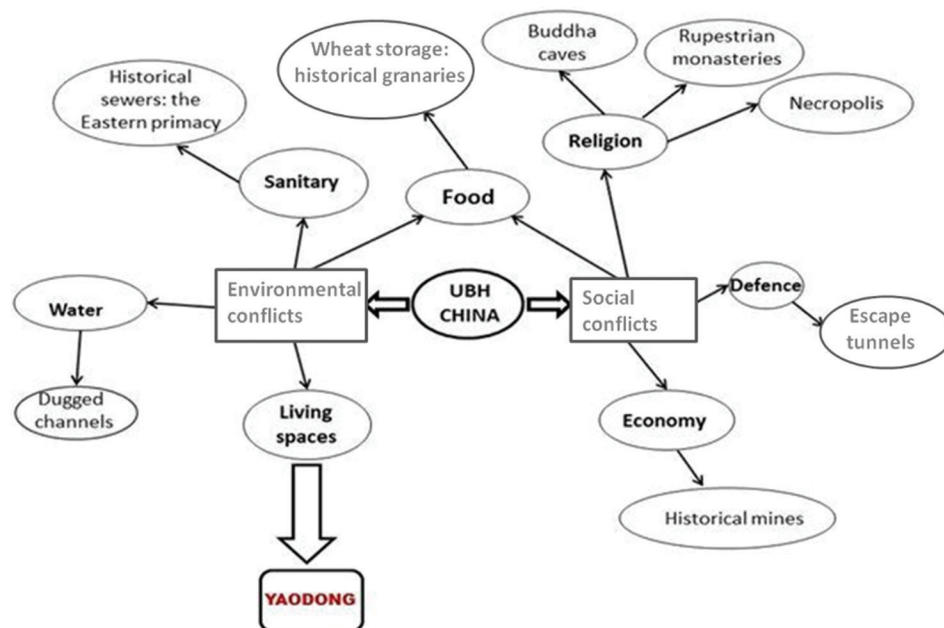


Figure 2. The Underground Built Heritage functional chart in China. Source: Diagram by Roberta Varriale

by enclosing the entrance with walls constructed from fired bricks, earthen bricks, stones, or wood, depending on the specific site. The interior space usually has mixed use: the main living room doubles as the kitchen and bedroom. Typically, multiple dwellings are built adjacent to or on top of one another and are connected to form a multitiered village, often for a single clan or an extended family (Figures 3A and 4). Terrain and semi-terrain elements are combined with a structure built above ground to form an integrated complex connected by a path. Yaodong settlements are isolated or form part of clusters of interdependent villages in a contiguous area. This last case depends on the original function of the settlement. For example, if it arose for the agricultural exploitation of the land, as an extension of a military post, or as an economic and commercial exchange center. Some are very old, it is even difficult to define their age. In this, only the documentation offers support because yaodongs are fragile geo-architectures requiring continuous maintenance. Their conservation depends on natural and anthropogenic factors (Feng, 2011; Li & Sun, 2013; Han & Li, 2014; Fan, 2019; Zhang *et al.*, 2021). On the one hand, environmental and climatic conditions, such as desertification, climate change, hydrogeological instability, and seismicity, heavily impact places' livability. On the other hand, reuse, rebuilding, abandonment, and demolition are common phenomena linked to the needs of local communities or the country's modernization and infrastructure policies (Hsing, 2010) (Figure 3).

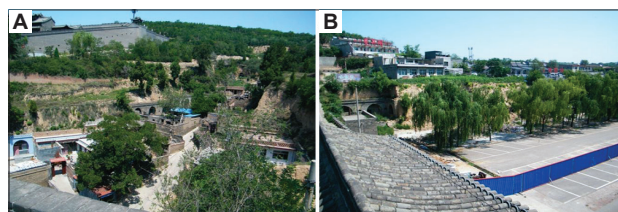


Figure 3. Jingsheng village, Lingshi County in Shanxi, 2017. The old yaodong village overlooks the Wang Family Compound (the gray brick walls). (A) Part of the old yaodong recovered and/or rebuilt in yaodong style. (B) Old yaodongs are being demolished to make room for the new tourist car park and urban development. Source: Photos by Laura Genovese

