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# Sustainable development strategy for historic neighborhood shrinkage: taking Puhuiquan neighborhood in Yulin, China, as an example

Yuzhao Zhang<sup>1\*†</sup>, Shanshan Chen<sup>2†</sup> and Mark A. Hoistad<sup>3\*</sup>

## Abstract

Western cities have been confronted with the challenges of 'urban shrinkage' as changes in economic and production models have caused population migrations. China, in its recent history, has experienced rapid and dynamic growth in its cities. However, as its economy is evolving, it too is being confronted with 'urban shrinkage' challenges. Populations have been shifting inside small and medium sized cities in response to problems created during this rapid growth period. Most heritage areas have suffered from depopulation, neglect and disinvestment. The historic Puhuiquan neighborhood in Yulin City is a classic example of the current Chinese version of 'urban shrinkage'. Yulin City, founded as a military city five centuries ago, has shifted its focus away from its historic purpose into a resource-based city. Yulin's planning developed new areas, drawing population out of the historic Puhuiquan neighborhood. This area is the home to a unique urban cultural landscape where land and architecture have merged to create the development of various types of 'cave' houses. Suffering from the effects of 'urban shrinkage', this research explores the causes and potential solutions for the area employing both 'smart shrinkage' and 'urban renewal' strategies, informed by local resident participation, to develop a sustainable renewal strategy for this heritage area.

**Keywords** Northern Shaanxi Province, Cave dwellings, Population contraction, Historic neighborhood, Sustainable development

## Introduction

Urban shrinkage is not a new phenomenon in the history of cities. As empires rose and fell, economic reversals occurred, or natural disasters changed the course of urban history, cities shifted away from previous developmental peaks. Ancient capitals were abandoned when they became untenable, industrial centers turned to rust when they no longer matched the needs of contemporary economic conditions, and catastrophic floods, fires and volcanic activity have caused dramatic shifts in human settlement. Whatever the cause, the departure of a significant amount of the population was one of the important indicators of shrinkage. In recent years, the global shrinkage phenomenon has impacted more and more regions, cities, areas, and neighborhoods [1–3]. Recovery from

<sup>†</sup>Yuzhao Zhang and Shanshan Chen have contributed equally to this work.

\*Correspondence:

Yuzhao Zhang  
zhangyuzhao@xjtu.edu.cn  
Mark A. Hoistad  
mhoistad1@unl.edu

<sup>1</sup> School of Human Settlements and Civil Engineering, Xi'an Jiaotong University, NO. 28 Xianning West Road, Xi'an, China

<sup>2</sup> State Key Laboratory of Western Green Building, School of Architecture, Xi'an University of Architecture and Technology, No.13 Yanta Road, Xi'an, China

<sup>3</sup> College of Architecture, University of Nebraska-Lincoln, 302 AHE, Lincoln, USA

this development in cities, characterized by population contraction, makes it much harder to sustain cities [2, 4–6].

In recent history, China's quick expansion caused by dramatic rural in-migration and rapid economic growth made managing growth the focus of planners and political leaders rather than shrinkage. However, in the past decade, as China's urbanization has entered a different stage in its development, Chinese scholars have begun to note the problem of urban shrinkage in their own country [7–10]. Recently, a series of case studies have been developed considering urban shrinkage in China in the context of the Western experience [11–19]. These studies found, different from European and American countries, urban shrinkage in China occurred primarily in small and medium-sized cities or resource-exhausted cities. Shrinkage was mainly characterized by labor outflow, creating localized shrinkage within an overall growth pattern [20, 21].

Yulin is a typical resource-based city in northwest China, possessing a relatively undiversified industrial structure. Although its economic development has continued to grow in the past few years, the urbanization rate has been slowing down, showing a trend of contraction [22, 23]. The population of Yuyang District, the downtown, increased by 33,022 in the decade from 2010 to 2020 [24]. However, Puhuiquan, the historic center of Yulin, experienced population outmigration and neighborhood decline. As with other urban shrinkage problems, this is not the result of a single factor, but rather the interaction of several triggers [20]. Because it was the result of many factors, in order to redirect the neighborhood away from this trajectory of decline, the interaction between population, economy, and space should be considered comprehensively [21, 25]. This study seeks to contribute to understanding of the effects of urban shrinkage, particularly in heritage urban landscapes, and propose strategies for local leadership in Yulin to positively address the shrinking phenomenon in the Puhuiquan historic neighborhood.

Survey results show the complex regional topography and the southward migration of the city center have contributed to the rapid population contraction in Puhuiquan. Further, the poor spatial accessibility and infrastructure conditions in the area have led to the decline of buildings in the historic neighborhood. To address these conditions and return the neighborhood to a more sustainable posture, it requires the application of strategies that build on the strengths of the area and involve the local residents in the process. To do this, the authors have combined the 'smart shrinkage' approach, recognizing the importance of the cultural heritage of the site, and an 'urban renewal' strategy, developing the

physical and social community infrastructure. These improvements will contribute to the quality of life for local residents, making the area a more desirable place to live. The interventions will require the editing of the existing urban fabric to positively leverage the results of the shrinkage and address existing deficiencies. The removal of poorly built construction and the preservation/adaptive reuse of important architectural assets, like the wraparound cave house clusters, is one of the culturally important assets of the area.

The overlay of a tourist focused economy that leveraged both the tangible and intangible cultural assets of the neighborhood, was pursued as the pathway to renewal. The southern part of the old walled city had maintained a successful tourism economy. With better circulation connections, venues for the presentation of various forms of folk culture indigenous to the area, and the establishment of unique homestay accommodation network, the study team developed a design that would facilitate this economic strategy. It was posited that this would generate economic opportunity for local residents. To be sustainable, this approach would also require the development of supportive policies and increased resident participation in subsequent development, to activate the historic and cultural heritage in the neighborhood, reshape the community's business framework, and improve the spatial and environmental quality of the Puhuiquan area.

## Theoretical background

### Urban shrinkage and neighborhood decline

Urban shrinkage, an unavoidable stage of the urban life cycle [26], has become one of the most significant urban issues that has attracted widespread attention from global scholars in the past few decades. When urban development enters the stage of deindustrialization [25], suburbanization [27], or globalization [28], the shrinkage of cities, parts of cities, or towns becomes one of its main development directions [20]. Although this is a highly diversified process [29–31], population loss, or aging, is the primary identification criteria for shrinking cities, parts of cities, or towns [2, 4]. Many studies suggest that the economic recession has caused critical unemployment and population outflow in many urban areas, which is the fundamental cause of urban shrinkage [30, 32].

With the decline of the birth rate and a growing elderly population, parts of China's cities are starting to show a growing 'shrinkage' trend [21, 33]. It is generally believed in related studies that the shrinkage of Chinese cities is the result of regional and urban development policies, competition between cities, and the interaction between employment opportunities and the workforce [21, 32]. The most prominent feature of shrinkage is population loss during urban spatial expansion and economic

growth [8, 26, 34]. This phenomenon has brought about problems such as rising urban vacant land, increased housing vacancy, deteriorating public infrastructure, a sluggish built environment, and a decrease in residents' happiness index in effected areas [34, 35]. The National Development and Reform Commission of China specified the objective existence of urban shrinkage in China in the documents 'Key Tasks for New Town Construction in 2019' and 'Key Tasks for New Urbanization Construction and Urban–Rural Integration Development in 2020'.

