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Cultural Landscape Reshaping Path with Rural Revitalization as the Background

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ABSTRACT: Rural revitalization, against the political background of traditional cultural renaissance, was put forward as a national strategy. The countryside is not only a mode of residence but also a way of life. In order to explore its revitalization path and realize the vision of common prosperity, the practice of Jingmei Village in Dongkeng Town, Dongguan City, used multifunctional cultural landscape as a medium of reform from multiple aspects such as compiling a planning blueprint, sorting out the regional cultural context, creating a batch of rural landscape features, improving public infrastructure, reviving agriculture and combining it with tourism, eventually presenting the image after governance. A people-centered pathway to rural revitalization that respects and protects the natural and ecological environment, improves people's quality of life, quality of survival, happiness and sense of gain is explored.

KEY WORDS: rural revitalization; cultural landscape; Jingmei Village Dongguan City; landscape reshaping

Introduction

In recent years, the central government has repeatedly proposed the rural revitalization strategy, placing the revival of traditional culture in a very important position. General Secretary Xi Jinping pointed out: "The construction of new rural areas must follow the path that conforms to rural realities, follow the laws of rural development, fully reflect rural characteristics, pay attention to the local flavor, preserve the rural landscape, keep the green mountains and clear waters, and remember the nostalgia for the countryside" [1]. The revival of local traditional culture is the root and soul of rural revitalization, and it is also a precious resource for the development of rural industries. The central government pointed out that rural revitalization is based on the comprehensive development and revitalization of rural collective economy, not simply the revitalization of rural GDP, nor is it a replica of urbanization. Rural revitalization is inseparable from rural governance, and governance is the endogenous driving force of rural revitalization. Rural revitalization is also inseparable from the construction of the ecological environment, which is an important measure to implement General Secretary Xi Jinping's "Lucid waters and lush mountains are invaluable assets" [2].

To explore rural revitalization, we first need toundertake a philosophical thinking on the concept of "the rural": being rural is not only a mode of residence but also a way of life. The purpose is to achieve common prosperity between urban and rural areas, break the urban-rural binary structure, and promote the integration of urban and rural development[3]. Although our country's urbanization has been advancing rapidly in the past 40 years, there will

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still be 400 to 500 million people living in rural areas for quite some time in the future. From this perspective, rural revitalization cannot be overemphasized. The philosophical thinking on the relationship between cities and rural areas is reflected in the attitude towards rural areas. Whether small towns and villages are included in the strategic planning of national space and regarded as an organic part of urbanization reflects the society's attitude and basic understanding of rural areas. The development of large cities and rural construction are not only non-contradictory but also complementary. Both the mature experience of developed countries and the development path of our country since reform and opening-up show that cities have been developing and expanding, with a very high population density and a growing proportion, but rural areas will not disappear and must be revitalized and become more and more beautiful. Urbanization does not exclude the modernization and revitalization of rural areas[4].

Rural revitalization and rural historical and cultural protection both have strong community governance characteristics. Under the guidance of central policies, they rely on grassroots organizations and villagers as the implementation subjects and adopt a model of co-construction, co-governance and sharing with social participation[5]. Whether it is a top-down or bottom-up practice, the government needs to organize villagers, experts, the society, and enterprises to participate together, so as to comprehensively improve the professionalism of environmental governance, engineering construction, protection and revitalization, historical and cultural display, etc. It is necessary to explore and gradually sort out the practical path of rural revitalization and summarize and establish a set of characteristic incentive mechanisms to promote the joint participation of all parties in the activities. In the process of promoting rural revitalization, our team took Jingmei Village in Dongguan City as an example. The city, town, and village jointly raised 30 million yuan to carry out the development based on the "Ten Ones" project of beautiful villages in Dongguan City, Guangdong Province[1)] and made it the first batch of exemplary villages. The focus was on shaping and improving the landscape, creating an exemplary village that is livable and tourist-friendly, and exploring the practical path of rural revitalization.

1 Compiling the landscape planning blueprint

Preparing a landscape planning blueprint is necessary for sustainable land space planning and design, and for the construction of a livable environment. We should learn from the experience and lessons of the protection of historical and culturalcities and prevent "constructive destruction" or "conservative destruction" of rural areas[6]. We should make good use of "embroidery skills" to prevent large-scale demolition and construction.

1.1 Planning should avoid development-oriented path dependence

The experience of new district development since the reform and opening-up, especially the development model targeting real estate, has affected the historical and cultural heritage in urban and rural renewal, and to a certain extent has led to the annihilation of regional characteristics, which not only wastes resources but also reduces the sense of belonging of indigenous peoples. Driven by the interests of development, development and construction that digress from the original intention have resulted in a rural landscape that is monotonous, featureless, and without personality. The "one-step" mentality in some places has led to "destructive construction and constructive destruction." For the regeneration of traditional villages, how can we "creatively transform and innovatively develop" in practice[7]? The large-scale demolition and reconstruction model has been proven to be infeasible in rural areas. We should adhere to "micro-renovation" in the built environment, not aiming to obtain quick and high returns, and ensure the harmonious unity of building height, volume, style, color and the genes of the original historical environment. Landscape planning should be based on protection, development, and improvement of the living environment and people's quality of life[8]. In addition to historical heritage, the protection of regional culture and the creation of a meaningful environment, including sculpture, painting, scene design and other practices, should be done with "embroidery skills." In October 2018, General Secretary Xi Jinping emphasized during his inspection in Guangzhou: "Urban planning and construction should attach great importance to the protection of historical and cultur-

al heritage, not rush for quick success and instant benefits, and not demolish and rebuild. We should highlight local characteristics, focus on improving the living environment, employ the "embroidery" of micro-renovation, focus on civilization inheritance and cultural continuation, let the city leave memories, and let people remember their nostalgia." According to the instructions of the General Secretary, micro-renovation methods such as "embroidery" and "weaving"[9] are adopted, which are not only applicable to public open spaces in historical and cultural cities, towns, villages, historical blocks and historical areas, but also to ordinary villages. To supplement and support the shortcomings of infrastructure and public service platforms, small-scale, gradual "micro-renewal" and refined construction have been explored to create a village appearance that is compatible with modern and traditional styles (Figure 1). The overall space is simplified, which not only contains traditional charm but also conforms to the modern life experience without the hustle and bustle of the city, leaving a unique tranquility.

Figure 1 Micro-renovation of the facade of Jingmei Village

1.2 Sorting out the regional cultural context and maintaining the continuity of tradition

In order to promote the implementation of the rural revitalization strategy, promote the two-way free flow of production factors and the rational allocation of public resources, based on the material representation of the relationship between people and land in rural cultural landscapes and the characteristics of the existence of intangible cultural heritage in ideology, the cultural landscape elements are identified, restored, utilized and inherited from the perspective of materialization and activation.

Rural revitalization often starts with improving the quality of the living environment[10]. When designers are involved in the exploration of rural revitalization, the design is not just for a building, but takes the building as the entry point to integrate the rural social economy, ecology, culture, etc. The designer strives to meet the villagers' dual needs for material and spiritual culture, proposes a plan for rural development with a comprehensive design thinking, which aspires to a livable and tourist-friendly living environment that facilitates sustainable production and common prosperity and explores the vitality of rural sustainable development. Due to cultural diversity, rural landscapes have the cultural characteristics of localization, and the relationship between people and land is one of its core contents. The alternation of time and space has precipitated the humanistic features, historical events and social activities of a specific region. The interpretation of cultural landscapes can not only reflect the life course of residents in the region, but also reveal historical value, deeply investigate and inherit the excellent traditional local cultural genes, transform cultural genes and historical events into cultural symbols and business card logos, and create a batch of rural landscape features and cultural facilities, which become the carrier and source of innovation for presenting and restoring historical culture and emotional memory, awakening and strengthening regional characteristics and charm. The evolution of rural cultural landscape is as diverse as the characteristics of cultural landscape itself, and the stereotyped imitation of ancient styles regard-

less of regional style, age, etc. is not worth promoting.

The idle land and collapsed earthen house land in the old alleys of Jingmei Ancient Village were redesigned to create"four small gardens" for villagers to participate in the construction: small vegetable garden, small flower garden, small park, and small orchard, which increased the interaction between people and public space; secondly, the old trees in the ancient alleys were used to create a "Jingmei Tea Garden" for villagers to rest, and night lighting and other facilities were added. The windows, doors, streetlights and other facilities within the visible range of the ancient alleys were decorated with Lingnan elements, which not only enriched the landscape of Jingmei Ancient Village that boasts more than 600 years of history, but also displayed the regional style (Figure 2). Based on respecting authenticity, the enthusiasm of grassroots organizations and villagers was fully mobilized to encourage their participation in the construction of the living landscape of the surrounding environment space.

Figure 2 Comparison of "Jingmei Tea Garden" before and after renovation

The traditional style of the village, including the surrounding natural environment, layout texture, spatial outline, architectural appearance, ancient trees, etc., was protected and reasonably rectified to coordinate the style of new and old dwellings. The traditional dwellings in the village were repaired, and the Jingmei Academy, Bitang Waterfront Platform, Shajingtou Children's Park, and the landscape of the square in front of the Jingmei Hall were improved. A series of signs and guide signs were added, and new cultural and leisure and sports venues were added, such as elderly leisure venues, children's playgrounds, singing and dancing squares, and stadiums. A pool of clear water in the center of the village reflects the blue sky and white clouds, gathers water and wealth to improve the community environment, and blesses the people of the whole village (Figure 3).

Figure 3 Shajingtou Cultural Landscape

2 Exploring the revival of rural culture through landscape

Rural landscape exists independently within a specific cultural and geographical scope, attached to a unique topography. The ethnic groups, population size, and level ofcivilization of the area shape the form of the landscape, and the history is passed down through folk customs, events, and local customs. It is transferred to future generations through the architectural space forms and their functions such as temples, ancestral halls, residences, and squares, and reproduced in the form of images and cultural imagination[11]. It has both diachronic and synchronic characteristics. Once this duality is lost, it is equivalent to blocking the flow of history and losing the vitality of sustainable development.

2.1 Diachronicity and synchronicity in the process of landscape renewal

Diachronicity and synchronicity are theoretical methods proposed by Swiss linguist Saussure based on the study of language system[12]. Examining from a histori-

cal perspective, allowing cultural traditions, historical figures, and events to be displayed in the present time and space and preserved in the future is diachronicity. Diachronicity emphasizes the system as a whole in the process of time interpretation, while synchronicity emphasizes the structural relationship in the spatial dimension, and studies the characteristics, internal connections, and the transition between the elements of the internal system in the specific period of the background of rural revitalization. For the diachronic and synchronic characteristics of rural living environment, especially rural architecture, the design method of restoring historical landscape experience is adopted to reshape the "points" of traditional culture, trace its experience, restore and establish its symbolism, and emphasize the display of geography, environment, culture, landscape, routes, and node relationships. The various elements and genes that have been precipitated through historical evolution, as well as the wonderful fragments and memories of different stages, are displayed in a narrative way in the process of landscape renewal.

There are many ways to display, and the following five are mainly used in the process of landscape reconstruction in Jingmei Village:

1) Maintain the authenticity of historicalrelics and only do minimal cleaning and reinforcement to the relics, such as the renovation of Jingmei Well.

2) Respect the topographical and geomorphic characteristics of the site, materialize people and events, and shape and restore historical narratives, such as the construction of the Red Lychee Park.

3) Respect the cultural traditions and usage needs of local residents, and the materials and construction methods of new buildings should be in harmony with local customs, such as renovating the landscape of old houses and adding wok-ear houses with Lingnan characteristics.

4) Adopt light and reversible treatment methods to form rest nodes on the linear heritage, without damaging valuable historical genes, such as water polo cultural sports sculptures.

5) Control carbon footprint (greenhouse gas emissions caused by human activities) and water body management in community centers through ecological technology to achieve green sustainable development, such as underwater planting and management of Jingmei Jade Lake.

The unique regional landscape change process of the countryside will affect the changes in other functions of the area. It is rare to see prefectural schools built in the countryside. As a historical relic of the Qing Dynasty, Wenchang Pavilion embodies the unique style of Jingmei Village, which is a tradition of poetry and culture. In order to optimize the ecological and humanistic pattern, Jingmei Village Cultural Park, Jingmei Hall, and Village History Museum have been built, and village records and village rules and regulations have been formulated. It is a Lingnan cultural village integrating ancient village conservation, cultural heritage, party building and learning, and leisure and vacation. While reshaping the living landscape, it is necessary to integrate the complex and scattered landscape resources and highlight the temporal and spatial characteristics of the landscape. The rural regional function and the landscape cultural function complement each other and keep pace with the times. Proper use of landscape functions can promote the coordinated development of villages in transition[13].

2.2 Carrying forward the unique well culture of Jingmei Village

The cultural landscape is functional, forming an integral part of the environment and evolving continuously. The Jingmei Village was founded on the ancient well culture. The well plays an important role in the living environment and is dynamic and developing. The Jingmei Well was first built in the first year of Jiajing in the Ming Dynasty (1522). When the ancestors founded the village, they chose an auspicious location to dig a large well in the village. For 500 years, clear spring water has been provided for the villagers to drink. The ancestors were grateful for the gift of nature and believed that the establishment of a village must begin with establishing virtue. Without virtue, a person cannot be established, and without virtue, a village cannot prosper. They hoped that their descendants would have the same kindness and virtue as the well. The water in the well is clear, sweet and cool, and has been supporting the villagers for generations. In addition to its functionality, it also has symbolic significance. In addition to naming the village Jingmei, the historical and cultural attributes of the well have evolved to the present, surpass-

ing its original material function. In order to inherit and reflect the characteristics of the well culture, on the premise of protecting the authenticity of the inherent heritage, the design team fully restored and displayed the unique well culture style of Jingmei Village in various forms such as relief, round sculpture, and wall painting (Figure 4).

Figure 4 Wellculture style display area

2.3 Mining the red gene and promoting the Red Lychee brand

To tell the red historical stories well, the Red Lychee Park was built. Jingmei Red Lychee Park (Figure 5) originated from the red cultural story of presenting Jingmei red lychee to Chairman Mao on July 6, 1975. How to grasp this red cultural

feature, strengthen brand packaging design, make the "Jingmei Lychee" brand famous and combine it with tourism? In addition to displaying in the form of sculptures, during the lychee harvest period, the "Red Lychee Festival" of Jingmei Village can be developed through activities like picking and tasting lychee to promote local culture.

2.4 Inheriting the Lingnan style of residential buildings and commemorating the predecessors of Jingmei

Protective repairs were carried out on the typical buildings of Jingmei Ancient Village. Traditional environmentally friendly materials such as blue bricks and granite were used to renovate the facades of old houses and the landscape in front of the door. The wok-ear houses were added to highlight the characteristics of Lingnan architecture.

Figure 5 Red Lychee Park

Jingmei Village had three Juren in the Ming and Qing Dynasties, namely Xie Xunchen (Juren in the Jiazi year of Tongzhi in the Qing Dynasty), Xie Lianghan (Juren in the Gengwu yearand the fourth year of Longqing in the Ming Dynasty), and Xie Wenwan (Juren in the Yimao year of Yongzheng in the Qing Dynasty). They brought far-reaching cultural influence to Jingmei Village. Therefore, a group of "Jingmei Three Juren Sculptures" were created and placed in Jingmei Academy to encourage villagers to study and make progress (Figure 6).

2.5 Appropriately present historical stories and events in a three-dimensional and materialized way

Mr. Xie Runshen, a villager in Jingmei Village, has been engaged in water polo since 1958. He has served as the captain and coach of the"August 1st" water polo team and the Chinese water polo team and has made important contributions to the development of water polo in our country. Based on this story, a group of water polo cultural sports sculptures were created, which not only commemorated the sports spirit of water polo, awakened and expressed the cultural pride of Jingmei Village, had regional attributes, and became a unique and aesthetic landmark

(Figure 7), but also beautified the public space of the village, added fun to it, and improved the quality of the environment. The main materials should be green, environmentally friendly, and recyclable.

Figure 6 Sculptures of the three Jurens in Jingmei and aerial view of the academy

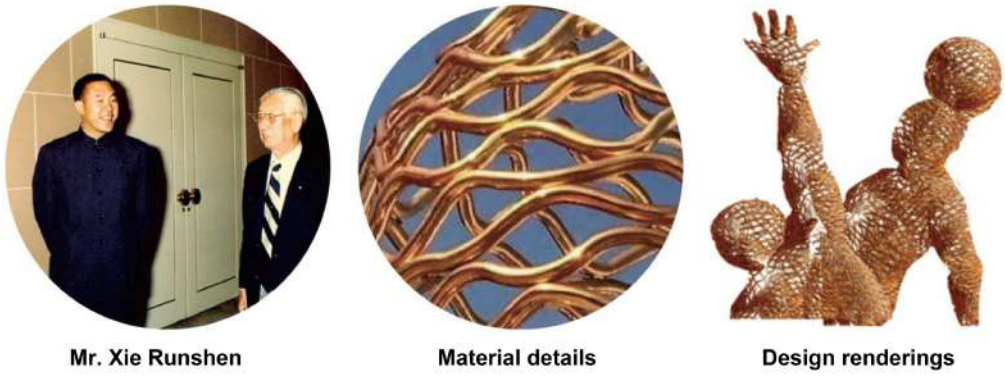

Figure 7 Water polo cultural sports sculpture

2.6 Design a sign that reflects the historical and cultural background

The overall logo design of Jingmei Village adopts the style of seal carving to highlight the ancient style. Since JingmeiWell is the origin of the village, the logo design integrates the structure of the well, which is square outside and round inside, reflecting the ideas of "the sky is round and the earth is square" and "harmony between man and nature" in traditional Chinese culture (Figure 8).

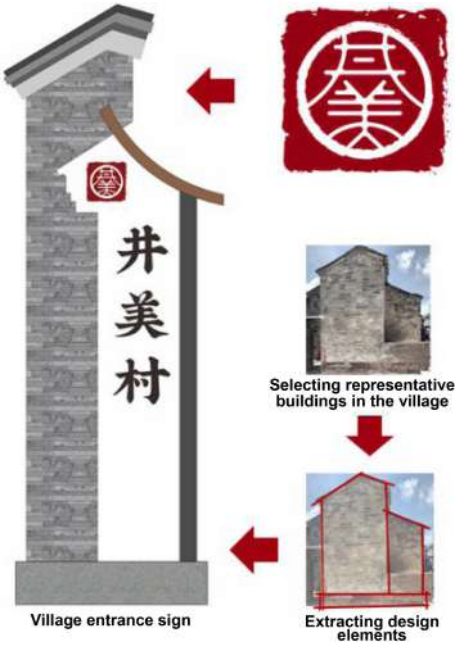

Figure 8 Jingmei Village entrance sign

3 Improving public infrastructure is conducive to the combination of agriculture and tourism

The shaping of rural multifunctional landscapesincludes establishing and enhancing public infrastructure on the premise of improving the living environment, so as to protect and repair buildings and environments with historical value, adapt to the development of profitable industries such as rural tourism, and maintain the balance of ecology and biodiversity.

3.1 Infrastructure

With the development of society, the environment should berectified, and infrastructure should be built according to the needs of modern lifestyles. The public product positioning of urban and rural infrastructure was clarified, which used the existing township government service platform to implement smart village initiatives and adopts a mechanism in which non-profit facilities were mainly invested by the government, quasi-profit facilities were mainly invested by social capital, and pure profit facilities were mainly invested by enterprises to promote the integrated development of infrastructure and realize the vision of smart villages.

3.1.1 Intelligent public facilities

Through the township government service platform, municipal services, payment, government affairs, police, medical care, education, transportation, etc. are seamlessly linked. Jingmei Village has freeWi-Fi coverage throughout the area, realizing smart transportation and parking, including smart monitoring of PM 2.5, etc. The various privately connected pipelines were put under control, which effectively solved the problems of garbage dumping and sewage flow that had long plagued the countryside, and enhanced road access, water supply compliance, sewage treatment, garbage collection, telecommunications coverage, and new energy utilization. By effectively matching the planning and construction standards of urban areas, municipal public facilities extended to rural roads, water supply, power supply, communications, logistics, garbage and sewage treatment and other infrastructure and 5G, artificial intelligence, Internet of Things, etc., which also improved the level of interconnection and interoperability of various parts of infrastructure.

While promoting the prefabricated electromechanical system with free disassembly and assembly characteristics, Jingmei Village designed an eco-degradable septic tank (finished septic tank + eco-degradation equipment) and photovoltaic solar equipment for low-carbon energy-saving operation and environmental protection, achieving power saving, emission reduction, and solid waste recycling.The improved hierarchical and classified investment mechanism ensured full coverage of new infrastructure construction. Improvements can be seen in aging-friendly and barrier-free facilities, flood control and drainage systems, parking, public sports, and public service activity venues etc. These measures to make up for shortcomings and benefit the people's livelihood have become the focus of rural renewal and make a contribution to achieving the dual carbon goals. In the process of renewal, we should

not only preserve the scale and pattern of the communities, make use of the valuable existing village buildings, continue their individual characteristics and features, but also reflect the regional style and clan characteristics, and coordinate the human geography environment. A fully enclosed intelligent parking lot was centrally planned and built to handle the relationship between the protection and development of cultural relics.

3.1.2 Water body management and garbage classification

Through the comprehensive technical integration of "ecological restoration system + harmless aquatic vegetation planting + landscape fountain construction," the algae in Shajingtou Lake were removed, the cleanliness and transparency of the water body were improved, and the odor was eliminated. The pond after ecological restoration was transformed into the Jingmei Jade Lake landscape, with Vallisneria, which can purify water and absorb nitrogen, phosphorus and other substances, as the main vegetation. It was planted on a large scale under the water of Jingmei Jade Lake to form an underwater forest, provide attachment space for microbial growth, cultivate the self-purification ability of the water body, increase its oxygen content, and build a healthy, beautiful public place that is loved by residents and tourists alike (Figure 9).

Figure 9 JingmeiJade Lake

The renovation and upgrading of the 13 garbage houses in the village (Figure 10) is conducive to garbage classification and reduces the impact on the surrounding environment.Twelve roads in the village were repaired and asphalt was paved. To reduce the amount of sewage discharged into the municipal pipe network, rainwater and sewage were separated, rainwater was discharged naturally, and the absorption and emission reduction of grass and plants were used. The "sponge" function of nature not only lowered cost but also improved environmental quality.

Figure 10 Garbage house

3.2 Revitalizing agriculture and developing tourism

Rural revitalization cannot be separated from agriculture. Agriculture has alwaysemphasized production, life, and ecology. Its core goal is to "promote intensive and efficient production space, livable and moderate living space, and beautiful ecological space"[14], which takes the form of the "three lives and three transformations" of production enterprise, life modernization, and ecological naturalization as well as the six-level agricultural industry proposed in recent years: emphasizing the added benefits of production, processing, and marketing services. Among them, the development of leisure agriculture combines agriculture and leisure, integrates local characteristic agriculture, culture, landscape and ecological resources, shapes regional industrial characteristics and leisure agricultural tourism, guides tourists to enter the countryside, experi-

ence the culture and local flavor of agriculture, and thus increase rural economic benefits. It also combines local creation, food and agriculture education, and consumption within the producing region to form a more sustainable, inclusive and resilient economic development model.

Based on surveys and investigations of resources within the village, unified plans were made, and nearly barren fields in the area were utilized reasonably. According to market demand, the industry layout was carried out. After analyzing the actual situation of the soil, the planting types were set. For example, strawberries with high economic value were introduced via social capital to build a strawberry garden when the villagers had little funds and lacked relevant skills. In combination with sightseeing, the strawberry garden was added with boardwalks, interactive check-in points, strawberry kiosks, agricultural product sales corridors, and beautiful countryside signs for tourists to walk and pick strawberries (Figure 11).

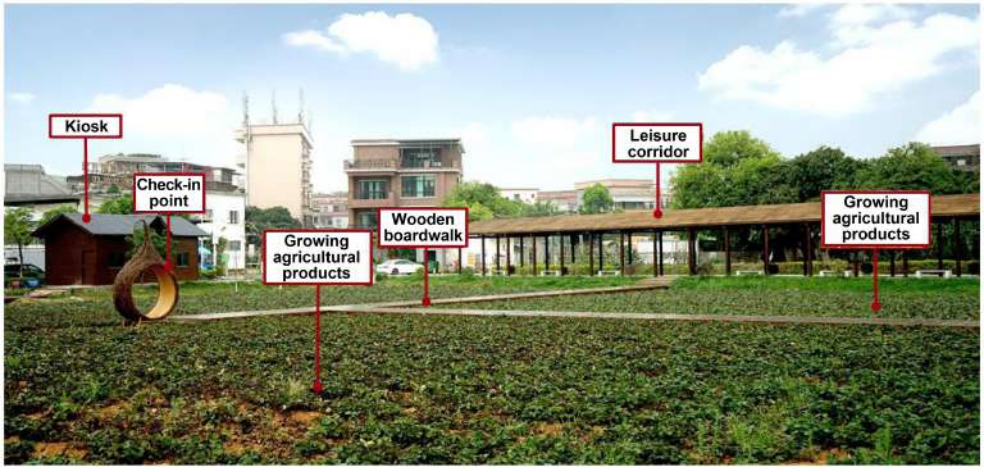

Figure 11 Strawberry Garden

The village unswervingly followed the path of high-quality development with ecological priority, green and low-carbon, and gave play to the advantages of regional natural resources such as farmlands, forests, lakes, and hot springs. An economic system of green, low-carbon and circular development was established and enhanced, carbon peak and carbon neutrality were incorporated into the overall economic and social development, and the system and mechanism for farmers to continuously increase their income was improved to ensure that farmers' wage income increases year by year.

Conclusion: Rural revitalization requires the reconstruction of rural civilization

Rural revitalization cannot be separated from the villagers (residents) as a cultural carrier. The decline of rural areas in recent years also started from the decline of culture and the decrease in population. The "three left-behind" people cannot bring revitalization to the countryside. The issues of "hollow villages" and "left-behind villages" need to be taken seriously. In the process of rural revitalization, a measure to facilitate sustainable environment is guiding urban residents who retain their nostalgia of or affinity with the countryside to realize their dreams of returning home and going to the countryside, bringing modern civilization concepts and social capital to the countryside, and practicing them in the countryside (Table 1).

Rural areas combine production, ecology, and life. Improving people's living standards and realizing modernization are the ultimate goals of the people's good life. Environmental harmlessness and ecological naturalization are prerequisites for sustainable development. By utilizing the vast resources of nature and combining them with the mountains, rivers, forests and grasslands in rural areas, agriculture and leisure can be integrated into planting, culture and landscape with local characteristics. Ecological resources can be used rationally, and industrial characteristics can be formed in different regions. Tourists can be guided to visit rural areas to experience agricultural culture, local flavor and low-carbon lifestyle, thereby increasing rural economic benefits. In addition, regional revitalization, food and agriculture education and consumption

within the producing region can be combined to provide a high-quality living environment for indigenous people while also providing reliable economic benefits. The public's understanding of modernization is also reflected in rural revitalization. The logical starting point for respecting and protecting nature and the ecological environment is people. With people as the center, improving people's quality of survival and quality of life is the purpose of rural revitalization. Since the 18th National Congress of the Communist Party of China, General Secretary Xi Jinping has made many statements on the inheritance and development of agricultural civilization and the improvement of agricultural civilization, such as "rural civilization is the main body of the history of Chinese civilization, villages are the carriers of this civilization, and farming and learning civilization is our soft power. In urban-rural integrated development, it is perfectly possible to preserve the original style of the village, be cautious about cutting trees, not to fill lakes, and demolish fewer houses, and try to improve residents' living conditions in the original village form as much as possible." [15] The grand goal of common prosperity is to be achieved. Looking into the future, people's concerns will be answered timely and the development of livable, green, resilient, smart and humanistic villages will be accelerated by virtue of the protection and renewal actions, so as to better meet people's expectations for a livable life.

Table 1 Practical path of Jingmei Village renewal

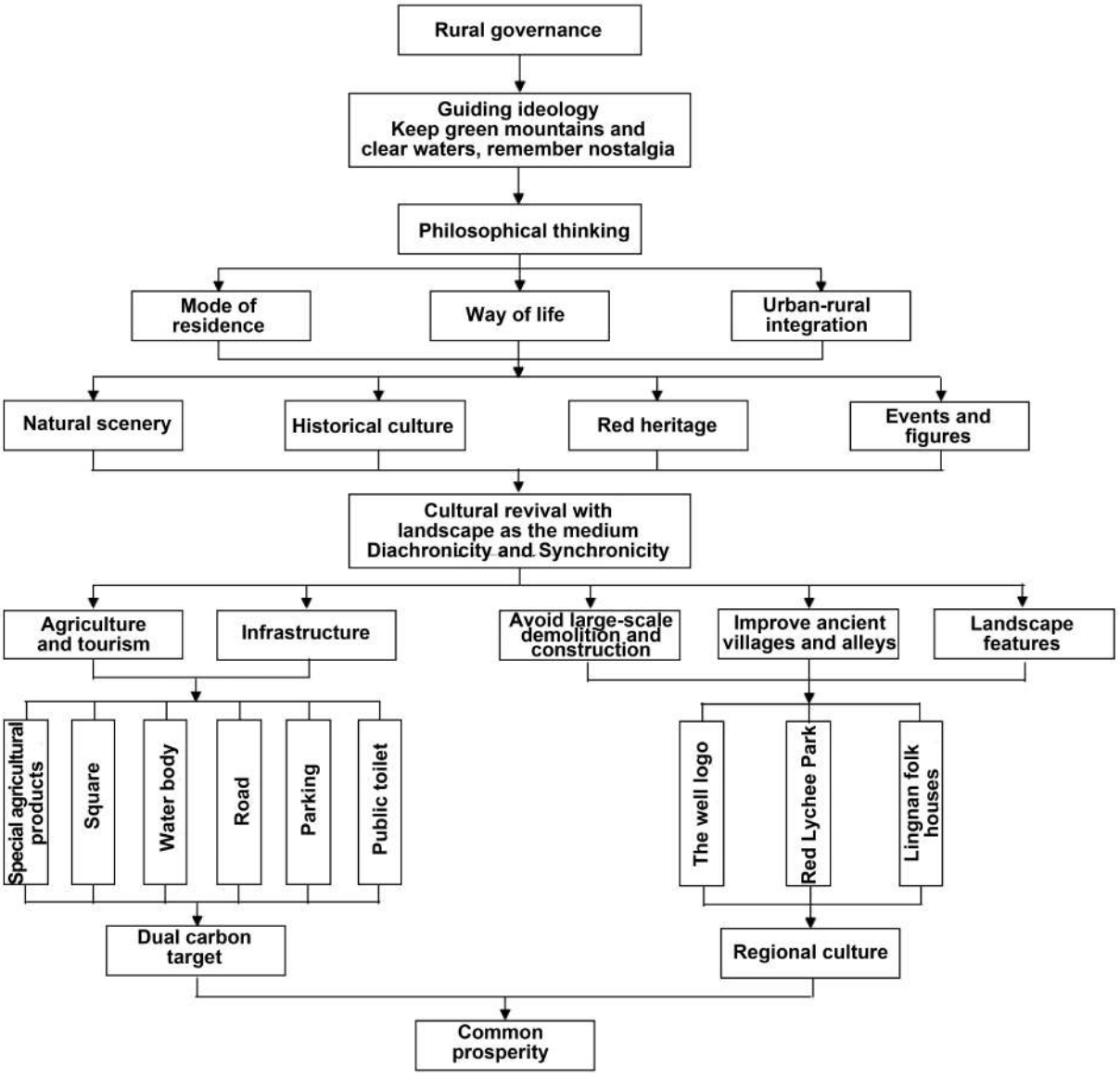

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Figure and table sources

All figures and tables are created by the team.

Notes

1) Dongguancity's Beautiful Countryside "Ten Ones" Project: 1. Prepare one construction planning blueprint. 2. Create one batch of rural landscape features. 3. Renovate one batch of architectural landscapes. 4. Build and improve one batch of sanitation facilities. 5. Improve one batch of public infrastructure. 6. Build one batch of cultural facilities. 7. Create one series of humanistic elements. 8. Make one batch of signs that can reflect the historical and cultural background of the local village (community). 9. Create one beautiful country view. 10. Revise and implement one set of rules, regulations, etc.

References

[1] Speech during investigation in Yunnan [N]. People's Daily, January 22, 2015.

[2] XI Jinping.Xi Jinping Talks about Governing the Country[M]. Foreign Language Press, 2020:375.

[3] HUANG Zuhui. Accurately Grasp Chinaese Rural Revitalization Strategy,Chinese Rural Economy[J].2018,4:2-12.

[4] ZHU Liangwen.Reconsideration of Traditional Villages under the Rural Revitalization Strategy [J]. South Architecture, 2020 (2): 62-67.

[5] YAO Shurong, ZHOU Shiyu. Research on the Path of Construction, Governance and Sharing of Rural Revitalization [J]. Chinese Rural Economy, 2020 (02): 14-29.

[6] YANG Guiqing, KAI Xin,SONG Daijun, et al .Exploring Approaches for Revitalizing Regeneration of Chinese Traditional Villages: a Case Study of Wuyantou Ancient Village in Huangyan, Zhejiang[J]. South Architecture, 2018 (5): 49-55.

[7] WANG Yuncai, LIU Binyi. On Chinese Rural Landscape and Rural Landscape Planning[J]. Chinese Gardens. 2003,1:55-58.

[8] ZHANG Bing. Re-think the Concept of Authenticity: Eeploring China's Way to Historic and Cultural City Conservation[J].City Planning Review,2011,35(S1):48-53.

[9] CHEN Min. Shanghai Practice of Urban Space Micro Renewal [J]. Journal of Architecture, 2020,(10):29-33.

[10] DONG Liwen, WANG Zhongjie.Construction of Beautiful Rural Environment With Villagers' Participation as the Main body—Taking bolinsi village, Hong'an County, Hubei Province as an Example [J]. Chinese garden, 2020, 36 (1):19-24.

[11] COSGROVE D, DAIINELS S. The Iconography and Landscape: Essays on the Symbolic Representation, Design and use of Past Environments [M]. Cambridge: Cambridge University Press, 1988.

[12] REN Yansheng, LENG Haoran, WANG Yali, et al, Research on the Reconstruction Design of Historical Town's Street Elevation with the Unified Synchronicity and Diachronicity: Taking Sanjiang Avenue, Sanjiang Town, Nanchang County as an Example [J]. Decorate,2022,(1):142-144.

[13] HUANG Jinchuan, LIN Haoxi, QI Xiaoxiao. A Literature Review on Optimization of Spatial Development Pattern Based on Ecological-Production-Living space[J]. Progress in Geography, 36 (3): 378-391.

[14] Speech at the Central Urbanization Work conference [C]. Selected and Edited Important Documents Since the 18th National Congress of the Communist Party of China Central Literature Press, 2014:605-606.

[15] LIN Ruoqi, CAI Yunlong. Study On Rural Multifunction And Landscape Reformulation In The Transitonal Period[J]. Human Geography, 2012,27(2):45-49.

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Research on Quantitative Evaluation Method for Morphological Resilience of Historical Blocks —Taking the Historical and Cultural Blocks in the Xinanyu and Dongnanyu Subdistricts of Luoyang City as an Example

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ABSTRACT: At present, the research on the resilience of historical blocks is mainly focused on the theoretical interpretation, and lacks the scientific and complete practical approach to quantify the resilience. For the purpose of protecting the morphology of historical blocks, the resistance of morphology is the main body of quantitative evaluation of the morphological resilience. On the basis of analyzing the feasibility of combining Conzen's morphological framework with the resilience theory, a quantitative evaluation method for the morphological resilience of historical districts was constructed, which took the division of "morphological resilience regions" as the core. Four morphological resilience indexes including road system connectivity, block modularity, land use function diversity and building texture robustness were used in the evaluation. Finally, weighted overlay was used to obtain the regional map of historical blocks' morphological resilience, which was used to reflect the resilience of different morphological types. On this basis, five types of morphological resilience management units are further divided according to the style type and the strength of resilience. The ultimate goal is to realize the meticulous protection and management of the morphology of the historic district.

KEY WORDS: historical block; quantification of morphological resilience; evaluation method; morphological resilience region; management units

1 Introduction

Historical blocks are concentrated areas of urban traditional style and local characteristics. Under the impact of incessant natural and social changes, the protection and continuation of material forms have always faced severe tests. In the field of urban morphology, Conzenian urban morphology can decompose the complex urban form into multiple single elements, which makes it possible quantify the urban form. Resilience is a multi-dimensional and multi-level concept, the application of which into the morphological protection of historical blocks furnishes a new perspective. However, the current research on the resilience of historical blocks focuses on the interpretation of the conceptual connotation, and it is urgent to supplement practical operation methods. Therefore, this paper combines the Conzenian urban morphological analysis framework with the resilience theory, proposes a path for quantitative evaluation of the morphological resilience of his-

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torical blocks, and conducts empirical research on the historical and cultural blocks in the east, west and south corners of Luoyang.