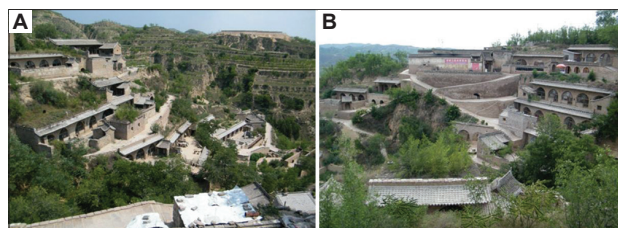


Figure 4. Lijiashan, Lin County Shanxi province, 2018. The photos show the characteristic layout of the village on overlapping terraces, which also find its counterpart in the agricultural management of the landscape, with terraces reserved for cultivation (A). There is a guest house at the top of the village (B). Source: Photos by Laura Genovese

Cases have been selected to offer the broadest range of typologies and functions, and the reuse of cave houses in the Lesbian area guarantees diversification as much as possible. In this sense, the selection only exhausts part

of the range of possibilities, considering the significant number of potential cases. Case studies were selected based on the following criteria:

- (i) Availability of a wide variety of typologies: A single village or clusters of interdependent villages in a contiguous area with traditional functions, such as rural, commercial, and military/fortified;
- (ii) Selection according to different levels of reuse and enhancement;
- (iii) Inspection of all case studies considered during on-site visits.

### 3.3. Selection of significant data for the analysis of case studies

Case studies were analyzed based on predefined criteria, already tested in other contexts using the UBH method, which have been perfected for the type of asset considered in the Chinese context. The use of these criteria is aimed at making the results of the data collection and subsequent analyses comparable with those already organized in the database concerning cave settlements, which was created using data collected in other countries and has been operational for some time. In this perspective, as a first step, information on each selected case was collected and organized thanks to a predefined datasheet – structured precisely on these criteria – as shown in [Table 1](#).

Some of these criteria are intuitive, and others require a brief comment. Concerning the settlement location, the parameter “County” is considered valuable, not only to point out the administrative competence but also to specify the geographical context; if the surveyed settlements are too small to be found on the map; if GPS coordinates are not available, or if a settlement system is considered within a broad territorial context. Finally, this geographical indication can offer qualifying elements on the geo-climatic characteristics and local geo-architectural typologies.

“Typology of geo-architecture” refers to identifying possible architectural declinations of the yaodong, depending on the soil morphology and composition, the local building culture, and so on. “Architectural quality” criterion refers to the harmony and homogeneity of the materials; the façades and roofs; the openings; the presence of symbolic decorative elements; the state of conservation of the historic building, for example, due to the effect of restorations, or that of abandonment, or modern destruction.

“Historical/cultural/natural connections in or around the settlement” refers to the presence of historic/cultural relics and natural scenic spots or attractions in and/or around the settlement, which may constitute an identitarian asset for the local community and/or a tourist attraction.

**Table 1. Criteria for data collection and systematization**

Criteria	Description
Name	
GPS coordinates	
Province	
County	
Date	
Typology of settlement	
Typology of geo-architecture	
Architectural quality	
Inhabited or not	
Prevailing economy	
Historical/cultural/natural connections in or around the settlement	
Infrastructural connections	
Level of protection	
Enhancement policies	
Tourism development	
Promotion	
Brief description	
Year of visit	
Sitography	
References	

Table shows the criteria defined for data collection and the organization of the datasheets. Source: Table by Laura Genovese

“Infrastructural connections” concerns the problem of accessibility and reachability of sites from important centers.

“Level of protection” refers to the presence of measures for protection at the provincial or national level or whether the site is a UNESCO property.

“Enhancement policies” criterion concerns interventions supporting the conservation and enhancement of the site and/or the surrounding environment, embellishing façades, presence of elements of modern urban furniture, care for public parks, and presence of signs.

“Tourism development” refers to the enhancement of tourist exploitation and the site’s national and international promotion. The relevant parameters are reflective of tourist attendance, presence of accommodation, availability of food catering and recreational activities, presence of art craftsmen and services, presence of commercial activities, presence of cultural activities/institutions (i.e., museums), and the reuse of folk spaces for new activities.

“Promotion” refers to the level of promotion of the site, thus including the presence of a tourist office or

information centers; partial or total closure of the town after ticketing; organization of guided tours; editions of guides and/or promotional brochures, websites, and communication tools (including digital); and presence of directional and information signs.

In the second step, relevant information was organized to simplify the subsequent comparative analysis phase, as shown in Table 2. In this phase, the parameters considered were as follows:

(i). The codification of settlement typology concerning historic functions;

- (ii). The presence of historical remains and relevant points of interest in or around the settlement;
- (iii). The level of protection of each site;
- (iv). The type of tourism development detected.