The large amount of vacant land and houses brought about by urban shrinkage [36, 37], presents the biggest challenge of maintaining neighborhood services and retaining investment in infrastructure [38, 39]. This trend of decline causes a deterioration of the neighborhood environment and a drop in the quality of life of residents, leading to a decrease in the livability and vitality of the neighborhood [2, 37]. The decline also hurts the city's image and threatens some of the cultural legacy of the community [27]. It also results in the selective out-migration of a portion of the population [40]. Therefore, the core issues needing attention, to improve the quality of the neighborhood, must include reasonable reuse of vacant houses, retention of displaced neighborhood residents, and the promotion of sustainable strategies for the community.

### **Sustainable neighborhood development**

Urban renewal and smart shrinkage are the mainstream planning strategies employed to respond to urban shrinkage and share the common goal of achieving sustainable development, but their response attitudes and implementation methods are different [20, 41].

Urban renewal 'resists' urban shrinkage through the injection of vitality to achieve the goal of urban revitalization and regrowth [20]. In this process, the importance and role of increasing building stock space in urban renewal is increasingly prominent [42]. Urban renewal is shifting the building environment towards more conventional neighborhood renewal [43]. Therefore, as the basic unit of a city, the state and condition of the building stock have a significant impact on the sustainability of the neighborhoods [44, 45]. The vacancy of buildings caused by urban shrinkage may disrupt the sustainability of the building environment, raising concerns for the community [44, 46]. Neighborhood renewal, one of the subsystems of urban renewal, is a considerable factor in the sustainable development of cities [47]. Its local focus helps to enhance the community awareness of residents, create new job opportunities, and improve environmental friendliness [48, 49]. Many case studies show that if the update project is suitably designed and implemented, it can enormously enhance urban competitiveness [50].

Smart shrinkage, pursues an attitude of 'adaptation', acknowledging the shrinking of cities. It attempts to manage the shrinkage [51], advocating for the development of appropriate planning within a smaller land area and population size [52]. The intention is to transform the negativity of loss into a positive, improving the quality of life as the affected area downsizes. At present, smart shrinkage is mainly used to study postindustrial Europe and some large cities in the American Rust Belt, with almost no research on the neighborhoods of small and medium-sized cities. Smart shrinkage may be the best choice to cope with long-term population loss in small and medium sized urban neighborhoods, organizing communities for a more sustainable future [38].

There are many cases worth learning from at the urban level in dealing with urban shrinkage. For example, some countries intervened in relevant policies, including the 'Eastern Urban Reconstruction Programme (Programm Stadtumbau Ost)' proposed by the federal government of Germany in 2002. Almost all east German cities with a housing vacancy rate of more than 15% announced large-scale demolition plans for vacant houses, restoring the demolished land to green spaces or other public spaces to adapt to the reality of a shrinking population [53]. Some medium and small cities and towns have pursued economic development by retaining local populations, establishing tourism industries, and creating employment opportunities. They choose to revitalize local resources by protecting cultural heritage and improving the accessibility of public services and infrastructure. For example, in Łódź, Poland, and Porto, Portugal, some public renovation and modernization programs have improved housing, transportation, and infrastructure in deprived and rundown urban areas, creating better urban livability and attractiveness [54]. Some towns in Italy adopted an economic model of decentralized hotels using existing historic building stock (Alberto Diffuso). This unique idea provided a means for protecting traditional residential buildings while also exploring neighborhood cultural connotations, integrating the development of the tourism industry with local characteristics, and driving employment and population growth [55]. The combination of preservation and economic development promoted a more sustainable city and community revitalization. Although these countries and cities have different response methods, they are all responding to the economic downturn and urban recession caused by population decline. These precedents have relevance to the Chinese situation, particularly in heritage areas through both their physical editing and economic strategies.

## Materials and methods

### Research method

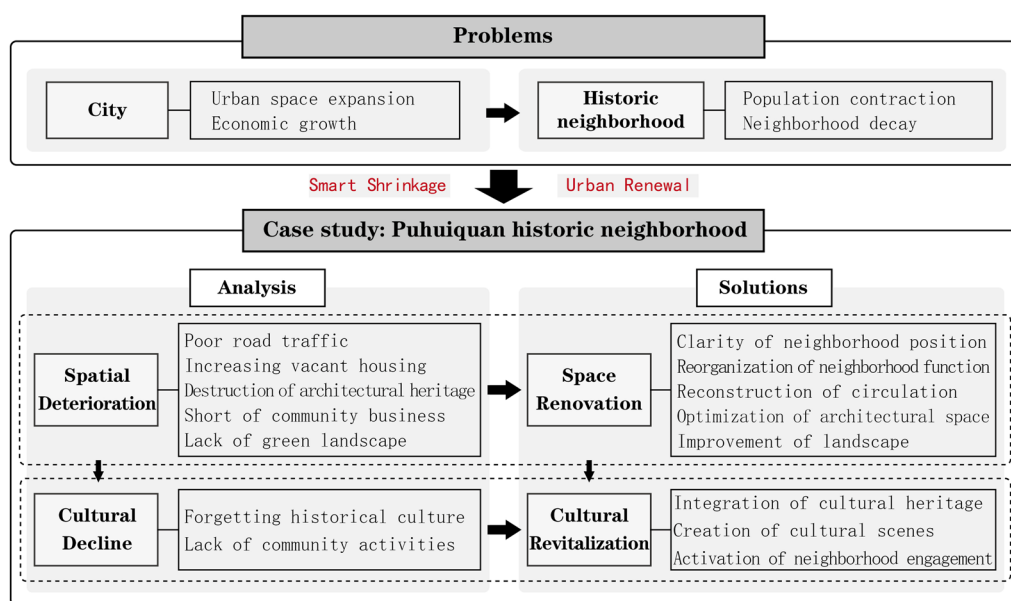
Authors conducted a detailed investigation of ancient Yulin City from 2017 to 2021. The declining Puhuiquan neighborhood, located in the north of the old city, in addition to rapid population loss, faced the challenge of complex terrain along with poor physical, social, and economic infrastructure. This neighborhood, part of the original founding location of Yulin City, however, still possesses a unique urban cultural landscape. It is the location of a large number of cave dwellings. This settlement pattern is a key component of the cultural memory of the city. Concerned about threats to heritage portions of cities throughout China facing similar circumstances, the authors pursued a research trajectory that combined both 'smart shrinkage' and 'urban renewal' strategies to provide a design research case study for renewal of similar urban environments. Urban shrinkage in the neighborhood led to the abandonment of many buildings in the area. The design research team, using a smart shrinkage approach, viewed this as an opportunity to give greater presence to the original cave house settlement pattern through the removal of deficient structures and the adaptive reuse of the built heritage landscape. The exposure and adaptive reuse of these structures were believed to have the potential to support a tourism initiative for the area. As with the previously mentioned case study in Italy, the pursuit of this strategy could result in many positive outcomes to bring the neighborhood back together and improve the local economy. The 'urban renewal'

aspect of the case study proposal explores spatial renovation and cultural revitalization. This is manifested by improving circulation, architectural space and landscape, integrating heritage resources, and creating cultural scenes. These proposed interventions were identified by integrating community participation in the research process. This hybrid approach had the combined goal of rebuilding residents' cultural identity and strengthening tourists' sense of local experience. Ultimately, the intention is to define a path forward to stimulate the vitality of the neighborhood, reproduce the regional cultural characteristics, and realize the sustainable development of Puhuiquan historic neighborhood (Fig. 1).