2 Morphological resilience of historical blocks and its quantitative evaluation

2.1 Resilience and urban morphological resilience

"Resilience" comes from the Latin word "resilio", which means "to restore to the original state". Although different international organizations have different ways of expressing the definition of urban resilience, they all contain typical characteristics such as diversity and variety, redundancy and modularity, multi-scale network connections, adaptive development and innovative learning [1]. At present, there is a basic consensus on the concept and evolution of resilience, but without a unified conclusion on the construction of a quantitative framework for urban resilience and the selection of evaluation indices, how to implement the concept of resilience in spatial operations has become a new issue [2].

The concept of resilience was introduced into the field of urban research in the 1990s, and it focused on the study of urban ecological environmental resilience. It was not until after 2010 that scholars such as Jack Ahern, Graeme Cumming and Ayyoob Sharifi began to apply resilience to urban design practice and initially established the relationship between resilience and macro-, meso- and micro-scale urban morphological elements [3]. In 2018, Feliciotti and Fusco proposed the concept of morphological resilience. Urban morphology resilience is based on the complex adaptive system (CAS) in resilience theory and also involves the two core concepts of adaptive cycle and "panarchy" proposed by Holling. In resilience theory, urban morphology is conceptualized as an organic system, in which each element has its own independent adaptive cycle. Small-scale elements usually tend to "revolt", while large-scale elements tend to "remember". They interact with each other and affect the renewal and evolution of urban morphology [4].

Urban morphology resilience belongs to the physical dimension of urban resilience, focusing on the physical properties of different morphological components (such as street networks, blocks, plots and buildings), and how to enhance their resilience potential through design [5]. Based on existing research, this paper defines urban morphology resilience as: the ability of its constituent elements to resist, adapt and transform in the face of urban changes, that is, the characteristics of maintaining stability or completing renewal without large-scale spatial destruction and heavy reconstruction operations [6].

2.2 Morphological resilience of historical blocks with protection as the goal

Historical blocks are a type of meso-micro-scale urban morphological area that has received widespread attention. The morphological resilience of historical blocks can be regarded as a combination of three resilience capabilities:"resistance", "recovery" and "adaptability" [7]. Among these three capabilities, resistance refers to the ability of the material form of historical blocks to resist and absorb disturbances and prevent structural changes, which is directly related to the maintenance and continuation of the morphology of historical blocks. In the protection of historical blocks, if the context and traditional atmosphere are to be continued, the protection of the material space form is the basis. Starting from the purpose of urban morphological protection of historical blocks, this paper takes resistance resilience as the main body of quantitative evaluation of urban morphological resilience. Resistance reflects the "rigidity" of urban morphology in the face of environmental changes and is also the "safety bottom line" of urban morphology against disturbances brought about by the "robustness" of urban morphology [8].

2.3 Necessity of quantitative evaluation of morphological resilience of historical blocks

Currently, domestic research on the resilience of historical blocks has mostlyapproached the resilience recovery mechanism from economic, social, and political perspectives [9]. Material spatial form belongs to the category of technical resilience in urban structural resilience [10], is the carrier of the above-mentioned "soft resilience", and is also the prerequisite for the "soft resilience"

of historical blocks to take effect. After 2010, special research on urban morphological resilience appeared internationally. In 2021, Zhai Guofang and other scholars proposed the theoretical framework of "spatial resilience" [11], emphasizing the necessity of spatial resilience research. Quantification is the way to translate morphological resilience from theory to practice. Kang Zeen proposed a qualitative understanding of the stability of urban morphological elements. In order to connect resilience theory with spatial operations and transform the abstract concept of resilience into a morphological protection strategy for historical blocks, it is also necessary to connect morphological resilience research with planning and design and translate it into spatial operations.

The spatial scale of the quantified object of urban morphological resilience covers multiple levels such as region, city, community, and single building. Existing meso-micro research at home and abroad includes the study of the Gobers area in Glasgow, UK by foreign scholar Feliciotti [12] and the quantitative evaluation of the urban morphological adaptive transformation process of Shenzhen Shekou Industrial Zone by Chinese scholar Chen Bilin [13]. The quantitative study of the resilience of historical block morphology not only expands the scope of the quantification of urban morphology resilience at the micro-scale but also has the social value and practical significance of protecting the traditional urban texture and inheriting the historical context.

2.4 Feasibility of quantitative assessment of the resilience of historical block morphology

After comparing theburgage cycle proposed by Conzen and the resilience cycle proposed by Holling et al., it is found that both summarize the evolution of the system as a dynamic cycle from growth, decline to reorganization. The Burgage cycle divides the evolution process of buildings in the plot into four stages: repletive, climax, recessive, and fallow. In the field of resilience, Holling summarized the adaptive cycle in order to distinguish the differences in the persistence and variability of elements at different scales [14], including four stages: exploitation, conservation, release and reorganization.

Urban morphology can be conceptualized as a multi-layered spatiotemporal system that evolves continuously in an adaptive cycle. In other words, urban morphology exhibits four basic characteristics that match the complex adaptive system identified by Holling et al., including: (1) Inter-system interaction: urban morphology can be decomposed into a series of components that belong to the same or cross-level scale categories and are characterized by interaction with each other; (2) Historical succession: urban morphology is a dynamic entity that undergoes multiple cycles of change and is affected by historical development and status; (3) Spatial connection: urban morphology is not only passive, but also has its own inertia to resist social, economic, political and other factors, and morphological evolution is spatially interrelated; (4) Nonlinear structure: The morphological evolution process can be fast or slow, and the interaction between them produces two types of changes, bottom-up and top-down, corresponding to small-scale internal adaptive updates and the promotion of major external events, respectively. This shows that urban morphology research is adaptable to resilience theory, providing the possibility of integrating the two research frameworks and forming a morphological resilience research framework (Figure 1).

In addition, with the development of geospatial information science and technology, detailed and accurate analysis of spatial data with the help of digital technology has provided technical support for the quantification of urban morphological resilience. A series of new quantitative analysis tools in the field of urban morphology research, such as Space Syntax,sDNA, GIS platform and other morphological quantitative analysis methods based on multiple data sources, have made up for the shortcomings of classical urban morphology research that is prone to subjectivity and difficult to refine and deepen, and provided a technical basis for the numerical characteristic description of urban spatial morphology [15].

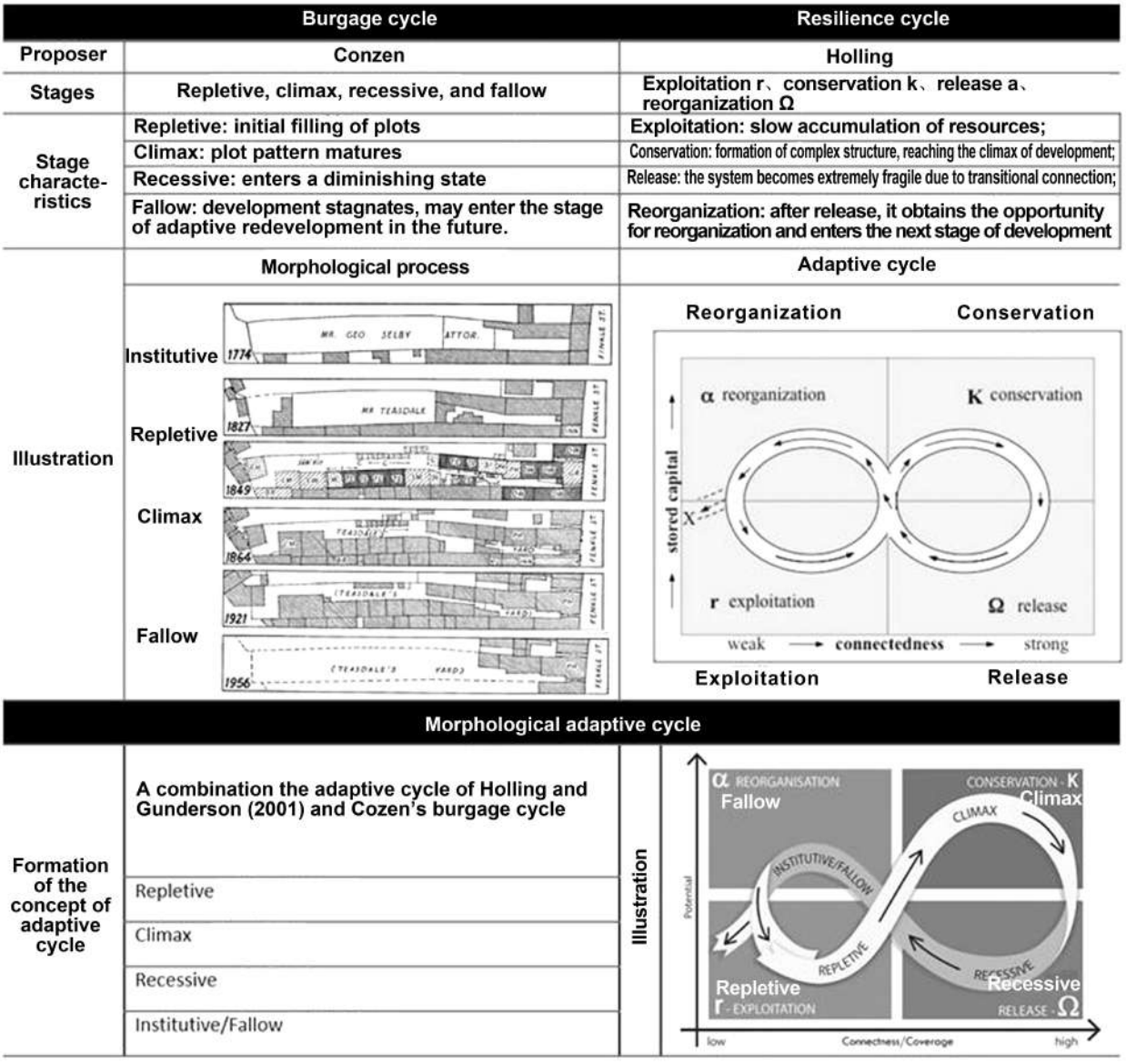


Figure 1 The Conzenianburgage cycle and the resilience cycle of Holling et al. are combined into an adaptive cycle

3 Evaluation method for morphological resilience of historical blocks

The original research goal of urban resilience was to resist and respond to sudden natural disasters. In fact, in addition to the natural impacts that have received widespread attention, the uncertain challenges of economic development and social changes have never stopped. These "hidden" disturbances often bring huge and sudden changes to urban morphology. Therefore, social disturbances are also an important source of impact for the urban system that cannot be ignored. The evaluation method for morphological resilience of historical blocks constructed in this study is mainly aimed at historical blocks and historical and cultural blocks that face human disturbances in the long term during social changes. In terms of the evaluation method, the concept of "morphological resilience region" is proposed. The idea of constructing the evaluation framework is to establish a clear correspondence between the three elements in Conzenian urban morphology and the resilience attributes, and after quantification of multi-indicator data, they are superimposed with the morphological area to form a morphological resilience region (Figure 2). The resulting graphic results are highly intuitive, which can be used as the basis for the division of spatial morphological management units of historical blocks in the preparatory stage of conservation efforts.

3.1 Selection of morphological resilienceindices

Connectivity, modularity, robustness, and diversity are selected as the resilience characteristic attributes of streets, plots, building textures, and land use in the micro-urban morphological analysis adopting the Conzenian theory, forming four first-level morphological resilience indices: street system connectivity, plot modularity, building texture robustness, and land use diversity. The four first-level indices contain qualitative and quantitative second-level indices that can be directly used for morphological analysis and quantification (Table 1). Second-level morphological indices can be expressed by function formulas, and data calculation and visualization can be performed on technical platforms such as GIS.

Table 1 Morphological resilience evaluationindices

Resilience characteristics	Concept analysis	Indices	Index connotation	Correlation
Diversity	Diversity refers to the ability of a system to contain multiple different functions that can be used simultaneously, which can be divided into richness and uniformity.	Facility diversity index FDIn	Number of public facilities per unit area (FDIn= Tn/Sn, where Tn is the number of facilities in plot n, Sn is the area of plot n)	+
		Facility mixedness index FMIn	Types of facilities per unit area ($FMIn = -\sum_{i=1}^{Nn}\left\{\left(\frac{Pi}{Pn}\right)\times\ln\left(\frac{Pi}{Pn}\right)\right\}$, where Nn is the sum of all types of facilities in plot n, Pi is the number of facility i in plot n, and Pn is the number of all facilities in plot n.	+
Connectivity	Connectivity refers to the ability of components in a system to connect to each other	Betweenness	Traffic flow model, reflecting the potential of people's cross-travel movement activities	-
		Closeness	The opposite of proximity, accessibility	-
Modularity	Modularity refers to the tendency of system components to be broken down into smaller units or aggregated into larger wholes	Plot Area	Reflecting the size and scale of the block	-
		Shape Index	Reflecting the degree of concavity and convexity of theblock (SI= shape length/4sqr (shape area, SI is shape index, shape length is the block perimeter, and shape area is the block area)	-
Robustness	Robustness refers to the solidity of buildings and other physical structures, reflecting the resistance of the morphological organization	Building Age	The initial construction year of the building (structure)	+
		Building Quality	The construction quality of the building (structure)	+
		Building Structure	The structural type of the building (structure)	/

3.2 Proposal of the concept of morphological resilience region

The morphological resilience region is based on the morphological region and can also reflect the resilience performance of the historical block morphology. To define a morphological resilience region, it is first necessary to determine the morphological region of the historical block and quantify the morphological resilience, which are then superimposed and integrated with each other [16]. The expression is: morphological resilience region = morphological region+ morphological resilience.

The morphological region comes from the urban morphological research established by M. R. G. Conzen. Conzen's urban morphological analysis decomposes the urban morphology into three typical elements: town plan (composed of street system, plot, building base), building fabric and land utilization. By identifying the "urban landscape units" with different morphological structures and then interpreting the complex urban built-up areas, the divided morphological regions can truly reflect the morphological characteristics of the historical city [17]. In this study, morphological resilience represents the comprehensive resilience performance of the "three elements" of morphology. Specifically, it selects the associated resilience attributes and quantifiable indices based on the characteristics of a single morphological element, quantifies the resilience data respectively, and then superimposes

them with different weights to obtain the morphological resilience of the research object.

The morphological resilience region is a way to evaluate and manage the complex morphological regions and morphological resilience of historical blocks. Each morphological resilience zone contains a certain morphological type and corresponding morphological resilience information.Regions of different morphological types or those of the same morphological type with different resilience strengths need to be divided into different morphological resilience regions and adopt different protection and management methods. Corresponding morphological resilience management units and guidelines can be further formed in the future.

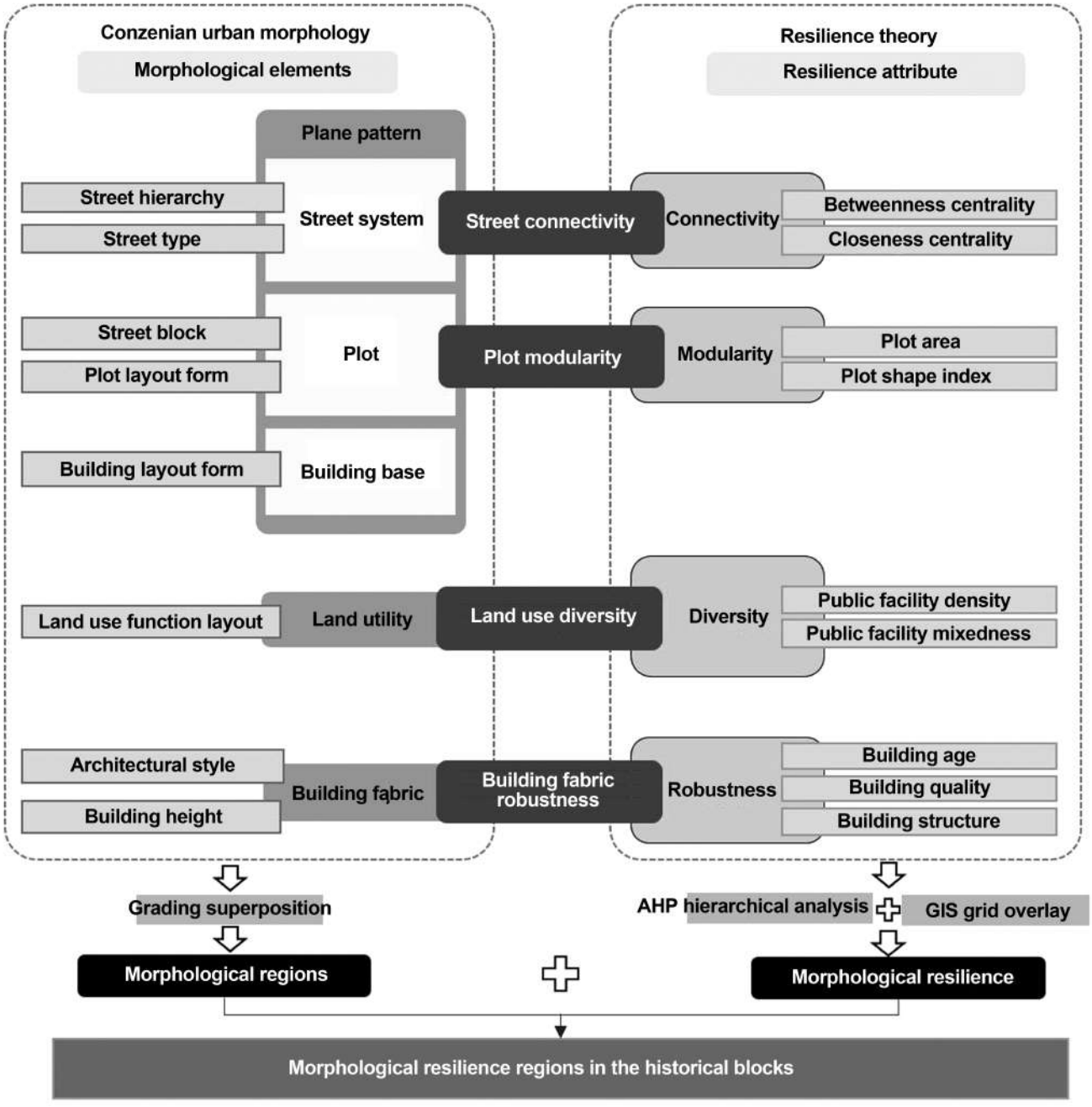


Figure 2 Outline of the analysis and quantification of historical block morphological resilience

4 Empirical study：Morphological resilienceregion of the historical and cultural blocks in the Dongnanyu and Xinanyu subdistricts of Luoyang

4.1 Research object

The historical and cultural blocks in the Dongnanyu and Xinanyu subdistricts of Luoyang (research area of about 94 hectares) are in the old city of Luoyang, Henan Province. They are in the protection area of the Luoyang City blocks in the Sui and Tang Dynasties and the ruins of the ancient city of Jin and Yuan Dynasties. They have retained the original city pattern and framework structure since the first year of Dazheng in the Jin dynasty and are an important carrier of Luoyang's traditional folk customs, history and culture. The plane morphological element information of the historical blocks in the Dongnanyu and Xinanyu subdistricts of Luoyang was sorted and entered into GIS, including roads, street frames (4), secondary street frames (47), property plots (1,300), building bases (7,524), rivers, etc. as the basis for morphological quantification.

4.2 Conzenian urban morphological region of the historical and cultural blocks in the Dongnanyu and Xinanyu subdistricts

4.2.1 The "three elements" of Conzenian plane morphology

The historical blocks inthe Dongnanyu and Xinanyu subdistricts of Luoyang have kept the street and lane pattern since the Ming and Qing Dynasties and the Republic of China, the most stable structures in the block morphology. According to the level and importance of streets and lanes, they can be classified into four categories: urban main roads, main pedestrian roads, important streets and lanes, and general streets and lanes (Figure 3a).

Plots are the basic components of the urban space system.Conzen defined it as a plot of land surrounded by four boundaries. One or more adjacent property plots can form a plot sequence [18]. The plots within the research scope can be divided into five types according to their arrangement methods: single row along the street, parallel multi-row, regular independent, irregular independent, and irregular splicing. The plot combination division of the historical and cultural blocks in the Dongnanyu and Xinanyu subdistricts of Luoyang is shown in Figure 3b.

The building base refers to the layout of buildings in the built-up area, which is defined by the projection of its enclosed exterior walls on the ground. It is usually calleda "building". According to the different filling methods of the building base in the plot, a total of five types of building base types were extracted in the the Dongnanyu and Xinanyu historical and cultural blocks: full paving, independent, row, courtyard, and open space. The division is shown in Figure 4a.

Compared with the street system and plots, the buildingfabric is less stable, but it can directly reflect the urban style. The architectural style (Figure 4b) and the number of building floors are selected as the indices for building fabric (Figure 5a). Land utilization is closely related to the decomposition and merger of plots in the city and the replacement of building types. The current land utilization division of the historic blocks in the Dongnanyu and Xinanyu subdistricts is shown in Figure 5b.

4.2.2 Division of morphological regions

The unit division of the three elements of Conzenian urban morphology is superimposed to form the morphological regions of the Dongnanyu and Xinanyu subdistricts of Luoyang. The morphological regions are divided according to three levels of boundaries (Figure 6). The first level is based on the three elements of the most macroscopic and most significant differences in morphology, the street, the combination of plots, and the type of building base plane, as the dividing criteria, forming 13 first-level morphological regions. Since the proportion of courtyard-style dwellings in the Dongnanyu and Xinanyu historical and cultural blocks is large and has historical protection value, the second level is based on the architectural style and the number of floors as the dividing standard, resulting in traditional red brick dwellings, traditional historical dwellings, traditional cultural dwellings and other regions. The third level is based on the least stable building use function as the basis for division.

Figure 3 (a) Division ofplot combination units (b) Division of street levels

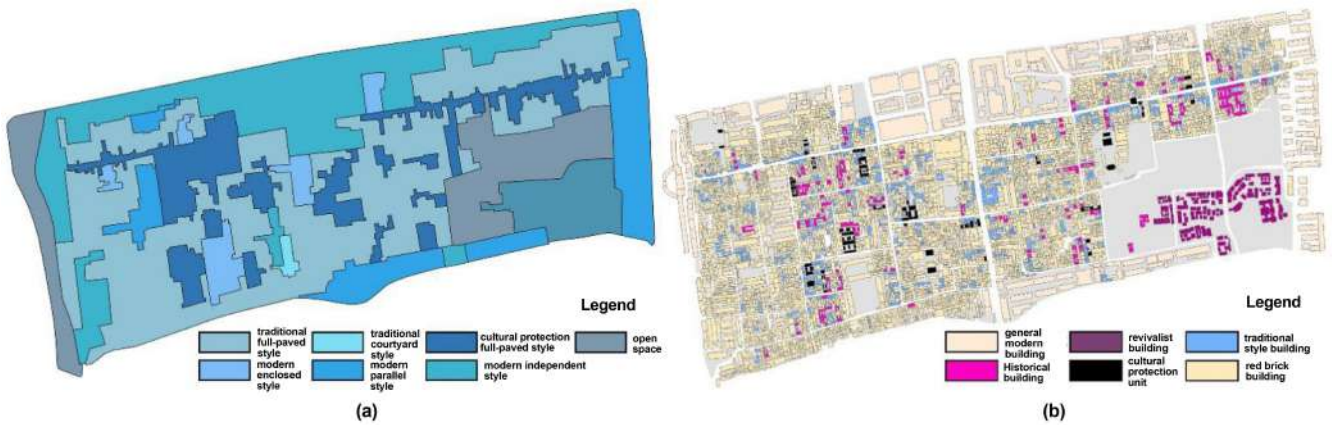


Figure 4 (a) Division of building base units (b) Architectural features

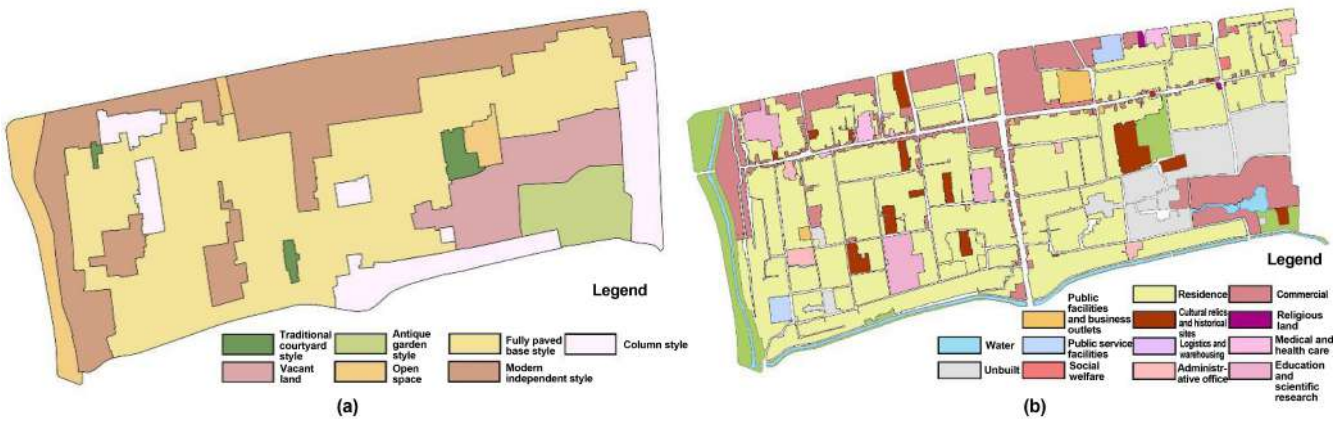


Figure 5 (a) Buildingfabric unit division (b) Land use unit division

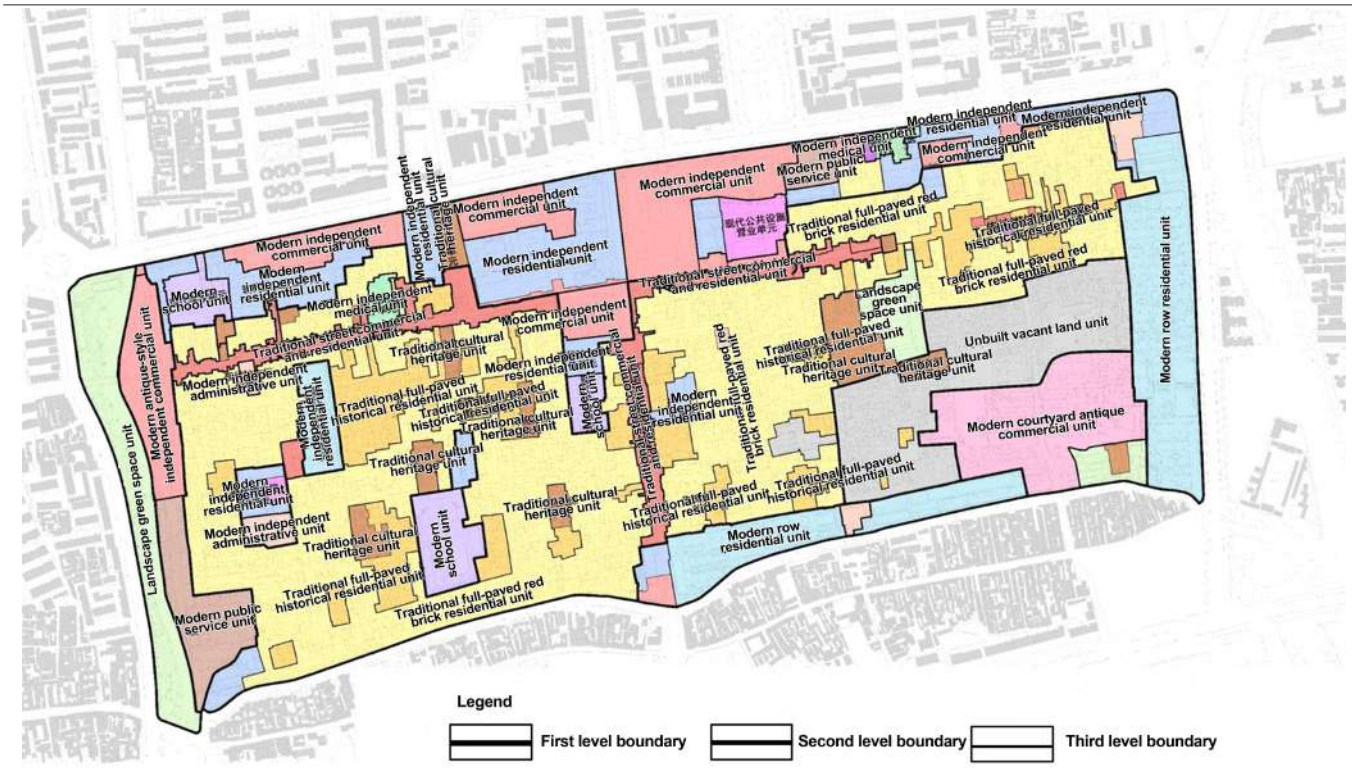


Figure 6 Morphological regions of the Dongnanyu and Xinanyu historical and cultural blocks

4.3 Morphological resilience of the historical and cultural blocks in the Dongnanyu and Xinanyu subdistricts

The morphological resilience of the historical and cultural blocks in the Dongnanyu and Xinanyu subdistricts will be quantified from four dimensions: the connectivity of the street system, the modularity of the plots, the robustness of the building fabric and the diversity of land utility. 2-3 secondary indicators are selected from each dimension, and the data are quantified separately, and then weighted and superimposed to form a comprehensive morphological resilience grid map.

4.3.1 Connectivity of street system

Connectivity refers to the ability to connect components in a system, which can be measured by accessibility. Connectivity has both positive and negative effects on resilience, where low connectivity promotes structural preservation and memory preservation. Taking urban morphology protection as the goal, it is believed that the streets with high connectivity in the Dongnanyu and Xinanyu subdistricts have weaker resilience than the dendritic streets with low connectivity.

The sDNA was used to analyze the betweenness and closeness of the Dongnanyu and Xinanyu historical blocks to obtain the connectivity values of the streets. The results show that the "cross streets" inside the Dongnanyu and Xinanyu historical blocks have high accessibility and activity, and the connectivity of the dendritic streets inside tends to decrease. Based on the distance decay model, the road-based accessibility analysis is converted to the plot, which is convenient for grid overlay with the subsequent morphological resilience quantitative indicators[1)]. The accessibility value map converted from street connectivity to the plot is shown in Figure 7.

4.3.2 Modularity of plots

Modularity refers to the tendency of system components to decompose into smaller units or aggregate into larger wholes. The more modular the components of highly modularized urban morphology are, the lower their morphological resilience is. The plot area and shape index are selected as indices to characterize modularity. This study follows the principle that the larger the plot area, the lower its modularity and the stronger its resilience. Shape index[2)] reflects the degree of concavity and convexity of the streetscape. The larger the value, the more irregular the

streetscape. Therefore, the plot with a larger shape index value has a weaker tendency to aggregate or decompose, and a higher stability, which is more conducive to the long-term preservation of the plot form.

Figure 7 Global integration of streets and accessibility of plots in theDongnanyu and Xinanyu historical blocks accessibility

The Dongnanyu and Xinanyu historicalarea has 4 blocks, 47 secondary blocks and 1,300 property plots. The sample size of secondary blocks and property plots is large, and the focus is on quantification. The results show that the average degree of concavity and convexity of secondary blocks and property plots is basically the same, and the difference between the shape index of property plots and the average is greater (Figure 8). The area and shape index of secondary blocks and property plots are reclassified in GIS to obtain the plot area and shape index raster maps (Figure 9).

Hierarchal level	Shape maximum/minimum	Shape mean	Shape standard deviation
Block	1.37/1.10	1.18	0.11
Secondary block	2.28/0.99	1.25	0.35
Property plot	2.23/0.99	1.25	0.20

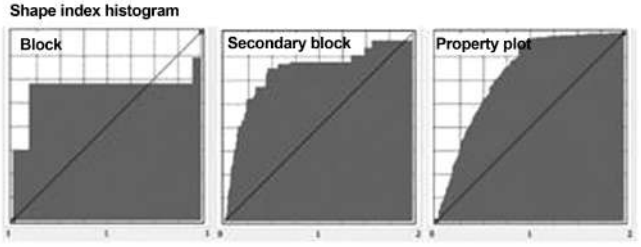


Figure 8 Shape indices quantification results

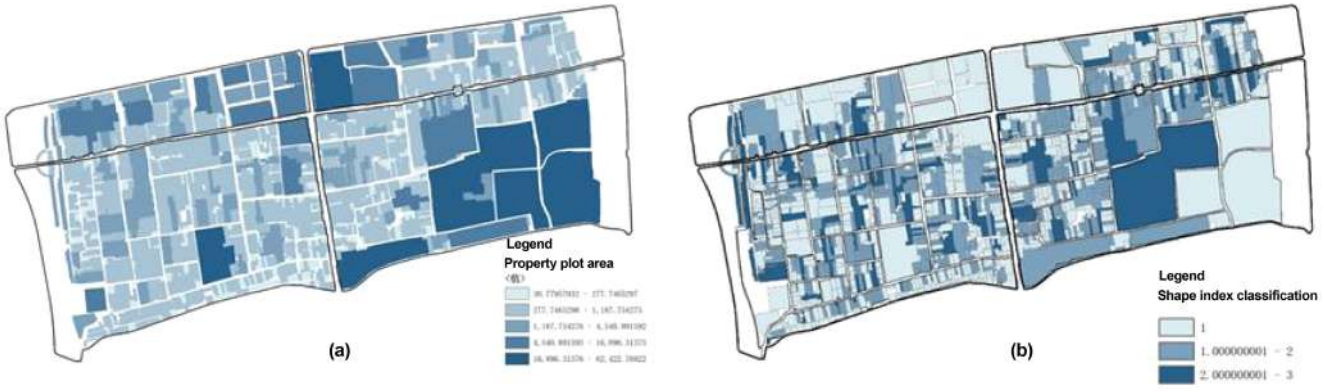


Figure 9 (a) Distribution of plot size (b) Classification of plot shape indices

4.3.3 Robustness of building fabric and land utility diversity

Robustness refers to the property of a system that can withstand internal and external shocks and pressures without serious loss or degradation of its main functions. The older the building, the more valuable it is to preserve and the more stable it is in the face of social changes. Building structure and building quality represent the objective level

of resistance of the building in the face of future disturbances. The three indices of building age, building structure and building quality are used to represent the robustness of building fabric. The building age, building structure and building quality of the historical blocks in Dongnanyu and Xinanyu are shown in Figure 9 (a), (b) and (c).

Diversity is considered to be the attribute that can most affect the resilience of the urbanorganism and can be measured from multiple perspectives such as economic mix, building mix, and transportation options [19]. This paper uses the degree of economic activity mixing as an index to reflect the degree of mixed use of land functions in a region. The crawler technology was used to obtain the POI point data of various public facilities in the Dongnanyu and Xinanyu historical blocks. The facility density index [3] and the facility mixedness index [4] were used as the representation of the degree of economic activity mixing. The larger the value, the higher the diversity of land use types and the stronger the resistance and resilience. The GIS processing results show the diversity of facility functions in the Dongnanyu and Xinanyu historical blocks (Figure 10d).