#### 4. Analysis of results from the comparative study

The study focuses on a particular tourist-oriented reuse approach for yaodong settlements. With regard to the analysis carried out with the UBH approach, it can be assumed that if the primary use of the yaodong settlements

Table 2. Synoptic table of selected cases

Name	Province	Settlement typology	Historic remains in or around the settlement	UNESCO-National-Provincial	Tourism development
Beiyong village (北营村委会) and Shanzhou district – Sanmenxia city (Guancaitou village, etc.)	Henan	Rural system	Shanzhou is renowned for its historical heritage sites of Yangshao culture	N: listed in the third batch of China's national intangible cultural heritage in 2011	Many residences in the Shanzhou district have been renovated and turned into tourist attractions
Jingsheng village (静升镇) – Lingshi County	Shanxi	Rural village	Wang Family Compound “Historic Residences in Shanxi and Shaanxi Provinces” UNESCO tentative list 2008	n.d.	The residential village has been partially rebuilt to host tourist facilities related to Wang Family Compound
Laoniawan village (老牛湾)	Shanxi	Fortified village	Castle and boundary walls as part of the military system of the Great Wall UNESCO site	N: Great Wall Protection Ordinance 2006	Some residences have been renovated and turned into tourist attractions
Lijiashan village (李家山)	Shanxi	Rural village		N: Historical and cultural towns and villages (HCTVs)	Bottom-up initiatives for tourism attraction
Pinglu County (平陆县) (Jidu, Yaoli, Shijianian villages)	Shanxi	Rural system		N: Included in People's Republic of China: Yellow River Basin Green Farmland and High-Quality Agriculture Development Project, 2022	Many of residences in Pinglu County have been renovated and turned into tourist attractions
Qikou town (碛口镇)	Shanxi	Merchant town	Offshore terminal of Yellow River, rich in artistic and cultural relics	N: Since 2004 subject of international projects for the protection of historic architecture	The city core has been renovated and turned into a tourist attraction
Snail Valley, in Tongchuan city	Shaanxi	Rural system		P: Provincial government initiative for recovering and converting into tourist accommodation	Many of the residences have been renovated and turned into tourist accommodations
Yan'an town (延安)	Shaanxi	Fortified village	Yan'an Revolution Memorial Hall	N: List of Major National Historical and Cultural Sites as Yan'an Revolutionary Site	Mao's yaodongs have been renovated and musealized
Zhangbi village (张壁古堡)	Shanxi	Fortified village	Underground tunnels		Underground defensive network has been recovered and musealized

Table summarizes some selected cases, which are significant for typology, traditional functions, level of protection, and tourism reuse. Source: Table by Laura Genovese

as a living space was interrupted and the function of the economy came in, three possible transformations can be found in the Chinese scenario.

Spaces are transformed into hotels, shops, and exhibition centers. Among the selected cases, transformations into B&B or charming hotels (blue in Figure 5) and commercial activities (violet in Figure 5) are more frequent in abandoned sites. In the Snail Valley Country Hotel, Tongchuan city, central Shaanxi, some abandoned vernacular villages were turned into tourist accommodations. The Snail Valley Country Hotel project aimed to attract tourists and develop the economically depressed area. The project dealt with the renovation and conversion of abandoned cave dwellings into hotel rooms and the architectural addition of connection to the old underground spaces to create the tourist center (Xu *et al.*, 2019). Nonetheless, this kind of reuse can also be found in inhabited villages. This is the case of Lijiashan, a historic Ming village in Lin County, west of Shanxi province (Yu, 2008; Wang, 2016), which is still partially inhabited. Even if it is well known and promoted by various international guides and tour operators, tourist reuse is limited to the reconversion of a yaodong courtyard into a family guest house – the Qikou Li Jianxin Farmstay (Figure 4). During the field visit in 2017, many renovation interventions on cave dwellings were seen, and we pointed out the techniques and solutions that were respectful of vernacular architecture, which came with excellent results (Genovese *et al.*, 2019).

Another possible reuse is the musealization or the transformation into a tourist and/or exhibition center (orange in Figure 5). In the country, culture and economic/

tourist development are generally considered together. This is why this function is considered a subset of the economy concept in Figure 5.