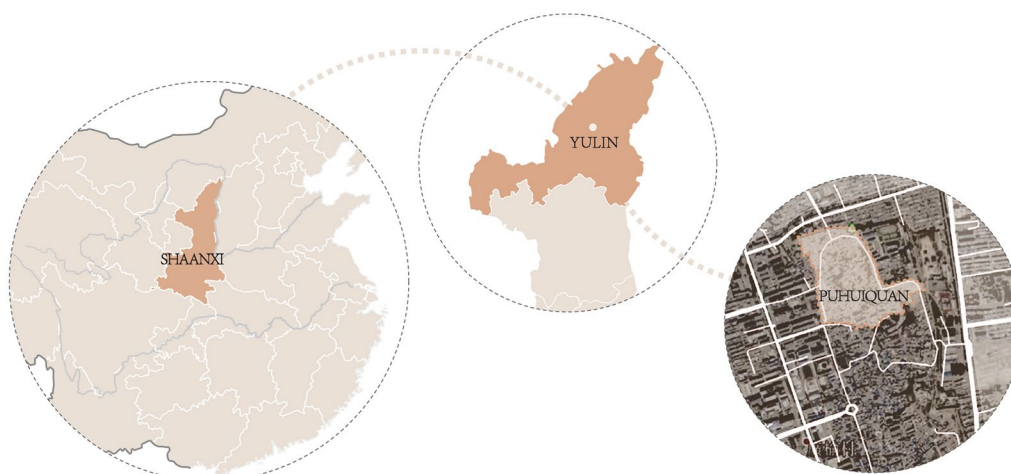
### Study area

#### Neighborhood history and heritage information

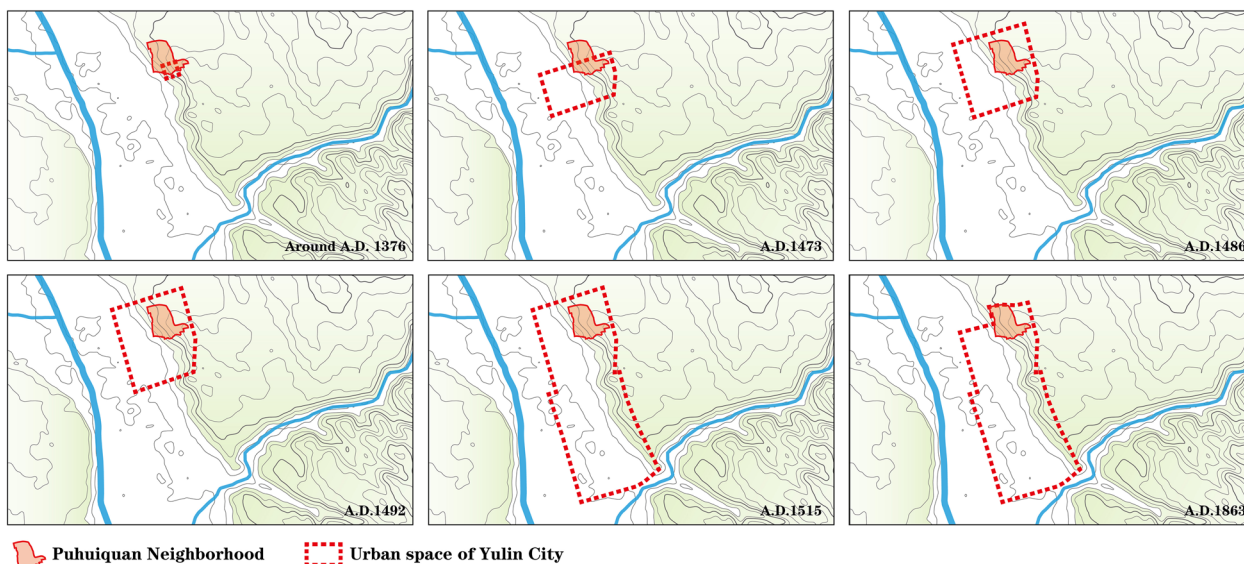
Yulin City is located at the junction of the Loess Plateau and the Maowusu Desert, in the northern part of Shaanxi Province (Fig. 2). It was founded in 1437 as a crucial military city along the Great Wall of the Ming Dynasty [56]. In 1986, it was listed as a National historical and cultural city in China. Puhuiquan neighborhood is located in the northernmost part of ancient Yulin City, adjacent to the city wall to the north and Guangyu Gate to the west, covering an area of approximately 10.7 hectares. The founding location of the historic city of Yulin (Fig. 3), the topography of Puhuiquan is complex and higher than the southern part of the city, with an internal elevation difference of up to 30 m. Taking advantage of the steeply sloped terrain and the loess soil, a unique vernacular of



**Fig. 1** Methodological framework



**Fig. 2** Location of Puhuiquan Neighborhood



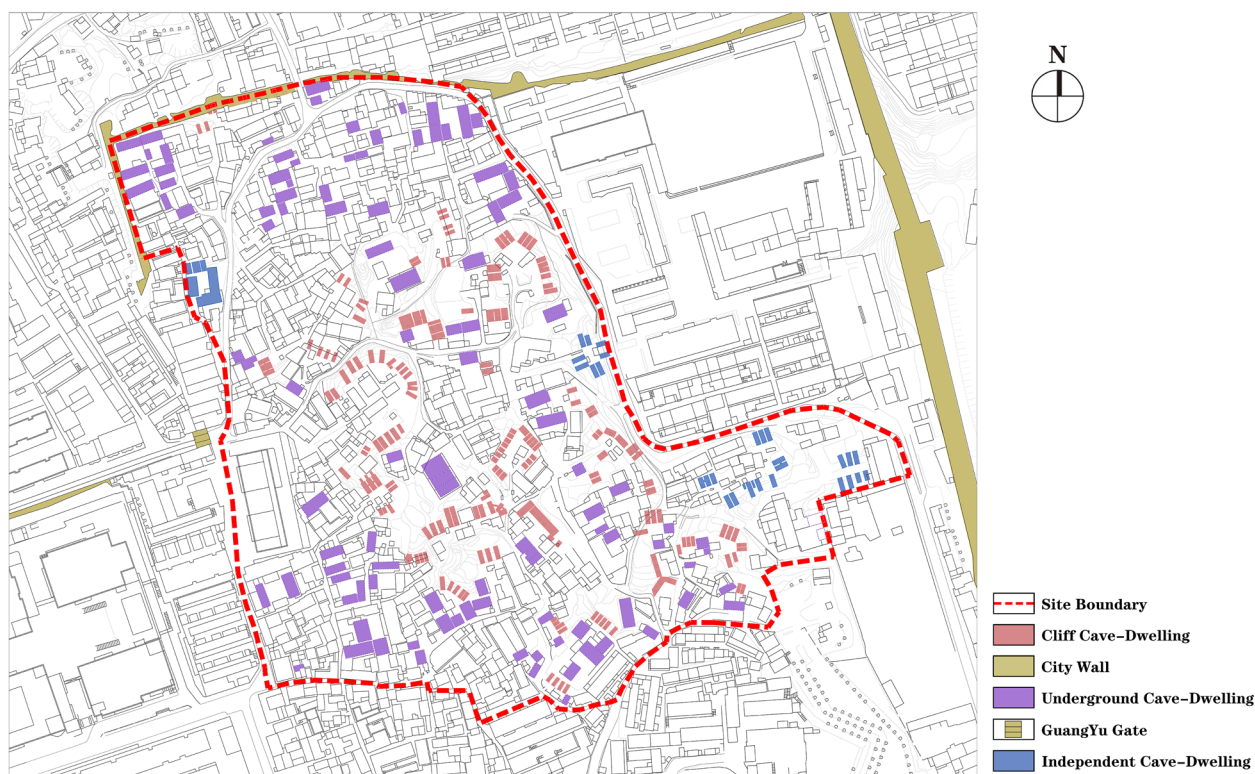
**Fig. 3** Development of Yulin City and location of Puhuiquan historic neighborhood

several types of cave dwellings emerged inside the city wall.