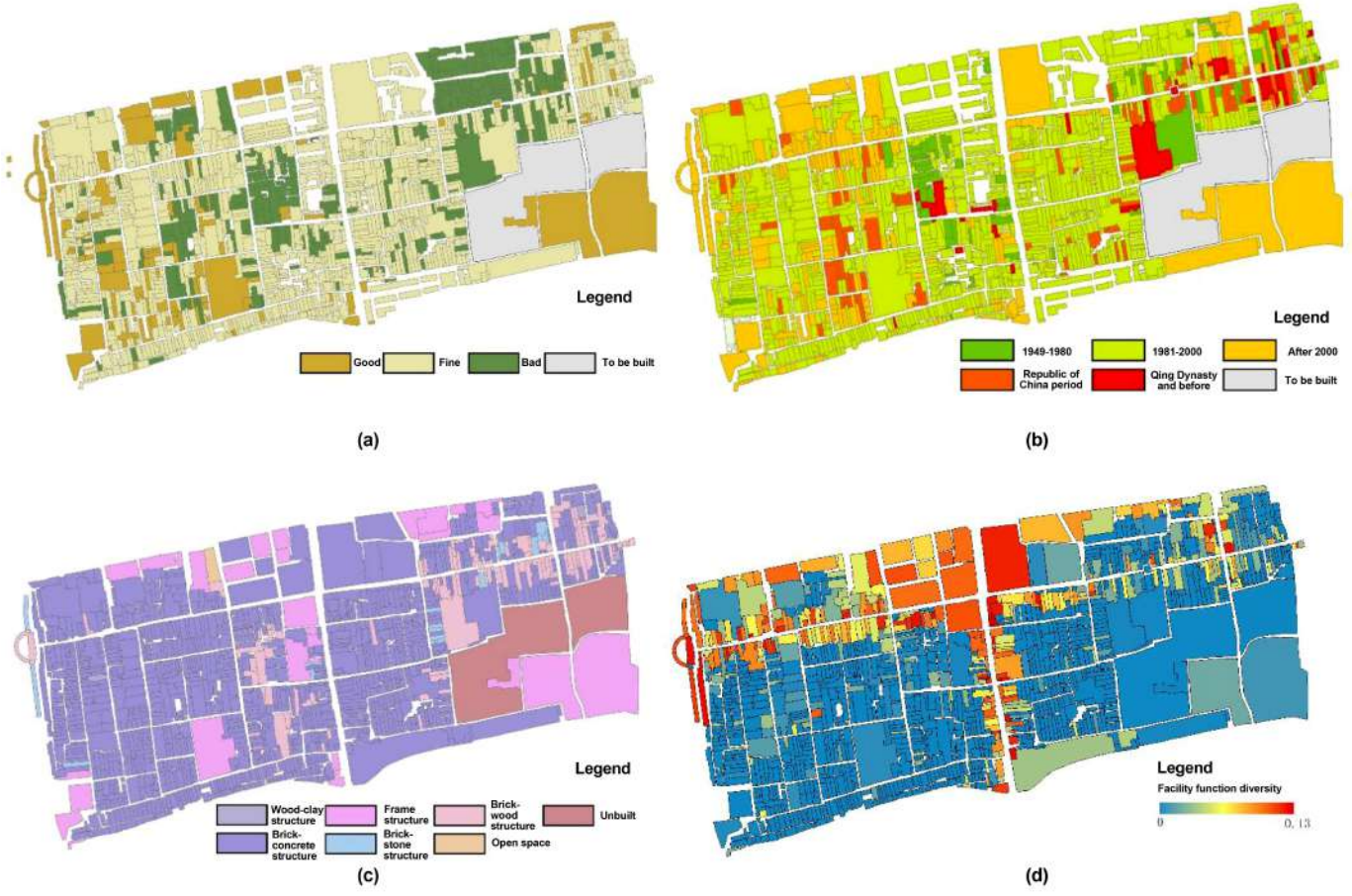


Figure 10 (a) Building quality (b)Building age (c) Building structure (d) Diversity of facility functions

4.3.4 Comprehensive morphological resilience

For evaluation index weight calculation method, this paper adopts the analytic hierarchy process (AHP) and the expert survey method (Delphi Method). Combined with existing domestic and foreign literature [12-14] and expert inquiries from universities and planning management departments, the importance of each layer of indiceswas scored, and the analytic hierarchy model was constructed using yaahp software. After establishing a pairwise judgment matrix, the scores were normalized, and the results were tested for consistency. When determining the index weight, the index weight was modified according to the expert opinions obtained by survey, and finally the weights of the four resilience characteristics of connectivity, modularity, diversity and robustness and their element layer indices were formed (Table 2). The comprehensive

morphological resilience grid map of the Dongnanyu and Xinanyu historical blocks was formed by weighted overlay in the GIS platform (Figure 11). It should be noted that the current element layer index selection and its weight take into account and combine the actual situation of the Dongnanyu and Xinanyu historical blocks. For example, in the criterion layer B4 building quality, since the most prominent features of the buildings in the blocks are building age, quality and quality, these three items are selected as indices reflecting building quality. When this method is applied to other research objects, the indices or weights can be adjusted according to the situation.

Figure 10 Weight of resilience indices

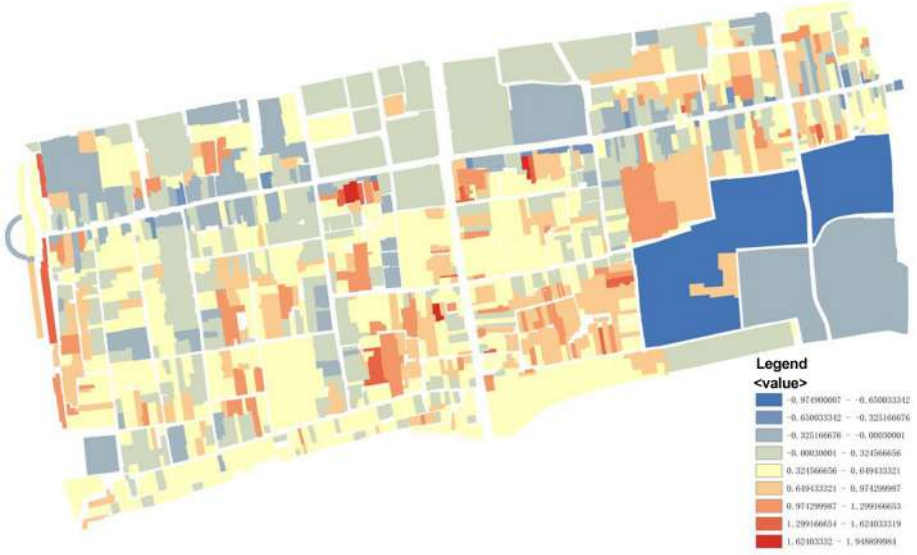


Figure 11 Grid map of comprehensive resilience of the Dongnanyu and Xinanyu historical blocks

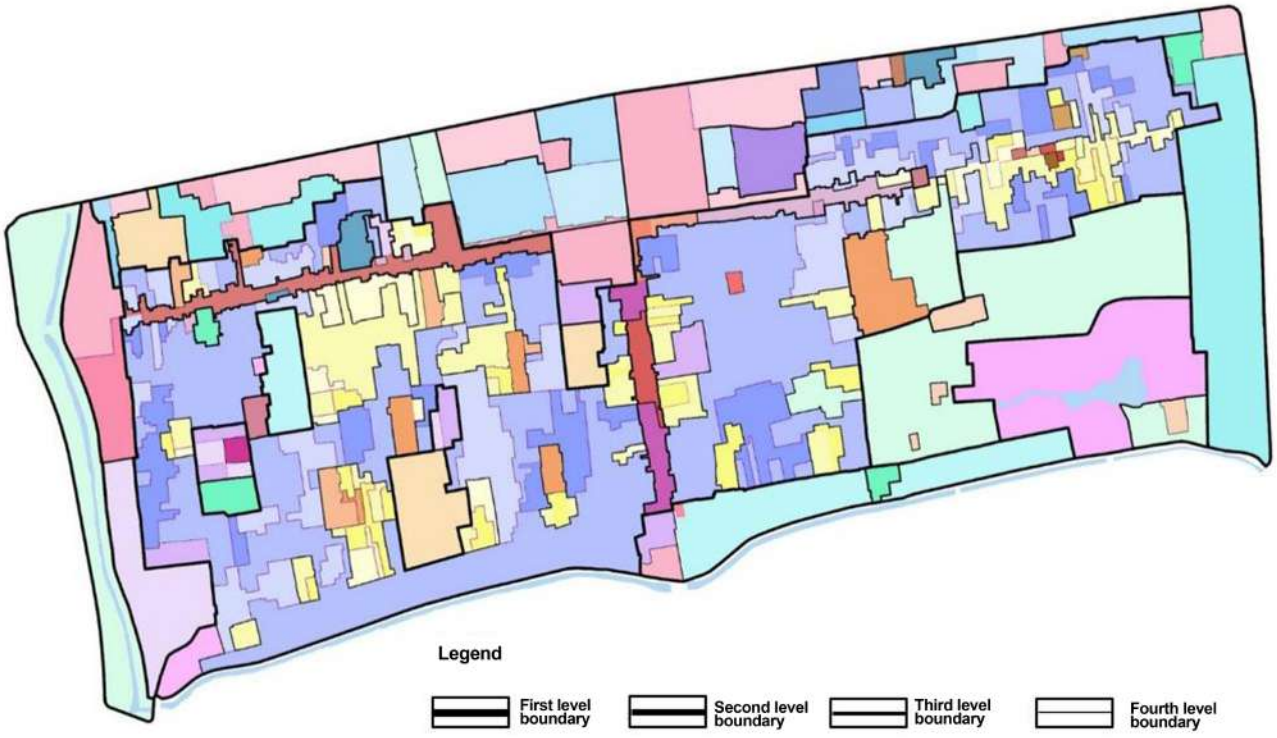
4.4 Morphological resilience regions of the Dongnanyu and Xinanyu historical and cultural blocks

The morphological regions are superimposed with the morphological resilience grid map to form the final morphological resilience regions of the Dongnanyu and Xinanyu historical and cultural blocks (Figure 12). The morphological resilience regions include both urban morphological type information and morphological resilience strengthattributes (divided into high, medium and low). The morphological resilience regions are divided by four levels of dividing lines (in order of era of style, plot type, use function and morphological resilience). Each color group in the figure represents a morphological type, and the color bands from light to dark represent the morphological resilience from weak to strong. The area proportions of different levels of resilience of the seven main morphological types in the Dongnanyu and Xinanyu historical and cultural blocks are shown in Figure 13.

The zoning results of the morphological resilience of theDongnanyu and Xinanyu historical show that among the seven main morphological types in the blocks, the low resilience areas of traditional historical commercial streets, modern row-style residential areas and traditional full-paved historical residential areas rank in the top three in terms of their respective area. This suggests that traditional commercial streets and modern residential areas with high accessibility and high modularity are more likely to undergo adaptive morphological changes when faced with disturbances, whereas historical monuments with low accessibility and low modularity and the morphological characteristics of residential buildings with historical value are preserved due to their strong resistance.

4.5 Morphological resilience management unit of the Dongnanyu and Xinanyu historical and cultural blocks

The morphological renewal and management of the Dongnanyu and Xinanyu historical blocks is carried out by constructing morphological resilience management units. Morphological resilience management units are the superposition of morphological resilience regions and style types, which are divided into five types: preservation units, improvement units, remodeling units, open space units, and vacant land units. There are 61 preservation units, 126 improvement units, 73 remodeling units, 4 open space units, and 2 vacant land units in the Dongnanyu and Xinanyu historical blocks (Figure 14).



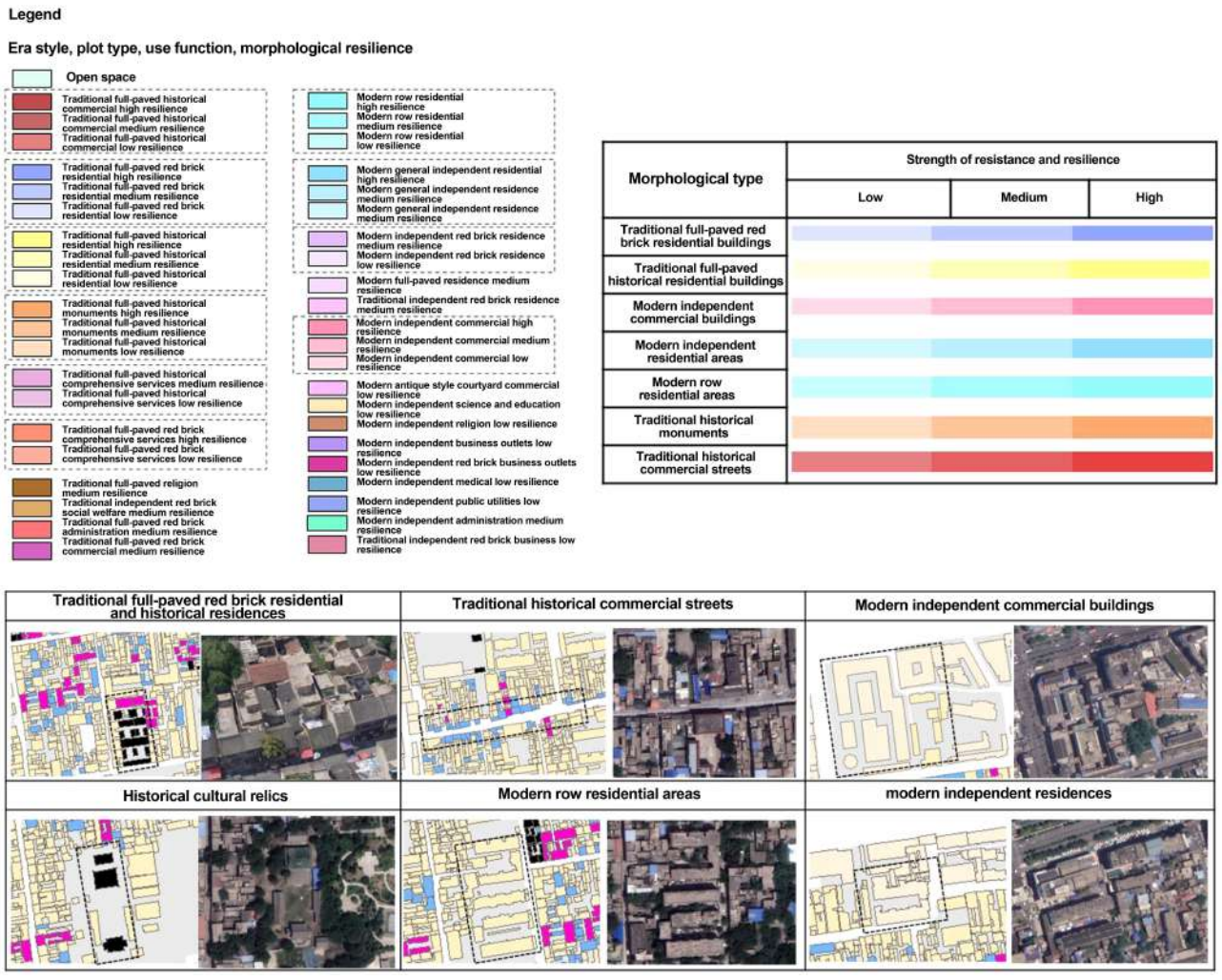


Figure 12 Morphological resilience regions in the Dongnanyu and Xinanyu historical blocks

	Traditional full-paved red brick residential buildings	Traditional full-paved historical residential buildings	Modern independent residential areas	Modern row residential areas	Traditional historical commercial streets	Modern independent commercial buildings	Traditional historical monuments	Total
High resistence and resilience	69085	30491	4225	7925	169	12052	24201	148148
Medium resistence and resilience	307241	71773	37946	2205	5585	69469	9456	503675
Low resistence and resilience	87228	25294	32993	52199	21147	48225	7198	274284

Figure 13 Proportion of area at differentresilience levels for seven main morphological types

The management unit guidelines include at least three aspects, namely, status information summary, management projects and management regulations, among which management projects and management regulations are the core [20]. The morphological resilience management guidelines of the Dongnanyu and Xinanyu historical blocks adopt the composition method of "basic project + targeted project", among which the basic project is to propose the construction direction of material environment improvement from the overall level based on the regional style characteristics, and the targeted project is to optimize and improve the resilience attributes of the weak morphological elements in the management unit in a targeted manner (Figure 15). Traditional residential upgrading units account

for the highest proportion of traditional residential management units, whose resilience measures are those aimed at encouraging residents to maintain daily maintenance and maintain the style and targeted strengthening of the robustness of the building. Traditional commercial remodeling units account for the highest proportion of traditional commercial management units, whose morphological resilience measures are those aimed at unified style guidance and specification, as well as improving the modularity of the plot, the degree of functional mixing, and the robustness of the buildings. Modern residential upgrading units and remodeling units account for a high proportion of modern residential management units, whose morphological resilience measures are those aimed at style rectification, as well as improving the accessibility of the plot, the degree of functional mixing, and the robustness of the buildings.

Through the evaluation of the morphological resilience management unit,"policy according to local conditions" is achieved. First, the macro-style control goals are determined, and targeted strengthening of element indices are carried out to ensure the orderly and organic protection, development and inheritance of the historical block morphology. The maintenance and upgrading units are optimized on the basis of inheritance, the remodeling units are adjusted and comprehensively rectified, and the vacant units aspire to style coordination and creating a highly robust, diverse and connected morphological region. Ultimately, the morphology of the Dongnanyu and Xinanyu historical blocks is protected and organically updated to adapt to social changes.

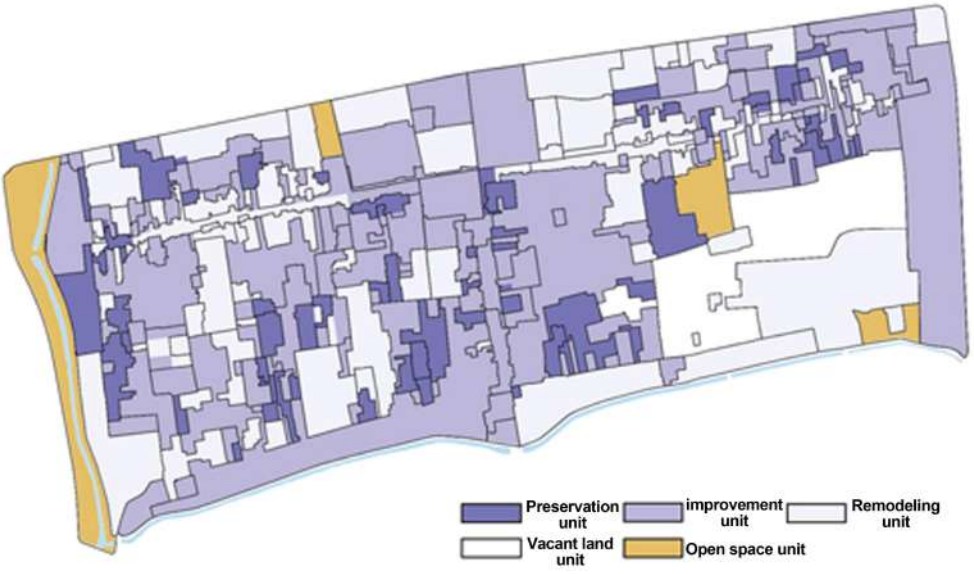


Figure 14 Morphological resilience management units in the Dongnanyu and Xinanyu historical blocks

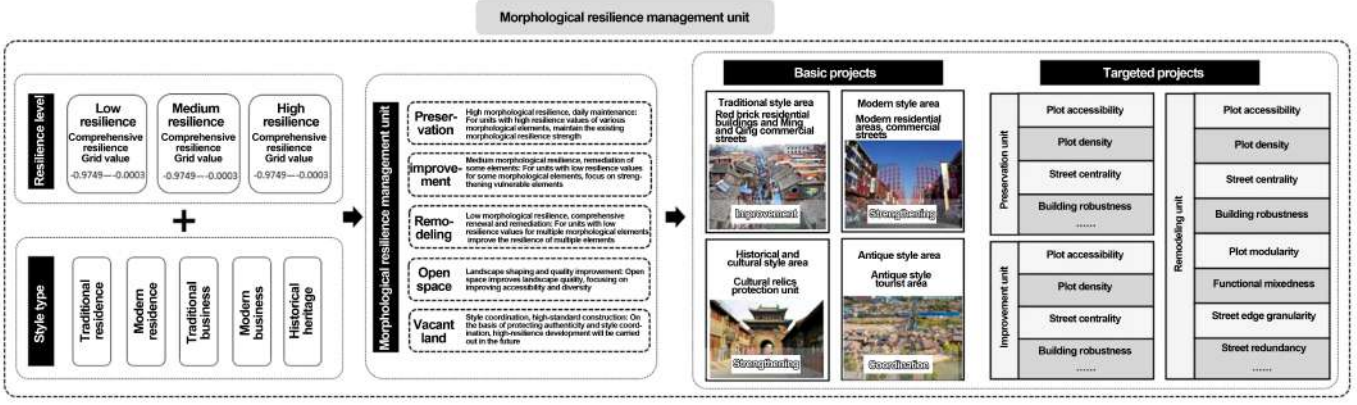


Figure 15 Schematic diagram of the project composition of the morphological resilience management unit

5 Conclusion and discussion

For the purpose of morphological protection, this paper takes the resistance performance in the morphological resilience of historical blocks as the subject of quantitative evaluation of the morphological resilience of historical blocks. The morphological resilience region is the core concept in this quantitative evaluation method, which is formed by the superposition of morphological region and morphological resilience. In the evaluation system, Conzenian urban morphology and resilience system are organically combined, and the"three elements" of morphology correspond to connectivity, diversity, modularity, and robustness in the resilience attributes. Through the selection of morphological resilience indices and the quantification of information data, the abstract concept of resilience is finally concretized, and it is also possible to translate the resilience theory into the planning and design of urban morphology. Five types of management units are further divided on the basis of the obtained morphological resilience regions, and management guidelines are formulated from both macro and micro levels to meet the requirements of refined protection and management of historical block morphology. As a supplement, future research is expected to cover the changes in urban morphological resilience over time and reveal the relationship between morphological resilience and urban social development.

Figure and table sources

Figures 1, 5, 6, 7, 8, 11, 12, 13, 14, 15,and Table 2: Created by the authors.

Table 1: Created based on references [11], [12], [14]

Figures 2, 3, 4, 9, and 10: Self-drawn based on theDetailed Construction Plan of the Historical and Cultural Blocks in the Dongnanyu and Xinanyu Subdistricts of Luoyang City (2019-2035)

Notes

1) The formula is $B_b = \sum_{i=1}^{n} BtAR_{(x)i} \frac{L_i D_i^{\alpha}}{\sum_{i=1}^{n} L_i D_i^{\alpha}}$, where B_b represents the accessibility of the plot, $BtAR_{(x)i}$ represents the accessibility of a street i surrounding the plot, L_i represents the length of the centerline of street i, D_i represents the shortest geometric distance between the centerline of street i and the edge of the plot, and α is the distance attenuation coefficient.Reference: [15]

2) The formula is SI = shape length / 4sqr (shape area), where SI is the shape index, shape length is the perimeter of the street, and shape area is the area of the street.

3) The formula for calculating the density of public facilities is: FDIn= Tn/Sn, where Tn is the number of facilities in plot n and Sn is the area of plot n.

4) The formula for calculating the facility mixedness is $FMIn = -\sum_{i=1}^{Nn} \left\{ \left(\frac{Pi}{Pn} \right) \times \ln \left(\frac{Pi}{Pn} \right) \right\}$, where Nn is the sum of all types of facilities in plot n, Pi is the number of facility i in plot n, and Pn is the number of all facilities in plot n.

References

[1] DAI Wei, SUN Yimin, HAN Meir, Taneer Kunikao Bachin. Towards Resilience Planning: a Study On Delta Planning From An International Perspective [J]. Urban Planning International, 2018, 33(3):83-91.

[2] ZANG X Y, WANG Qiao. Concept Evolution, Research Content And Development Trend of Urban Resilience [J]. Science and Technology Review,2019,37(22):94-104.

[3] XIE Wenlong, SUN Cheng. Analysis on the Contemporary Development Trend of Resilience-Oriented Urban Design [J]. Contemporary Architecture,2021(12):21-24.

[4] XU Chan, ZHAO Zhicong, WEN Tianzuo. Resilience: Concept analysis and reconstruction from a multidisciplinary perspective [J]. Journal of Western Human Settlements and Environment, 2017, 32(05): 59-70.

[5] DASTJERDI M S, Lak A, GHAFFARI A, et al. A Conceptual Framework for Resilient Place Assessment Based on Spatial Resilience Approach: An Integrative Review [J]. Urban Climate, 2021, 36: 100794.

[6] FUSCO G, VENERANDI A. Assessing Morphological Resilience. Methodological Challenges for Metropolitan areas [C] // International Conference on Computational Science and Its Applications. Springer, Cham, 2020: 593-609.

[7] PENG Chong, GUO Zuyuan, PENG Zhongren. The Theoretical And Practical Progress of Community Resilience in Foreign Countries [J]. Urban Planning International,2017,32(4):60-66.

[8] GUO Xiaodong, FEI Zhitao, WANG Zhitao. The Rigidity, Elasticity and Resilience of Urban Disaster Response [J]. Urban and Rural Planning,2021(3):35-42.

[9] YUAN Qifeng, CAI Tianshu, HUANG Na. Preservation and Renewal of Historic Blocks From the Perspective of Resilience: A Case Study of Shantou Small Park Historic Block and Foshan Zumiao Donghuali Historic Block [J]. Planner,2016,32(10):116-122.

[10] QIU A. Ten steps Towards Toughness City [J]. Journal of China city, 2021, 35 (01) : 1-8.

[11] LU Y, ZHAI G, ZHOU S, et al. Risk Reduction Through Urban Spatial Resilience: A Theoretical Framework[J]. Human and Ecological Risk Assessment: An International Journal, 2021, 27(4): 921-937.

[12] FELICIOTTI A, ROMICE O, PORTA S. Design for Change: Five Proxies for Resilience in the Urban form[J]. Open House International, 2016.

[13] CHEN Bilin, SUN Yimin, LI Yinglong. Study on Adaptive Transformation of Meso-Micro Resilient Urban Morphology: A case study of Shekou Industrial Zone in Shenzhen [J]. Urban Development Research, 201,28(6):101-111+ 2+ 45.

[14] FELICIOTTI A. Resilience and Urban Design[D]. University of Strathclyde, 2018.

[15] YE Y, ZHUANG Y. Evolution Hypothesis of Spatial Form and Vitality of New District: Based on Integrated Analysis of Street Accessibility, Building Density, Form and Functional Mixing Degree [J]. Urban Planning International,2017,32(02):43-49.

[16]TIAN Yinsheng. The Management Unit of Urban form: Significance, Construction and Application [J]. City Planning Review, 2021,45(7):9-16.

[17] YAO Sheng, TIAN Yinsheng, CHEN Jintang. Theory of Regionalization of Urban Form and its Role in Heritage Protection [J]. City Planning Review,2013(11):47-53,66.

[18] ZHANG Jian, TIAN Yinsheng, GU Kai, et al. Property plot Under the Perspective of Western Urban Morphology Research and Enlightenment [J/OL]. Urban Planning: 1-9 [2022-03-19].http://kns.cnki.net/kcms/detail/11.2378.TU.20220301.1650.004.html

[19] FELICIOTTI A, ROMICE O, PORTA S. Urban Regeneration, Masterplans and Resilience: the Case of Gorbals, Glasgow[J]. Urban Morphology, 2017, 21(1): 61-79.

[20] TIAN Yinsheng, CAI Meng, DENG Shushan. Organic Renewal of Historical Towns Based on "Management Unit"—An experiment of Wenquan Town in Conghua District, Guangzhou [J]. Urban construction, 2017 (33) : 33-37.

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Study on Landscape Cluster Model and Continuous Conservation of Traditional Villages in Southeast Chongqing

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ABSTRACT: Southeast Chongqing is one of the most concentrated areas of traditional villages in China, and its rich and diverse mountain traditional village landscape is an important historical and cultural heritage, which is formed under the dual influence of geography and ethnicity. Faced with the realistic requirement of concentrated and continuous conservation of traditional villages in this region, there is an immediate demand to investigate the formation background, cluster model and conservation and utilization system of traditional village landscape in the region. By using the research methodology of historical geography, GIS spatial analysis, and spatial planning, the study analyzes the clustering, correlation, systematization and specificity of traditional village landscape clustering pattern in southeast Chongqing and proposes the clustering conservation and utilization system and implementation strategy of traditional village landscape from three scales: regional, watershed and settlement, so as to explore the current stage of traditional village clustering conservation work. It also proposes an effective path for the conservation of traditional villages and sustainable development of the region.

KEY WORDS: traditional village; landscape cluster; cluster-based conservation; southeast Chongqing; concentrated continuous conservation

1 Introduction

In the mountainous southwestern areas of our country, where the natural environment is complex and ethnic groups are diverse, there are a large number of traditional villages. According to the statistics of the six batches of the Chinese Traditional Villages List, the number of traditional villages in the four provinces and one city in southwest China is as high as 2, 177, accounting for 26% of the total number in the country. Among them, the density of traditional villages is the highest in the Yunnan-Guizhou Plateau, southeast Guizhou, and southeast Chongqing (Figure 1). The traditional villages in these areas not only retain rich historical and cultural resources and cultural landscapes, but also fully reflect the diversity and complexity of the evolution of human-land relations under the dual influence of the natural environment and ethnic history and culture in mountainous areas[1-2]. In order to fully protect the cultural heritage of concentrated and contiguous traditional villages and explore a long-term mechanism for the protection of traditional villages, the Ministry of Finance and the Ministry of Housing and Urban-Rural Development have put forward the requirement of "implementing the protection and moderate development of traditional villages in areas with suitable

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conditions" since 2017, which has opened up the protection and development practice of traditional villages in concentrated and contiguous areas from single settlements to settlement clusters [3]17. In 2022, Youyang Tujia and Miao Autonomous County and Xiushan Tujia and Miao Autonomous County in southeast Chongqing were listed as national demonstration counties for the protection and utilization of concentrated and contiguous traditional villages. Faced with the overall protection requirements of "connecting points and lines into pieces" for traditional villages, how to deeply grasp the regional traditional village landscape formation mechanism and clarify the relationship between the traditional village landscape cluster model and spatial structure is an important basis for the regional protection and differentiated utilization of traditional villages.

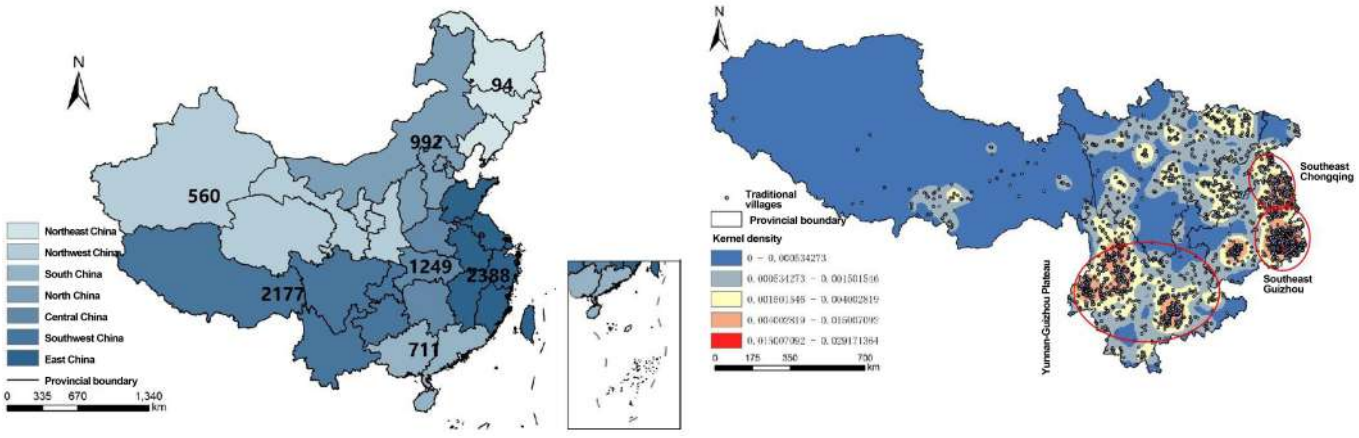

Figure 1 Number and kernel density distribution of six batches of traditional villages in southwest China

In recent years, with the introduction of the rural revitalization strategy and the advancement of traditional village protection inChina, research on the protection and development of traditional villages has gradually expanded from the study of the internal space of a single settlement to the protection of settlement landscapes. The study of traditional village settlement landscapes mainly revolves around landscape genes [4], element identification [5], characteristic mapping [6], and influencing factors [7]. The research scope has gradually expanded from the identification of landscape elements of a single settlement to the exploration of the characteristics of traditional settlement landscape metabolism, inheritance, and variation [12] at different scales, such as watersheds [10] and regions [11], based on the concepts of landscape gene cells [8] and gene chains [9]. The research methods have also gradually been combined with spatial analysis methods such as GIS [13] and GeoDesign [14]. In contrast, the research on the overall protection and utilization strategies of traditional villages in concentrated and contiguous areas is relatively weak. Existing studies are mostly aimed at exploring the influencing factors, landscape value and characteristic generation mechanisms of traditional settlement landscapes [15-17]. Some scholars use quantitative analysis methods such as social network analysis, minimum resistance model [18] and MST clustering [19] to evaluate the spatial distribution characteristics and development level of regional traditional villages, and suggest building a regional network linkage pattern of traditional villages [20] and exploring a cluster protection and development model for traditional villages [21] to solve the problem of scattered protection caused by insufficient protection motivation and lagging development of individual villages or cultural heritage. However, in general, the application of overall protection strategies is still in its infancy [22]. It is urgent to analyze the generation, characteristics and development pattern of regional traditional village landscapes based on specific case areas, analyze the driving mechanism of traditional village landscape generation and the guiding strategy for concentrated and contiguous pro-

tection and development, and improve the research system of overall protection and development of traditional villages.

Therefore, in order to explore the characteristics of the traditional village landscape cluster in southeast Chongqing and construct a concentrated and contiguous protection strategy based on landscape clusters, this study sorted out the staged influence of regional natural environment, institutional policies, transportation and technological development in the formation of traditional village landscape in southeast Chongqing through historical and geographical literature. Through the correlation analysis of the spatial distribution of traditional villages and landscape elements, the agglomeration, correlation, characteristics and systematicity of traditional village landscape clusters were explored. On the basis of constructing a cluster protection and utilization framework for traditional village landscapes, a "point-line-surface" landscape cluster construction with settlement landscape as point, watershed unit as line and cultural cluster as surface and a regional coordinated protection and utilization strategy of zoning, grading and differentiated development were proposed. It is hoped that taking the southeast Chongqing area, where traditional villages are most concentrated and multi-ethnic cohabitation is the representative, as an example, the experience and model of regional traditional village landscape cluster protection and development with practical application value can be summarized to provide reference for the concentrated and contiguous protection and regional coordinated development of traditional villages in my country.

2 Phased impact mechanism of landscape formation of traditional villages in southeast Chongqing

The southeast Chongqing region discussed in this study refers to the one district and four counties of Chongqing City located on the northwest edge of the Wuling Mountain Area, including Qianjiang District, Shizhu Tujia and Miao Autonomous County, Pengshui Miao and Tujia Autonomous County, Youyang Tujia and Miao Autonomous County, and Xiushan Tujia and Miao Autonomous County (Figure 2). Through the analysis of historical and geographical documents in the region and the field survey of the first five batches of 73 traditional Chinese villages, it was found that the southeast Chongqing region, due to its status as a transportation corridor and hub between Ba and Chu, and its proximity to the political center of Chongqing Prefecture, has made the traditional villages in the region present a mountain settlement landscape with the integration of Tujia, Han and Miao cultures. In the historical process of its landscape formation, the opening of the Yuanshui River Basin by the imperial court in the fifth year of Xining in the Song Dynasty (1072) and the "bureaucratization of Tusi" in the twelfth year of Yongzheng in the Qing Dynasty (1734) and the twenty-sixth year of Qianlong in the Qing Dynasty (1761) were key historical nodes that affected the development and governance of the southeastern Chongqing region. Therefore, what follows uses the mid-Song Dynasty and the early Qing Dynasty as two dividing lines to analyze the phased impact mechanism of the formation of traditional village landscape in southeast Chongqing (Figure 3).