Furthermore, musealization has been found in sites both inhabited and not. Laoniawan village, Pianguan County, Datong City in Shanxi, is historic. Since the Ming dynasty (1368 - 1644), Laoniawan fortress was erected as a fundamental garrison in support of the Great Wall and control of an essential landing on the Yellow River to Mongolia, thus playing a strategic role in the defense of borders and trade with the Tartars, on the Mongolian side of the river. The village was developed under the Qing dynasty (1636 - 1911) around the castle when it lost its military functions and troops became farmers. Recently, the village is almost deserted, and the local people have moved to new settlements close to the historic one. Some cave dwellings have been recovered in the context of the Great Wall Protection Ordinance 2006 – regarding the conservation and protection of the Deshengbao Fortresses network – and few have been turned into photographic exhibition spaces. Others have been recovered and opened to the public as tourist attractions that display the folk lifestyle in vernacular cave dwellings. On the other hand, Yan'an is a thriving town in Shaanxi. The city hosts the most famous Chinese cave dwellings, which are an important historical symbol, having been inhabited by Mao Zedong and some comrades of the Party between 1935 and 1948. Here, they headquartered and elaborated the ideology that later became known as “Maoism.” Today, Yan'an Revolutionary Site is listed as a Major Historical

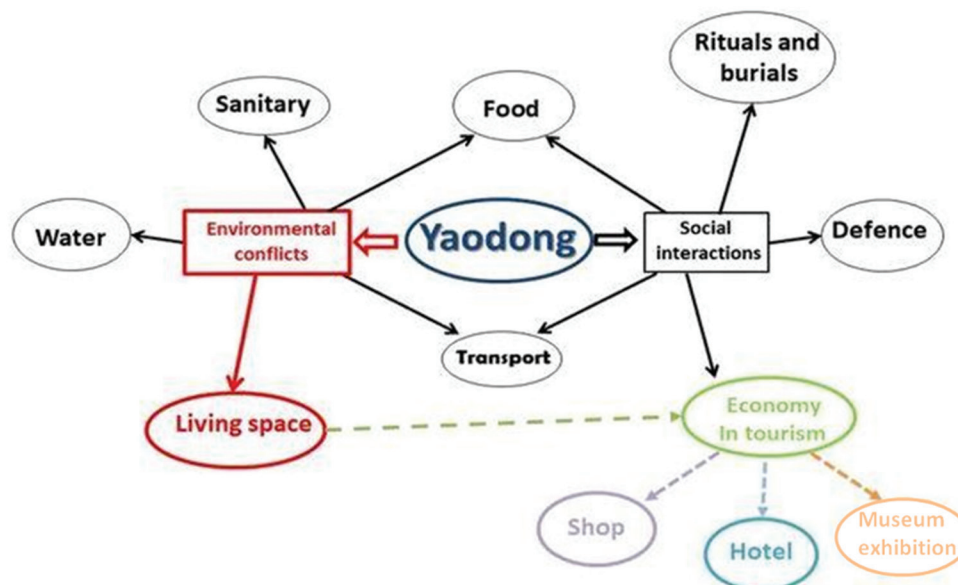


Figure 5. Underground Built Heritage chart of yaodong functions transformations. At the bottom part, the transformations from living space to economy are represented. Source: Diagram by Roberta Varriale



and Cultural Site protected at the national level, and all historic cave dwellings have been recovered and enhanced, becoming a must-see for red tourism.

Musealization is the approach also for underground spaces with hybrid functions, such as those initially built for military and defensive functions. This is the case of the Zhangbi fortified village, Jiexiu City in Shanxi (Figure 6). The ancient village, from the Sui (581 - 618) and Tang (618 - 907) dynasties, stands on steep rocky cliffs, having been pierced by an intricate tunnel system. The tunnels were created for military and defense purposes and have been connected to dwellings and spaces with varied uses. Nowadays, the village is still vital, and the underground system has been recovered and turned into a museum. The ticket gives access to three tunnel levels, including mangers, furnaces, wells, grain silos, flood prevention structures, and wall communication facilities.

In all these tourist-oriented reuses, interpretation action represents the first step as the basis for the reconversion projects.

Re-building and destruction are other actions adopted in the tourist-oriented development strategy. In truth, these practices are widespread in variable proportions in almost all cases and are considered part of modernization and urban development. Nonetheless, “developmental destruction and constructional destruction” seem to have a more significant impact on vital centers, if they arise near the famous tourist attractions (Zhang *et al.*, 2021). This is the case of the Jingsheng village, Lingshi County in Shanxi (Ping & Chunyang, 2022), an old yaodong village from Yuan (1271 - 1368) to the early Ming (1368 - 1644) dynasties. It overlooks the Wang Family Compound, which is a well-known tourist attraction as it is one of 123 residences of the “Historic Residences in Shanxi and Shaanxi Provinces” submitted in 2008 for inclusion in the UNESCO World Heritage Tentative List, for the cultural category (Ancient

Residences, 2008). Modern urban development, on the one hand, and the tourist pressure related to the Wang Courtyard, on the other, are crushing the historic housing fabric, endangering the survival of traditional folk villages (Figure 3). Furthermore, vernacular architecture has mostly been restored or rebuilt with new materials in the traditional style. Modernizing the structures with different colored plasters, cables, water heaters, and antennas creates a truly chaotic and confusing effect.