- 1) Tangible Culture: City wall and Cave courtyard
- 2) Ancient city wall of Yulin

The ancient city of Yulin was located to take advantage of the natural features of the site for defensive purposes. Protected by rivers on the west and south, the city nestled up against a natural ridge line on the east. Starting in 1486, a rammed earth wall covered with bricks and

stones was built on top of this ridge line to a height of ten to twelve meters to further protect the eastern side of the city. The west and north side walls were built in 1863 to address the overrun of sand from the Maowusu Desert of northern Yulin City (Fig. 3). The Puhuiquan area was surrounded by the ancient city wall, on the upslope to the walls on the west. The Guangyu Gate, the north gate of Yulin City, has been standing on the west side of Puhuiquan for around 160 years as the primary access point into the area. The city wall, still somewhat intact on the north and east of the historic area, is instrumental in giving definition to the historic area.



**Fig. 4** Development of Yulin City and location of Puhuiquan historic neighborhood

- Cave Courtyard

Cave-dwelling typology was a practical response to the terrain, topography, climate, environment, and other conditions of the Loess Plateau region in China. Its existence is an excellent example of how one can establish harmony between human settlement and nature [57]. Due to the characteristic warmth in winter and coolness in summer inside the cave house, it is a popular traditional living form among residents. The records of cave-dwelling in Puhuiquan can be traced back to the Chenghua period (1465–1487) of the Ming Dynasty. There is a street in the southern part of the neighborhood called Yaoqu, named after residents digging caves to live in [58]. The existing cave courtyards in the neighborhood are mostly composed of cliff caves and independent caves. There are still a few underground cave courtyards (Fig. 4). The building quality of most cave dwellings is good with minimal safety issues, but the original facades have in most cases been lost.

Cliff caves, underground caves, and independent caves are the three main types of cave dwellings in the Loess Plateau. Cliff caves are built on the edge of a mountain slope or plateau gully, arranged along contour lines, conforming to the mountain terrain and dug inward [59].

There are a total of 175 cliff cave-dwellings in Puhuiquan, forming a distinctive wrap-around structure based on the terrain (Fig. 5a). Underground cave-dwellings are square courtyards dug vertically downwards on a flat area of the loess plateau. The cave houses are then carved into the vertical faces of the courtyard [59]. There are 4 underground cave-dwelling courtyards in Puhuiquan, with a total of 33 cave houses (Fig. 5b). Independent caves are brick or stone buildings using cave arch forms and filled with loess [59]. The independent cave-dwellings in Puhuiquan are all made of brick. There are over 110 of this cave house type (Fig. 5c). Among them, there is a 2-story building built about a century ago, using a special form of the cave arch downstairs and the Chinese classical beam-column structure upstairs (Fig. 5d).

## 2) Intangible Culture: Customs and Rituals

In ancient times, Yulin was in the fusion zone of farming and nomadic culture, creating a rich intangible cultural heritage. The characteristic folk customs in Yulin include Zhuanjiuqu (转九曲), Yulin Yangko (榆林秧歌), Yulin Shuoshu (榆林说书), Yulin Xiaoqu (榆林小曲), Yulin Jianzhi (榆林剪纸), etc. Zhuanjiuqu, which translates to turn-nine-tune, is a maze of lanterns



**Fig. 5** Cave-dwellings in Puhuiquan Neighborhood: **a** Wraparound cliff cave-dwelling; **b** Underground cave-dwelling courtyard; **c** Independent cave-dwelling; **d** Special independent cave-dwelling with the cave arch downstairs and the Chinese classical beam-column structure upstairs

arranged to symbolize the mother river of the Chinese nation, the Yellow River, in which people walk to eliminate disasters and pray for blessings. Yulin Yangko is a kind of regional traditional dance performance art with a bold style and a cheerful mood. Yulin Shuoshu is a kind of easy-to-understand story-telling form with melody. Yulin Xiaoqu is a form of singing accompanied by musical instruments that combines the musical styles of northern and southern China. Yulin Jianzhi is more common; every family cuts and pastes colorful paper with an auspicious meaning for the pattern decoration house.

Yulin also has a unique folk and food culture that has distinctive regional features. Yulin's diet is diverse and inclusive, and the locals like to eat millet, mung beans, soybeans, and others from farming, as well as goat meat from grazing. The locals ate "Twelve Dishes" (十二件) in the banquets in ancient times, which were a collection of diverse meals by combining the variety of foods both from farming and grazing. The local community also has a robust drinking culture connected to the rhythm of "Yulin Jiuqu" (榆林酒曲). This kind of wine song contains

sitting, pouring wine, toasting, drink-urging, and other ritual customs.

In addition, because the Yulin area was one of the areas of fierce competition between farming and nomad nations before the seventeenth century, there are many border fortress poems and war stories, which are still the enduring themes of artistic performances, such as stories about the family of General Yang are still popular in Yulin Shuoshu nowadays.

#### **Current issues of Puhuiquan neighbourhood**

##### 1) Shrinkage of neighborhood population

At the end of the twentieth century, as the urban center of Yulin shifted towards more open and flat areas to the west and south, Puhuiquan historic neighborhood gradually declined. With the completion of the Dongsha and Qinhe districts since 2010, the population of the ancient city and the Puhuiquan neighborhood has declined [23]. This external catalyst of urban shrinkage in the area is making the position of Puhuiquan even more difficult. The disinvestment in and outmigration of population

from the area are important challenges caused by this planning strategy for the city.

The household survey done in 2019 shows that there were about 450 households in Puhuiquan, with a registered resident population of more than 1300 people. With the significant outflow of the population in the past 5 years, nearly 40% of houses have been vacant, and the current number of living households is about half of the original number. There are currently less than 700 permanent residents here, with approximately 63% of the population over 60 and under 18. The majority of young and middle-aged people are migrant workers in surrounding areas. This outmigration of population takes with it many of the practitioners of traditional culture. Their replacement with migrant workers represents both a cultural and economic decline.

## 2) Deterioration of neighborhood space

In the field investigation, the authors found with the population contraction, the neighborhood space gradually deteriorated in Puhuiquan. The physical environment faces severe problems. The current circulation system is inadequate to meet the needs of the community. The condition of the existing building stock is declining through abandonment and a lack of investment in their maintenance. Green space in the area is limited and fails to offer adequate recreational support facilities. Add to these deficiencies, a general lack of public facilities, and it is easy to understand why the neighborhood is in decline and suffering from urban shrinkage. The outmigration of its population further impacts the local economy of the area, which now lacks employment opportunities for residents. The results of a household survey of 143 residents have confirmed these negative influences also reflect the opinions of neighborhood residents. A summary of this survey indicates the following:

- There is no traffic organization plan in Puhuiquan, where only a U-shaped road with a width of about 4-5 m can accommodate one-way traffic. The average width of other spontaneously formed roads is about 1.5 m, the narrowest point can only be passed by one person. Roads generally have large slopes, low identification, poor directional guidance, and serious fire hazards.
- The buildings in the neighborhood beyond the cave dwellings are mainly one-story, with a high building density. Most buildings were built in the 1990s and early twenty-first century, have poor quality and lack sunlight.

- There are no public facilities in the neighborhood except for a kindergarten in the south and a small shop in the middle.
- The green space is seriously lacking, and the existing vegetation is mostly shrubs that grow wild on steep slopes. There is also no public activity space for residents in Puhuiquan.
- There are disorderly structures and sundries accumulated in courtyards, with poor sanitation. As the number of vacant houses increases, the environment becomes even more depressed.
- Most cave-dwellings don't have drainage or natural gas, and still use dry toilets.