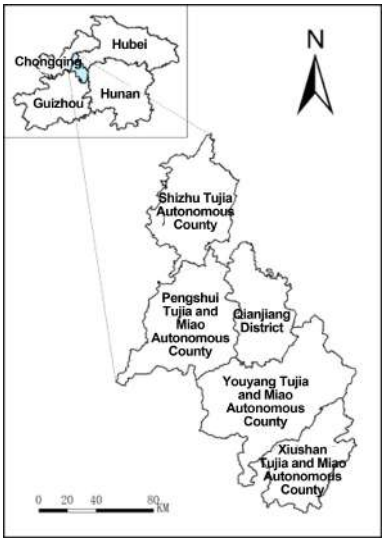

Figure 2 Location and scope of the study area

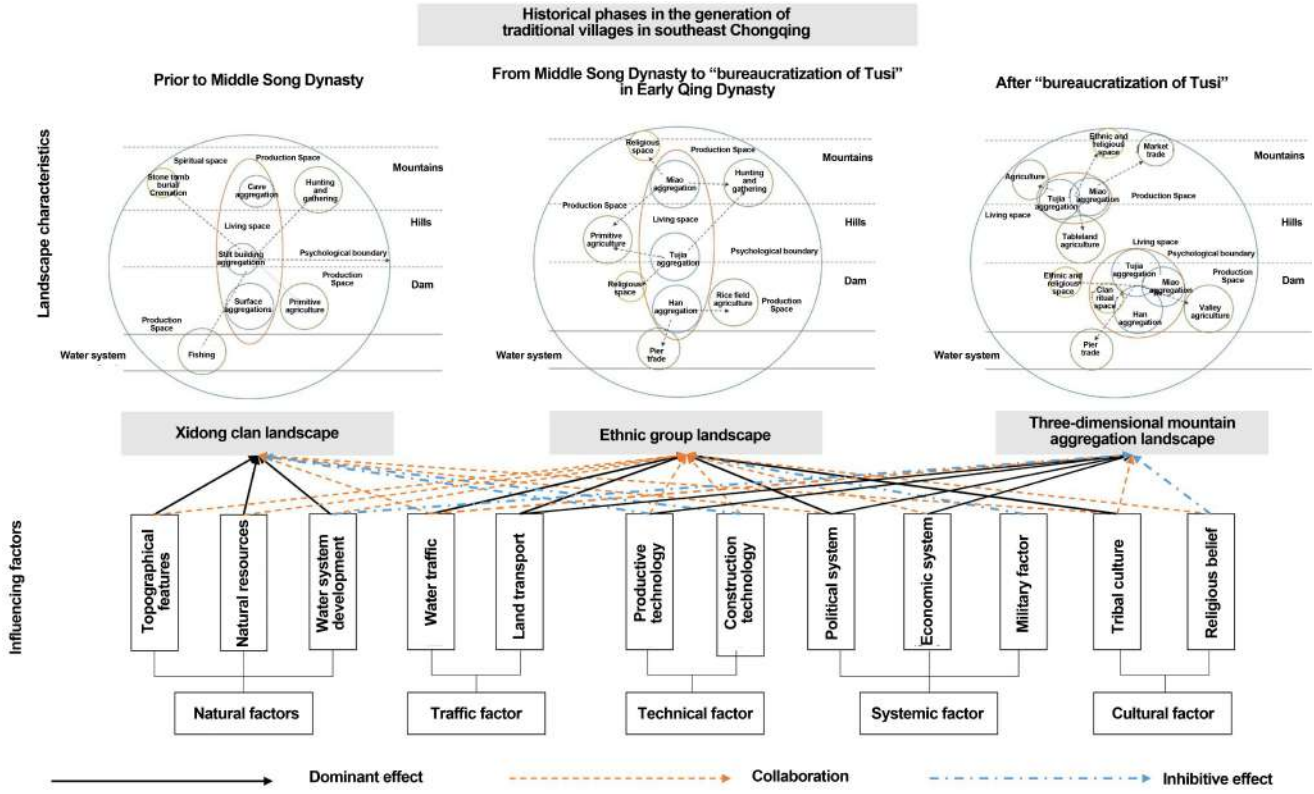

Figure 3 Phased impact mechanism of landscape formation of traditional villages in southeast Chongqing

2.1 Formation of the Xidong tribe landscape under the dominance of natural factors (before the mid-Song Dynasty)

Before the large-scale development of the Wuling Mountain Area in the mid-Song Dynasty, the local human settlements in the southeast Chongqing area were mainly concentrated in the middle hills and flat river valley areas of varying heights and sizes. The settlement archaeological sites discovered in southeast Chongqing and its surrounding areas today mainly include three types: cave sites, ground settlement sites, and stilt settlement sites, all of which are closely related to rivers and streams1). In the historical documents of the Tang and Song Dynasties, whether it is the record that the Ba people flowed into the Wuxi area at the junction of Hubei, Hunan, Guizhou and Chongqing at the end of the Qin Dynasty, and the five sons of the Ba people "each became the head of a river"2), or the historical and geographical description of "Nine creeks ('Xi') and eighteen flatlands ('Dong'), one tribe for one flatland" in the Wuling Mountain Area, it shows that the riverside flat landforms scattered among the canyon-type mountains in the area, as well as the fishing and hunting resources near the water and mountains, provided a relatively suitable and closed waterside settlement environment for the formation of the original settlements in the area, and the criss-crossing water systems between the valleys became an important clue to the formation of the Xidong tribe landscape based on blood relations.

2.2 The formation of ethnic landscape under the influence of transportation development and system (from the middle of the Song Dynasty to before the reform of theadministrative system)

During the Xining period of the Northern Song Dynasty (1072), the central government opened roads and built borders in the Wuling Mountain area in southeast Chongqing in order to open up a passage from Dongting Lake to Guangxi. This led to the formation of military transportation post roads with the Wujiang River and Yuanshui River as the core [23] 50-56 (Figures 4-1 and 4-2).Tuntians were set up on the post roads and military administrative guard posts were established. As a result, relying on the development of water and land transportation and the implementation of the tuntian and immigration reclamation system, a large number of Han immigrants

moved into the river valleys along the river. The prosperity of agriculture led to the continuous expansion of cultivated land in the shallow hills along the river (Figures 4-4 and 4-5). On the other hand, in the Tusi area covering most of Shizhu, Youyang and Xiushan, the feudal lord economy and small-scale agricultural production of slash-and-burn farming made it more primitive than the agricultural economy of the tuntian areas. The main ways of wealth accumulation were nanmu felling and the collection of military pay by the Tusi army [23] 125-128. Therefore, under the prohibition of "barbarians do not leave the border, and Han people do not enter the dong," Tusi, prefectures and counties, garrisons and scattered Miao areas formed ethnic divisions in geographical units, that is, Han settlements were located in garrisons, tuntian areas, and commercial areas, Tujia settlements were located on both sides of streams and rivers and in shallow hills in Tusi areas, and Miao settlements were located in the back mountains, "inside the stream" and other semi-high mountain areas.

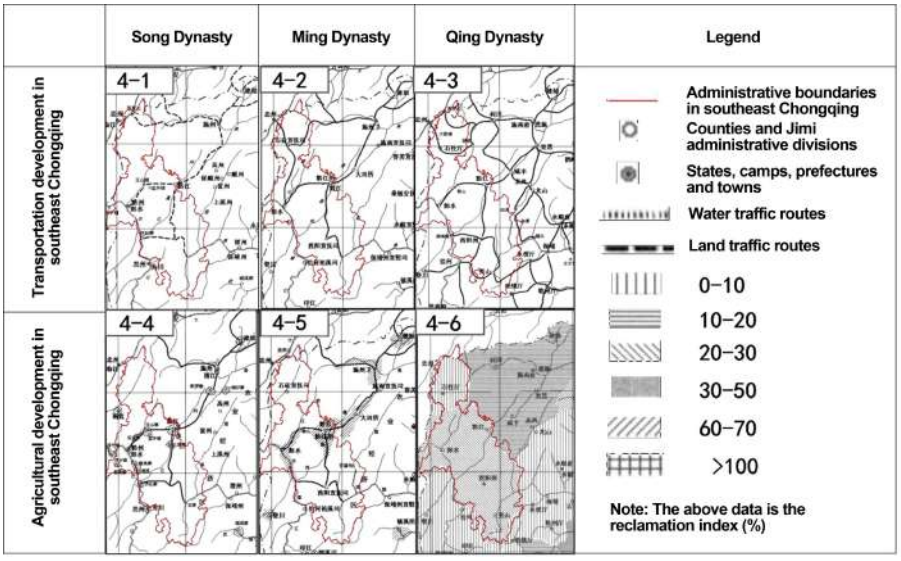

Figure 4 The historical process of transportation and agricultural development in southeast Chongqing

2.3 The formation of mountain three-dimensional settlement landscape under the influence of cultural integration (after the reform of Tusi to officials)

Under the implementation of the "reform of Tusi to officials" system in the early Qing Dynasty, the Qing government further renovated the mountain post roads opened in the Ming Dynasty, forming a transportation network system with waterways as the axis and land as the network. The commercial geography structure with Gongtan and Longtan in Youyang Prefecture as the regional commercial centers and Shizhu and Qianjiang as the secondary centers gradually matured (Figure 4-3), and the market town commercial landscape formed along the commercial roads developed rapidly. At the same time, under the policy of "recruiting people to reclaim wasteland," a large number of people poured into the southeastern part of Chongqing in the early Qing Dynasty. The immigrants or the descendants of the local Tujia people gradually moved to the hillsides, presenting a mountain three-dimensional agricultural settlement landscape with comprehensive coverage of settlements from river valleys to mid-mountains (Figure 4-6).

3 Characteristics of traditional village landscape clusters in southeast Chongqing and the construction of a protection and utilization framework

From the above analysis, it can be seen that the mountainous three-dimensional traditional village landscape clusters with multi-ethnic cultural integration in the region are not formed by chance or random, but are the result of spatial organization of human settlement space elements in mountain valleys under theeffect of a series of influencing factors such as nature, transportation, technology, system, and culture[24]. Over time, a traditional village cluster with closely related elements and mutually

supported functions has been formed in southeast Chongqing. Based on the delineation of the supporting attributes of the traditional rural settlement cluster model by existing scholars, the following will analyze the characteristics of the traditional village landscape clusters in southeast Chongqing from the three attributes of agglomeration, correlation, and characterisits [3] 19, and delineate its landscape cluster units based on the systematic mechanism of landscape generation [25].

3.1 Agglomeration characteristics with tributary water system as the core

Agglomeration is a manifestation of the evolution of traditional village landscapes, that is, the agglomeration of spatial attributes is formed through the agglomeration of social relations such as population and production. It is also a prerequisite for the concentrated, continuous and clustered protection and development of traditional villages. Through the nearest neighbor index and kernel density analysis of 73 sample villages in southeast Chongqing, it was found that the distribution of traditional villages in the region isvaried in density, with multiple aggregation cores and an obvious "core-edge" structure. The aggregation cores are located in small marginal areas within the tributary basins, mainly concentrated in the Youshui River Basin and the Apeng River Basin on the east and west sides of Youyang, as well as the Meijiang River Basin in Xiushan, and are aggregated in round patches (Figure 5).

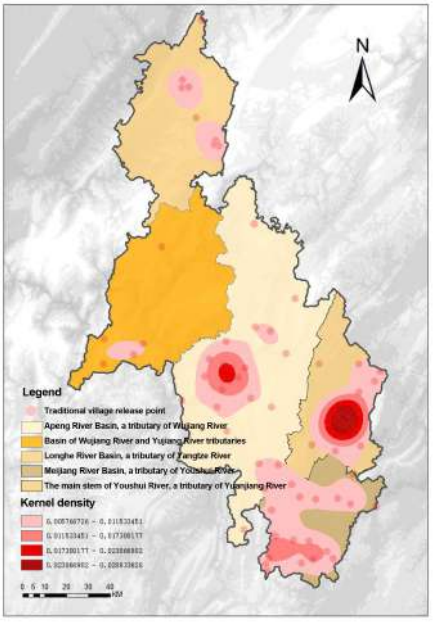

Figure 5 Kernel density analysis of the spatial distribution of traditional villages in southeast Chongqing

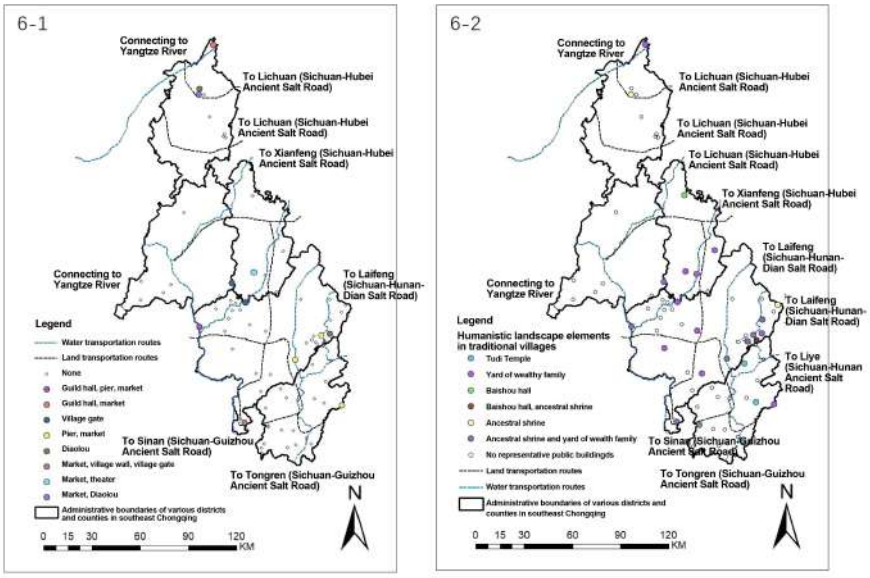

Figure 6 Spatial distribution of cultural landscape elements in traditional villages in southeast Chongqing

3.2 Correlation characteristics based on ancient road transportation

Correlation is an important factor in the formation of traditional village landscape clusters. From the above analysis of the influencing mechanism,it can be seen that water and land transportation and cultural identity are important clues to maintain the stability and development of the traditional village landscape cluster in southeast Chongqing

and are also important bases for the delineation of objects in future cluster protection and development. Therefore, by analyzing the spatial distribution of sample villages and their internal human landscape elements with the natural water system and the ancient road routes sorted out in the county annals, it is found that commercial function landscapes such as guild halls, docks, and markets and defensive function landscapes such as watchtowers and village walls are mainly distributed in villages adjacent to the ancient road routes (Figure 6-1); cultural core elements with regional influence, such as ancestral halls and baishou halls, are also closely related to historical ancient road routes (Figure 6-2).

3.3 Unique characteristics based on historical functions and national culture

Unique characteristics refer to the differentiated yet similar values of various landscape elements in the traditional village landscape cluster, which are also the resource and competitiveness of village landscape protection and utilization. Through the correlation analysis between the spatial distribution of sample villages and altitude, it is found that the functions of villages show vertical differentiation characteristics by altitude (Figure 7, Figure 8). The main functions of valley areas are water-land trade and agriculture combined with polder fields and dam fields, those of low-altitude mountain areas are land trade and agriculture combined with terraces, dam fields, and ridge fields, and medium-altitude mountains feature land trade and agriculture combined with ridge fields and terraces. Therefore, combined with the differences in the types of typical cultural landscape elements in traditional villages in southeast Chongqing, the traditional village landscapes in southeast Chongqing are divided into five landscape types: mountain agricultural landscape, ancient road trade landscape, military defense landscape, immigrant clan landscape, and ethnic landscape (Table 1).

3.4 Framework for cluster protection and utilization of traditional village landscapes based on systematic characteristics

Through the analysis of the three supporting attributes of agglomeration, correlation andcharacteristics, it can be found that the traditional village landscape cluster is

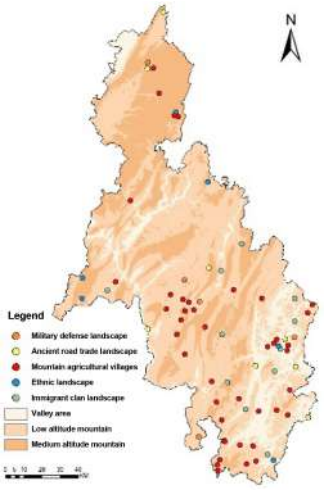

Figure 7 Spatial distribution of functional elements in traditional villages in southeast Chongqing

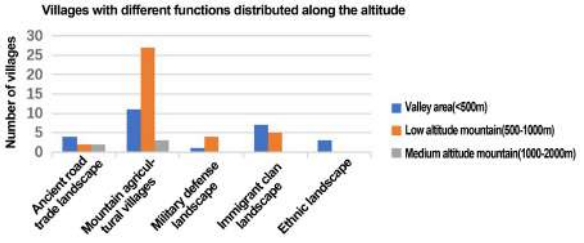

Figure 8 Distribution of villages with different functionsby altitude in southeast Chongqing

not a simple sum of settlements and spatial collections, but a spatial structure of traditional settlement woven by water systems and roads under specific natural conditions. It embodies the multi-complex dynamic system relationship composed of the coupling interaction between natural, economic, political and cultural elements. How to optimize the agglomeration and correlation of the existing spatial functional system, optimize and reorganize these rich single settlement landscape type characteristics with the regional natural ecological environment and human geography resources, and form a traditional village landscape cluster protection and utilization system with agglomeration effect, group characteristics and differentiated development is a key issue that needs to be solved at this stage. Therefore, the study combines the landscape generation mechanism and spatial structure characteristics of traditional villages in southeastern Chongqing, analyzes regional cultural characteristics, delineates landscape cluster units, sorts out the key elements of landscape clusters, and constructs a framework for cluster protection and utilization of traditional villages in southeast Chongqing (Figure 9).

Table 1 List of landscape characteristics of traditional villages in southeast Chongqing

Broad categories of landscape features	Narrow categories of landscape features	Natural ecological landscape	Economic production landscape	Group settlement landscape				Family house landscape	Typical villages	Typical village aerial photo/ current status
				Spatial pattern	Street pattern	Cultural space	Spatial pattern			
Mountain agricultural village landscape	Slope terraced field village landscape	Mountain semi-slope	Mainly curved terraced fields	Large, medium and small-sized	Massive/ strip	Organic organized	Ancestral house, well	Stilt house + zuozi house, courtyard	Hejiayan Village, Dahekou Village, Youyang County, Dazhai Village, Xiushan County (see the picture right))	
	Valley fishing and hunting village landscape	Mountain valley/river valley	Mainly polder/irregular dam field	Large, medium and small-sized	Scattered /strip	Organic dispersion /organicorganized	Baishou hall, pier, square	Courtyard,zuozi house	Cangling Village, Youyang County (see the picture right), Nanxi Village, Lianghe Village, Xiushan County	
Ancient road trade village landscape	Riverside trade village landscape	Riverside valley	Riverside trade, no farmland	Large-sized	Strip	Street-dominated	Ancestral hall, guild hall,pier	Shop, courtyard , zuozi house	Youyang Xiaoyin Village (seethe picture right), Yandi Village, Xiushan Biancheng Village	
	Land-based village landscape	Hillyflat land/mountain valley	Land-based trade, no farmland/ mainly irregular dam fields and curved terraces	Large and medium-sized	Strip	Street-dominated	Ancestral hall	Shop house, courtyard , zuozi house	Qianjiang Shuicheping Old Street (seethe picture right), Shizhu County Fumin Village	
Military defense village landscape	Civil defense village landscape	River valley coast/ hilly flat land/mountain valley	Land trade/ mainly irregular dam fields and curved terraces	Large and medium-sized	Massive/ strip	Organic organized /street-dominated	Village wall, watchtower , mountain village	Shop house, courtyard	Xincheng Village, Shizhu County (seethe picture right), Nanjie Village, Youyang County, etc.	

(Continued)

Broad categories of landscape features	Narrow categories of landscape features	Natural ecological landscape	Economic production landscape	Group settlement landscape				Family house landscape	Typical villages	Typical village aerial photo/ current status
				Spatial pattern	Street pattern	Cultural space	Spatial pattern			
Immigrant clan village landscape	Immigrant manor village landscape	River valley	Mainly polder/ irregular dam field	Small and medium-sized	Massive/ scattered	Organic organized /organic scattered	Ancestral hall, ancestral house	Manor	Daping Village, Wuli Community, Youyang County Yangang Ancient Village (see the picture right), etc.	
Ethnic characteristics village landscape		Mountainous half-slope/hilly flat land	Mainly curved terraces	Large, medium and small-sized	Massive	Organic organized	Baishou hall, tudi temple	Stilt house + zuozi house	Hewan Village (seethe picture right) in Youyang County, Qinglongzhai, Ethnic Village in Xiushan County, Xinjian Village in Qianjiang District	

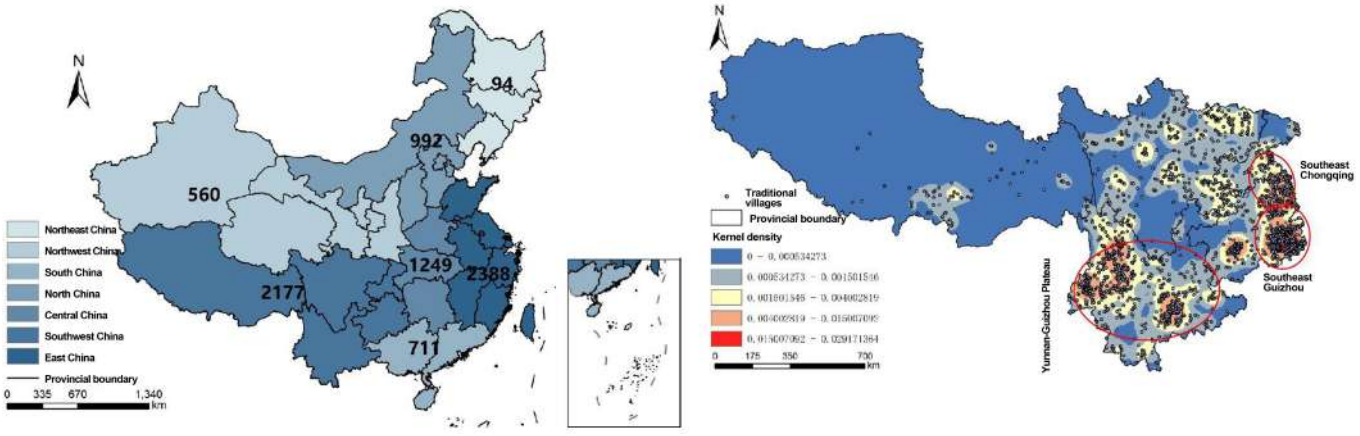

Figure 9 Framework of the cluster protection and utilization system of traditional villages in southeast Chongqing

4 Cluster protection and utilization system of traditional village landscape in southeast Chongqing

4.1 Region scale: spatial framework of landscape cluster protection based on cultural ecosystem

The regional cluster protection and utilization of traditional village landscape in southeast Chongqing not only needs to protect the "point-shaped" traditional village landscape characteristics, but also emphasizes the "surface" mountain topography and ethnic cultural foundation, the cultural routes composed of natural water systems, historical ancient roads, and the village landscape composed of traditional village ecology, economy, settlements, hou-

ses and other landscape elements, which together form a regional cultural ecosystem [26]. This regional cultural ecosystem is the basis for the sustainable development of historical and cultural protection in southeastern Chongqing, and its regional overall protection value is far greater than that of a single settlement.

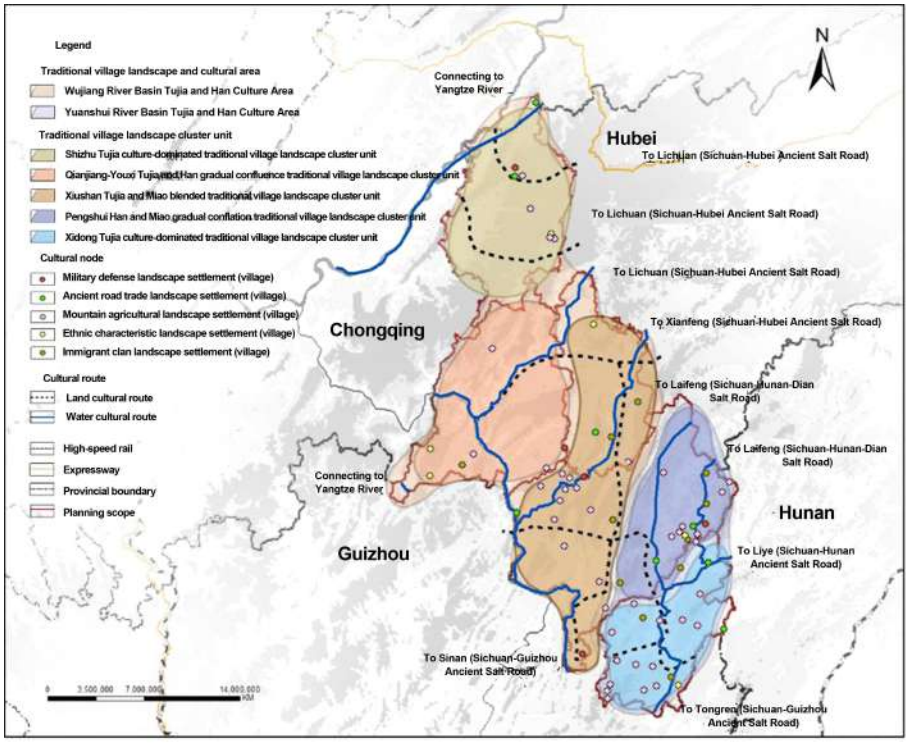

Figure 10 Cluster protection space framework for traditional village landscape in southeastern Chongqing

Therefore, starting from the agglomeration,correlation and characteristics of landscape clusters, a cluster-type spatial framework for the protection of traditional village landscapes consisting of "points-lines-surfaces" is established. The study comprehensively considers the agglomeration characteristics of traditional villages in southeast Chongqing with tributary water systems as the core, the correlative characteristics with ancient road transportation as the clue, and the unique characteristics with historical functions and ethnic culture as the value. The southeast Chongqing region is divided into two large traditional village landscape cultural areas in the north and south with Maobagai-Guangyangai as the boundary: the Tujia and Han cultural area in the Wujiang River Basin and the Tujia and Miao cultural area in the Yuanshui River Basin. Within the two cultural areas, they are further subdivided into five traditional village landscape cluster unit areas based on "geographical location + dominant or integrated cultural type" and the distribution and enrichment of cultural landscapes, so as to carry out more targeted protection (Figure 10).

On this basis, it is necessary to break administrative boundaries at the regional scale and clarify the control measures for the basic elements and relevance elements that maintain the stability of landscape clusters [27]. For example, the protection of the regional Maobagai-Guangyangai mountain ecological basic network, the cultural ecological protection of the Youshui River, Meijiang River and Wujiang historical waterways and post lines, the protection of the traditional village structure and entity in the river basin, etc.

4.2 Watershed scale: Construction of cultural routes and hierarchical protection strategies within cluster units

The basin is both a geographical unit and a cultural unit. The natural geographical environment within the basin unit affects the generation of traditional village ecological landscape elements in a one-way dimension, while the human geographical environment affects the generation of village settlement landscape and architectural landscape in

the form of the flow of multiple elements such as transportation, technology, and culture [28]. The five traditional village landscape cluster units delineated above correspond to the Long River, a tributary of the Yangtze River, the Apeng River and Ayi River, tributaries of the Wujiang River, and the Youshui River and Meijiang River, tributaries of the Yuanshui River.

Therefore, the study proposes the construction of cultural routes and hierarchical protection strategies for the traditional village landscape clusters in the five tributary basin units. The basin units where traditional villages are concentrated are taken as the core areas of the traditional village landscape cluster units, and linear heritage protection corridors are constructed. According to the historical functional characteristics of the villages and the types of landscape elements, core protection villages, key protection villages, and general protection villages are delineated (Figure 11, Table 2). First, a cultural route with water systems and ancient roads as clues is constructed within the landscape cluster unit. Taking the core area of the Youshui River Basin in the Youdong Tujia culture-dominated traditional village landscape cluster unit as an example, the delineation of the heritage corridor relies on the original site selection factor of the traditional village - the water system, and the 1.8 km range of the Youshui River mainstream and the 1.2 km range of tributaries such as Dajiangxi, where the historical and cultural resources are most concentrated, are delineated as the heritage corridor.

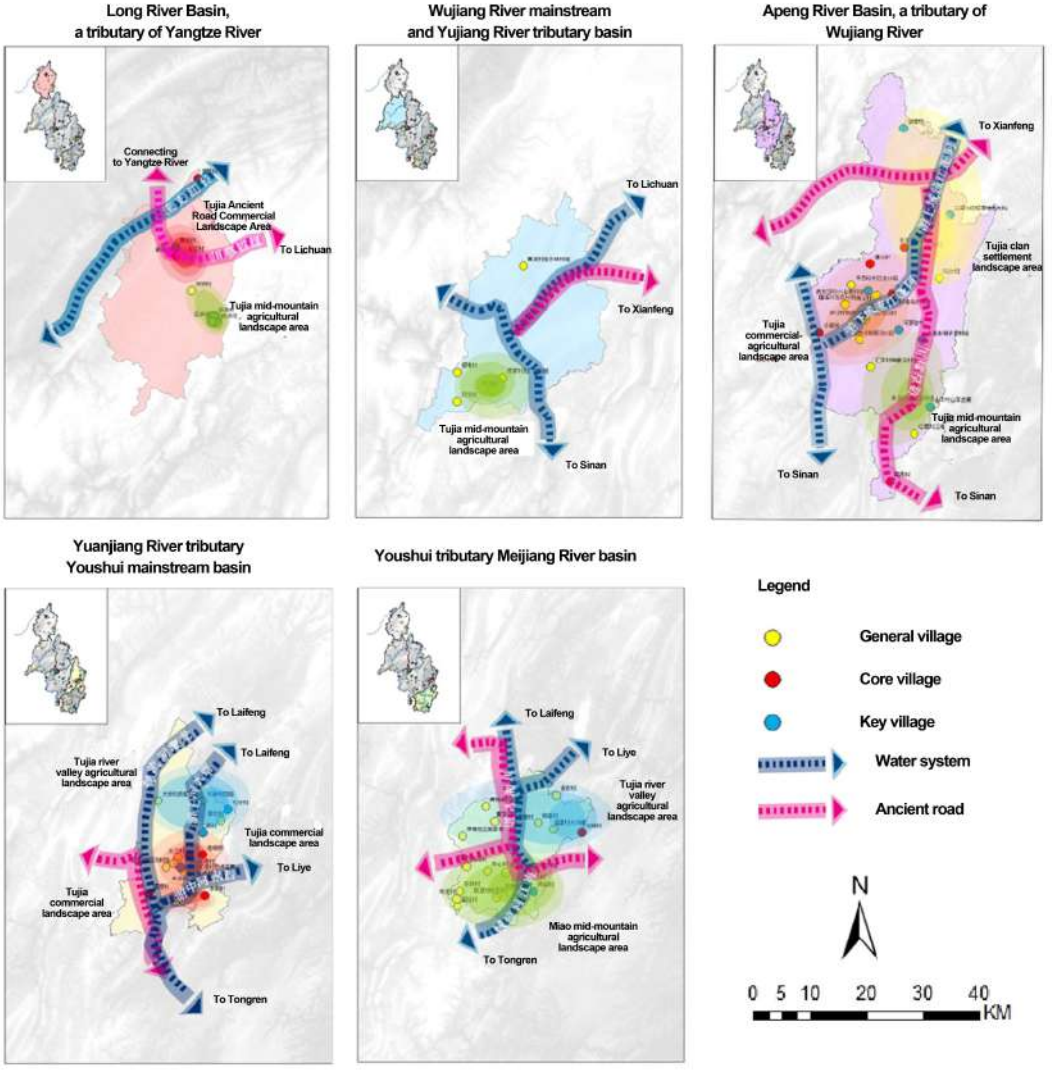

Figure 11 Hierarchical protection and cultural route map of traditional village landscapes in southeast Chongqing at the watershed scale

Secondly, in terms of the hierarchical protection strategy, the core protected villages with the landscape characteristics of the ethnic settlements in the mountainous areas of southeast Chongqing are comprehensively protected, their historical resources and surrounding environment are strictly controlled, and the important historical landscape elements in the villages are protected and designed to intuitively reflect the regionality of the traditional village landscape in southeast Chongqing; they are relied on to form the dominant center of the traditional village land-scape resources in the basin. Secondly, the structural and related landscape elements such as the ancient transportation roads and military and commercial landscapes in the key protected villages are protected to strengthen their hub status in the basin landscape unit. For general farming villages, maintenance of the existing style is the main focus, and the integrity of the traditional village landscape elements is protected according to the three-zone control requirements.

Table 2 List of the zoning of traditional village landscape cluster units and village classification protection in southeast Chongqing

Traditional village landscape and cultural area	Traditional village landscape cluster unit	Landscape cluster unit area	Landscape cluster corridor	Traditional village landscape protection classification	
Maobagai-Guangyangai north of Tujia, Han and Miao culture mixed traditional village landscape and cultural area	Area I—Shizhu Tujia culture dominant traditional village landscape cluster unit	Tujia ancient road commercial landscape area	Sichuan-Hubei ancient road	Core village	Xincheng Village
				Key village	Huanglong Village
				General village	Jinhua Village
		Tujia mid-mountain agricultural landscape area	—	General villages	Yinxing Village, Xiangshui Village, Shisun Village, Pingba Village
		Scattered distribution	Yangtze River tributaries	Core village	Fumin Village
	Area II — Pengshui Han-Miao culture-gradual conflation traditional village landscape cluster unit	Miao mid-mountain agricultural landscape area	—	General villages	Yingtao Village, Tianwan Village, Shuanglong Village, Rongjia Village Wachangba
		Scattered distribution	—	General village	Huangni Village Danzixia
	Area III — Qianjiang-Youxi Tu-Han culturegradual conflation traditional village landscape cluster unit	Tujia business-agricultural landscape area	Lower reaches of the Apeng River Basin	Core villages	Foshan Village, Shuicheping Old Street, Xiaoyin Village, Yongxiang Village
				Key villages	Hejiayan Village, Cangling Village Chiliushui Village Group, Dahekou Village, Shuiba Village Xiaoshanpo Village Group
				General villages	Lingkou Village Yangjiazhai Village, Qiantian Village Muoushui Village Group, Miaoxi Village Wulong Village Group, Nanxi Village
		Tujia clan settlement landscape area	Upper reaches of the Apeng River Basin	Key village	Shuicheping Old Street
				Key villages	Xinjian Village, Daping Village, Wuli Community Chengjia Characteristic Courtyard
				General village	Fengtai Village
		Tujia mid-mountain agricultural landscape area	Sichuan-Guizhou ancient road	Core village	Nanjie Village
				Key village	Longchi Village Dongzituo Village Group, Yangyang Village Yanggu Village
				Generalvillage	Huijia Village Shenliangxi Village Group, Bingyuan Gelaoxi Village Group, Hongxia Village Group 3

(Continued)

Traditional village landscape and cultural area	Traditional village landscape cluster unit	Landscape cluster unit area	Landscape cluster corridor	Traditional village landscape protection classification	
Maobagai-Guangyangai South Tujia-Miao Culture Mixed Traditional Village Landscape	Area IV - Youdong Tujia Culture Dominant Traditional Village Landscape Cluster Unit	Tujiacommercial landscape area	Longtan River Basin	Core villages	Yanti Village, Shuiba Village
				General village	Yanyuan village
		Tujiacommercial landscape Area	Youshui River Basin Middle Reaches	Core villages	Laobai Village, Houxi Village
				Key Village	Qinglong village Qinglong stockage
				General villages	Qianjin Village, Hewan Village, Dajiang Village, Hewan Village Konghuxi Village, Changyuan Village, Liangzhi Village Lantiangou, Guangming Village Zinc Jianggou Village Group, Daban Village Pidu Village Group
		Tujia river valley agricultural landscape area	Upper Youshui River Basin	Key villages	Qifen Village, Jiangxi Village
				General villages	Daban Village Pidu Village Group, Xibi Village, Shanling Village Group 4
	Area V - Xiushan Tu-Miao Culture Integration Traditional Village Landscape Cluster Unit	Miaomid-mountain agricultural landscape area	Sichuan-Hunan Ancient Road	Key villages	Minzu Village, Kaigan Village
				General villages	Caitang Village, Dazhai Village, Lianghe Village, Kaibao Village Chenjiaba, Dongping Village, Fuyu Village, Cenlong Village, Guanxian Village Dayeshanzhai Village Group,Zhongxin Village
		Tujia river valley agricultural landscape area	Meijiang River Basin	Core village	Biancheng Village
				General villages	Xinnon Village, Caojiagou Village, Huangyangbiandan Village, Maopo Community Xiongjiapo, Baixiang Village, Yuanyang Village, Mengdong Village Dagou Group

4.3 Settlement scale: Exploring innovative utilization models for differentiated development

On the one hand, the traditional village landscape is a cultural landscape heritage that has continued to evolve over a long period of historical change, and on the other hand, it is also an important component of the contemporary rural living environment. At this stage, the concentrated and contiguous protection of traditional villages requires the protection and utilization of traditional villages to be transformed from the utilization of landscape resources of a single village to the upgrading of traditional village cluster capital. The traditional village cluster utilization model expands the planning scale to the natural space system and the urban-rural coordination system from the perspective of holistic protection and sustainable development, and explores ways to activate the protection of cultural heritage and match urban and rural economic development [3]16-20. Taking the traditional village landscape cluster unit of Qianjiang and Youxiof gradual confluence between Tujia and Han cultures as an example, in addition to the typical commercial villages and towns of Longtan Ancient Town and Gongtan Ancient Town, the natural landscape of the canyon of the Apeng River tributary in the Wujiang River Basin, the long-established Ran family Tusi administrative center, the "Qianjiang Ancient Road" running through Hunan and Guizhou, and the extensive pastoral and mountain villages between the river valleys and mountains together constitute the Youxi's traditional village landscape pattern of "ancient road commerce, mixed residence of Tujia and Han." At present, the ancient towns of Longtan and Gongtan have been well protected, but the overall pattern of their historical villages

and towns and many of the "points" and "lines" of traditional village landscape resources are being destroyed by the homogenized tourism industry competition and the gap in urban and rural economic development. Therefore, it is necessary to carry out targeted guidance on industrial development, urbanization, road traffic, landscape control, etc. in the landscape cluster units of Qianjiang and Youxi traditional villages, establish a landscape cluster system development strategy with cultural heritage function as the core, and list ecological conservation function and traditional agricultural fine transformation as the priority areas for the development of traditional villages in the landscape cluster units, so as to ensure agricultural production functions and provide support and control for the development of heritage tourism. On this basis, combined with the location conditions of the villages, the landscape types of traditional villages and the current socio-economic situation, three models of living in the countryside, ecological conservation and heritage tourism are proposed (Figure 12) to achieve differentiated development.