Similar problems affect Qikou town, Lin County, Luliang city in Shanxi (Wang, 2016). As a prosperous historic land-and-water port along the Yellow River since the Ming dynasty, the town lost its strategic role around the 1930s due to the introduction of rail transport and fell into decline. After years of almost total abandonment, starting from 2004, the city has been the subject of an international debate for the conservation of traditional architecture, aspiring for the candidacy for UNESCO site (Chen, 2004; Ma, 2006; Yan, 2018). Nonetheless, recent tourism – both cultural and ecological – development started, triggering a process of urban and infrastructural transformation, which can put the historic town and its cultural landscape at risk. On the one hand, particularly in the outlying areas, some cave dwellings have been abandoned and filled in, left for collapse or demolition (Figure 7A). In some cases, they have been rebuilt with modern materials according to traditional typologies, adapting to the needs of modern lifestyle (Figure 7B). On the other hand, the threat of highway access to Qikou and the creation of the highway along the river call for disrupting its historic waterfront access. For these reasons, since 2006, the site has been under observation by the World Monument Fund (World Monument Fund, n.d.).

Regarding the abandonment action, it must be stated that abandoned spaces have been identified in almost all the cases evaluated. This practice is regular in urban development and generally concerns spaces no longer relevant or usable



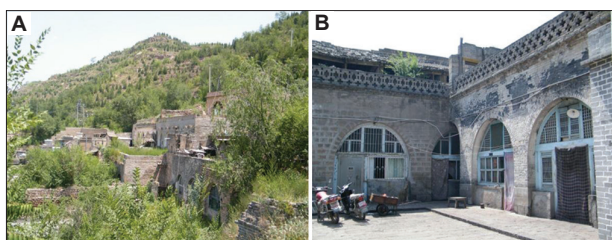
**Figure 6.** Zhangbi village, Jiexiu City, Shanxi province, 2018. (A) A diorama illustrating the structure of the hill, with the city built on top of the network of underground tunnels. (B) An old yaodong, along the slope of the hill facing the valley, used as a tourist shop. (C) Renovation of a yaodong connected directly to the tunnel network. Source: Photos by Laura Genovese

for various reasons. However, in the specific case of the effects of tourism on practice, we cannot say that we have encountered gentrification phenomena at the moment.

Table 3 offers a summary of the reuse highlighted in selected cases.

#### 4.1. An overview of cave settlement development initiatives in the Chinese scenario

The protection practice deserves a different treatment and a classification in the broader national scenario. As explained above, it should be emphasized that yaodong villages and their territorial context are very fragile, and the consequences of their abandonment of vernacular architecture are multiple. Depopulation means the deterioration and destruction of earthen heritage, which is made from highly perishable materials, thus requiring constant maintenance and protection from atmospheric agents (Genovese *et al.*, 2021). Looking at the problem from a micro- to macroscale, it is the loss of local architectural typicality and craftsmanship, the loss of cultural and social integration of communities, and the loss of the sense of place. More generally, it impacts the conservation of the historical and cultural landscape.



**Figure 7.** Qikou town, Lin County, Shanxi province, 2017. (A) A complex of yaodong, which is almost degraded and partially abandoned. (B) A yaodong courtyard, at the basis of the monumental complex, having been rebuilt many times in traditional style with modern materials. Source: Photos by Laura Genovese

The abandonment phenomenon has undergone an acceleration since the 1980s, during the period of reform and opening-up of China, after which residents in Loess terrace-like plains gradually moved to new or more significant settlements or, simply, from cave dwellings to aboveground architectures, searching for more comforts and modern standards. The vernacular architecture was filled, collapsed, or abandoned almost in all Loess areas. To avoid these risks, since the 1990s, various government initiatives have been promoted, basically dedicated to two areas of intervention: (i) The revitalization and rural development that seeks to address and alleviate poverty, and (ii) the conservation of traditional settlements and their productive landscape, seeking to promote the development of rural tourism (Li, 2009; Wang, 2016; Zhang *et al.*, 2016; Liu *et al.*, 2019; Wang *et al.*, 2021). Among the initiatives, the Loess Plateau Watershed Rehabilitation project, which is concentrated in the northwest of Shanxi, including Pianguan County and Laoniawan village, was initiated to avoid desertification and support the survival of farms in the plateau area (World Bank, 2006). Very recently, China’s new Rural Revitalization has entered a new stage, and a Promotion Law to advance the work of rebuilding the rural economy came into effect in June 2021 (*Rural Revitalisation Promotion Law*, 2021). Furthermore, in 2022, the Ministry of Agriculture launched a project supported by the Asian Development Bank, aiming to strengthen sustainable green agricultural production systems and agricultural value chain, to revitalize rural areas in six provinces, such as southern Shanxi, particularly the Pinglu County (“Yellow River Basin Green Farmland,” 2022).