## 3) Decline of neighborhood culture

The history of Puhuiquan can be traced back to the beginning of Yulin City, about 550 years ago. The small mountain inside it is called Zhonglou Hill, named after the bell tower built on its top in 1475. Although this bell tower was destroyed in 1824 [58], the main road in the neighborhood is still called Zhonglou Hill Street. The construction history of the cave-dwelling here dates back to the mid-term of the fifteenth century.

In more recent history, Yulin's urban development has been focused on new districts. The Puhuiquan historic neighborhood, as a result, has become a neglected place in the development of the city. As the decline of the neighborhood continues, cultural information is rapidly disappearing with the relocation of indigenous residents. The perceived value of this cultural legacy is also an outcome of the decline of the area. Interviews with 106 indigenous residents indicate, 76% of them agree that history and regional culture are the most significant values in the community, but almost no one believes that living in Puhuiquan is something to be proud of. The interviews have indicated their memories of community culture mainly focus on:

- There was a bell tower site on the top of Zhonglou Hill, which can overlook the northern city with an excellent view.
- The number of cave dwellings here is the largest inside Yulin City. The elderly are accustomed to living in caves that are warm in winter and cool in summer. They prefer to sleep on the heated brick bed in winter and do not want to move out.
- Guangyu Gate and the ancient City Wall were once popular playing places for pupils, especially boys.
- Puhuiquan Spring was once the most important drinking water source in Yulin City. It is the source of water for making the local specialty, Yulin tofu.



These unique cultural resources present opportunities for future revival efforts in the neighborhood. At present, these have not been fully valued, effectively integrated, and activated, threatening their survival in the future revival of the area.

**Design research results**

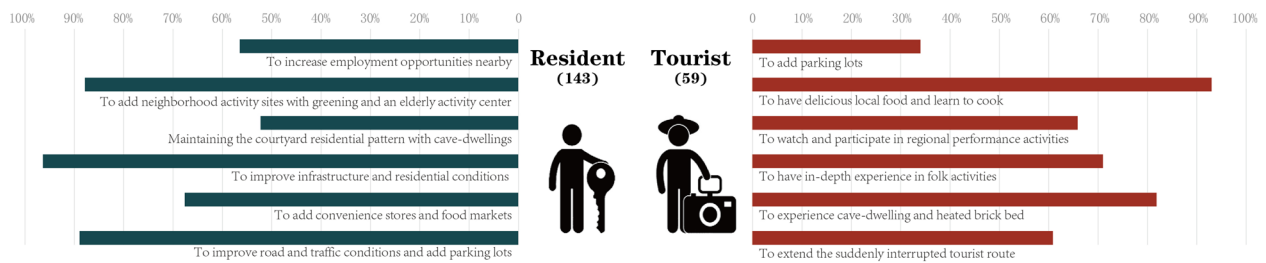
**Space renovation**

*Clarity of neighborhood position*

The historical fabric of the southern portion of ancient Yulin City is relatively intact, and it is an important tourist attraction in northern Shaanxi. The folk tourism and



**Fig. 6** Main tour route of ancient Yulin City



**Fig. 7** Investigation of resident and tourist needs

cultural activities of the Northern Shaanxi's New Year Folk Event held in 2019 attracted 2.42 million tourists. The main tour route of the ancient city enters from the south gate and travels north along the central pedestrian street. The Puhuiquan historic neighborhood is just off the north end of the route (Fig. 6). Despite the Puhuiquan neighborhood's proximity to this route, it fails to attract tourists to the area because of its many deficiencies. Site research indicates there is no clear route into and through the area, and there is a general lack of venues that would be of interest to tourists (Fig. 7). This lack of connection, while viewed as a deficiency, could be turned into a strength through the pursuit of the cave house cultural assets located in Puhuiquan. Following the 'smart shrinkage' approach, the study proposes the creation of a special historic and cultural neighborhood with 'owner-occupied + cave dwelling homestay + cultural experience'. Pursuing the idea of creating an authentic and immersive cultural experience, it could create a connection with the busy tourist area to the south, and allow them to be connected by separate at the same time. This approach, providing direct access to the characteristic cave dwellings, could additionally expose tourists to the genuine folk culture of the area through the development of venues that facilitate this experience. This approach, embedded in and supportive of the local community, would make a significant and unique addition to the tourists' experience already occurring in the southern portion of the ancient city.

#### **Reorganization of neighborhood function**

According to the cultural resources and topography of Puhuiquan, it can be divided into three functional areas. The southwest area near the central pedestrian street and Guangyu Gate of the ancient city, with relatively convenient transportation and large-scale wrap-around cave-dwelling groups, is set as the tourist cultural experience area. The southeast area with many cave-dwellings is designated as the homestay area. The northern area, which is far from the main tourist routes and relatively quiet, is designed as a residential area. In addition, public service facilities such as a tourist service center, a performing arts center, an elderly service center combined with day care, a kindergarten, and neighborhood commerce will be added to the corresponding functional zoning (Fig. 8). It is important, while leveraging the economic potential brought by the overlay of a tourism economy, that local residents are still able to live ordinary lives with important support infrastructure necessary to have a good quality of life. Sustainability comes with an appropriate balance between economic and social interventions in the neighborhood.