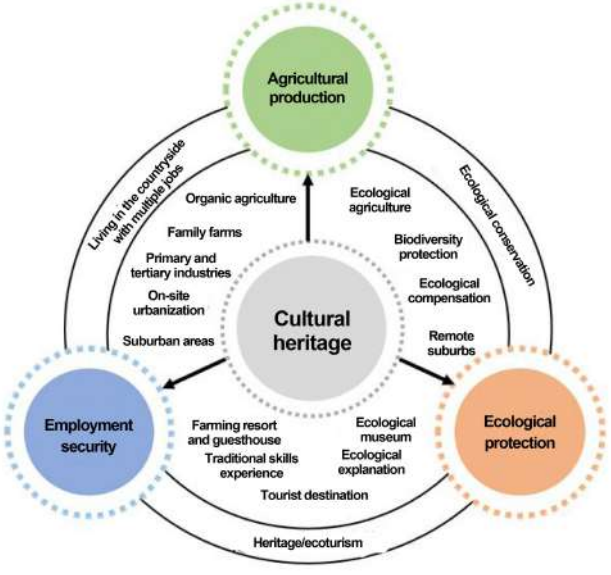

Figure 12 Utilization model of cluster protection of traditional village landscape in southeast Chongqing

The development positioning of traditional villages such as Xinjian Village and Daping Village is mainly based on the heritage tourism model. In terms of landscape types, they are mainly military defense landscapes with distinctive cultural landscape elements, immigrant clan landscapes and ethnic landscapes. Their tourism development has great potential and their employment guarantee function is relatively obvious. However, in order to avoid the gentrification and kitsch tourism development that deviates from the cultural heritage function, the combination of heritage interpretation, traditional village cultural landscape types and tourism should be emphasized. We cannot simply pursue the maximization of economic benefits. We need to develop more forms from the collective level of rural communities to achieve the goal of heritage and ecotourism development.

The development positioning of traditional villages such as Shuicheping Old Street and Xincheng Village is mainly based on the model of living in the countryside with multiple jobs. In terms of landscape types, they are mainly ancient road trade landscape villages and intensive agricultural landscape villages. They rely on relatively convenient transportation conditions, based on traditional agricultural resources, and increase the relative profits of agriculture in the form of family farms, organic agriculture, and ecological agriculture, attracting rural young labor to combine agriculture and nearby employment to achieve "local urbanization."

The development positioning of traditional villages such as Fengtai Village and Xiangshui Village is mainly based on the ecological conservation model. In terms of landscape types, they are mainly a few traditional agricultural and forestry landscape villages. Because agricultural productivity is weak, populationdecline is serious, and infrastructure construction is difficult to be effective, reducing the human and material input per unit area is more in line with the natural resource and environmental characteristics of the village, and is also conducive to improving its ecological conservation function. For such villages, it is necessary to actually reduce the economic pressure on farmers. Eco-museum projects or natural reserves can be used to develop eco-friendly agriculture and protect the characteristics and patterns of rural ecological landscapes. The key is to strengthen the comprehensive construction of social infrastructure and achieve the goal of social equity.

5 Conclusion

With the advancement of the concentrated and contiguous protection of traditional villages in China, the significance of the holistic and clustered protection of traditional village landscapes from a regional perspective has gradually received attention. In 2020, the Ministry of Finance and the Ministry of Housing and Urban-Rural Development issued the "Notice on Organizing the Application for Demonstration Cities for the Concentrated and Contiguous Protection and Utilization of Traditional Villages in 2020" (Finance Office Construction [2022] No. 6), which clearly defined the overall goal of "promoting the comprehensive improvement of the appearance of regional traditional villages, while exploring the establishment of a long-term mechanism for the protection and transformation of traditional villages, and demonstrating and driving the protection and utilization of traditional villages in other regions." Therefore, this study takes the southeastern Chongqing area on the northwest edge of the Wuling Mountain area, where traditional villages are most concentrated, as the research area. Based on the analysis of the influencing mechanism of traditional village landscape generation and the characteristics of landscape clusters, a framework for clustered protection and utilization of traditional village landscapes is constructed, and the clustered protection space and implementation strategy of the "point-line-surface" regional landscape space are proposed, amounting to an empirical study of the existing holistic concentrated and contiguous protection model.

As the research on the protection and development of traditional villages in China continues to advance, the exploration of regional, holistic, and cluster protection models and paths for traditional villages will become an important topic for future research. The problems of insufficient functions, disorderly competition, and resource waste caused by the protection model dominated by the protection of single settlements in the previous stage will become the core issues that need to be solved in the protection and utilization of historical and cultural resources at the scale of national space planning. This study is based on the exploration of the classification of traditional village landscape types from a historical and geographical perspective, and the exploration of the cluster protection and utilization system of traditional village landscapes at the three levels of region, watershed, and settlement. It can provide methodological support for the overall systematic protection and dynamic coordinated development of traditional village landscapes in areas with concentrated and contiguous traditional villages in China, and provide a reference for the regional and holistic protection of traditional settlements and dwellings in other ethnic regions.

Figure and Table Sources

Figures 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, and 12: created by the authors.

Figure 4: Redrawn according to Figures 4-1, 4-2, 4-3, 4-4, 4-5, and 4-6 in reference [28].

Table 1: The table and the photographs are all works of the authors.

Table 2: Made by the authors.

Notes

1) Archaeological discoveries in southeast Chongqing are relatively scarce, but the sites of Yongshun Buermen in Xiangxi, Chadong in Huayuan, and Liujiahe settlement in the Lingshui River Basin that have been discovered in the Wuling Mountain area in southeast Chongqing are closely related to rivers.

2) See (Song) Le Shi: Taiping Huanyu Ji, Volume 120, Jiangnan Xidao 18.

References

[1] LIU Peilin, LIU Cunla, DENG Yunyuan, et al. Landscape Division of Traditional Settlement and Effect Elements of Landscape Gene in China[J]. Journal of Geographical Sciences, 2010, 65(12): 1496-1506.

[2] WU Yan, SHAN Jun. Association Study on Regionality and Ethnicity of Building in the Minority Settlements of Northwest Yunnan [J]. Architectural Journal, 2013(5): 95-99.

[3] ZHANG Dayu, ZHANG Wenjun, CHEN Danliang. Analysis and Exploration of the Concept of Traditional Settlement Protection and Development Cluster Mode in The New Period[J]. Urban Development Studies, 2022, 29(4): 17, 19, 16-20.

[4] LIU Peilin, LIU Cunla, LI Bohua, et al. Characteristic and Genes-Analysis of Traditional Settlements' Landscapes in Chinese Minority Areas[J]. Chinese Geographical Science, 2010, 30(06): 810-817.

[5] ZOU Weihan, ZHANG Dingqing. Research on Landscape Gene I-

dentification and Mapping of Traditional Settlements: A Case Study of Traditional Settlements along Shu Routes in Southern Shaanxi[J].New Architecture,2021(1):121-125.

[6] WANG Zhaofeng,LI Qin,WU Wei.Genome Map Construction of the Cultural Heritage Landscape and Its Characteristics in Traditional Villages of Wuling Mountain Area[J].Economic Geography,2021,41(11):225-231.

[7] LI Xin,GUO Wei,LIN Qing.Research on Landscape Characteristics of Traditional Settlements in Hangjiahu Area[J].Modern Urban Research,2022(1):62-68.

[8] YIN Langchuan，LI Bohua，LIU Peilin, et al.Biological Characteristics of Landscape Gene Cells in Traditional Settlements[J].Economic Geography,2022,42(03):182-189.

[9] HU Hui,HU Zui,WANG Fan,et al.Features of Gene Information Chain of Traditional Village Landscape and Its Identification[J]. Economic Geography,2019,39(08):216-223.

[10] YIN Langcuan,LIU Peilin,LI Bohua et al.Map of Traditional Settlement Landscape Morphology Gene: A Case Study of the Xiangjiang River Basin[J].Chinese Geographical Science,2023, 43(6):1053-1065.

[11] LI Jing, YANG Dinghai, XIAO Dawei. Regional Differentiation and Forming Mechanism of Cultural Landscape of the Traditional Settlements and Vernacular Dwellings in Hainan Island[J].Urban Development Studies,2020,27(5):1-8.

[12] XIANG Yuanlin,CAO Mingming,QIN Jin,et al.Study of Traditional Rural Settlements Landscape Genetic Variability in Shaanxi Province Based on Accurate-Restoration[J].Progress in Geography,2020,39(09):1544-1556.

[13] HU Zui.A Research on the Geographical lnformation Features of Traditional Settlement Landscape Geneand the Related Understanding Approaches[J]. Journal of Geo-Information Science, 2020,22(5):1083-1094.

[14] HU Zui,LIU Peilin.Exploration on the Combination of GeoDesign and the Theory of CulturalLandscape Genes of Traditional Settlements[J].Economic Geography, 2021,41(8):223-231.

[15] LIN Likai,GUI Yan,DU Chunlan.Study on Landscape Environmental Adaptation of Traditional Yi Settlements in Southwest China[J]. Chinese Landscape Architecture,2023,39(4): 27-33.

[16] PAN Ying, WU Qi,SHI Ying.Research on the Landscape Characteristics and Values of Traditional Settlements in Gulao Watersids Settlement[J].City Planning Review,2022,46(7):108-118.

[17] PAN Ying,BAI Rui,SHI Ying.Research on the Landscape Characteristics of Traditional Settlement under the Influence of Topographic Factors—A Case of Weizhou Island in Beibu Gulf[J]. Chinese Landscape Architecture,2021,37(11):33-38.

[18] CHEN Xiaohua,WU Shiqiang.Development Pattern, Mechanism and Guiding Strategy of Network Protection of Regional Traditional Villages: Taking Jixi County of Anhui Province as an example[J].Journal of Anhui Agricultural University,2023,50(3): 473-483.

[19] JIANG Pei chen,WANNG Zhu.Exploration on the Construction of Regional Traditional Village Hierarchical Collaborative Network Based on MST Clustering: A Case Study of Concentrated Continuous Protection and Utilization of Traditional Villages in Yongzhou City[C]// Academic Committee of Urban Planning New Technology Application of Urban Planning Society of China. Consolidating the Data Foundation, Strengthening the Innovation Engine and Empowering Multi-dimensional Scenarios——Proceedings of the 2022 China Urban Planning Informatization Annual Conference. Guangxi Science and Technology Publishing House,2022:408-416.

[20] LYU Ningxing,FAN Zaiyu,GENG Hong, et al.The Integral Cultural Protection Dilemma and Revitalization Development Strategy of Ethnic Villages in Poverty-Stricken Areas[J].ModernUrban Research,2019(07):8-15.

[21] CHANG Guangyu,HU Yan.Exploring the Protection and Development of Traditional Villages Cluster[J].Urban Development Studies,2020,27(12):7-11.

[22] LI Mei,XU Dongsheng,ZHAO Pengfei,etal.Investigation on Continuous Protection and Activation Utilization of Traditional Settlement Space Via Digital Technology-Taking Jingxing County as an example[J/OL].Industrial Construction:(2022-10-31)[2022-12-27].https://kns.cnki.net/kcms/detail/11.2068.TU.20221031.0927.002.html.

[23] XIE Xiaohui.Manufacturing Marginality: Xiangxi in the 10th-19th Centuries[M].Beijing:Triptych Bookstore,2020:50-53、125-128.

[24] XIE Yuting, YING Jiaxin, CHEN Lin. Typology, Morphogenesis and Adaptive Transformation of Polder Landscape in the Yangtze River Delta[J].Urban Development Studies, 2022,29(4):70-77.

[25] GAO Fanqing,YANG Yuliang,ZOU Kaize, et al.The Study of the Basin Differentiation of Traditional Villages in Yunnan Province [J].Journal of Yunnan Normal University(Natural Sciences Edition),2022,42(1):64-72.

[26] SHAO Yong,HU Lijun,ZHAO Jie.Research on the Overall Protection and Utilization of Historical and Cultural Resources from a Regional Perspective: A Case Study of Southern Anhui[J].Urban Planning Forum,2016(3):98-105.

[27] SHAO Yong,CHEN Huan,HU Lijun.The System,Types and Characteristics of Historic Settlements in Southern Anhui[J]. HE Ritage Architecture,2021(1):38-51.

[28] ZHU Shengzhong.Regional Economy and Spatial Process: An Exploration of the Historical Economic Geography of the Tujia Region[M].Beijing:Science Press,2015:76-78、193-795.

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Study on Micro-updating Strategies for Age-Friendly Public Spaces in Small and Medium-Sized Cities' Old Communities

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ABSTRACT: Focusing on the scarcity of elderly care resources in small and medium-sized cities in Zhejiang Province, this study aims to efficiently, gradually, and precisely improve the age-friendliness of stock spaces in old communities. Based on the shortage of age-friendly spaces and the conflict between supply and demand, the study identifies four typical spatial features through on-site questionnaires and other surveys. Moreover, by focusing on the behavior of elderly residents and analyzing the content, patterns, and priority of their needs, the study identifies principles for extracting potential micro-public spaces, including proximity, disadvantaged spaces, and surplus spaces. Finally, the study proposes micro-updating strategies for age-friendly communities in small and medium-sized cities by improving the design guidelines, establishing industrial component standards, and exploring diversified collaborative mechanisms, which is demonstrated by a case design.

KEY WORDS: small and medium-sized cities; old communities; age-friendliness; micro-public spaces; micro-updating

1 Background

The aging of old communities has always been a hot social issue.With the proportion of elderly people in some old communities even exceeding 40% and there being a large number of elderly people living alone or in empty nests, the resulting agglomeration of such elderly people [1] urgently needs social attention and government support. At present, most of the more mature elderly care transformation systems and mechanisms are established in large cities or rural areas. Small and medium-sized cities have different characteristics and attributes from the former in terms of community physical form, living pattern, neighborhood relations, social supporting model, regional culture, and the status of the elderly population. Compared with large cities, small and medium-sized cities have more scarce elderly care supporting resources, weaker elderly care awareness, and a larger elderly population. Therefore, the current elderly care systems cannot be directly applied to small and medium-sized cities.

At the same time, the existing old community transformation modelis relatively coarse and cannot meet the humanistic needs of the elderly. In September 2022, the Department of Housing and Urban-Rural Development of

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Zhejiang Province issued the "Technical Guidelines for the Renovation of Old Urban Communities in Zhejiang Province (2022 Edition)." The content about renovation and renewal mainly focuses on the overall comprehensive improvement at the macro and meso levels of the community, such as public services, municipal supporting facilities, house building maintenance, and environmental improvement. However, there is still a certain gap with the quality of life demands of the elderly, so it is particularly important to seek a more "micro" level of renewal. At present, more and more scholars are exploring the significance of micro-renewal through continuous practice. For example, large cities such as Beijing, Shanghai and Guangzhou are the main typical practice places for micro-renewal [2-4]. Whether from the perspective of trial and error of construction models, inheritance of historical context, activation of community vitality, or optimization of social networks, a large number of micro-renewal pioneer explorations have been carried out.

In the context of limited resourcesregarding space, funds, supporting facilities, and talent reserves, the "micro" renewal of small and medium-sized cities for the elderly needs to consider its economic feasibility, universal applicability, and functional optimization, rather than the experimental and personalized design of large cities. This article mainly focuses on the public spaces in old communities in small and medium-sized cities (within the range of 5-10 minutes of living circles). Based on the recognition of limited community space, the author hopes to further focus on and refine the main behavioral activities of the elderly and explore the potential small and micro public spaces suitable for the elderly, so as to sort out the micro-renewal strategy of suitable spaces for the elderly through typological methods and means of architectural industrialization. By paying attention to small and micro public spaces and using micro-renewal methods, we can achieve a transition from relatively coarse comprehensive improvement to refined quality improvement, and effectively optimize the suitability of old communities for the elderly.

2 Spatial characteristics and limitations of old communities

The old communities in small and medium-sized cities focused on in this article are mainly residential areas from the 1980s to the 2000s. These communities have poor environmental quality and poor suitability for the elderly. According to incomplete statistics, most of the residential buildings in cities were built after the 1980s, especially during the period of welfare housing distribution (the proportion of residential communities built during the period of 1980-2000 accounted for more than 50% of the urban residential area [5]). The community space form during this period had historical limitations, and conventional renovation methods failed to effectively solve the problems brought about by the increasing aging of the community. The phenomenon of the extension of the daily life of the elderly has caused considerable conflicts with the existing community space.

2.1 Characteristics and types of old community space

The team visited and surveyed small and medium-sized cities in Shaoxing, Jinhua, Wenzhou, Huzhou and other places in Zhejiang Province, and selected a relatively typical old community as shown in Figure 1 below, showing the relationship between its satellite images, road network and residential units, reflecting a relatively high-density and compact geometric layout. Different types of residential units form the existing community public space under the constraints of the "fishbone" structure road system [6], showing the typical characteristics of "single line" layout. The spatial form of this type of "single line" residential unit is simple and small and fragmented. Combined with the invisible space field of residents' life extension, its physical space type can be divided into four categories: outdoor house-to-house space, house-side space, alley space and indoor residential traffic space (as shown in Figure 2). The specific spatial characteristics are as follows:

1) House-to-house space: a large space area between residential units in the long direction (mostly north-south direction), usually with functions such as green parks, traffic parking, and leisure space, with good openness and suitable for large-scale gatherings. Part of it is occupied by supporting warehouses.

2) House-side space: the edge space within 1-3M of the residential unit building. The space is compact, and due to the close connection with the first-floor function, the spatial independence is poor, and its domain and sense of belonging are relatively strong. It usually includes functions such as residen-

tial entrance, house-side green space, house-side street, and house-side trail. It is also the area where the phenomenon of life extension is most obvious.

3)Alley space: Alley space in the direction of the gable of the residential unit building, most of which are the main roads in the community, with a width of 4-12 meters, good accessibility, mainly including spaces for transportation, parking and other purposes.

4) Residential traffic space: Public vertical and horizontal traffic space in the unit building, mainly including stairs and walkway space, generally limited to the activities of the elderly in the unit.

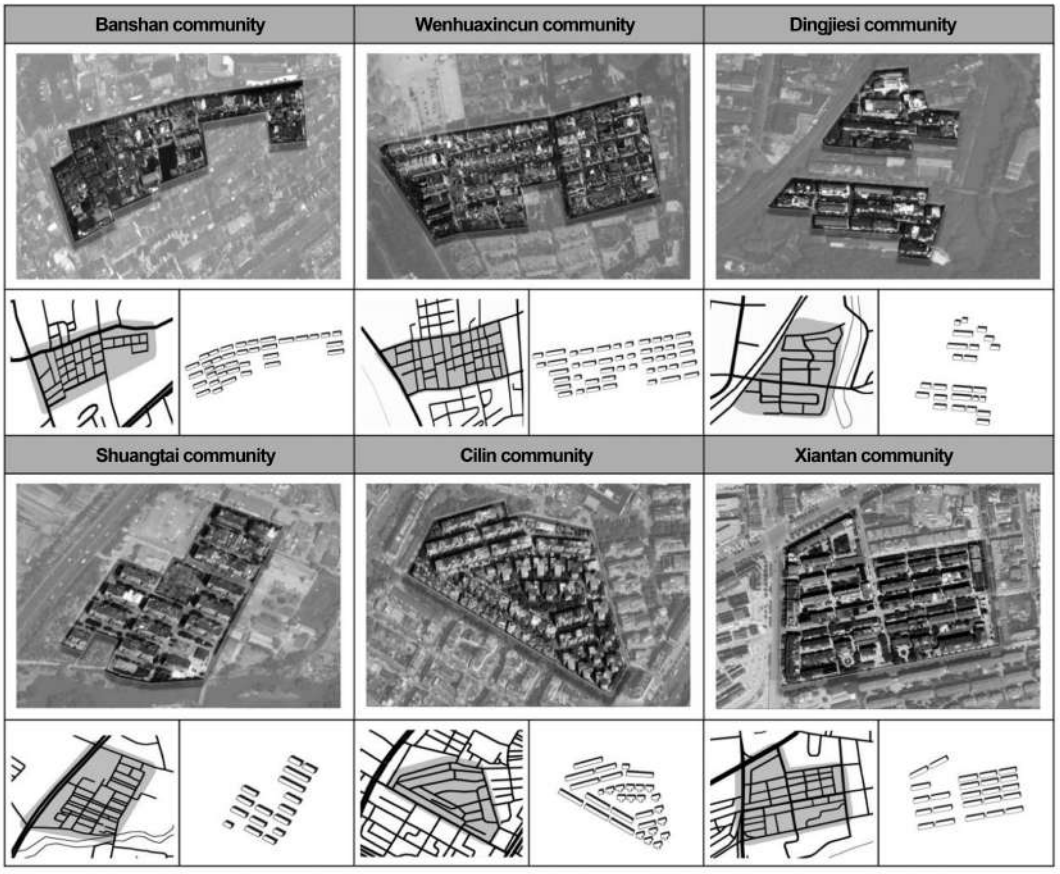


Figure 1 Texture relationship diagram of a typical old community (drawn by the authors)

2.2 Spatial limitations and problems of old communities

The above-mentioned 80-00 old communities are different from the current mainstream high-rise low-density residential planning. Their multi-story high-density layout makes the space resources for activities scarce. By comparing the utilization rate and development degree of space, it can be found that there are roughly two types of fragmented remaining spaces for residents' activities, such as house-to-house spaces, n. One is the functional space that already exists in the planning and cannot bear the residents' activities; the other is the functional space that is spontaneously "occupied" and carries a certain number of residents' self-organized activities. The former does not match the living habits of residents, and the latter's poor spatial arrangement will disrupt the overall unity of the community, further exacerbating the fragmentation and disorder of the already limited space. Faced with this type of old communities with limited construction resources, it is no longer possible to carry out large-scale integration or transformation, and it is very difficult to update for the elderly. At the same time, compared with larger cities, the old communities in these small and medium-sized cities have the following characteristics and problems:

1) The community boundaries are more blurred and open, the overall space is slightly looser than that of larger cities, and the mixed functions of the first floor are more obvious;

2) The parking problem is prominent, but the phenomenon of random occupation and random parking of

vehicles is relatively mild, and there is still room for improvement;

3) The outdoor greening rate is low, and the environmental quality and humanized space are relatively weak;

4) The phenomenon of residents' life extension is more serious, and the functional occupation of nurseries, livestock, drying and other functions is prominent (as shown in Figure 3);

5) There is a lack of barrier-free design, low continuity of access, and a weak sense of living circle.

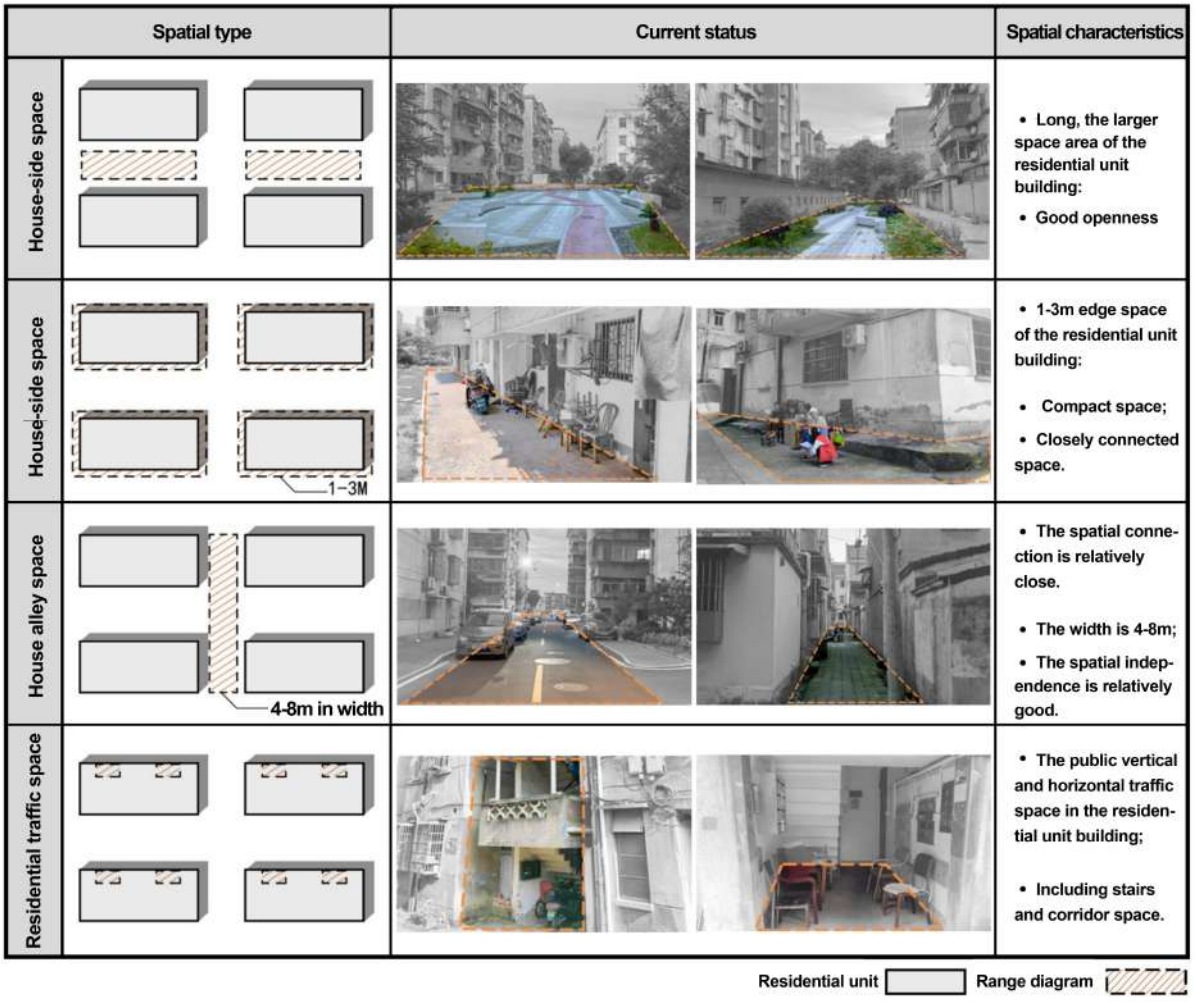


Figure 2 Types and characteristics of old community spaces (drawn by the authors)

Figure 3 Current situation of residents' life extension phenomenon (photographed by the authors)

3 The behavior and needs of the elderly in old communities

When entering the stage of senior citizenship, the functions of the body have declined to varying degrees. Due to the limitations of time and distance, the behavior and activities of the elderly show certain patterns, and their activity range gradually shrinks. The 5-10-minute community living circle (200-500 m) is the basic scale of old communities and the high-frequency range of elderly activities. Especially for the elderly over 70 years old, the proportion of needs within a 5-minute walk exceeds 50% [7]. How to condense the elderly's activities within this 5-10-minute living circle is the key.

The elderly's behavior and activities can be divided into relatively dynamic and static. The dynamic behavior is mainly based on mobility such as traveling, including walking and running. The scope of such activities is relatively large, the differences are relatively random, the range is wide, and the spatial form is difficult to define. The relatively static residence behavior almost covers the important social and leisure activities of the elderly, and there are patterns to follow. Its spatial range is limited, and the scale is relatively fixed. Under the background of limited resources, it has certain limitations and guiding significance for further focusing on the scope of elderly-friendly renewal and screening the existing "micro" space. This article will focus on the resident behavior and needs of the elderly and analyze the demands of resident behavior on the function, scale, energy efficiency and other aspects of the elderly-friendly space through the three dimensions of behavior content, rules and demand order.

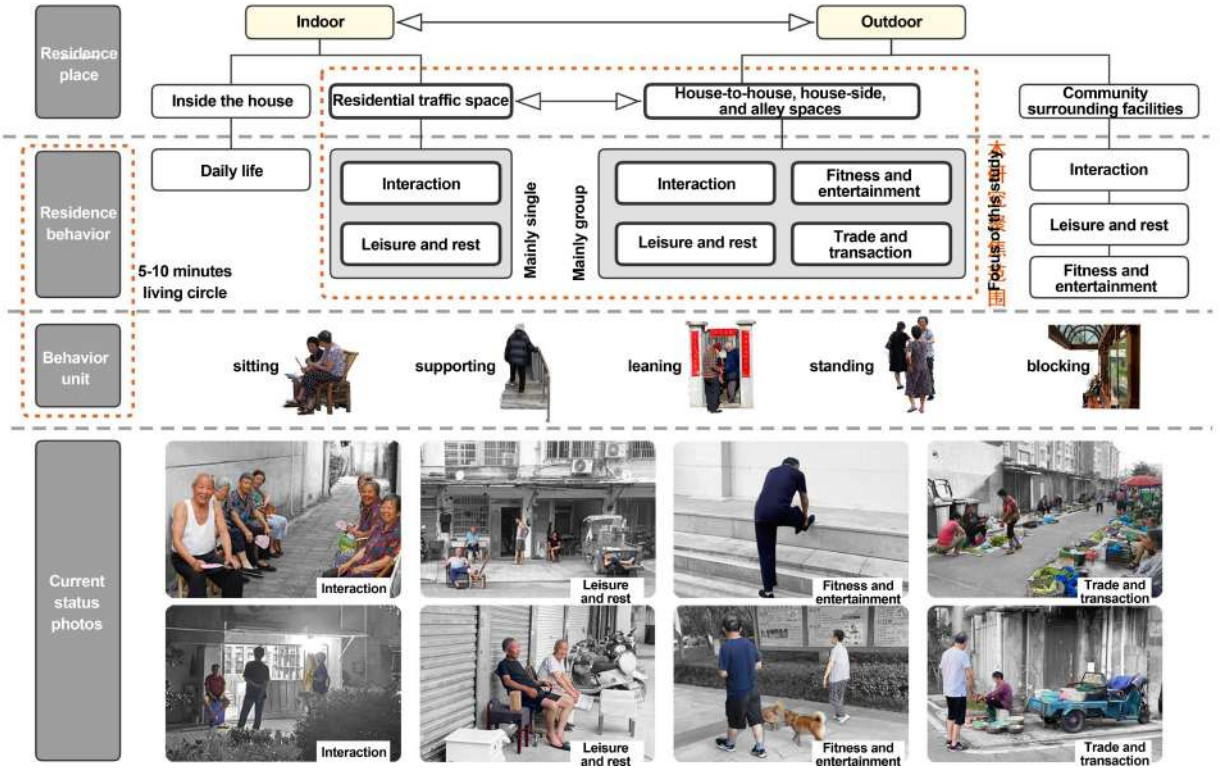


Figure 4 The behavior of the elderly in old communities (drawn and photographed by the authors)

3.1 Behavior content and unit elements

This article understands resident behavior as the life and social behavior of the elderly staying or moving in a limited area. According to the current situation survey and tracking, the resident behavior of the elderly can be divided into four categories (as shown in Figure 4): interactive communication, mainly chatting; leisure and rest, mainly sunbathing, enjoying the cool, resting, viewing, reading newspapers, gardening and other behaviors; fitness and entertainment, mainly sports, square dancing, chess and cards and other behaviors; trading, mainly informal market behaviors such as stalls. The above four types of people's behavior activities are inseparable from unit actions, such as standing to chat, sitting to read newspapers, etc. Once

these ordinary actions involve the elderly, they need more humane care, such as the need to shelter from the elements, and the need to rest and sit when tired. In summary, the author believes that to meet the needs of the elderly's stay, we must first consider the needs of the five major unit elements of the space: sitting, supporting, leaning, standing, and blocking.

3.2 Behavioral patterns and spatial utility

The behavior of the elderly has certainpatterns in terms of time, space use and group size. In terms of time, summer and winter outdoor activities are selected as typical representatives. The survey found that in summer, the principle of keeping cool and avoiding the heat is followed. Among the elderly interviewed, the two peak time periods for outdoor activities are 5-8 am and 16-19 pm. In winter, the principle of sunbathing is followed to keep warm. The time of outdoor activities is affected by the movement of the sun. The two peak time periods are 7-10 am and 14-17 pm. Among them, morning exercises, shopping and walking are the main activities in the morning, while rest, exercise and entertainment are the main activities in the evening. The willingness for outdoor activities in other time periods is affected by the suitability and accessibility of the space around the residential building units. In the above time periods, especially in the evening, the spontaneous stay behavior of the elderly is mostly in groups of 1 to 3 people (including 1 to 2 elderly people with 1 child), with 2 to 3 groups gathering together. The stay space is mostly maintained in an area of 2 to 6 people (as shown in Figure 5). However, due to the different preferences of the elderly, the space formed by this kind of life extension phenomenon is messy and unsystematic, and often only meets the use of local groups in a single time period. The needs of residents of other age groups in the community for staggered use are not considered, and the space utilization rate is low.

3.3 Demand order and principle characteristics

The needs of the elderly mainly show a strong demand for a sense of security, belonging, neighborhood, privacy, and comfort. Among them, a sense of security is the foundation and guarantee; belonging, neighborhood, and privacy are the embodiment of social and individual elements and occur in different functional places; comfort is the pursuit of a higher quality of life. Based on the above demand logic, the team briefly conducted interviews and created questionnaires from the three aspects of safety, functionality, and comfort. A total of 136 questionnaires were collected, of which 127 were valid. It is generally believed that the elderly attach importance to the three aspects of demand in the order of safety $\geqslant$ functionality > comfort. As shown in Table 1, in terms of safety, most of the elderly are mainly concerned about the travel hazards of mixed people and vehicles and anti-slip roads. At the same time, looking back at the long-term epidemic prevention and control measures, the elderly have a stronger demand for communication and activities; in terms of functionality, in addition to the demand for some indoor functional places, the elderly are more concerned about the perfection of facilities that affect their own activities such as exercise and leisure places, as well as the potential for adding parking facilities such as elderly mobility. In terms of comfort, most elderly people pay more attention to the overall macro experience or are more concerned about the quality within their own activity areas. The diversification of nearby spaces can enhance the elderly's sense of belonging. In the process of micro-renewal for the elderly, considering economic and conservation issues, meeting the basic barrier-free safety and access to multiple functions are the fundamental need of the elderly, while the pursuit of comfort can effectively increase the elderly's living satisfaction in terms of belonging to the field.

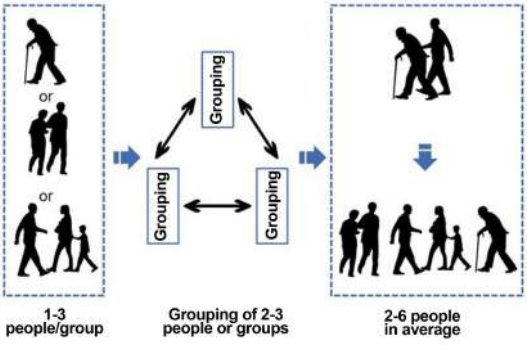
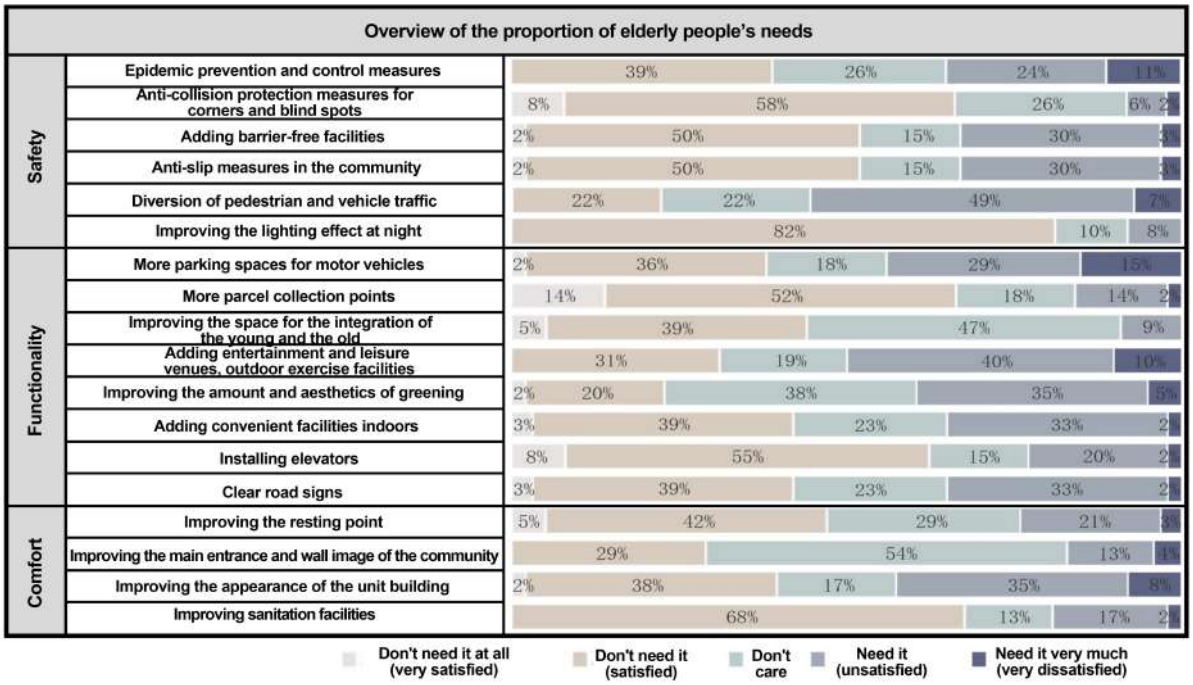


Figure 5 Typical scale analysis of the elderly's resident behavior

Table 1 Overview of the proportion of elderly people's needs (created by the authors)



4 Analysis of the types of potential elderly-friendly micro-spaces

The mismatch between the fragmented and limited space of old communities in small and medium-sized cities and the current behavior of the elderly has led to a chaotic phenomenon in the hierarchical order of community space. The author hopes to redefine, sort out, refine and integrate the concepts and type characteristics of potential elderly-friendly micro-public spaces by matching the above physical space with behavioral needs, so as to clarify and effectively limit the scope of elderly-friendly micro-renewal.