In the long run, this trend of protecting and enhancing rural assets has acted as a tool to articulate the country’s urbanization and modernization project. At the same time, this initiative has made it possible to preserve and strengthen the Chinese historical and cultural identity. The inclusion of many rural settlements in the national or

**Table 3. UBH analysis and RE-USE classification**

Name	Interpretation	Protection	Reusing	Rebuilding	Abandonment
Beiyong village (北营村委会)	x	x		x	
Jingsheng village (静升镇)				x	
Laoniawan village (老牛湾)	x	x	x		x
Lijiashan village (李家山)		x	x		x
Pinglu County (平陆县) (Jidu, Yaoli, Shijianian villages)	x		x	x	
Qikou town (碛口镇)		x		x	x
Snail Valley, in Tongchuan city	x		x	x	x
Yan’an town (延安)	x	x	x		
Zhangbi village (张壁古堡)	x		x		

The table summarizes cases illustrated above, in relation to the type of action detected for the adaptation of historic underground architecture to the site’s tourism development strategy. Source: Table by Laura Genovese

provincial lists of historical and cultural towns and villages, and that of traditional villages, starting from 2003 (Yan *et al.*, 2017; Zhang *et al.*, 2021), such as the case of Lijiashan, fits into this scenario. Likewise, the National List of Intangible Heritage of Pinglu technological culture and craftsmanship in building silo-houses in 2021 (“Cave Building Technique,” 2021), as well as the candidacy and inclusion in UNESCO Lists of numerous architectural and cultural expressions of various ethnic groups linked to regional and rural, might be considered (Chinese Paper-cut, 2009). In this context, although conservation and enhancement practices are mainly seen in the function of tourist-oriented economic development – the aim is to support and increase the “lost” national cultural identity (Zan *et al.*, 2018; Varriale *et al.*, 2019) – relevant cases emerged, in which the communities have been involved in preserving details that give meaning and quality to yaodong’s lifestyle and in testing solutions for sustainable development (Yong *et al.*, 2019). Rarely, bottom-up initiatives were found, which were subsequently supported by local policies, as found for various types of rural settlements affected by tourism development (Yin & Wu, 2008; Huang, 2021; Li *et al.*, 2021; Qi, 2023).

On the other hand, early attention of the country toward underground heritage should be noted, highlighting the importance of the troglodyte culture, which is part of the national identity. In this perspective, of the 56 sites inscribed in the UNESCO World Heritage list, 18 include the word “rock” in its description, and 14 have the word “cave”. Between the cultural and mixed sites (cultural/natural), there is evidence of prehistoric settlements, rock sanctuaries, and Buddhist cave temples. Among these kinds of underground heritage, yaodong is included: the serial site “Silk Roads: the Routes Network of Chang’an-Tianshan Corridor” (“Silk Roads,” 2014) includes, which remains of terrain and semi-terrain settlements. In this regard, a 20-year tradition of academic study has been focused on yaodong settlements. The interest was concentrated on deepening technical and performance characteristics in internal insulation and environmental sustainability, evaluating solutions to replicate cave dwellings in a contemporary way (Golany, 1992; Li & Sun, 2013; Wang, 2014; You *et al.*, 2019).

Nonetheless, a recent attitude has spread toward considering the intangible values that they represent, such as those on the cultural landscape. Thus, solutions for conserving livability, historical memory, and the sense of place have been explored (Qi, 2023). In this context, social participation in recovery processes and enhancement cases was individuated.