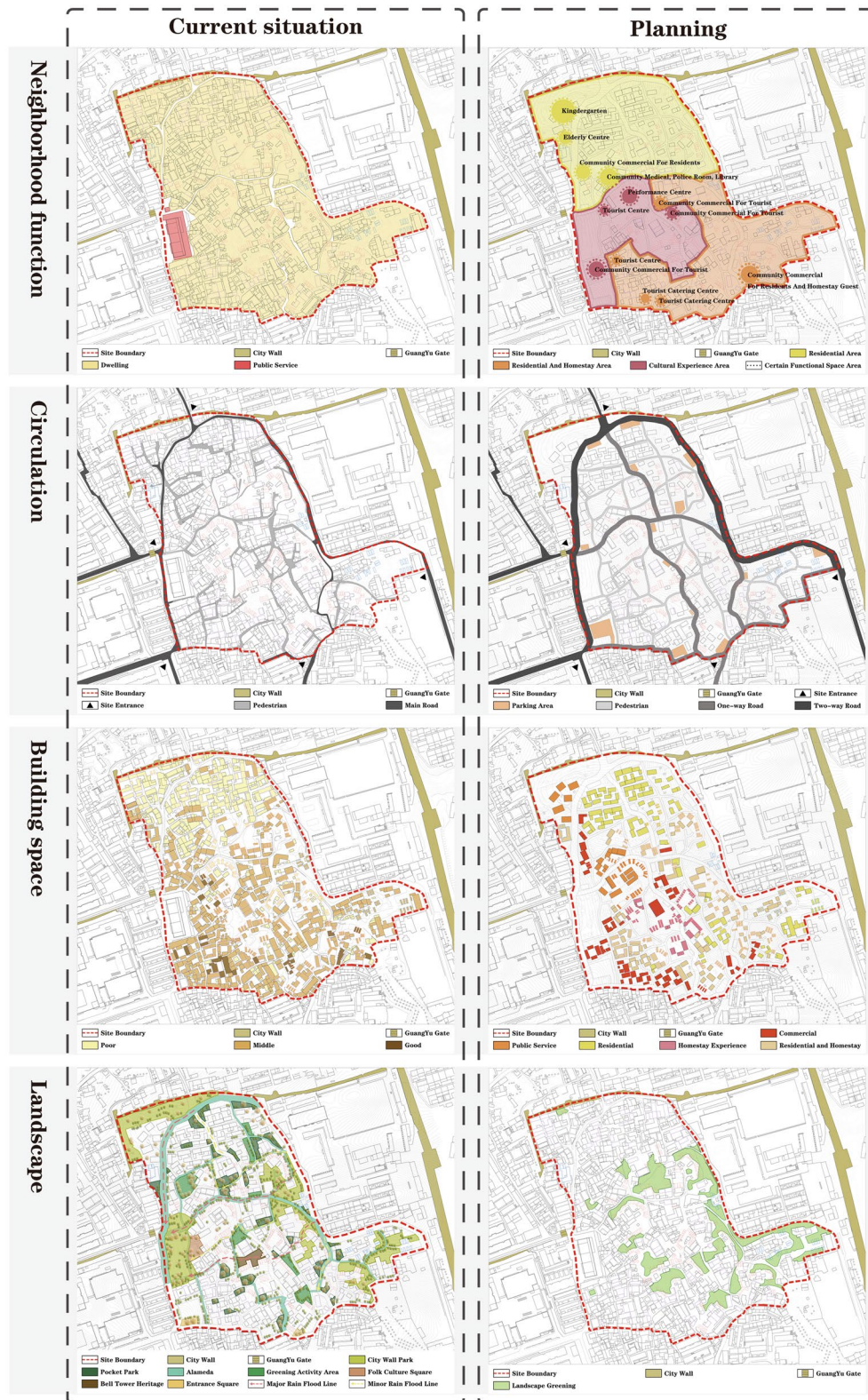
#### **Reconstruction of circulation**

The issue of connectivity and circulation is both a functional and a cultural-environmental question. Reasonable access needs to be improved, but not at the expense of scale of the pedestrian experience in the historic neighborhood. In order to address this issue of poor road connectivity, a nuanced circulation system was developed that provided a mixed-traffic approach accommodating both vehicles and pedestrians in Puhuiquan. To achieve this goal, the neighborhood road traffic system was reconstructed, expanding in some places, improving in others, and adding where better connections were required. The negotiation of the steep terrain and the need for parking were also significant influences on the design of the evolved circulation system.

The system design began with the definition of entry points, according to the surrounding roads and function distribution. The main circulation entrances in the Puhuiquan neighborhood included both vehicle and pedestrian entrances. Selected existing roads in the neighborhood were improved upon to form a ring road, and the wider Zhonglou Hill Lane was extended into a two-way road to meet the requirements of vehicle traffic and fire safety. Combined with the existing internal roads, two one-way crossing car roads were established. Then, the parking lots are distributed according to the main roads and the living and tourism areas. Finally, based on the topography, functions, and existing roads of Puhuiquan, a convenient route with a gentle slope is selected to set up the main pedestrian roads (Fig. 8). The improvement of circulation in the area is an acknowledgement of the changing needs of the contemporary world. However, it should not be a defining force in the cultural landscape of this historic area. The new nuanced circulation system is proposed to find the right balance between function and the preservation of the atmosphere and scale of the heritage environment. It seeks to sustain the heritage environment while at the same time adapting it to the contemporary condition.

#### **Optimization of architectural space**

A condition evaluation of the existing built environment in the Puhuiquan area has revealed a complicated assessment. Beyond the significant collection of cave houses, there is an inconsistent inventory of buildings, many constructed by residents, possessing serious safety hazards and quality deficiencies. This loosely coordinated settlement pattern lacks the infrastructure and living conditions expected to meet the needs of modern life. The situation will require significant investment and a multifaceted renewal program combining preservation, demolition, adaptive reuse, and new construction to



**Fig. 8** The comparison of the current situation and planning

improve the architectural space of the Puhuiquan historic neighborhood.

The first effort must involve the retention of the important existing heritage environment. Most important among this inventory are the cliff, underground, and independent caves. This will involve an evaluative process to determine those that are the most significant and present the greatest potential for future use. In conjunction with this initial effort will be the removal of buildings that compromise or negatively impact the potential of the cave house inventory. This could include those that block the cave-dwellings lighting, buildings of substandard construction, negatively impact circulation, or are of a scale that compromises the environment of the heritage urban landscape. Following this evaluation, stabilization and editing processes, programing and restoration efforts, working with existing residents, should be pursued to integrate the large wrap-around and other cave houses into an overall smart shrinkage renewal strategy. Finally, making strategic use of the demolished land, the renewal efforts should respond to functional needs and the topography adding buildings, that retain the form and volume characteristics of the existing independent cave and slope roof buildings. In the northern part of Puhuiquan, replacing the demolished, poorly constructed building stock, new construction will focus on

residential buildings and neighborhood service facilities. In the southern part, more focus is on tourism, new tourist facilities and courtyard reconstruction to facilitate cultural experiences, and adaptive reuse of cave-dwelling functions (Figs. 8 and 9).

**Improvement of landscape**

The landscape is an integral part of the unique cultural landscape of the Puhuiquan neighborhood. The symbiotic relationship between the land and the architecture requires both to be given equal attention. The current environment with an abundance of poor-quality infill construction, is generally lacking in green space. The landscape response requires a balance between the celebration of the native landscape and the provision of traditional park landscapes. The steep topography of the site requires the landscape to contribute to the stability of the site and assist in the management of storm water moving through the site. The quality of the public environment in the neighborhood is important to the revival and return of population to the neighborhood.

By combining green space with important civic and tourist spaces, the atmosphere and walkability of the neighborhood are enhanced. Entry points into the area have been greened to create a positive first impression. Green spaces along the historic city wall and at the



**Fig. 9** General layout of Puhuiquan Neighborhood

Bell Tower site, allow these important parts of the historic cultural landscape to be appreciated. Strategically located green spaces in the residential areas, associated with community service facilities, and tourist gathering points, facilitate the building of community spirit and the presentation of folk culture. A pedestrian walkway system based on the natural terrain of the mountain slopes was also developed to enjoy the native landscape within Puhuiquan area. Other green spaces are also proposed to be integrated in courtyards and cave house wraparound clusters. Collectively, the landscape is intended to be an integral and consistent participant in the overall environment of the heritage environment (Fig. 9).

An important part of creating a sustainable urban environment involves fostering a positive connection between nature and human settlement. The historic connection between the cave houses and the land is an important expression of this relationship. The restoration of the native landscape above the cave houses allows visitors to experience this relationship. The addition of new park spaces, including venues for the presentation of folk culture, facilitates the connection between intangible culture and nature. The construction of a positive environmental relationship between the heritage cultural landscape and the natural environment is an important path toward sustainability.

## Cultural revitalization

### *Integration of heritage resources*

The historic origins of the Puhuiquan neighborhood, make focusing on the preservation of tangible and intangible heritage an appropriate effort in the regeneration of this area. This effort will also benefit the city of Yulin through the affirmation of the long history of the city and the cultural traditions originated in this place. History and culture are the aspects of human civilization that lend credibility and gravitas to a community. The revitalization of the Puhuiquan neighborhood will build on the successes of the southern parts of the old city and enhance the city's collective image.