4.1 Scope of micro-public spaces suitable for the elderly

"Micro-public spaces" can be understood as small open places artificially created in the city to provide services for human interaction and other social activities [8]. For example, starting with the renovation design represented by parking micro-parks, attempts to create new behavioral patterns through small furniture and non-enclosed public spaces (Atelier Bow-Wow 2002), or using basic elements such as "tree-bench-grass" to form the smallest scale open space type model (Rebal Design Co. 2005). Although existing typical studies provide references for further understanding of micro-public spaces in this paper, their spatial scale is more focused on urban functions and interfaces, and their goals are mostly to explore context and awaken regional vitality. The micro-public spaces in this paper mainly focus on the community level and are based on the perspective of age-friendliness, so the definition of their spatial scope needs to be re-examined.

This paper understands potential micro-public spaces suitable for the elderly as existing micro-public activity spaces within the 5-10-minute living circle of community residential units (200-500m), which are convenient for the elderly to travel, perceive and stay. Such potential elderly-friendly spaces are scattered between houses, beside houses, lanes and traffic spaces of residential buildings. They have no clear boundaries and specific spatial forms, but their basic space units need to meet the small-scale activity functions of 1 to 8 people, and the scale is mostly between 4 and 30 square meters. At the same time, based on the resident behavior characteristics of the elderly and their needs for safety, function and comfort, the above-mentioned potential elderly-friendly small and micro public space units can eventually meet the five behavioral-needs of the elderly, namely, sitting, supporting, leaning, standing, and blocking, through micro-renewal, meet the elderly's demands for aging-friendly living from a micro scale, and further efficiently improve the quality of life of the elderly in old communities.

4.2 Extraction and analysis of potential elderly-friendly micro-spaces

Potentialelderly-friendly micro-public spaces can be extracted following the three principles: the principle of spatial proximity, that is, the vicinity of the elderly's homes, including the floors, entrances, and residential units, can bring more security, territory, and sense of belonging to the elderly; the principle of integration of disadvantaged spaces, that is, the ambiguous, mobile, and temporary marginal spaces used by disadvantaged groups [9], which are relatively independent and can form their own areas, are often more typical, and the two types of planned existing spaces and spontaneous "invasion" spaces are reorganized in a coordinated manner; the principle of spatial surplus exclusion, excluding spaces with clear public functions and potential private areas (including spaces within a certain range such as in front of doors and windows). Based on the above principles, the four types of old community spaces are further typified to explore potential elderly-friendly micro-public spaces at a micro scale. For each type of community space, three potential subtypes are summarized (Fi-gure 6):

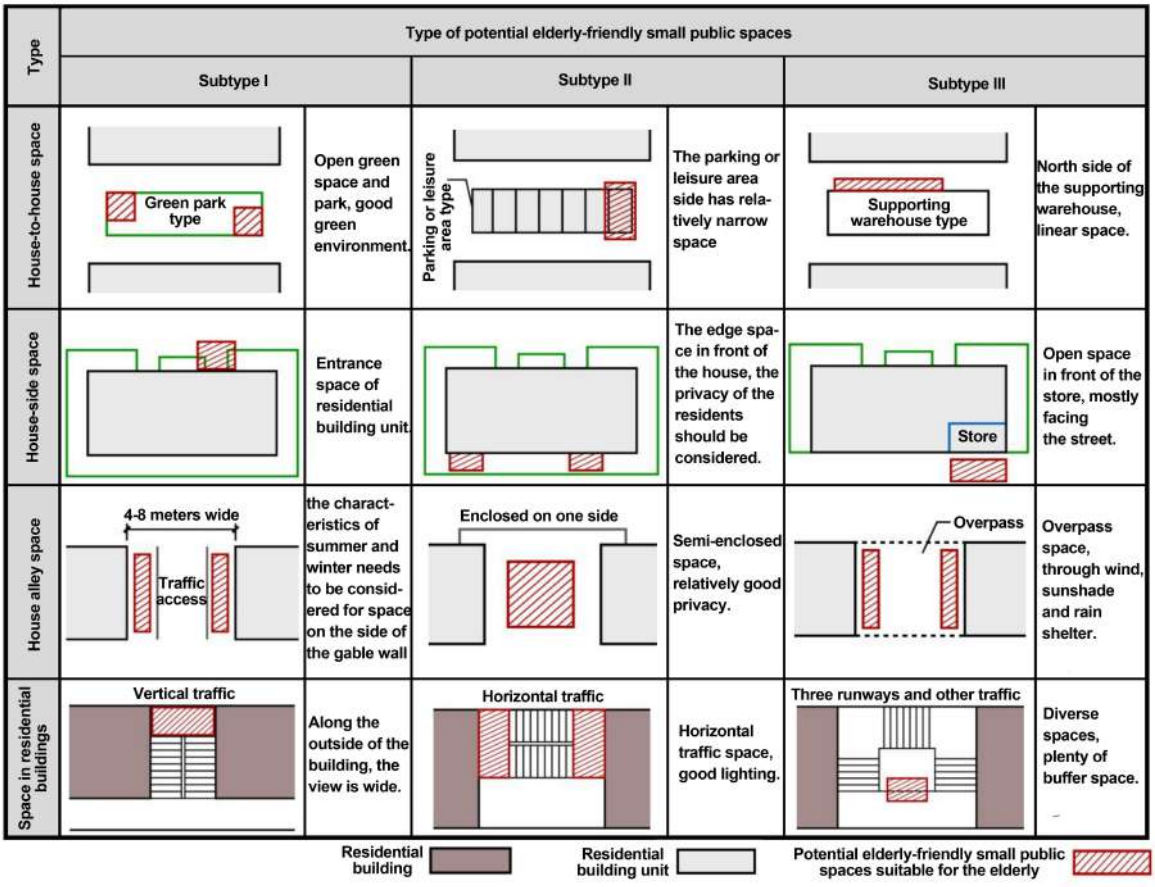


Figure 6 Schematic diagram of potential types of elderly-friendly micro-public spaces in old communities (drawn by the authors)

1) House-to-house spaces: typical examples are green parks, parking or leisure spaces, and supporting warehouses. Among them, the first two types of potential elderly-friendly micro-spaces should be partially updated in combination with the actual behavioral needs of the elderly, such as accessibility and privacy. The space restrictions are relatively few and can meet the needs of large-scale aggregation. The supporting warehouse type can be combined with the linear space on one side (avoiding the warehouse entrance side and obtaining the consent of its users) for aging-friendly transformation.

2) House-side spaces: including three typical micro-spaces: the entrance space of the residential unit, the edge space in front of the house, and the open space in front of the store. Among them, there is a certain flow of people at the entrance and in front of the store, which is also a high-

frequency area for the elderly to stay, which can meet their information exchange needs, especially the space in front of the store. Considering the characteristics of the business hours and lighting effects of small supermarkets and shops, its spontaneous aggregation effect at night is more prominent. The potential utilization of spaces in front of the house needs to consider the privacy within the outdoor windows of the first-floor residents.

3) Alley spaces: divided into gable side space, semi-enclosed space and over-street building space. Among them, the gable side space is the most typical, and the community road it faces is particularly suitable for the elderly to "go to the market," but the needs and possibilities of summer cool-off and winter sunbathing and wind protection must also be considered.

4) Residential traffic spaces: divided into vertical traffic, horizontal traffic and other traffic types. The rest platform is the most promising for elderly-friendly uses, as it has less impact on the entrance door of the corridor and is relatively independent and can be combined with the elderly's needs for rest and sightseeing.

5 Elderly-friendly micro-renewal strategies for old communities

Combining the characteristics of four types of public spaces in old communities, and through in-depth research on the elderly's resident behavior, this paper provides certain guidance and reference for the screening of potential elderly-friendly micro-spaces from the aspects of spatial scope, scale, and conditional restrictions. Just as this article explores the economic feasibility, universality, and functional optimization of elderly-friendly renewal in small and medium-sized cities, the elderly-friendly micro-renewal of old communities, based on the five principles of elderly people sitting, supporting, leaning, standing, and blocking, transforms potential micro-spaces into elderly-friendly "micro base stations" one by one, and at the same time satisfies the functions of "micro base stations" in functional complexity, staggered time and peak, information sharing, and easy repair and construction, and ultimately improves the communication and integration of community neighborhood culture. The following sections will outline the elderly-friendly micro-renewal strategies suitable for small and medium-sized cities from three dimensions: guidelines for elderly-friendly micro-renewal (design and strategy), industrial component standards (production and technology), and construction coordination mechanisms (management and implementation), and provide a schematic design of micro-renewal plans.

5.1 Improving the menu-style design guidelines

Through the integration and refinement of four types of potential elderly-friendly micro-spaces, the design guidelines for the spaces are summarized as follows from the perspectives of space applicability, personnel activity scale, and corresponding strategies (as shown in Figure 7):

1) house-to-house spaces: Type 1-1 is suitable for relatively complete micro-plots. It can be attached to different positions between houses while ensuring that sunlight is met as much as possible. The functional settings must meet the needs of the elderly and children, and reserve interactive space for them, taking into account both communication and care [10]. In addition to meeting the needs of safe travel, the handrail space also provides a certain amount of simple exercise and stretching functions for the elderly; Type 1-2 is mainly aimed at the space on the north side of the warehouse. On the premise of giving way to some private spaces such as warehouse windows, foldable seats and handrails are simply arranged to meet the needs of the elderly to stay without affecting the operation of the original space.

2) house-side spaces: Type 2-1 is suitable for entertainment activities of the elderly living downstairs in this residential unit. At the entrance of the residential unit, it can be combined with functional settings such as announcements and parcel storage; Type 2-2 generally faces the main community roads or branch roads, but the elderly-friendly micro-renewal of its space needs to balance the normal drainage function of the store.

3) Alley spaces: Type 3-1 is the same as Type 2-1. Whether the seats are foldable depends on the original space scale. This type of space is mostly north-south oriented. In winter, the baffle needs to be set according to the direction of the monsoon. At the same time, since the public nature of the space is relatively pronounced, it can also be appropriately considered to reserve simple fitness

stretching, non-periodic market activities and information-related functions; Type 3-2 is a semi-enclosed space. If needs such as community parking and greening are satisfied, activity functions such as chess and cards can be set.

4) Traffic spaces in residential buildings: The micro-renewal principles of types 4-1 and 4-2 are similar. The former is mainly for the staircase semi-platform space, while the latter is for the floor space. In addition to setting up a certain number of foldable seats, the elderly's safety must be considered when using the free surface on the outside of the building for leaning. At the same time, sliding rail handrails can be added according to the needs of residents. The above space is mainly for communities without elevators.

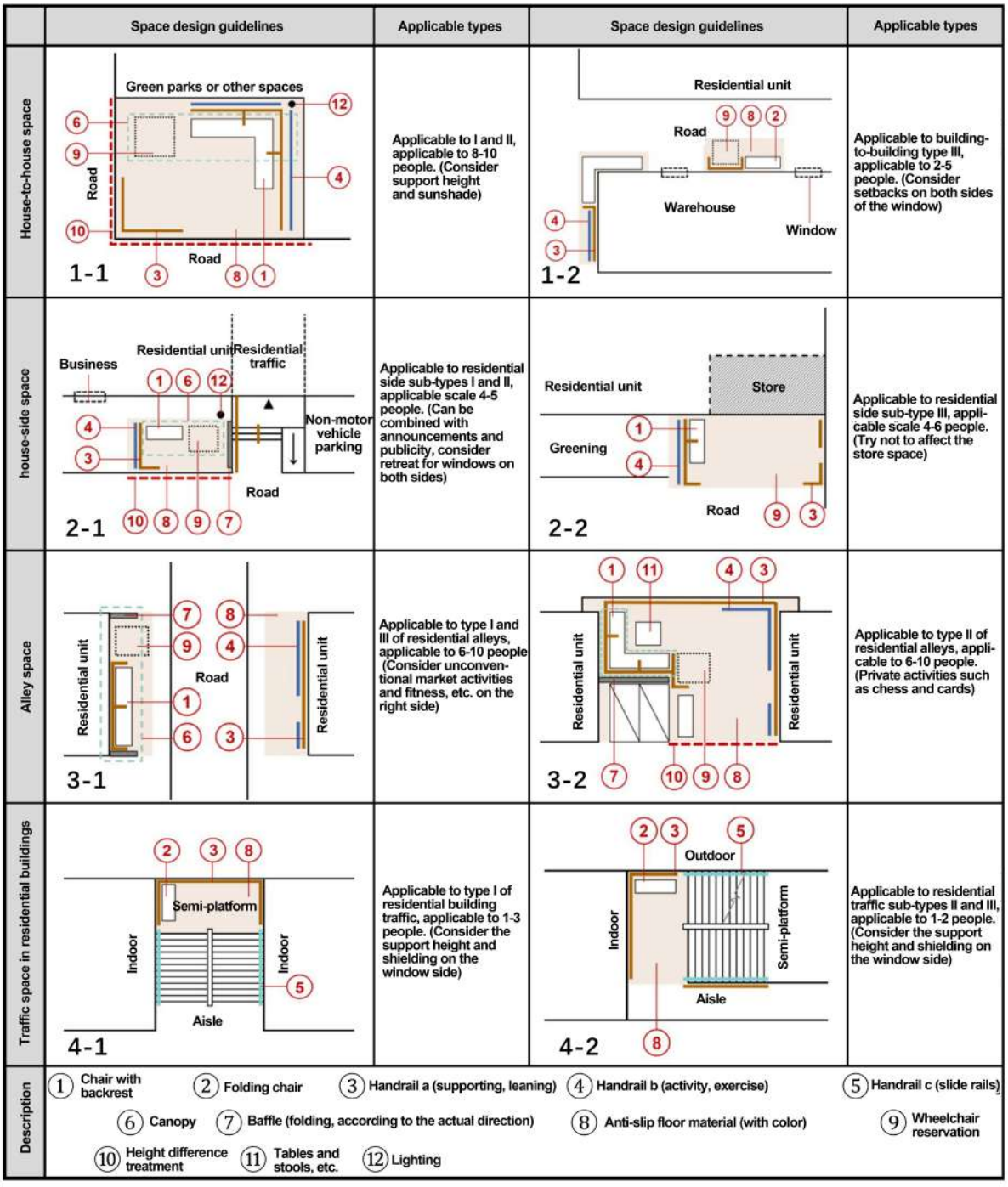


Figure 7 Design guidelines for elderly-friendly micro-renewal of old communities (drawn by the authors)

5.2 Establishing industrial standardsfor components

Under the national strategic background of "dual carbon" and new "building industrialization," the upgrading and transformation of building construction technology is imperative. Under the requirements of building assembly, standardization, and componentization, it can bring economic value, construction value, and later operation and maintenance value to construction projects, and can coordinate and optimize their entire life cycle. The focus of this article is relatively specific, and considering factors such as easy production, easy processing, easy transformation, easy disassembly, lightweight, low-carbon and green, the design analysis of elderly-friendly components based on wood is selected as the main material. As shown in Figure 8, taking the design guideline 1-1 of the residential space as an example, the two approaches of standardized modulus and componentized parts are explained and attempted.

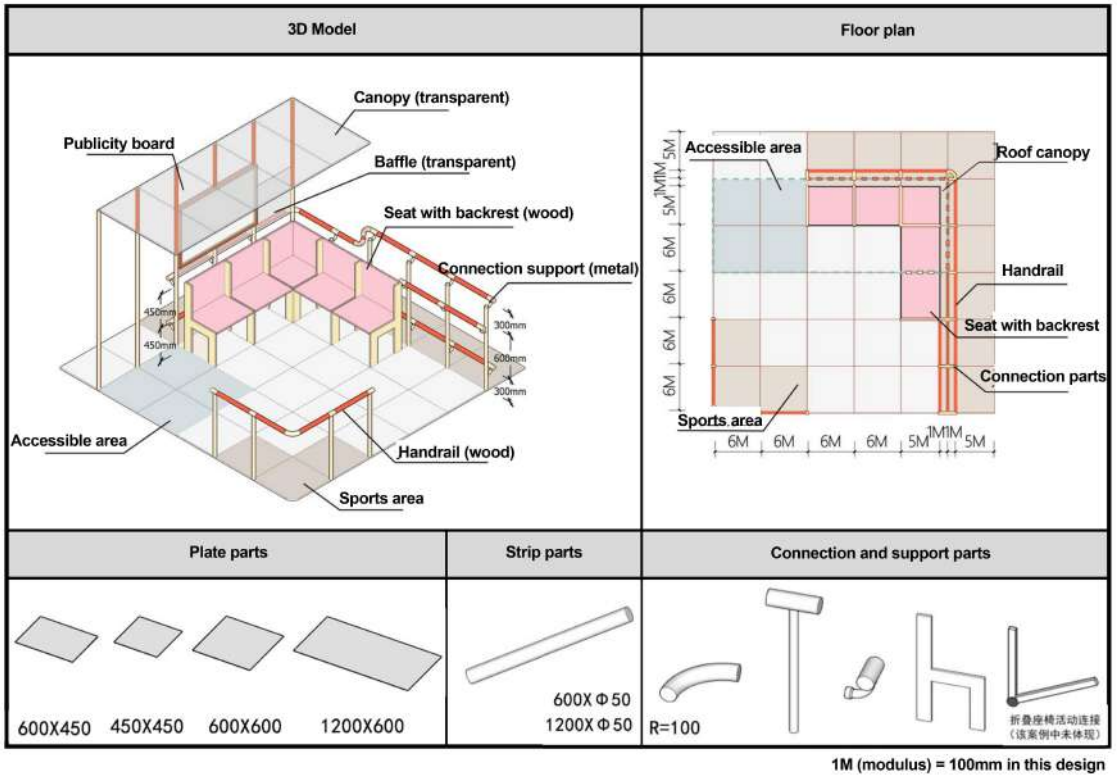


Figure 8 Illustration of elderly-friendly micro-update components and standards (drawn by the authors)

1) Standardized modulus: Modulus is the basis of standardized construction, but the coordination of modulus between different interfaces, levels, components and subcomponents is particularly important [11]. If necessary, a multi-layer modulus grid should be established to consider its standard system from the perspectives of design, production, construction, and operation and maintenance.This study takes 100mm as the basic modulus 1M (Figure 8, top). Starting from the spatial activity scale of the elderly, among the three dimensions, the plane dimension should be extended by 6M, and the vertical dimension should be extended 3/2M and 3M, thus forming a corresponding modulus grid, and all components are limited and controlled in this grid system.

2) Componentparts: Based on the above modulus grid, various functional components are decomposed and classified into three categories: plate components, strip components and connection support components (Figure 8, bottom). While meeting the modulus, its size needs to consider the spatial error and adjustability of the connection and splicing. The plate and strip components are mainly made of wood (the anti-corrosion durability of wood outdoors should be considered), and the plate also contains some transparent materials (lightweight and durable materials such as PC board), and the connection support components are mainly made of metal materials. Of course,

these components also need to consider the reservation and implantation of various interfaces such as information networks and electronic power supplies to meet the needs of information dissemination and sharing.

5.3 Exploring diversified coordination mechanisms

Compared with the practical exploration and research on the participation of multiple subjects in some large cities, most of the traditional community renovation activities in small and medium-sized cities are currently carried out by government funds for single mandatory operations [12]. Coarse development is prone to lead to an imbalance between interests and needs, and the flexibility of the renovation process is relatively low. The following shortcomings are reflected mainly from the four subjects of government managers, professional designers, developers and builders, and community users: passive control conditions, coarse design and production, maximization of construction profits, and low user participation. There is insufficient linkage and coordination between the subjects, and the top-down construction projects cannot meet the needs of the elderly. Micro-renewal, especially elderly-friendly, is a continuous task. Under such a wide range, large volume, scattered, trivial and high humanization requirements, it is necessary to coordinate the participation of multiple subjects, carry out design empowerment, integrate new technologies such as big data and the Internet to establish a new platform [13], enhance community stickiness [14], and explore a bottom-up project screening, evaluation and construction system under the background of limited capital investment, which are the key to ensure its sustainable construction and promotion.

At the same time, we should further seek social investment models other than government funds. Of course, compared with comprehensive renovation projects, the purpose of elderly-friendly micro-renewal is to implement the last small step of humanization.As such, the project has limited impact on land appreciation and space appreciation, innovative advertising is necessary. For example, through the concept of "sharing" [15], we can integrate cultural, media and other forms of information network propaganda with "micro base stations," which are both elderly-friendly micro-spaces and information dissemination stations. While enhancing user interaction, it also increases the potential value of social intervention.

5.4 Schematic diagram of elderly-friendly micro-renewal plan

Combined with the above three-dimensional elderly-friendly micro-renewal strategy, we still take the design guideline 1-1 of the house-to-house space as an example to illustrate the micro-renewal design. The before and after comparison is shown in Figure 9. The functions are improved from three aspects: free activity, cultural identity building, and information sharing:

1) Free activity: forming a complex elderly-friendly community space. Modularization allows facilities such as seats and handrails to be combined according to the needs and preferences of the elderly themselves, realizing the needs of different scenes. At the same time, it provides a resting place to create a warm community environment.

2) Cultural identity building: forming diversified humanistic connotations, inheriting and carrying forward the party building leadership and traditional culture, etc., spreading through the electronic bulletin board in the form of video clips, arousing the sense of identity and belonging of the elderly, and creating a fresh humanistic environment.

3) Information sharing: forming a variety of business formats through digital empowerment, adapting to the technological era through digital empowerment, expanding the functionof the display to be used for commercial advertising, weather forecast broadcasting, healthy diet push and other business formats.

The updated house-to-house space provides a rich activity venue for the elderly. According to the travel and gathering patterns of the elderly and focusing on the two high-frequency activity periods of early morning and evening, a summary of the outdoor residence behavior of the elderly is made (as shown in Figure 10). In the early morning, the crowd is mainly composed of the elderly alone, who often engage in quiet leisure and simple exercise; in the evening, young people and children will join the crowd, which then leads to a comprehensive activity for multiple groups.

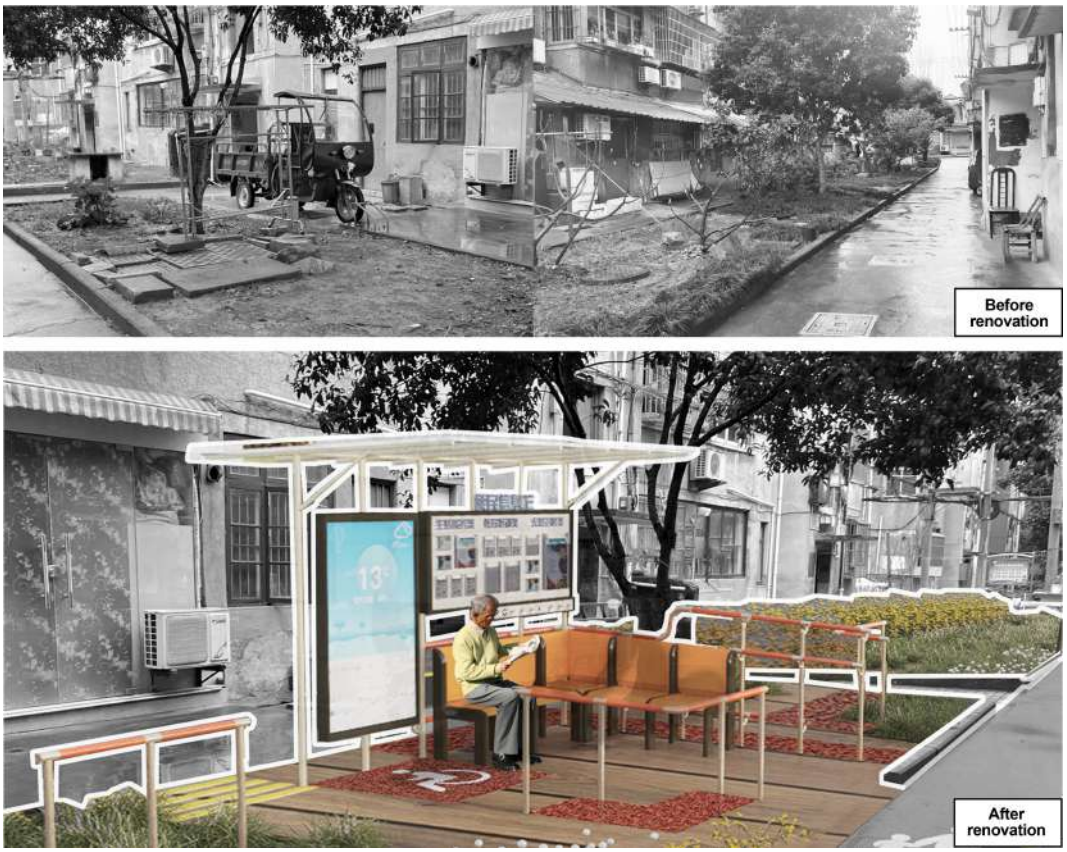


Figure 9 Comparison of renovation plans for house-to-house spaces (drawn by the authors)

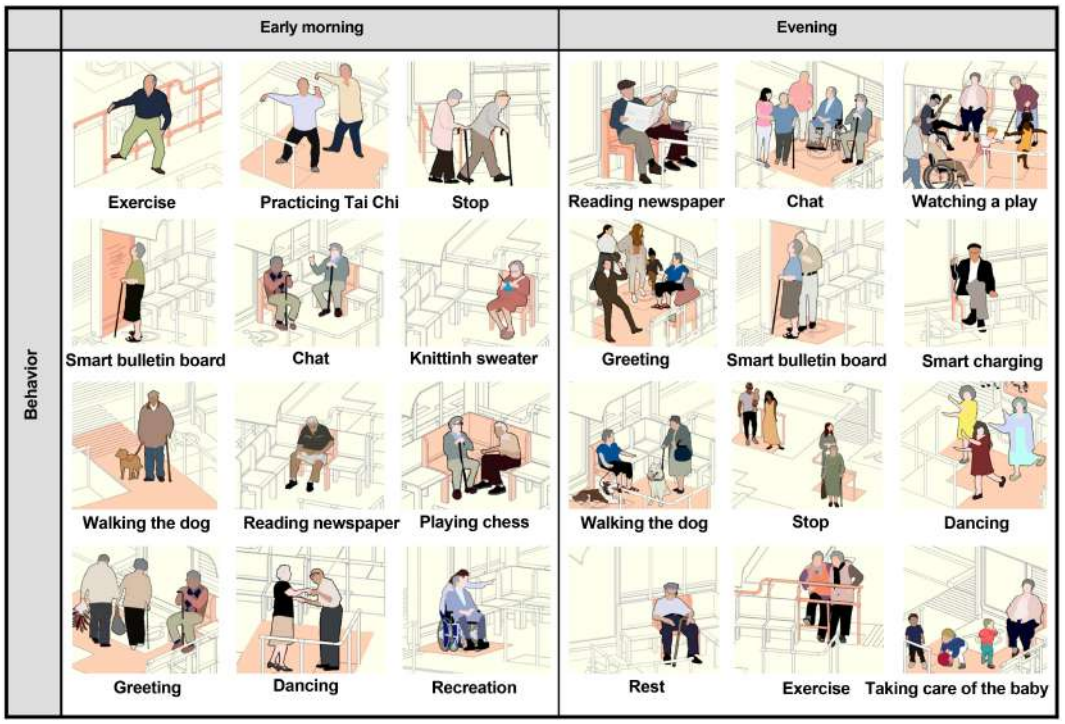


Figure 10 Summary of outdoor activities for the elderly (drawn by the authors)

Conclusion

Compared to the Matthew effect and resource allocation advantages enjoyed by big cities, as well as the distinctive rural regions, small and medium-sized cities between the two are often on the edge of being relatively neglected. Faced with increasing urbanization, large-scale demolition and construction is no longer the theme song of urban development. A series of sustainable development concepts such as "organic renewal," "micro-renewal" and "micro-circulation" have attracted public attention. Micro-renewal in big cities is more unique and leading, but micro-renewal in small and medium-sized cities needs to pay more attention to universality and feasibility. This article hopes to explore the strategy of elderly-friendly micro-renewal, and on the premise of continuously improving the quality of the living environment for the elderly in small and medium-sized urban communities, try to explore how to tackle the problem of elderly-friendliness in an efficient, gradual, precise and economical manner in the stock space of old communities in small and medium-sized cities, where elderly care resources are scarce, and provide a reference for the practice of universal elderly-friendly micro-renewal construction in old communities.

Figure and table sources

Figures 1, 2, 4, 5, 6, 7, 8, 9, 10:drawn by the authors.

Figure 3:taken by the authors.

Table 1: made by the author.

References

[1] CHAI Yanwei.An activity space for the elderly in urban China. Science Press,2010:13-14.

[2] LIU Yuelai, YIN Keluan, GE Jiajia. Community Participation, Co-sharing, Approaching Perfection —A Case Study of Shanghai Community Garden Space Micro-regeneration[J]. Journal of Human Settlements in West China，2018 (04): 8-12.

[3] HUA Xiahong,ZHUANG Shen.Promoting Everyday Public Space through DesignA Review ofUrban Micro-Regeneration Practices in Shanghai [J]. Architectural Journal, 2022 (03):1-11.

[4] ZHAO Nannan, LIU Yuting，LIU Zheng. Co-wisdom, Co-strategy, and Co-benefit: Urban Regeneration and Community Governance in Guangzhou City[J].Urban Development Studies，2019，26 (04): 117-124.

[5] YING Lianxing, On Establishing a New Urban Planning System Based on Communities-Taking Hangzhou City as an Example [J]. Urban Planning, 2004 (12): 63-68.

[6] LOU Yinghao, QIU Zhi, HUA Yi, WANG Yuan,Explorations on the Renewal Strategy of "Neighborhood-Based" Community Public Space Adaptive for the Elderly —A Case Study of the Old Urban District of Hangzhou City [J].Journal of Human Settlements in West China，2018,33 (06): 95-99.

[7] LI Meng. The Planning Strategies of a 15-minute Community Life Circle Based on Behaviors of Residents [J]. Urban Planning Forum, 2017, No.233(01): 111-118.

[8] WILLIAM H Whyte, YE Qimao, YANG Ting. Reading "The Social Life of Small Urban Spaces" by cracking the Password of public space [J]. Shanghai Urban Planning Review, 2018, No.140 (03): 130-131.

[9] GAO Changzheng, TIAN Weili, HOU Juejian, etc. Discussion on urban "micro renewal from theperspective of Vulnerable Space—Taking Erqi Dehua Street in Zhengzhou as an Example [J]. Urbarn Development Research，2020,27 (12): 17-21.

[10] ZHOU Yanmin, WANG Chunyu. Research on Outdoor Environment Design of Elderly Friendlycommunity to create a good social atmosphere—Taking the Continuous Follow-up Survey of Acommunity in Beijing as an Example [J]. Shanghai Urban Planning, 2020, No,155 (06): 15-21.

[11] LIU Changchun, ZHANG Hong, CHUN Qing, etc. Discussion on Modular Coordinati on System About New Industrial Building [J]. Architectural Technology，2015，46 (03): 252-256.

[12] Kuai is Gorgeous,Bai Mengyuan The Game and Balance of Multiple Subjects in the Decision ot0ld Community Reconstruction—Taking the Reconstruction of a Community in Beijing as an Example[J].Planner，2015(04): 48-54.

[13] HAN Yanan, MAO Mingrui, HE Junyao, etc. Design empowerment of urban Micro renewal Drivenby new Technology-based on the Practice of Participating in Micro Renewal of Shuangjing Streetin Beijing [J].New Architecture，2021 (04): 11-17.

[14] CHEN Ye, ZHANG Shangwu, SHI Yu, et al. Thinking on the Path of Renewal and Governance ofold Residential areas in Shanghai from the perspective of aging—Taking the Survey Practiceof Workers' new Village in Lane 396, Changning Road, Shanghai as an example [J]. Urban Development Research，2021,28(01): 39-44.

[15] ZHANG Yingqing, MENG Junjun, Research on the Public Space renewal Strategy of Old Communitiesbased on the concept of "sharing"—Taking Xililong Community in Guizhou, Shanghai as an example[J]. Urban Development Research，2020,27 (08): 89-93.

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Research on the Correlation Mechanism between Street Space Quality and Walking Behavior in Data Environment

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ABSTRACT: It is of great significance to explore the correlation mechanism between urban street space quality and residents' walking behavior for rational and effective allocation of street facilities resources and promotion of healthy and green travel. Taking Qiguitang block in Hefei as an example, the streetscape image is crawled through Python, and the elements of street spatial quality are quantified by a machine learning algorithm, spatial syntax, and ArcGIS. Get travel data through behavior observation, and then build a multiple linear regression model for the correlation study of spatial quality and behavior characteristics to summarize the interaction degree and mode of various influencing factors. The research shows that there is a specific mathematical relationship between walking behavior and street space elements, among which functional formats, walking width, and interface openness have a more significant impact on walking behavior. Accordingly, the optimization strategy of street space in the old city area is proposed to provide a reference for the formulation of Hefei street design guidelines.

KEY WORDS: big data; street space; walking behavior; street view pictures

Introduction

As my country's urbanization process continues to advance, the "car-oriented" urban space expansion model has led to a lack of walking space for residents, prompting academia to rethink and improve street space [1-2]. Its quality improvement and refined design are increasingly attracting attention[2].Street design guidelines, as a novel area of research on road spaces, have been emerging in both domestic and international cities in recent years[3]. This study, from the perspective of street space quality, investigates the correlation between its spatial characteristics and walking behavior[4-7],explores the space quality features that influence residents' walking behavior[7-8], and has significant implications for improving environment quality, promoting green and healthy travel[6],and enriching the content of street design guidelines.

The research on the correlation between street space and walking activities started from the material space level, and scholars at home and abroad have achieved quantification of qualitative research. In traditional research, William White used behavioral observation to count crowd behavior, which promoted the study of the relationship between material space and behavior.[1] Huang Jianzhong established a comprehensive measurement method for the built environment that includes multiple dimensions such as accessibility, convenience, comfort, and safety[2] . In

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addition, under the background of new data environment support, the relevant research on streets has gradually broken through the limitations of traditional field measurement and collection. The emergence of new technologies and new methods has helped to solve the previous relatively vague and subjective evaluation of urban space quality, as well as the current situation of too large scale and unclear indicators due to the limitation of data acquisition conditions[8].Long Ling, Hao Xinhua, Tang Jingxian, Xu Leiqing, and others used street view image data and machine learning algorithms to construct a street space measurement method based on visual morphological indicators such as sky visual index, green view index, and street color pleasure index from a human-centered perspective[4-12].From the perspective of research methods, existing studies mainly rely on theoretical perspectives such as environmental behavior, sociology, and street morphology aesthetics to conduct analysis. The methods used can be divided into classification description, subjective preference, and correlation analysis.[13] Early studies were mostly based on environmental behavior, summarizing the internal laws by observing street space and classifying behavior,[14-15] but it is difficult to quantify accurately. The subjective preference method needs to be analyzed with the help of statistical methods such as the analytic hierarchy process[16], semantic differential method [17],and factor analysis[18].To further quantify the differences in the impact of each indicator, the quality of samples and data is very crucial. The correlation analysis method mainly uses mathematical statistical methods such as correlation analysis and regression analysis to explore the mutual influence mechanism between behavior and space quality. Due to its objective, intuitive, and sophisticated characteristics, it has been widely used in related research in recent years.