Concerning selected cases, the analysis evidenced three principal scales of intervention for tourism-oriented strategies for rehabilitation and reuse:

- (i) Bottom-up initiative. This is the case of Lijiashan village, historically devoted to a farm-based economy and developed due to the economic influence of the nearby Qikou town. Recently, it has been attempting to attract tourists visiting Qikou in a bid to improve local tourism. The first form of promotion was through word of mouth among visitors. Then, the increasing number of visitors motivated the conversion of a yaodong courtyard at the top of the village into a family guest house (Figure 7B). Nonetheless, occasionally, ordinary people offer hospitality to trippers. Nowadays, it is recognized as one of the historical and cultural towns and villages (HCTVs).
- (ii) Provincial/local government initiative. Several villages in the Shanzhou district, Sanmenxia city of Henan province have been included in the national or provincial traditional village list since 2012, including Beiyong, Qu, and Liusi villages in the Zhangbian township. More than 80 silo-caves in the Beiyong village have been renovated and turned into tourist attractions that display the folk lifestyle and craftsmanship. The village is a famous tourist attraction (Li & Li, 2018; Zhang *et al.*, 2021).
- (iii) Central governmental initiative. This is the case of the Laoniawan Deshengbao fortress and village mentioned above, having been restored in the context of the national project on the protection of the Great Wall zone, together with other Deshengbao villages close to the Great Wall, and enhanced to attract tourism (Genovese *et al.*, 2021).

## 5. Discussion of results: Contextualization of Chinese troglodyte settlements in the national and international scenario and opportunities for the future

Nowadays, the conservation and sustainable development of folk villages in rural and remote areas, as well as the need to manage underground spaces in rural and urban contexts, have become a global issue. Chinese yaodong settlements combine two issues that are not simple to deal with. Settlement pattern, plan layout, façades, and internal organization of the artificial cavities express local human abilities and craftsmanship in dealing with the Plateau’s physical and climatic characteristics (Wang, 2016).

Yaodong settlements express an entire vulnerable complex territorial system comprising geographical, economic, political, social, and cultural elements. Let’s call this system Historic Underground Landscape (Genovese, 2021). Investigating this complex system has many challenging aspects and criticalities, which do not strictly

depend on China itself. However, one of the main critical issues is the lack of a study protocol that allows for an adequate understanding.

The lack of a study approach so far has been the basis of the lack of recognition of the high value and potential of most of these sites. In fact, where there has been an adequate understanding and interpretation of this heritage, there have been cases of successful conservation and enhancement, as demonstrated by the few cases of troglodyte settlements included in the UNESCO List. More commonly, these precious treasure nests of information and examples of living heritage are completely undervalued and left abandoned or sacrificed to urban development.

Our research highlights that, at a global level, there are still many fundamental steps to go through to approach the topic and define a framework for heritage-led sustainable strategies for underground rural settlements. More specifically, a universally recognized and shared glossary, a universally recognized classification for troglodyte architecture, the census and systematization of troglodyte settlements on every national scale are all necessary steps in a first phase of both a quantitative and qualitative analysis of this kind of heritage. In the second phase, the improvement of the interpretation, communication, educational, enhancement, and management practices will provide bases for elaborating conscious strategies for protecting and developing these contexts. In this scenario, the comparative analysis of international cases is very complicated. Attempts have been made in this direction, for example, in the context of the project Underground for Value (COST ACTION 18110, 2019-2023), led by the National Research Council of Italy (CNR) and involving the authors. This project involved more than 200 members from 32 countries. It has experienced the interdisciplinary approach for promoting the UBH methodology as a

valuable resource to celebrate and preserve and, when sustainable, to reuse and enhance, realizing its full potential to support local community development (Pace & Salvarani, 2021).

Cave dwellings in the Mediterranean basin are better-known, thanks to historical and comparative studies (Laureano, 1993; Urdiales & Maccarone, 2011; Horden & Kinoshita, 2014). Furthermore, the project Vernacular Knowledge for Sustainable Architecture (VerSus) gave a big input toward their knowledge. It was a European initiative developed in the framework of Culture 2007–2013 program, which partners with CRAterre-Ecole Nationale Supérieure d'Architecture de Grenoble (France), Escola Superior Gallaecia (Portugal), DIDA (Department of Architecture, University of Florence-Italy), DDICAAR (Department of Civil Engineering, Environment, and Architecture, University of Cagliari-Italy), and Escuela Técnica Superior de Arquitectura of Polytechnic University of Valencia, Spain (Vegas *et al.*, 2014).

Hence, a partial comparison is presented below between a Chinese case and some worldwide famous underground settlements, mostly in the Mediterranean area, some of which have already been studied according to the UBH methodology (Varriale, 2014; Varriale, 2021).

The comparison is summarized in Table 4. All examples are located on plateaus at a latitude between 32° (the Libyan case) and 40° (the Italian case). Differences were found in current uses: only Gharyan (Tripoli), Matmata (Tunisia), Kandovan (Iran), and Lijiashan (China) are still inhabited by the locals, while in the other cases, underground settlements are mostly interpreted as examples of traditional lifestyle, protected in natural areas, or inscribed in protection lists or reused.