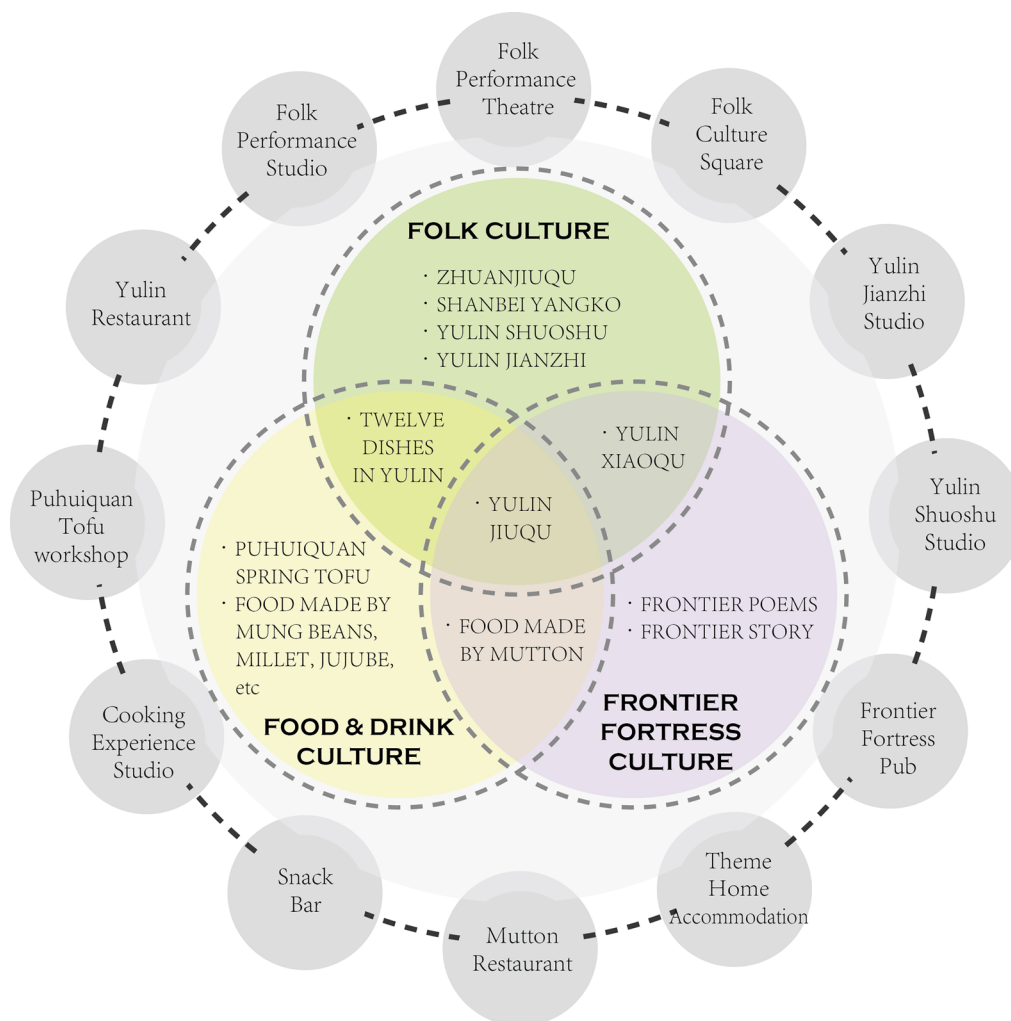
The development of an improvement strategy for the area's cultural resources will provide a plan to enhance the area's physical environment, promoting further investment by residents and others. Given the authenticity and uniqueness of the neighborhoods cultural assets, it is likely they may be the main engine for the renewal effort [60]. As mentioned earlier, the Puhuiquan historic neighborhood, is the birthplace of Yulin City, possessing a rich material and intangible cultural heritage. In addition to its collection of various types of cave-dwellings on the Loess Plateau of China in its 10-hectare area, it is the home to important intangible culture for the area. This

intangible culture includes unique folk customs, dietary culture, and frontier fortress culture. The preservation of this culture is threatened both by population outmigration, and the lack of venues to share these both within the area and with an external audience. Therefore, exploring ways this culture can be active and on display is an important part of design research. The renewal strategy for the neighborhood therefore included ways to organically achieve a diversified "Culture + Experience + Living" composite. This method integrates the unique composite experience, adding depth to the presentation of regional culture while at the same time building pride in the heritage of the residents of the area (Fig. 10). By establishing inheritance paths and venue opportunities for regional intangible cultural heritage, its preservation will continue providing high-quality display windows for residents and tourists alike.

### *Creation of cultural scenes*

The presentation of intangible culture is most poignantly displayed when it is connected to the environment that brought it into the world. Through the creation of appropriate presentation scenes with regional characteristics and integrated with neighborhood cultural resources, tourists could receive a more immersive experience that embodies the local culture. The cultural elements of Puhuiquan need to be carefully selected to create these venues. The wrap-around cave-dwellings, Guangyu Gate, ancient city wall, and Bell Tower site were selected for these reasons. Through the inclusion of these tangible heritage memory cues, the participants enter into the local life and stories of the area. For example, the largest wrap-around cave-dwelling group in the center of the neighborhood will be integrated and renovated as a place to showcase regional culture and customs. The existing caves could be used for the exhibition of regional culture, and a folk performance center will be designed in the courtyard to form an important spatial node and a social venue in Puhuiquan (Fig. 11).

The cave-dwellings are the most distinctive architectural heritage in the Puhuiquan historic neighborhood. For those tourists seeking a deeper peek into the lives of local people, the development of an organized homestay opportunity could add this experience to their visit. This will require both the creation of human infrastructure to facilitate and host tourists, and improvements in the infrastructure to accommodate visitors and support host residents. Residents with particular skills in regional food preparation, and folk art skills like Yulin paper-cutting, will need to be recruited and supported in the overall effort (Fig. 12).



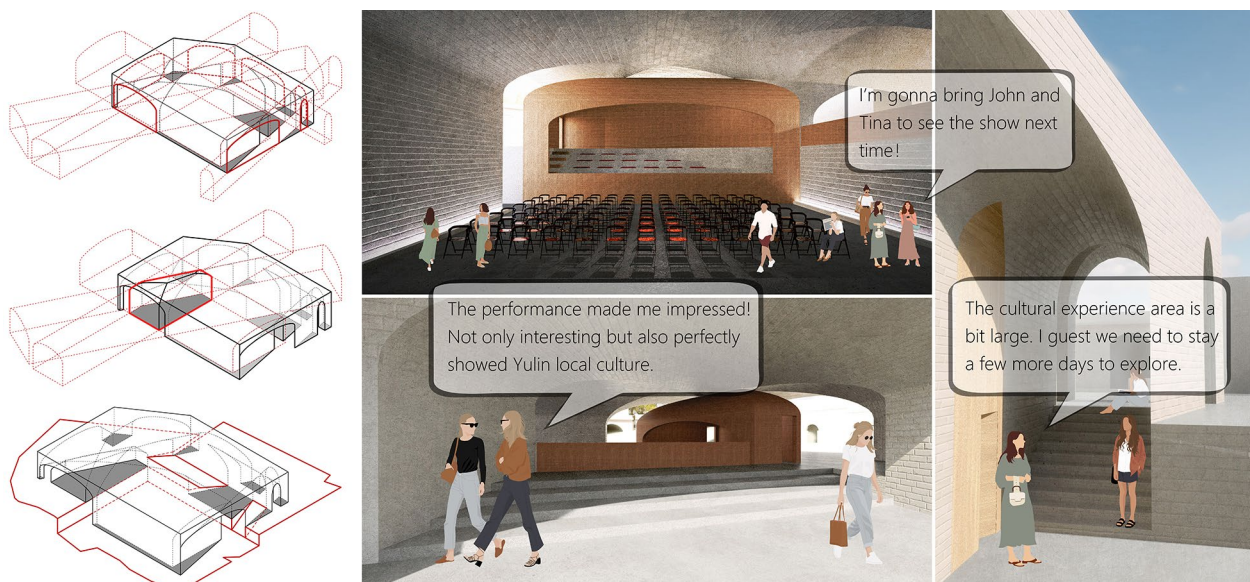
**Fig. 10** Main intangible cultural heritage of Yulin and experience methods in Puhuiquan

### **Activation of community engagement**

The neighborhood shrinkage is not only a question of population contraction, but also one that involves social, economic, and architectural issues, affecting the lives of residents. Strengthening public participation through direct engagement and activating community initiatives to build social capital, are considerable means to address the shrinkage [61]. The initial investigation of this design research involved a community outreach effort to develop the initial planning strategies. In future planning and construction efforts for the Puhuiquan historic neighborhood, ongoing attention should be paid to the participation of the residents. Residents are the group with the deepest understanding of issues in Puhuiquan. The extensive solicitation of residents' insights and desires, was collected and summarized to inform the design research. This had a direct and important impact on planning. The acknowledgement of this feedback in the

design reinforces buy in from the residents. An important part of achieving a sustainable and positive momentum amongst the residents is to empower them to be the main actors in improving neighborhood culture and the smart shrinkage solutions crucial to stemming the outmigration from the area. Integrating and empowering the community and the revitalization of cultural functions could have the impact of providing more employment and participation opportunities for residents.