In the past two years, with the development of technology and its dissemination in the world academic community, a large number of quantitative studies in urban-related fields have emerged. However, the proportion of quantitative research on street space quality at the human scale is relatively low, and the traditional methods commonly used in the research process have problems such asbeing time-consuming and inaccurate. In the context of the new data environment, the perspectives in quantitative research mostly focus on urban space at the macro level, and the research content mostly focuses on the spatial form and land use composition of the streets. There is a lack of quantitative research on the micro characteristics of street space quality, and the impact of human behavior on street space quality is ignored. The few studies on quantitative street space quality mostly use descriptive induction and lack the use of mathematical models to quantify the coupling mechanism between street space quality and behavior.

Therefore, this study is guided by environmental behavioral theory and supported by a new data environment. It takes the correlation mechanism between street space and walking behavior as the research object and explores the interaction patterns and degree of influence among various factors from a human-centered perspective. By measuring street space quality and studying the correlation between street space quality and behavior, we can understand the mutual needs and connections between pedestrians and various elements of material space and clarify the difference in intensity of significant influencing factors of various behaviors. Finally, based on the perspective of street space quality, the study offers suggestions for optimizing the street design guidelines for the old city area of Hefei.

1 Research design and indicator system construction

1.1 Research scope and sample selection

The old city area of Hefei (within the first ring road) has a long history and profound cultural heritage. It was once the political, economic, and cultural center of Hefei. It is also the place that best reflects the daily life of Hefei citizens[19]. With the evolution of the spatial functions of the old city, the changes in history, and the promotion of "urban dual repair"[20] the development history of the historical streets (Table 1) such as Hongxing Road, Women's Street, and Renmin Alley in the Qiguitang Block (Figure 1) represents a microcosm of urban renewal and construction history of the old city. Research on the street space quality of the Qiguitang Block is of great significance to the improvement of street quality and optimization of guidelines in Hefei.

The road network coordinate information within the blockis selected, and 146 sampling points are established on the road network with a sampling interval of 0.0005 degrees of longitude and latitude (about 30 meters) (Figure 1). The spacing is based on the theory of the human scale of external space.[21]It not only reduces the repetitiveness of street view content but also ensures the acquisition of refined and perceptible results while also taking into account the quality of behavioral data obtained by video shooting. The large-scale and high-precision sampling point setting ensures the diversity and authenticity of the research data.

Through the study of the phenomenon of Qiguitang Street in Hefei City, the built-up situation of the street space characteristics of the oldcity area of Hefei City is summarized, and the causes, impacts, and corresponding optimization methods of the built-up environment problems are deduced. Then, specific renewal ideas are developed to improve street space quality and promote healthy travel.

Table 1 Overview of typical streets

Street Name	Characteristics	Business Composition	Era	Street Length
Women's Street	Commercial pedestrian street	Dining, shopping, leisure	1990s	~ 270 meters
Hongxing Road	Cultural and artistic street	Shopping, leisure, residential	1980s	~ 1,700 meters
Renmin Alley	Dining and service street	Dining, convenience services, residential	1960s	~ 500 meters
Yimin Street	Clothing and service street	Shopping, residential	1960s	~ 500 meters
Lujiang Road	Food and service street	Shopping, residential	1960s	~ 1,500 meters
Dingjia Alley	Convenience service street	Convenience services, residential	1950s	~ 260 meters

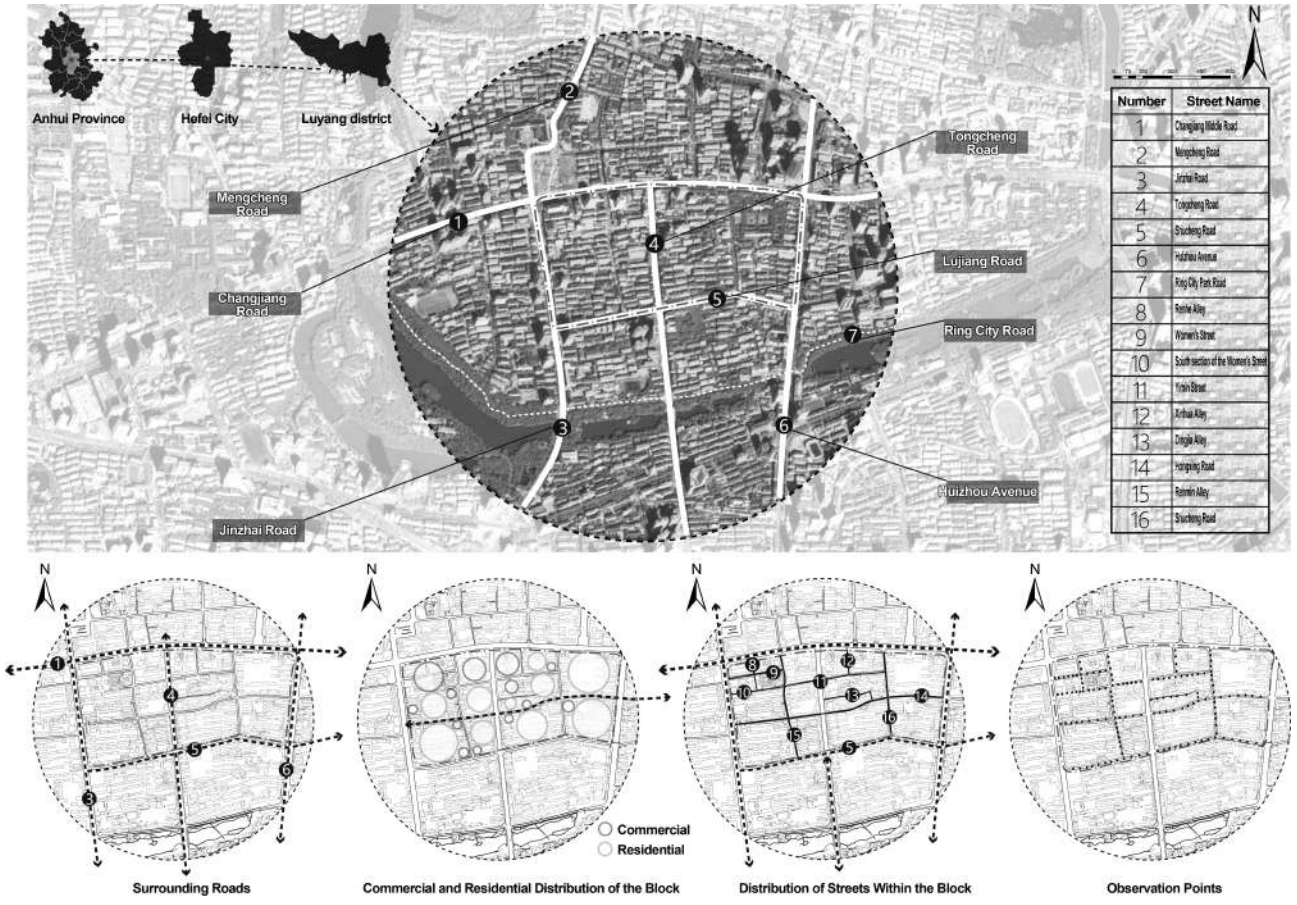

Figure 1 Research scope and observation point locations

1.2 Research Methods

Firstly, street space quality characteristics are extracted through multi-source big data relying on machine learning algorithms, and then a street space quality evaluation index system is constructed; secondly, behavioral observation is used to obtain the specific spatiotemporal characteristics of pedestrian behavior; then, a multivariate linear regression model for the study of the correlation between space quality and behavior is constructed, which includes comfort, convenience, safety, richness and four behavioral characteristics, as well as a corresponding measurement index system of 12 variables, and the degree and mode of interaction between the influencing factors are summarized based on the data processing results. The purpose is to provide precise support for the construction of high-quality block spaces by objectively analyzing the relationship between street space elements and walking behavior based on the urgent needs of urban micro-renewal and high-quality development of street guidelines.

1.3 Indicator selection

1.3.1 Review of existing research

The street space quality covers both objective material space and subjective psychological feelings[12].Its improvement and exploration have always been a hot topic of research. By reviewing classic urban design theories and sorting out relevant literature, we have concluded that (Table 2): 1. The indicator characteristics are not only continuous but also continue to expand in depth and breadth. 2. The research on space quality has gradually shifted from early qualitative analysis to comprehensive quantification, and the source of measurement data has also shifted from traditional, small sample data to multi-source big data.

Most of the current quantitative studies on street space quality use relatively subjective analysis methods, ignoring the relevant characteristics of street space quality from a human-centered perspective. The street space quality includes both objective material and psychological feelings. Different disciplines analyze it from different perspectives. Its connotation is complex, so it is necessary to adopt a comprehensive quantitative measurement method. The new data environment brings new possibilities in terms of scale, dimension, and content of analysis. It can obtain multi-source data on street material space and users' subjective psychological feelings at a human scale, providing strong support for multi-scale and high-precision evaluation of street space quality.

Table 2 Summary of research on street space quality characteristic factors

Period	Research content	Main characteristic factors	Data Sources and Research Methods	Research Scholar	Major references
1950—1999	Objective material space	Street form, color, landmarks, etc.	Observation and interviews	Lynch K	Good City Form
		Accessibility, density, mix of uses	Observation and interviews	Jacobs J	The Death and Life of Great American Cities
		Urban texture and architectural interface	Research and interviews	Trancik R	Finding Lost Space: Theories of Urban Design
		Pedestrian-friendly, moderately built-up, mixed-use	Research and photo documentation	Katz P	The New Urbanism: Toward an Architecture of Community
		Building form, green view index street furniture, human-centered scale, mixed functions, etc.	Literature Summary	Montgomery J	Making a City: Urbanity, Vitality and Urban Design
	Subjective psychological feelings	City intention	Observe and record	Lynch K	City Sense and City Design
		Safety, security, continuity, comfort, attractiveness	Observe and record	Fruin JJ	Pedestrian Planning and Design
		Intentionality, readability, diversity, street vitality	Literature summary	Montgomery J	Making a City: Urbanity, Vitality and Urban Design

(Continued)

Period	Research content	Main characteristic factors	Data Sources and Research Methods	Research Scholar	Major references
2000—2010	Objective material space	Street width, sidewalk width, street greenery, street-to-wall ratio, sky visibility, street furniture, street color, building visibility	Questionnaire Scoring	Ewing R	Measuring the Unmeasurable: Urban Design Qualities Related to Walkability
		Street business density and functional density	Research and statistical analysis	Xu Leiqing et al.	The impact of commercial street space and interface characteristics on pedestrian stay activities: a case study of Nanjing West Road in Shanghai
	Subjective psychological feelings	Intentionality, enclosure, human-centered scale, transparency, complexity, safety, comfort, fun, walkability	Questionnaire Scoring	Ewing R	Measuring Urban Design: Metrics for Livable Places
		Resident satisfaction, sense of security, etc.	Questionnaire Survey	Chen Yong	Analysis of pedestrian-friendly environment and influencing factors in rail transit station areas: an empirical study of 12 residential areas in Shanghai
2010 to present	Objective material space	Street width, street function density, functional mix, etc.	0SM map, POI data	Long Ying et al.	Quantitative evaluation of street vitality and analysis of influencing factors: A case study of Chengdu
		Green view index, street interface openness index, spatial enclosure index, and vehicle interference index	Street view images, ScgNct image segmentation, subjective scoring	Ye Yu et al.	Measuring street space quality at this scale: a large-scale, high-precision evaluation framework combining streetscape data and new analytical techniques
		Street function density and mix	Social networking site points of interest and check-in data	Shen Y	Urban Function Connectivity: Characterisation of Functional Urban Streets with Social Media Checking Data
		Street Greening and Accessibility	0SM Maps, Google Street View, Space Syntax	Tang Jingxian et al.	Measurement of street space quality in the central area of a megacity: A case study of the second and third ring roads in Beijing and the inner ring road in Shanghai
		Street length, width, height, cross-section ratio, street wall continuity	ESRI data, basic engineering ArcGIS platform measurement data	Harvey C	Streetscape Skeleton Measurement and Classification
		Accessibility of street space	Line segment model and natural street model, space creation evaluation	Batty M	Building a Science of Cities
		Street Space Quality and Accessibility	Street view image data, machine learning algorithms, ArcGIS data	Ye Yu et al.	Measuring street space quality at this scale: a large-scale, high-precision evaluation framework combining streetscape data and new analytical techniques
		Street space quality and pedestrian flow	Axwoman63 quantitative data 0SM map, street view pictures Pearson related	Zhao Xiaolong et al.	Study on the correlation between residential street space characteristics and pedestrian flow based on multi-source open data
		Convenience of life	0SM data, POI data, bus stop data	Fan Jun et al.	Multi-dimensional evaluation and control strategies of slow-moving street quality: integrated analysis based on multi-source urban data

1.3.2 The measurement indicators of street space quality

By reviewing classic urban design theories and sorting out the measurement indicators proposed by relevant researchers[20-26], the objective material space and subjective psychological feelings of space quality characteristics are divided into four analytical dimensions: safety, convenience, comfort, and richness according to Maslow's needs theory (Figure 2). Therefore, the indicators are further subdivided based on these four dimensions. Additionally, an analysis is conducted on machine learning algorithms represented by SegNet[27], DeepLab[28], YOLO[29], etc., to identify the key factors that existing analysis techniques can support for measurement. Ultimately, 12 spatial feature indicators are determined (Figure 3, Table 3).

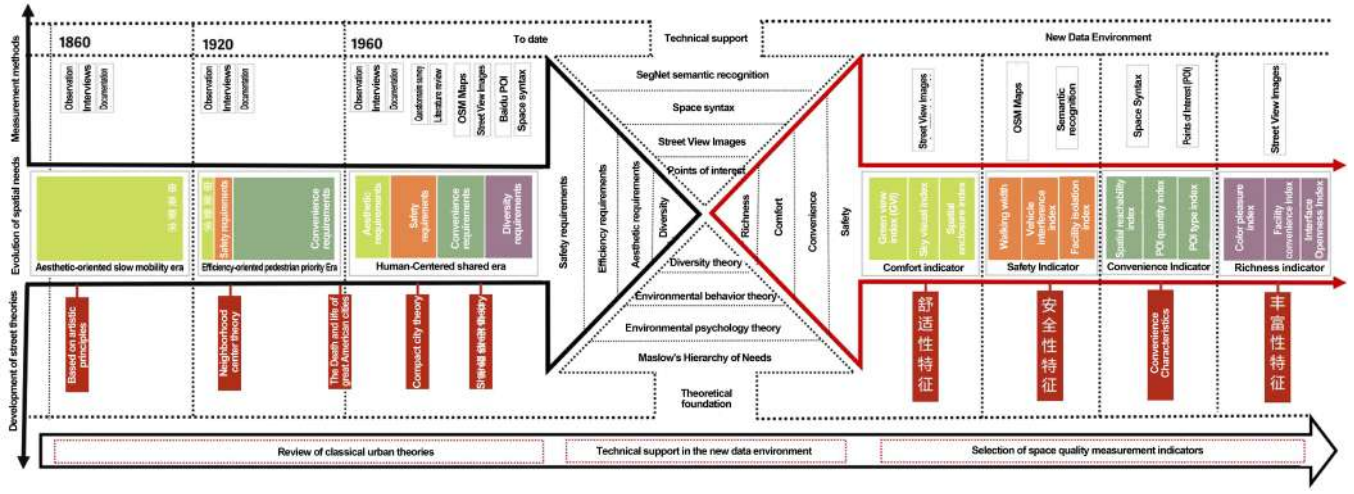

Figure 2 Roadmap of indicator screening technology

(1) Comfort characteristics: refers to the ability of street space to provide users with a comfortable and relaxing walking experience and visual perception. Among the many factors that affect spatial comfort, landscape greening and the openness of space have the most direct and universal impact on walking comfort[12]. Based on this, combined with existing analysis techniques, green view index, sky visual index, and spatial enclosure index are selected as measurement indicators. (Figure 4)

(2) Safety characteristics: The establishment of safety facilities is intended to ensure the safety of pedestrians. This is an active process. Only when users can gain a sense of active protection from the street material space for their travel can the construction of street safety be achieved. Therefore, the street safety discussed in this study mainly refers to the sense of security actively provided by the street material space[30]. Vehicle interference index, walking width, and facility isolation index are selected to quantify street safety.

(3) Richness characteristics: refers to the rich and layered visual experience that street elements bring to users, including the rich visual experience brought by the types of facilities, shop windows, and colors. Loveland (1998) pointed out that the most direct manifestation of beauty is the color observed by people, and visual color will directly affect people's preference for street space[12]. In summary, this article selects facility convenience index, color pleasure index, and interface openness index to further quantify the richness of the streets.

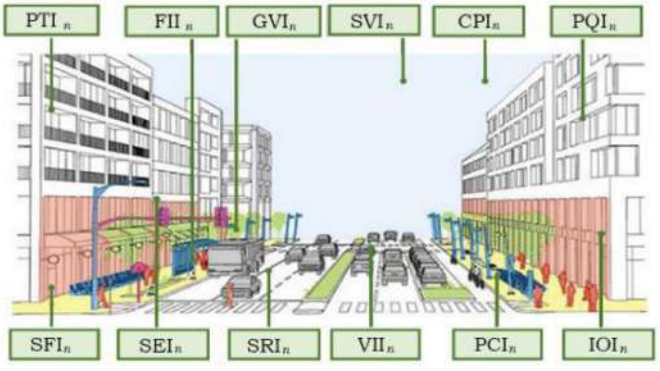

Figure 3 Street space quality index measurement chart

(4) Convenience characteristics: refers to the potential for a street to provide sufficient number of street services

and spaces for surrounding residents and pedestrians to meet the needs of users. From the perspective of street functional carrying capacity, it can be divided into two aspects: business function and traffic accessibility. This article selects POI business data and spatial reachability index to quantify street convenience.

Table 3 List of street space quality measurement indicators

Target layer	Analysis Dimensions	Measurement indicators	Collection method	Quantitative Model
Street space quality	Comfort	Green Viewindex (*GVI*)	Use Python to crawl street view data and use SegNet to cut and classify features.	Green plant pixels /total image pixels
		Skyvisual index (*SVI*)		Sky visible pixels/total image pixels
		Spatial enclosure index (*SEI*)		Building pixels/total image pixels
	Safety	Sidewalk footpath index(*SFI*)	Quantitative measurement based on OSM open data	Sidewalk footpath
		Facility isolation index (*FII*)	Use Python to crawl street view data and use SegNet to cut and classify features.	Isolation Facility Pixels/Total Image Pixels
		Vehicle interference index(*VII*)		Vehicle pixels/total image pixels
	Richness	Color pleasure index (*CPI*)	Identify the type of factors through semantics and calculate the numer of factor types.	Use the Simpson index to calculate
		Interface openness index (*IOI*)	Use Python to crawl street view data and use SegNet to cut and classify features.	Open interface pixels/total image pixels
		Facilityconvenience index (*FCI*)		Total number of facility categories
	Convenience	Spatial reachability(*SRI*)	Quantitative measurement based on ArcGIS\ Axwoman63	Space syntax calculation
		POI quantity index (*PQI*)	Baidu Map Open POI Capture\ ArcGIS Calculation.	Total PQI
		POI type index(*PTI*)		Number of PTI

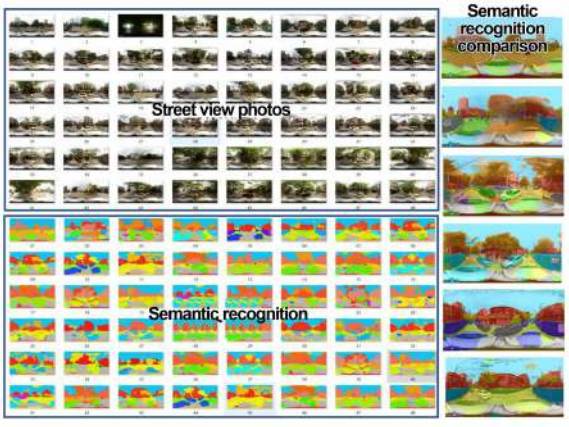

Figure 4 Semantic recognition results

1.3.3 Walking behavior

The selection ofwalking data is based on environmental behavioral theory, and its diversity is the result of the role of specific street space factors. As a representation of street space quality, walking data is extracted based on the classification of outdoor activities in *Communication and Space*.[21] Through on-site video recording and behavioral annotation, walking activities within the street area are captured. Subsequently, walking behaviors are categorized into four major types: sightseeing, leisure, consumption, and passing, which serve as the outcomes of spatial characteristics-driven behavior.

Sightseeing behavior mainly refers to the active behavior of users towards space under the influence of visual factors such as landscape, signs, and facilities, reflecting the ability of space to attract people. It mainly includes stopping to watch, taking photos, and admiring the buildings.

Leisure activities mainly refer to leisure activities that seek physical and mental adjustment and relaxation through various forms of "playing" during non-labor and non-working hours, with the purpose of achieving physical and mental health[31]. It specifically includes chatting, playing, sitting and resting, etc.

The consumption behavior in this study refers to the purchasing transactions of pedestrians attracted by the business formats along the street, including dining, shopping, etc.

Passing behavior refers to the behavior of the absolute and relative displacement of two points within a cer-

tain spatial range[32], reflecting the accessibility and continuity of the space. It specifically includes pedestrians walking, brisk walking, jogging, etc.

1.4 Data Processing

Walking behavior data: using a combination of video recording and behavior annotation. The recording spanned four days in total, including two weekdays and two rest days, with observation periods from 7:00 AM to 7:00 PM. Data is recorded for 0.5 hours every two hours. During recording, devices are placed diagonally at both ends of the observation space to avoid errors caused by perspective distortion and occlusion.

OSM open road network data is an open source world map that is freely used under an open license agreement. It contains information such as roads, green spaces and water systems, and is widely used in the study of space quality. Road network datais obtained by crawling Baidu Map raster images and performing vectorization processing using ArcGIS.

Street view data: By calling the Baidu Map API through Python, four street view pictures are captured at each sampling point with vertical and horizontal viewing angle, and then the SegNet machine learning algorithm is used to semantically recognize the target elements in the image to achieve accurate extraction of street space quality indicators.

Baidu POI business data: Pythonis used to crawl the Baidu map within the block. Based on the street scale and the combination of street-facing shops, a 20m radius buffer zone centered on sampling points is created using ArcGIS. Within these buffer zones, a total of 1,579 POIs are covered and calculated.

Based on space syntax theory, the Axwoman63 plugin for ArcGIS is used to calculate the spatial reachability index within the street area[33], explaining the potential that space can reach.

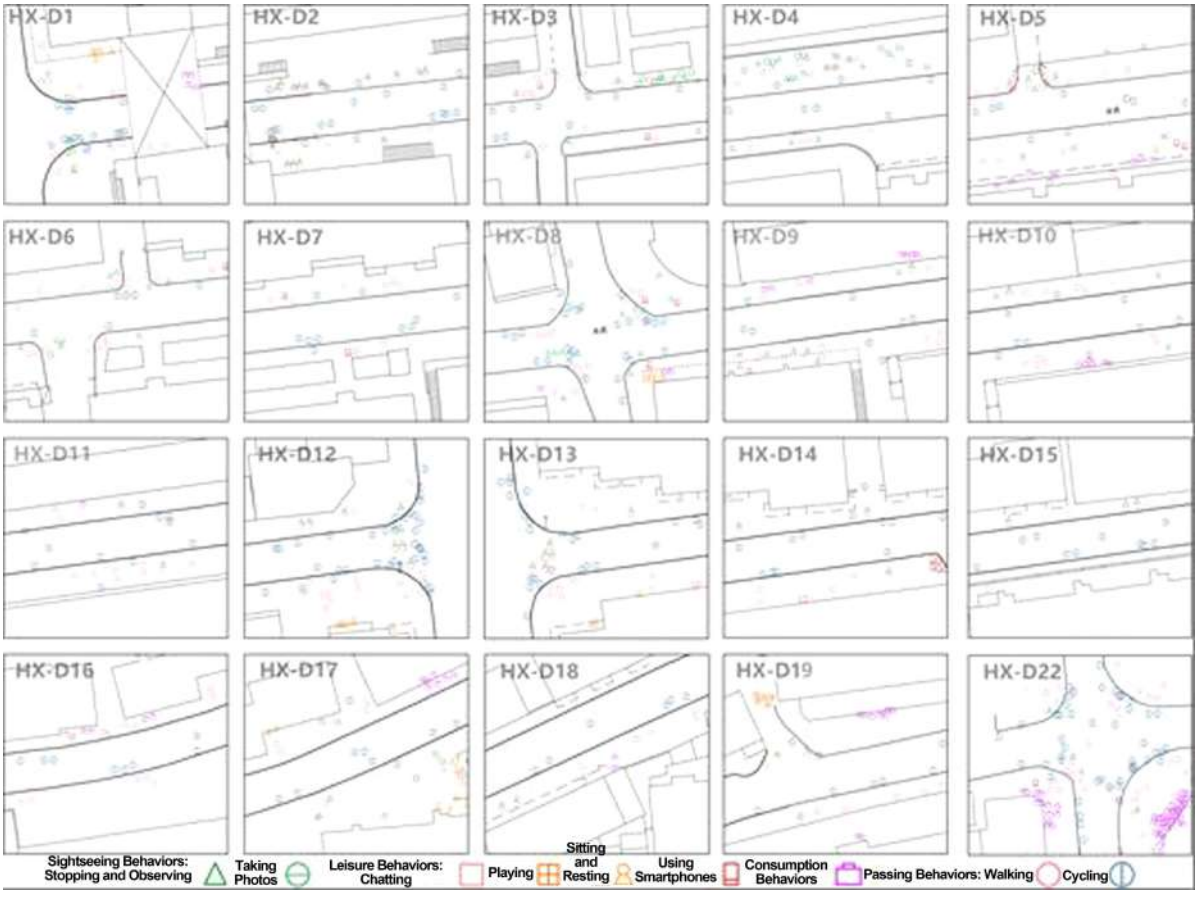

Figure 5 Behavior distribution diagram (partial)

2 Empirical research

2.1 Characteristics of Pedestrian Walking Behavior Data

According to statistics (Figures 5 and 6), people tend to choose spacious areas for walking and talking, while the narrow side is mainly for passing through and less spontaneous behavior; people will be attracted to look at the dazzling windows on both sides of the street, and will also look at the sudden road forks. When the spatial interface undergoes major changes, it is easy for people to observe out of curiosity or safety awareness; the beautiful street environment and interesting street facilities will attract pedestrians to take pictures. These findings suggest that specific pedestrian behaviors are influenced by environmental factors, and conversely, specific environmental elements guide pedestrian behaviors.

Based on ArcGIS kernel density analysis, the behavioral data from 146 observation points in the block across six time periodsare analyzed to obtain the kernel density map of the usage patterns of each sample space in the block in each time period (Figure 6), which shows that the density of user groups follows a trend of initial increase, subsequent decline, and final resurgence. In general, the flow of people in the morning period is higher than that in the afternoon, and the high density is scattered, with the main behavior being walking around, and there is no obvious aggregation. From the perspective of space usage, after 15:00, the spatial aggregation effect continues to expand over time from a scattered point-like distribution to a surface-like distribution fixed in a few places in the block.

By classifying and summarizing the behavioral data of the observation points, we obtained the behavioral characteristics to form a bar graph (Figure 7). The overall number of behaviors is uneven, with high-value fluctuations in the periphery and low-value continuity in the center, revealing that the difference in street space quality inside and outside the block leads toan uneven distribution of behaviors. The total number of behaviors and consumption behaviors in the behavior composition of Xinhua Alley and Dingjia Alley are far lower than the overall block level. It is found that the space quality indicators of the two are also lower than the overall level (Figure 8). On the contrary, Women's Street has high spatial vitality and high space quality. Therefore, the improvement of the internal vitality of the block requires the improvement of spatial quality as an internal driving force.

Based on this, there is a correlation between street space quality andwalking behavior. And what is the interaction between space and behavior? What is the extent of the influence of each factor? Studying the mathematical correlation mechanism between the two is of great significance to improving street quality and promoting healthy walking travel.

2.2 Spatial Data Characteristics

Based on the ArcGIS analysis platform, the quantitative data of 12 spatial characteristic indicators in four dimensions correlates with the sample space, and then a visual analysis is obtained through kernel density calculation (Figure 8).

2.2.1 The analysis of spatial characteristics of comfort

The environmental comfort indicators within the block exhibit two distinct patterns. The green view ratio and sky openness demonstrate a hollowing-out distribution pattern (Figure 8), with higher values near main roads and lower values in the block interior, indicating relatively limited green visibility and sky openness in the inner areas compared to the periphery. This reflects the compact spatial configuration and insufficient landscape vegetation in the old urban district's interior blocks. Conversely, the artificial comfort indicator -spatial enclosure index - shows an inverse pattern with lower values in the interior and higher values towards the periphery (Figure 8). This distribution characteristic shows that the building layout density and height inside the block also show a pattern of decreasing from the center to the periphery.

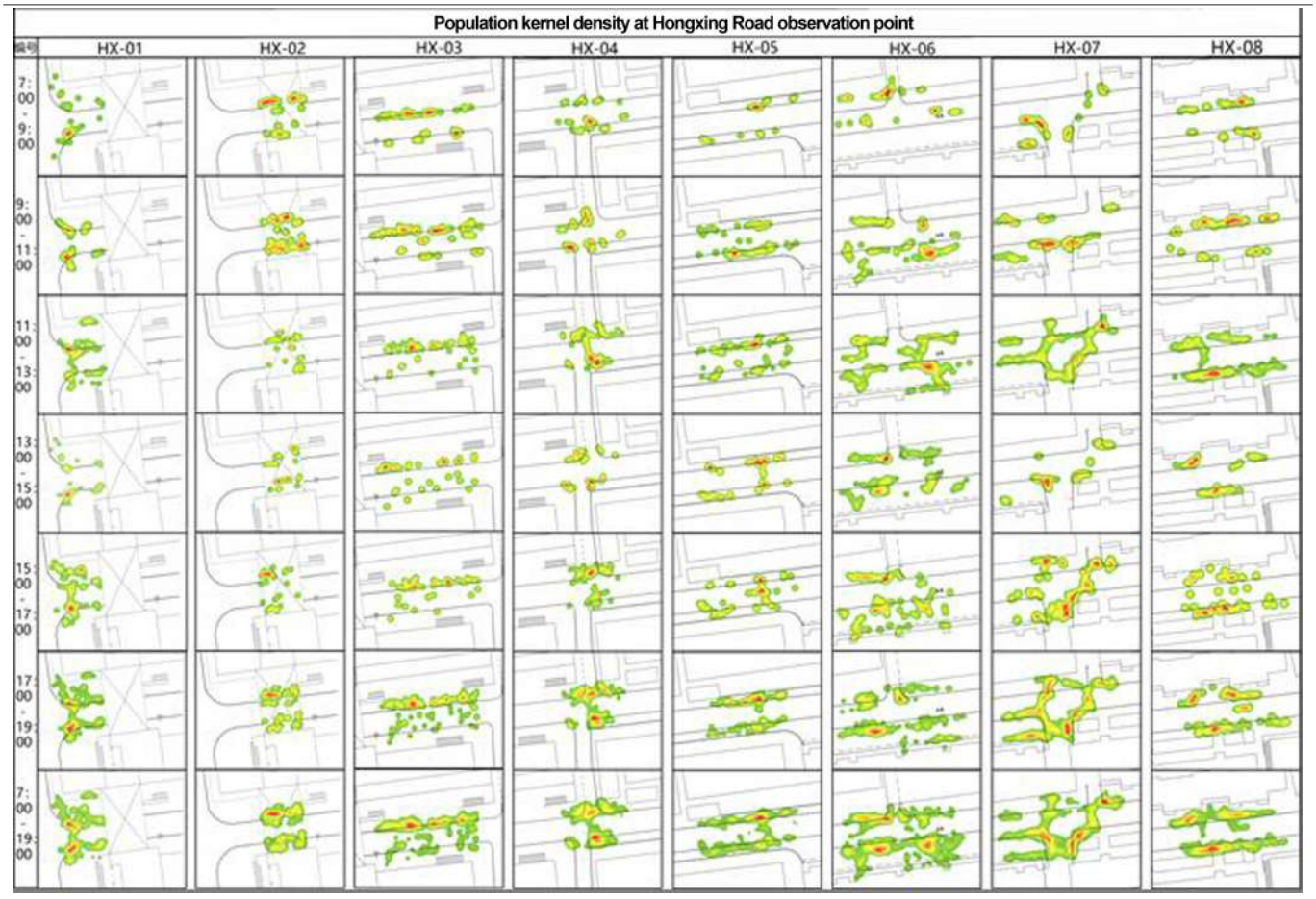

Figure 6 Kernel density map of behavior distribution (red star section)

Women's Street performs better than other streets in terms of comfort indicators, with a relatively suitable sense of enclosure and a relatively good green landscape. Other typical street data all clearly lean towards one indicator. The Renmin Alley has high sky visual index and spatial enclosure index, but the street's green view index has large areas of zero values. On the other hand, Hongxing Road shows a mixed pattern with both high and low values across the three indicators. Yimin Street has high green view index and low spatial enclosure index, reflecting a noticeable uneven distribution of current comfort levels across the streets in the old city area.

2.2.2 The analysis of spatial characteristics of safety

The quantitative results of various street safety indicators generally show a characteristic of being high outside and low inside (Figure 8), indicating that there are differences in the material space inside and outside the block, which in turn leads to the destruction of safety. From the analysis ofwalking width index and vehicle interference index (Figure 8), the vehicle interference index reflects the traffic conditions of the block; the walking width reflects the size of the walking space; the comprehensive measurement results of the two indicators show that the walking width presents a high value at the periphery and a low value in the center; the vehicle interference index presents a high value at the periphery and continuous holes in the inner core (Figure 8); therefore, the motor vehicle flow in the entire block is high, and the internal roads are narrow, and the pedestrian right of way is encroached, resulting in poor safety. Therefore, the balance between driving and walking is particularly urgent in the optimization of streets in the old city. The quantification of facility isolation index shows high values concentrated at the periphery, with a mixed pattern of highs and lows in the interior. Reasonable configuration of isolation facilities is conducive to ensuring smooth and safe travel for people and vehicles[32].

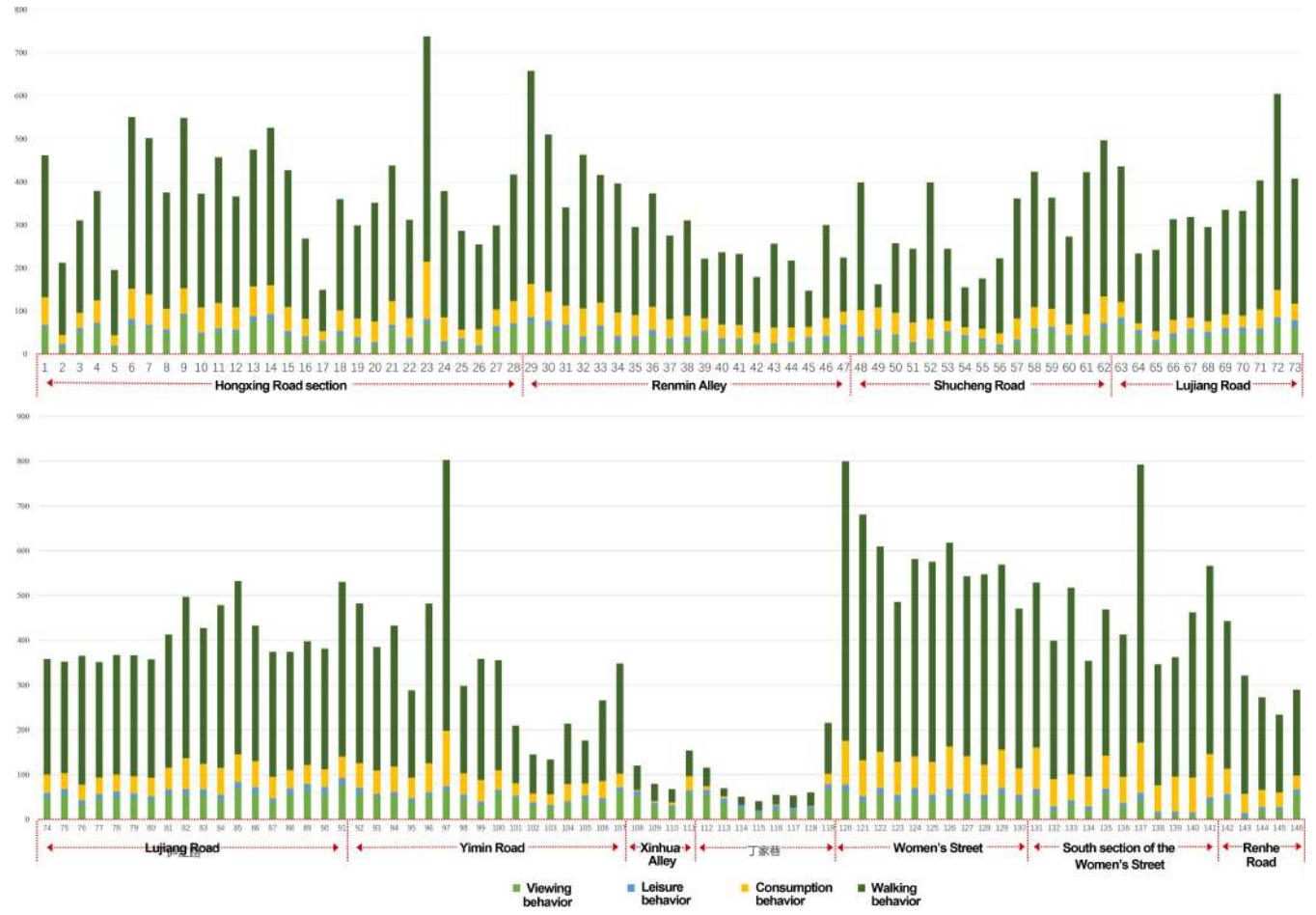

Figure 7 Bar graph of behavior characteristics composition

Based on the measurement results and the survey situation, Women's Street and Dingjia Alley are pedestrian streets and, therefore, have the best safety conditions. Hongxing Road's condition is relatively poor, with many entrances and exits. The walking width and facility isolation index are discontinuous, which affects the smoothness and safety of walking. The distribution of motor vehicles is staggered with intersections, indicating that there are many static parkings on the road, revealing the shortage of parking space in the block.