**Table 4. UBH RE-USE classification in cases from different countries**

Site	Country	Data and information				
		Name of the plateau	Meters o.s.l.	Latitude	Inhabited	Interpretation
Gharyan	Libya	Jabal Nafūsah	700 o.s.l.	32°10' N	x	x
Matmata	Tunisia	Matmata Plateau	600 o.s.l.	33°32' N	x	x
Sassi Matera	Italy	Murge Plateau	401 o.s.l.	40°40' N		x
Kandovan	Iran	Iran/Persian Plateau	2300 o.s.l.	37°47' N	x	
Derinkuyu	Turkey	Anatolian Plateau	1300 o.s.l.	38°37' N		x
Ürgüp	Turkey	Anatolian Plateau	1050 o.s.l.	38°38' N		x
Göreme	Turkey	Anatolian Plateau	1104 o.s.l.	38°38' N		x
Avanos	Turkey	Anatolian Plateau	920 o.s.l.	34°42' N		x
Lijiashan	China	Loess Plateau	2628 o.s.l.	36°52' N	x	

This table illustrates the UBH RE-USE classification tested in cases from different countries. Abbreviation: o.s.l., over the sea level. Source: Table by Roberta Varriale

As anticipated, Lijiashan village is still inhabited, with a traditional farming-based economy. It is a protected site, listed as a historical and cultural town and village, and a well-known tourist destination. Nonetheless, tourist-oriented reuse is limited to the guest house, which was created inside a courtyard cave dwelling.

The comparative study showed how the Chinese village is one of the few still inhabited cave villages worldwide, together with some villages in Libya, Tunisia, and Iran. However, its peculiarity is that even though it is a protected and reused site, its interpretation as a typical expression of local cultural heritage is inferior. This aspect, which is fundamental in communicating both tangible and intangible values of the caved settlement of Lijiashan, can influence its future preservation as a cultural site. The establishment of a museum dedicated to traditional troglodyte cultures, like those dedicated to Italian Sassi in Matera, Tunisian Matmata, and Turkish Göreme, could support both the conservation and the divulgation of those value and support the sustainable development of those elements, also in the touristic sector.

## 6. Conclusions

At a global level, rural and remote areas' sustainable development and reuse of underground spaces are two heartfelt issues. In China, these two topics are synthesized in the yaodong villages of the Loess Plateau. From the analyzed cases, numerous suggestions for the interpretation, reuse, and enhancement – also in the touristic sense – can be derived, which can be included in a more general census of options. The authors are committed to this direction, seeking the creation of standard guidelines for the sustainable enhancement of UBH, to explore all the potential of these forms of heritage, whose variety and complexity have yet to be fully understood. In this regard, the research on Chinese cases form part of a broader comparative research by the authors and their multidisciplinary team, extended to Eastern and Western countries.

As declared, many criticalities hinder research development because there is no recognition of a single glossary and a shared classification globally. The improvement and experimentation of the UBH method are pushing in this direction. Good results are being achieved, thanks to the European project Underground for Value (COST ACTION 18110), led by CNR and involving the authors, which brings together 32 countries for the experimentation of the method. In the same direction, bilateral projects between Italy and individual European and non-European countries such as Georgia, Iran, Armenia, Tunisia, Turkey, Jordan, and Israel are under evaluation by the authors and are trying to stimulate a census of underground settlement in each country.

Among the challenging goals to be achieved in the future is the improvement of the interpretation, communication, education, enhancement, and management practices related to this kind of asset to elaborate conscious strategies for its protection and development. As the international experience shows, the only possibility to avoid Disneyfication and contrasting with the gentrification processes, already experienced in worldwide famous caved settlements having been transformed into popular tourist destinations, is to integrate them in scientific and educational tourism and therefore expand the interest in society. In this sense, social participation in the development process could be a way to share responsibility between local institutions and communities. It would require building a shared strategy and undertaking the responsibility for developing a plan, allocating resources, and implementing and evaluating development activities that would better cater to local needs (Huang, 2021). Engaging local citizens mean strengthening and preserving local identity, ensuring that increased tourism does not become an agent of destruction.

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## Conflict of interest

The authors declare they have no competing interests with any institutes, organizations, or agencies that might influence the integrity of results or objective interpretation of their submitted works.

## Author contributions

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## Ethics approval and consent to participate

Not applicable.

## Consent for publication

Not applicable.

## Availability of data

Raw data can be shared with readers upon reasonable request to corresponding author.

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