With the development of a positive momentum in the community, the natural next step to making it sustainable is the residents participation in management and operation in the form of autonomous committees. The creation of this human community infrastructure provides even more opportunities for individual residents to participate in neighborhood development. For example, the operation of homestay cave house network could establish a special organization set up to develop marketing



**Fig. 11** Scene of the Performance Center



**Fig. 12** Scene of cave-dwelling homestays

strategies, unify service standards, maintain customer relations, etc. Profits from this activity, in addition to providing an income stream for residents, could be set aside to assist in quality maintenance of the neighborhood and expansion in subsequent development.

### Discussion

The Puhuiquan neighborhood inside the ancient fortified city of Yulin is facing the problem of urban shrinkage. Having lost a significant amount of its population to newer areas in the developing city of Yulin, the problems associated with urban shrinkage are contributing to the economic and cultural decline in the area. Despite its proximity to the successful southern part of the old city and its many potential heritage assets, Puhuiquan has been unable to find a positive path for the area.

Our research suggests that the sustainable development of neighborhoods should be understood from both physical and cultural perspectives. The physical foundation of space is the most tangible manifestation

of the neighborhood view. Space can also be considered a physical form of neighborhood culture and an urban environmental atmosphere [62]. Therefore, we believe that the sustainable development of the Puhuiquan historic neighborhood should first solve the problem of the current space and the needs of different people. Improving the quality of human life, protecting the architectural heritage, improving public service facilities, and promoting traffic accessibility. The connection to and relationship of local life and cultural activities to the economics and impact of tourism will also be a central initiative in the revitalization process. To facilitate this partnership, cultural heritage integration, cultural scene creation, and community participation activation should be carried out to revitalize the neighborhood's cultural environment, enhance residents' cultural confidence, and revitalize local resources. This done creatively through smart shrinkage partnerships with local people can provide more employment opportunities, improve life and tourism experiences based on the characteristics of the Puhuiquan historic neighborhood.

To achieve the broad goals described above, it requires the development of specific objectives that will establish the framework and metrics for a successful plan. The first part, the inventory of existing conditions to establish an understanding of what we have to work with, the interaction with residents to inform design program initiatives, and the development of a conceptual design, has been completed. The next steps require the formation of collaboration groups to give clear direction and timelines for a coordinated investment of resources and human capital. These groups should include residents, government agencies, development partners and the design team in a facilitation and representation role. The groups should focus on the critical themes central to the revitalization of the Puhuiquan neighborhood. Preservation and reuse, cultural assets and promotion, economic development, and environmental sustainability are important monitoring points for neighborhood revitalization. These efforts include the improvement of overall environment, retention and recruitment of residents, nurturing and promotion of local culture, and the development of a sustainable environmental and economic model for the area. The identification of the nature and scope of these committees should be the next step.

The process must involve all the stakeholders and have a tone that is neither top-down nor bottom-up, but rather springs from the middle ground established through this dialogue. Key objectives or metrics for this effort should include the following:

- Identification of governmental agencies with expertise, resources for infrastructure investment and enforcement power to support approved initiatives.
- Identification of residents with connections, vested interests, and special knowledge to serve on the committees.
- Identification of economic stakeholders in tourism promotion and programing, coalition partnerships for internal development and potential investment partners

The specific metrics for overseeing the revitalization process should be the initial charge of each committee. At the very least they should include the following:

- Securing of both tangible and intangible cultural assets for support and development (cave houses, city wall, loess soil landscape, folk culture performers and other assets).

- Implementation of critical site infrastructure (circulation, community gathering space, green space reserves).
- Development of important community support facilities (civic, cultural, educational, social services).
- Establishment of tourism support infrastructure and economic development partnerships (investment partners, cave house collectives, tourist venues for visitors and residents, information and support facilities).

These suggestions serve only as a starting point for the revitalization effort. The more specific goals and objectives should be developed through a facilitation process based on informed understanding and collective agreement.

### Conclusion

The problem of recent urban shrinkage in Europe and the United States is a result among other things of economic and redistribution of production models. China is entering a new phase of urbanism after its period of rapid expansion and population migration into its cities. Its cities, as demographics and migration policies have evolved, are facing their own urban shrinkage problems of a different kind. Slowed growth in small and medium sized cities is causing internal population shifts that impact different areas of cities. Heritage areas that have been neglected or damaged during the rapid development of the past couple decades, are particularly vulnerable to this problem. The team believes evolved planning strategies involving both 'smart shrinkage' and 'urban renewal' approaches need to be employed to mitigate the problems created by urban shrinkage, particularly in heritage areas, to develop a sustainable future for these parts of cities. The intent of 'smart shrinkage' is to adapt the evolving, changed urban situation, to a new positive reality. The 'urban renewal' strategy focused on the adaptive reuse of the heritage environment and the addition of supportive infrastructure necessary to support the new initiative. The development of the strategic plan involved an inventory of the existing circumstances of the area and a survey of existing residents to understand the strengths, weaknesses, opportunities and needs of the area.

Originally a military outpost, the planning for the 500-year-old city of Yulin was done to maximize its strategic location, taking advantage of the natural features of its location. The partnership between the natural features and human intervention in the development of this military city led to its early success as a critical part of the support for the Great Wall. These lessons of strategic thinking may give clues to how the Puhuiquan



neighborhood can find the path to a successful future. Facing the area's harsh climate and the opportunities the loess soil provided, cave-dwellings were a part of this early success. Poorly constructed simple houses spontaneously built by residents in more recent history, have obscured and damaged the cultural identity of the area. Many of these poor-quality buildings will be abandoned and demolished. This presents an opportunity to restore the original urban cultural landscape characteristics of the area. The design research team explored the possibility that these tangible heritage assets along with other intangible cultural assets, could be the catalyst for the renewal of the area in the face of its urban shrinkage challenge. In collaboration with the residents of the Puhuiquan historic neighborhood, the team explored the prospect of pursuing both a 'smart shrinkage' and an 'urban renewal' strategy. This article indicates that, to be successful, sustainable solutions in heritage areas require the participation of local residents and the integration of both tangible and intangible assets. This complex integration of the physical and cultural environment will yield the most grounded and legitimate urban heritage development that will allow the urban memory of a city to linger on into the future.

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#### Author contributions

Conceptualization, investigation, validation, visualization and writing—original draft preparation, YZ and SC; methodology, supervision and writing—review and editing, MH and YZ; data curation, SC; project administration, YZ; funding acquisition, MH All authors have read and agreed to the published version of the manuscript.

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#### Data availability

All data and materials are available from the authors.

#### Declarations

#### Competing interests

The authors declare no competing interests.

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