2.2.3 The analysis of spatial characteristics of richness

The overall color pleasure index and interface openness index of the blocks show the characteristics of multi-core scattering in the north, staggered highs and lows in the center, and low and continuous values in the south (Figure 8). They are greatly affected by the distribution of business types. The higher the commercial vitality is, the higher the interface openness index and the variety of colors are. Therefore, the measurement results indicate both the lack of street interface richness and the uneven distribution of business vitality. The facility convenience index is characterized by multi-core continuous distribution and central low-value point distribution, indicating that the overall distribution of facilities in the block is too balanced and unchanged, and there is a lack of intrinsic exploration of different types of street spaces, such as pocket parks, corner squares, street entrances, and other spaces for walking and leisure, interactive fun, and cultural improvement.

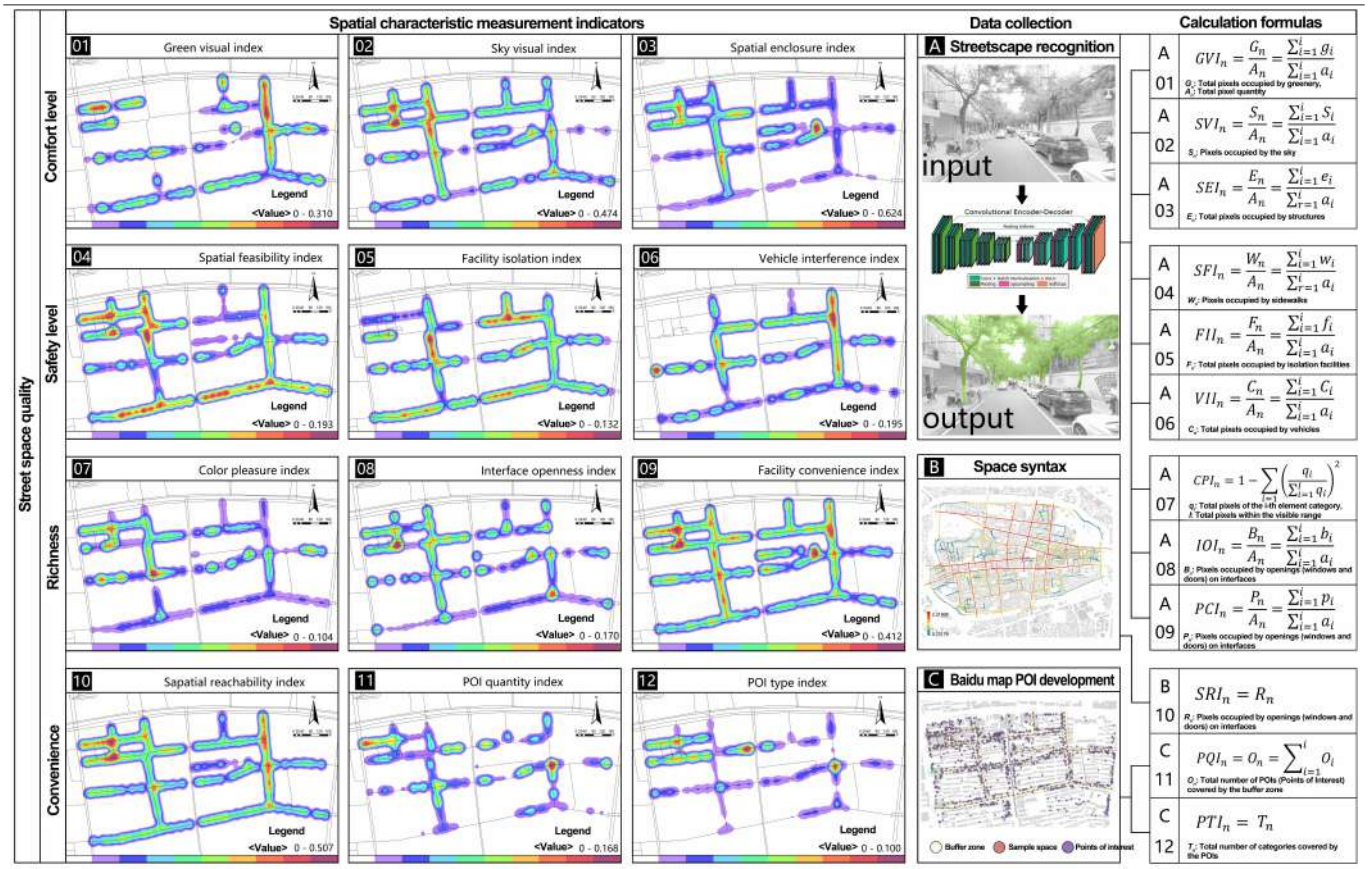

Figure 8 Measurement method and visualization of street space quality index

2.2.4 Analysis of spatial characteristics of convenience

Convenience index reflects the convenience level of the space in the entire space, which includes both the functional business types of the space and the accessibility potential of the space. There are differences in the distribution characteristics of the two. The overall distribution of POI types and numbers of the functional business convenience index is measured to show a multi-core dispersion, with high values extending from the north to the south (Figure 8). That is, high values spread from the center of the old city to the surrounding areas, reflecting the agglomeration and uneven distribution of business functions. Therefore, it is necessary to insert functions according to local conditions to activate the vitality of the block. The integration degree of the spatial reachability index is characterized by high values in the periphery and low values in the center, and the closer to the main road, the higher the integration degree. Most of the streets in the old city have similar characteristics and rules. The key to solving the problem is how to improve the attractiveness of the street space based on the existing spatial organizational relationship.

2.3 Results of correlation data analysis

Considering that the relationship between street space characteristics and behavior is relatively complex, the value of the behavior variable is not uniquely determined by the variable of a certain spatial characteristic. There may be multiple variables interacting with each other, and the degree of interaction between variables varies. Therefore, based on the SPSS data analysis platform, this study constructed a multiple linear regression model to study the association between space quality and behavior, including comfort, convenience, safety and four behavioral characteristics.

2.3.1 The impact of street space characteristics on various behaviors

(1) Constructing an impact mechanism model Based on the SPSS analysis platform, with street space quality characteristics as independent variables and the number of various behaviors distributed in the street space as the de-

pendent variable, a model of the impact mechanism of street space characteristics on life behaviorsis established, showing the quantitative relationship between various behaviors and street space characteristic indicators.

Table 4 Results of multiple regression analysis of sightseeing behavior and spatial characteristics

Level 1	Level 2	Standardized coefficient			Collinearity statistics		Adjusting R^2	F
index	index	Beta	t	p	Tolerance	VIF		
	constant		−3.087	0.00**				
Comfort	Green view index(*GVI*)	0.172	2.355	0.020**	0.349	2.865		
	Sky visual index(*SVI*)	−0.044	−0.740	0.460	0.518	1.930		
	Spatial enclosure index(*SEI*)	0.013	0.192	0.848	0.378	2.647		
Safety	Sidewalk footpath index (*SFI*)	0.254	4.147	0.000**	0.496	2.014		
	Facility isolation index (*FII*)	0.013	0.221	0.825	0.577	1.733		33.609
	Vehicle interference index(*VII*)	0.072	1.422	0.157	0.718	1.394	0.730	p= 0.000
Richness	Color pleasure index(*CPI*)	0.215	4.016	0.000**	0.651	1.537		
	Interface openness index (*IOI*)	0.586	10.593	0.000**	0.609	1.642		
	Facility convenience index (*FCI*)	0.357	7.907	0.000**	0.914	1.094		
Convenience	Spatial reachability index(*SRI*)	−0.036	−0.490	0.625	0.346	2.886		
	POI quantity index(*PQI*)	−0.065	−0.985	0.326	0.432	2.317		
	POI type index(*PTI*)	0.014	0.194	0.846	0.365	2.742		
DW value= 2.289								

* p< 0.05, ** p< 0.01

Table 5 Results of multiple regression analysis of leisure behavior and spatial characteristics

Level 1	Level 2	Standardized coefficient			Collinearity statistics		Adjusting R^2	F
index	index	Beta	t	p	Tolerance	VIF		
	constant		0.272	0.786				
Comfort	Green view index(*GVI*)	0.013	0.332	0.740	0.349	2.865		
	Sky visual index(*SVI*)	0.002	0.067	0.947	0.518	1.930		
	Spatial enclosure index(*SEI*)	0.014	0.387	0.700	0.378	2.647		
Safety	Sidewalk footpath index (*SFI*)	0.810	25.453	0.000**	0.496	2.014		
	Facility isolation index (*FII*)	−0.002	−0.052	0.958	0.577	1.733		154.584
	Vehicle interference index(*VII*)	−0.431	−16.286	0.000 **	0.718	1.394	0.927	p= 0.000
Richness	Color pleasure index(*CPI*)	−0.003	−0.104	0.917	0.651	1.537		
	Interface openness index (*IOI*)	0.212	7.375	0.000 **	0.609	1.642		
	Facility convenience index (*FCI*)	0.328	13.992	0.000 **	0.914	1.094		
Convenience	Spatial reachability index(*SRI*)	−0.043	−1.122	0.264	0.346	2.886		
	POI quantity index(*PQI*)	0.036	1.044	0.299	0.432	2.317		
	POI type index(*PTI*)	0.015	0.414	0.680	0.365	2.742		
DW value = 1.946								

* p< 0.05,** p< 0.01

Table 6 Results of multiple regression analysis of consumption behavior and spatial characteristics

Level 1	Level 2	Standardized coefficient			Collinearity statistics		Adjusting R^2	F
index	index	Beta	t	p	Tolerance	VIF		
	constant		−4.753	0.000**				
Comfort	Green view index(*GVI*)	−0.046	−1.611	0.110	0.349	2.865		
	Sky visual index(*SVI*)	0.070	2.994	0.003**	0.518	1.930		
	Spatial enclosure index(*SEI*)	0.087	3.174	0.002**	0.378	2.647		
Safety	Sidewalk footpath index (*SFI*)	0.244	10.192	0.000**	0.496	2.014		
	Facility isolation index (*FII*)	−0.062	−2.807	0.006**	0.577	1.733		281.941
	Vehicle interference index(*VII*)	0.031	1.547	0.124	0.718	1.394	0.959	p= 0.000
Richness	Color pleasure index(*CPI*)	0.009	0.434	0.665	0.651	1.537		
	Interface openness index (*IOI*)	0.210	9.729	0.000**	0.609	1.642		
	Facility convenience index (*FCI*)	−0.023	−1.278	0.203	0.914	1.094		
Convenience	Spatial reachability index(*SRI*)	0.206	7.193	0.000**	0.346	2.886		
	POI quantity index(*PQI*)	0.386	15.028	0.000**	0.432	2.317		
	POI type index(*PTI*)	0.393	14.083	0.000**	0.365	2.742		
DW value= 0.876								

* p< 0.05，** p< 0.01

Table 7 Results of multiple regression analysis of passing behavior and spatial characteristics

Level 1	Level 2	Standardized coefficient			Collinearity statistics		Adjusting R^2	F
index	index	Beta	t	p	Tolerance	VIF		
	constant		−8.543	0.000**				
Comfort	Green view index(*GVI*)	0.026	0.762	0.447	0.349	2.865		
	Sky visual index(*SVI*)	0.148	5.285	0.000**	0.518	1.930		
	Spatial enclosure index(*SEI*)	0.162	4.932	0.000**	0.378	2.647		
Safety	Sidewalk footpath index (*SFI*)	0.359	12.539	0.000**	0.496	2.014		
	Facility isolation index (*FII*)	−0.108	−4.072	0.000**	0.577	1.733		193.953
	Vehicle interference index(*VII*)	−0.005	−0.201	0.841	0.718	1.394	0.941	p= 0.000
Richness	Color pleasure index(*CPI*)	0.028	1.137	0.258	0.651	1.537		
	Interface openness index (*IOI*)	0.224	8.655	0.000**	0.609	1.642		
	Facility convenience index (*FCI*)	−0.005	−0.228	0.820	0.914	1.094		
Convenience	Spatial reachability index(*SRI*)	0.330	9.632	0.000**	0.346	2.886		
	POI quantity index(*PQI*)	0.512	16.687	0.000**	0.432	2.317		
	POI type index(*PTI*)	0.039	1.156	0.250	0.365	2.742		
DW value= 1.790								

* p< 0.05，** p< 0.01

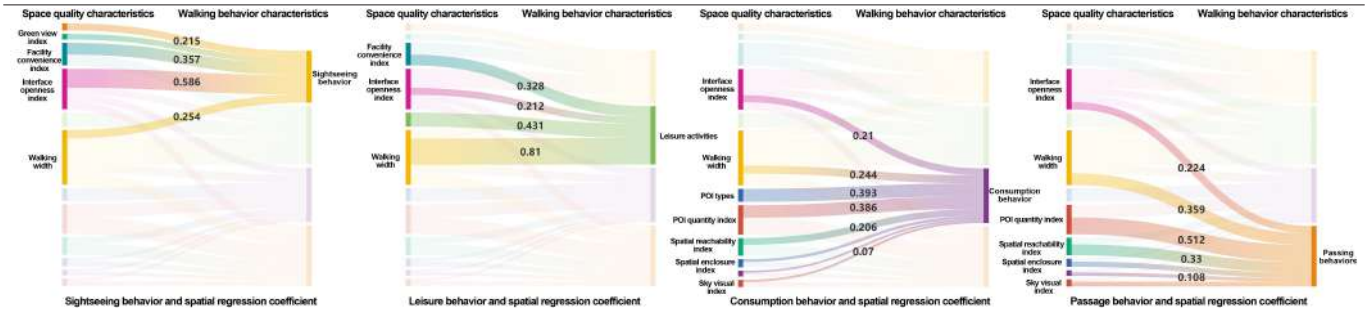

Figure 9 Multiple regression Beta value quantification chart

2.3.2 The influence of street space characteristics on various behaviors

On the basis of clarifying the influencing mechanism of each behavior and spatial characteristics, the P value is used to screen out the significant influencing factors, and the influence of each spatial characteristic on each behavior is analyzed by comparing the Beta value. (Figure 9)

(1) The influence of street space characteristics on sightseeing behavior. As shown in Table 4, the adjusted R-squared of the model is 0.730, indicating a good fit. The model passes the F-test (F= 33.609, P< 0.001), suggesting that the fitted equation is statistically significant; the VIF values of the independent variables are all less than 5 and the Debin-Watson test value of this study is 2.289, indicating that the observations in the study are independent of each other. By screening P values and comparing Beta values, the influence of various factors on sightseeing behavior in streets, ranked from strongest to weakest, is as follows: interface openness index (*Beta*= 0.586), facility convenience index (*Beta* = 0.357), walking width (*Beta* = 0.254), color pleasure index (*Beta*= 0.215), and green view index (*Beta*= 0.172). That is, interface openness index has the greatest impact on sightseeing behavior in living streets. Following that, facility convenience index, walking width, and color pleasure index play major roles, while green view index also promotes sightseeing behavior.

The richness index of street space has an important impact on viewing behavior. Among them, improving the interface openness in street space and reasonably arranging street furniture and facilities are important means to promote sightseeing behavior; spacious walking space, rich and diverse street colors and dense greenery are also space characteristics that attract pedestrians to stop and watch.

(2)The impact of street space characteristics on leisure behavior. As shown inTable 5, the model fits well, the fitted equation is statistically significant, and the observations in the study are independent of each other. By screening P values and comparing Beta values, the influence of various factors on leisure activities in streets, ranked from strongest to weakest, is as follows: walking width (*Beta* = 0.810), vehicle interference index (*Beta* = −0.431), facility convenience index (*Beta* = 0.328), and interface openness index(*Beta*= 0.212). That is, the walking width has the greatest impact on leisure behavior in living streets, and spacious pedestrian spaces are conducive to promoting the mixing and interaction of ground-floor commercial spaces. Following that, the impact of vehicle interference index is also significant and has an inhibitory effect on leisure behavior. In other words, the greater the number of motor vehicles in street spaces, the lower the likelihood of leisure activities. On the other hand, facility convenience index and interface openness index have a positive effect on leisure behavior.

Spacious pedestrian space has an important impact on leisure behavior. Improving the utilization rate and quality of pocket squares in blocks is an important design point to promote leisure behavior. Parking of motor vehicles in blocks and reasonable planning of motor vehicle lanes are also effective measures to encourage leisure behavior.

(3)The impact of street space characteristics on consumer behavior. By screening the P value and comparing the Beta value(Table 6), the influence of various factors on consumer behavior in streets, ranked from strongest to

weakest, is as follows: POI type index(*Beta*= 0.393), POI number index(*Beta*= 0.386), walking width (*Beta*= 0.244), interface openness index(*Beta*= 0.210), spatial reachability index(*Beta*= 0.206), enclosure index(*Beta*= 0.087), sky visual index (*Beta*= 0.070), and facility isolation index (*Beta*= −0.062). That is, the types and number of POIs have the greatest impact on consumer behavior. Following that, the influence of walking width, interface openness index and spatial reachability index plays a major promoting role on consumer behavior. The enclosure index, sky visual index, and facility isolation index also have an impact on consumption behavior to a certain extent, and the facility isolation index is negatively correlated with consumption behavior, which has a certain inhibitory effect.

In the influence relationship of consumer behavior, the higher the convenience of the street space, the more corresponding consumer behaviors will occur. Street space with high convenience characteristics can better stimulate people's consumer behavior. For example, the types and number of POIs on Hongxing Road and Women's Street are higher than those on the surrounding streets, and the number of consumer behavior distributions is also obviously high in the entire block.

(4)The impact of street space characteristics on passing behavior. By screening the P value and comparingit with Beta value(Table 7), the influence of various factors on passing behavior in streets, ranked from strongest to weakest, is as follows: PQI (*Beta*= 0.512), walking width (*Beta*= 0.359), spatial reachability index(*Beta*= 0.330), interface openness index(*Beta*= 0.224), spatial enclosure index(*Beta*= 0.162), sky visual index(*Beta*= 0.148), and facility isolation index(*Beta*= - 0.108). That is, PQI, walking width, and spatial reachability index have the most significant impact on passing behavior. Interface openness index, spatial enclosure index, and sky visual index have important impacts on passing behavior. The facility isolation index has a certain inhibitory effect on traffic behavior.

In general, street spaces with high convenience often havea large flow of people and are accompanied by a concentration of business types, such as Women's Street and Hongxing Road; there are also street spaces with high accessibility and low functional density, such as Lujiang Road. This shows the important influence of the convenience index on traffic behavior. Walking width reflects the accessibility of the street and the road grade. The higher the street grade and the better the accessibility, the more conducive it is to facilitating residents' travel.

3 Street guideline optimization strategy based on space-behavior correlation

Summarizing and sorting out the research findings of current street optimization strategies: (1) The proposed strategies do not fully consider the regional characteristics of the research objects. (2) Most of the strategies are proposed through qualitative analysis and empirical analysis, and there are few studies that propose strategies based on quantitative relationships. (3) The research on street design guidelines is in the ascendant, and it is meaningful to provide suggestions for the optimization of guidelines from the perspective of street space quality[3].

Therefore, in the process of optimization and transformation, in addition to considering objective material factors, we should also pay attention to combining it with its unique regional characteristics[34-36]. This study fully considers the existing situation of the old city of Hefei and, based on the mathematical relationship between space and behavior, puts forward suggestions for optimizing street guidelines from the perspective of street space quality.

3.1 Optimization strategies based on comfort

3.1.1 Create a green ecology and comfortable and pleasant interaction

The green view index of the blocks in Hefei's old city shows a hollow distribution, and the street space resources are unevenly allocated. In addition, how to reasonably and effectively allocate them under the contradiction of compact spatial layout is the key to the design. We should focus on the multi-dimensional expansion of green open spaces and combine them with commercial spaces [34]; fully explore the compound utilization of the remaining space on both sides of the street, and coordinate

pocket parks, street corner squares, and other spaces. The reasonable layout of green plants in street space and increasing street greening in various ways can effectively regulate street microclimate and play the role of street shading, dust filtering, and noise reduction in hot summer [37]. Therefore, island flower beds and tree pools can be used to form the vitality tentacles of green ecology, which can not only create the possibility of intermittent stop and sightseeing for people's necessary activities but also create conditions for people to pass through traffic and penetrate natural landscapes[38].

3.1.2 Create a pleasant space and a rhythmic interface

Thespatial enclosure index has different degrees of influence on consumption behavior and traffic behavior, and the relationship is positively correlated. The appropriate spatial enclosure index is conducive to creating an orderly, comfortable, and pleasant street space. Street spaces should be reasonably organized to form a rhythmic and orderly spatial interface through the alignment of street-facing buildings, street trees, and walls while encouraging the creation of a multi-layered street interface[37].

3.2 Spatial optimization strategies based on safety

Ensuring pedestrianpassing safety is the primary issue in improving the quality of street space. The sections of Hongxing Road, Renmin Alley, and Yimin Street tend to gather a large number of commercial and crowd activities and also serve as important transportation carriers within the neighborhood. Currently, the shops along both sides of Hongxing Road, Renmin Alley and Yimin Street have developed to a certain scale, but this has also caused a contradiction between traffic safety and crowd gathering activities.

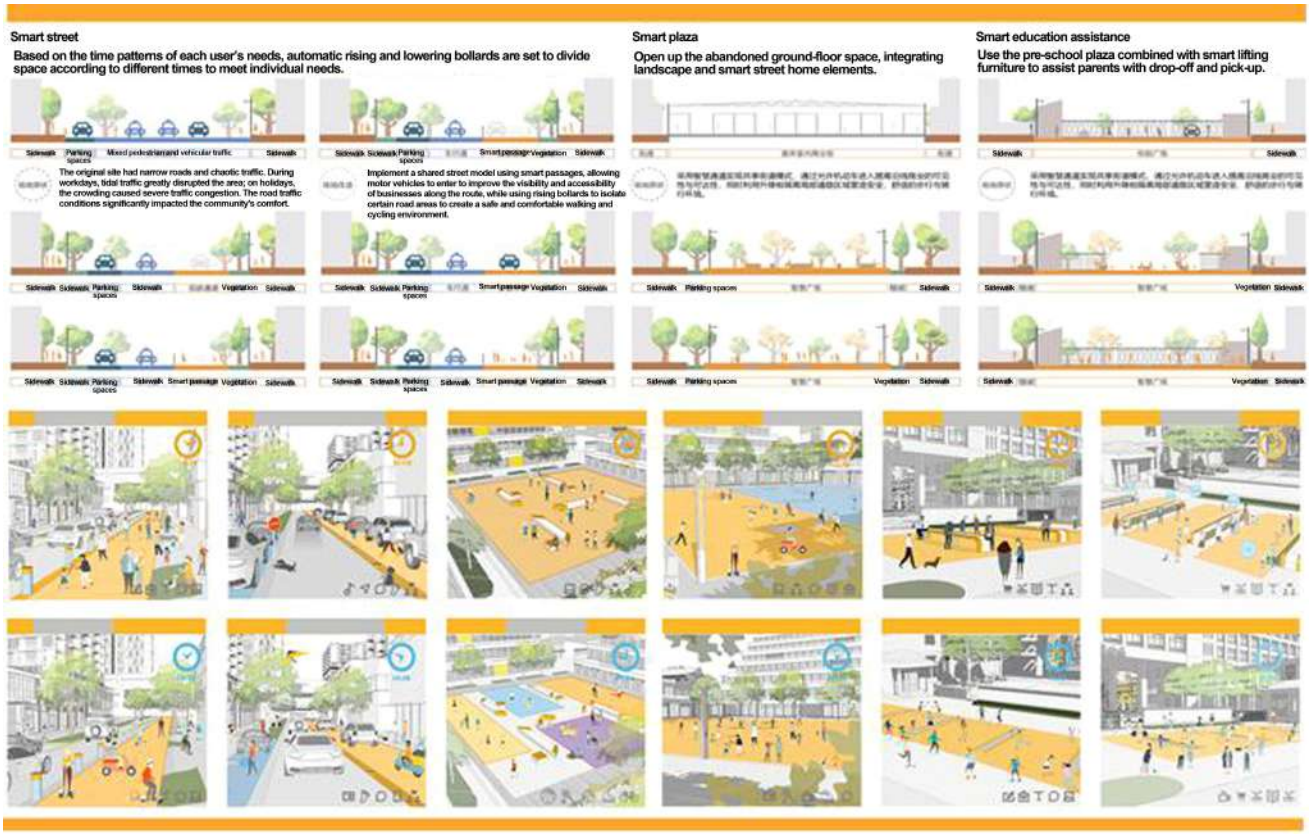

Figure 10 Tidal Street Strategy

3.2.1 Smarttidal streets and shared mixed spaces

Expanding pedestrian spaces plays an important role in improving travel safety. Currently, there are periods of congestion in both motor vehicle spaces and sidewalks in urban streets, creating safety hazards and inconveniences for pedestrians, especially in the Hongxing Road section, RenminAlley section, and Yimin Street section. Research has shown that traffic congestion in the inner districts typ-

ically only occurs during peak hours, with lighter traffic during off-peak periods. Moreover, the well-developed surrounding road network helps alleviate urban traffic pressure during off-peak times. Based on this, we propose the concept of tidal streets: During off-peak periods, smart rising bollards are used to convert part of the vehicle lanes into pedestrian spaces, significantly improving the utilization of street space. This expansion of pedestrian areas ensures walking safety while not interfering with motor vehicle traffic flow, thus revitalizing the street(Figure 10). During peak hours, smart rising bollards will be lowered to restore space on motor vehicle lanes and ease urban traffic pressure.

3.2.2 Appropriate division and isolation to strengthenthe functional connection

While ensuring pedestrian safety, the economic and social benefits generated bypassing and consumption behaviors in the block should not be overlooked. Excessive implementation of unnecessary isolation measures may lead to negative consequences[38].For instance, in the case of the North and South sections of Women's Street and the East and West sections of Yimin Alley, excessive isolation under similar conditions has resulted in significant reduction in commuting and consumption activities. Therefore, the accessibility to commercial and residential spaces should be achieved through an integrated design that connects pedestrian spaces with parking areas and transit stations, rather than complete segregation from vehicular spaces. Practical solutions should be developed based on existing conditions, emphasizing enhanced connectivity with other public open spaces to strengthen functional integration throughout the block.

3.3 Spatial optimization strategies based on richness

3.3.1 Improve street facilities and strengthen characteristic guidance

The facility convenience index plays an important role in promoting sightseeing and leisure behaviors. The current distribution of facilities within the block exhibits low-value scattered patterns, indicating limited variety and monotony. Given the concentration of historical buildings and interconnected alleys in Hefei's old city, the key challenge lies in improving facilities while preserving and enhancing historical characteristics. The difficulty of the renovation is how to improve the facilities, strengthen the characteristics, and continue the rich history of the streets. During the design and renovation process, in addition to focusing on the design of areas close to people, using awnings and spaces along the edges to provide shade, improving furniture items for people to rest, and selecting various paving materials to enrich the horizontal interface of the street; it is also possible to strengthen the guidance of street advertising slogans, facade window designs, cultural wall displays and block colors, which can help strengthen pedestrians' overall cognition of the block and form a unique cultural image.

3.3.2 Grasp the reality and virtuality of the facade and enrich the visual experience

The interface openness index is mainly affected by the transparency of the street facade. Attention should be paid to the virtual-real relationship of the ground floor facade along the street to avoid large areas of solid walls. Excessive use of highly reflective glass is unnecessary and will affect the walking experience of pedestrians. Buildings along the street are encouraged to provide exquisite and rich details, the design of building entrances should form a rich image, and the walking speed should be catered to form a rich visual experience.

3.4 Spatial optimization strategies based on convenience

3.4.1 Enriching business functions and facilitating the neighborhood

According to the theory of space syntax, the interaction between space, function, and human flow will produce

a multiplier effect. That is, the high accessibility of the street often attracts people to gather, and the dense human flow activities promote the development of business along the street. The rich and diverse business functions promote the increase of road network density, thus forming a sound cycle of coordinated development between space, function, and human flow.[35] Taking Yimin Street as an example, this type of street has a dense number of business functions but low accessibility, resulting in insufficient street space quality. To this end, while maintaining the original street mechanism, we can properly clear the relationship between the internal alleys and main streets within the block and effectively optimize the organization of traffic and functions, thereby attracting more people flow and a mix of functions.

3.4.2 Combine land use functions and strengthen characteristic themes

The land use structure in Hefei's old city is complex. The core of the problem is how to extract the unique cultural intentions and connotations of the streets and continue the city's regional characteristics.

We need to understand each street in depth, explore its characteristics and connotations, and divide the streets into theme streets according to their functions. For example, the surrounding land occupied by Nanmen Primary School can be used to create a vibrant campus theme section; the old residential areas around the land can be combined with the unique courtyard culture of the old city to create a city life theme section; the commercial functions of Hongxing Road are concentrated to create a creative commercial section, etc.

Centered around the core functions of various street themes, diverse commercial activities should be introduced. Through the development of street themes, the unique culture of the street can be highlighted, catering to different types of people with varying needs. This approach maximizes the cultural imagery and cultural connotation of the streets[34].

4 Summary and discussion

This article obtains space characteristics data through a multi-source big data collaborative machine learning algorithm, combines the behavioral observation method to obtain behavioral data, and explains the relationship between street space and walking behavior based on mathematical models. The study found that there is a specific mathematical influence relationship between walking behavior and street space elements, among which functional business types, walking width, and interface openness have a more significant impact on overall walking behavior. Based on this, the strategy for street optimization and renovation should be tailored to local conditions based on the characteristics of street space quality under different behavioral needs.

Due to the limitations of multi-source data acquisition, the quality characteristics of some factors have not been taken into account for the time being due to the difficulty of obtaining and converting them. As a result, the variables affecting walking behavior are still not perfect, such as the sense of harmony, microclimate, soundscape, traffic flow, and social factors of travelers. In addition, due to the limitations of the scope of walking behavior collection and the effort required to organize the behavioral observation method, the size and number of statistical blocks cannot be too large, which in turn affects the sample size and data quality. In subsequent research, we can try to use machine learning algorithms and WIFI data to obtain travel data characteristics to improve the richness and efficiency of data analysis.

The correlation mechanism between street space quality andwalking behavior can provide a strong basis and support for scientifically diagnosing urban built environment problems and optimizing travel experience. It can also provide new solutions for the rational allocation of facilities, the promotion of low-carbon travel, and the formulation of Hefei street design guidelines.

Sources of Figures and Tables：

All figures and tables are made by the author

References

[1] WHYTE W H. The Social life of Small Urban Spaces[M].The US: The Conservation Foundation,1980.

[2] HUANG Jianzhong,HU Gangyu.Comparison and Thinking of Pedestrian Measurement Methods of Urban Built Environment [J]. Western Journal of Human Settlements, 2016,31(1):67-74.

[3] MA Qiang,WEI Xiao,REN Guannan. Street Design Guidelines and Optimization and Improvement of Urban Road System Transformation From Traffic Capacity to Space Quality [J]. Urban traffic, 2021,19(5):1-16.

[4] LONG Ying, SHEN Yao. Data Enhanced Design—Planning and Design Response and Change in the New Data Environment[J]. Shanghai Urban Planning,2015(2):81-87.

[5] HAO Xinhua,LONG Ying,SHI Miao,et al.The Vitality of Beijing Streets: Measurement, Influencing Factors and Inspiration From Planning and Design[J].Shanghai Urban Planning,2016(3):37-45.

[6] HAO Xinhua,LONG Ying.Street Greening:a New Pedestrian Evaluation Index[J].Shanghai Urban Planning, 2017(1):32-36,49.

[7] TANG Jingxian,LONG Ying.Measurement of street space quality in the central area of mega cities—taking the second and third ring roads of Beijing and the inner ring roads of Shanghai as examples[J].Planners,2017,33(2):68-73.

[8] YE Yu, ZHANG Zhaoxi, ZHANG Xiaohu, et al. Humanistic Street Space Quality Measurement—a Large-Scale and High-Precision Evaluation Framework Combining Street Scene Data and New Analysis Technology[J].International Urban Planning, 2019,34(1): 18-27.

[9] XU Leiqing,MENG Ruoxi,CHEN Zheng.The Charming Street:The Influence of Architectural Interface and Green Vision[J]. Landscape architecture,2017(10):27-33.

[10] YANG Junyan, WU Hao, ZHENG Yi. Research on the Spatial Characteristics and Optimization Strategies of Urban Street Walkability Based on Multi-Source Big Data—Taking the Central Urban Area of Nanjing as an example[J]. International Urban Planning,2019,34(5):33-42.

[11] CHEN Jingjia, ZHANG Zhaoxi, LONG Ying.Strategies for Improving the Quality of Public Health Oriented Street Space — From the Perspective of Spatial Disorder[J]. Urban Planning, 2020,44(9):35-47.

[12] MIAO Cencen.Research on the Measurement and Impact Mechanism of Urban Street Space Quality Based on Street View Image Data[D].Southeast University, 2018.

[13] ZHANG Zhang,XU Gaofeng,LI Wenyue,et al.The Impact of the Micro-Scale Built Environment of Historic Street on Visitor's Walking Behaviors:A Case Study on Wudaoying Hutong in Beijing[J].Architecture Journal,2019(3):96-102.

[14] JACOBS J.The Death and Life of Great American Cities[M]. New York:Random house,1961.

[15] Gehl, J.Life Between Buildings[M].New York:Van Nostrand Reinhold,1987.

[16] LI Chi,HUANG Zhejiao,ZHU Sisi.An Investigation on Pedestrian Pleasure inShichahai,Beijing[J].Planner,2014,30(4):112-118.

[17] GOU Aiping,WANG Jiangbo.SD Method Based Street Space Vitality Evaluation[J].Planner,2011,27(10):102-106.

[18] ZHOU Wei, HUANG Zhenfang, GUO Wen, et al. Empirical Research on The Tourists' perception After The Trip of Landscape Preference of The Historical Culture Block: A Case Study of Confucius Temple in Nanjing[J].Human Geography,2012,27(6): 117-123.

[19] WANG Kun. Research on the Street Space in the Old city of Hefei [D]. Hefei:Hefei University of Technology, 2019.

[20] LONG Ying,ZHOU Yin.Picture Urbanism: A New Approach to the Study of Human based Urban Form[J]. Planner, 2017, 33(2): 54-60.

[21] JAN G.Communication and Space[M].China Architecture Press, 2002,10

[22] XU Leiqing,JIANG Wenjin,CHEN Zheng.Research on the Sense of Security in Public Space: Taking the Perception of Urban Street Scenes in Shanghai as an Example [J]. Landscape architecture,2018,25(7):23-29.

[23] YANG Junyan,CAO Jun. Dynamic • Static • Visible • Hidden: Four Application Modes of Big Data in Urban Design[J]. Journal of Urban Planning,2017(4):39-46.

[24] TIMMERMANS H, VAN D W, ALVES M, et al. Spatial Context and the Complexity of Daily Travel Patterns: An International Comparison[J].Journal of Transport Geography,2003,111:37-46.

[25] GIULIANO G，NARAYAN D.Another Look at Travel Patterns and Urban Form: The US and Great Britain[J].Urban Studies,

2003,40(11):2295-2312.

[26] SHAO Yuan,YE Dan,YE Yu.Research on Large-Scale Measurement of Street Interface Permeability Based on Streetscape Data and in-Depth Learning-Taking Shanghai as an Example[J/OL]. International Urban Planning:1-13[2022-11-14].

[27] BADRINARAYANAN V,KENDALL A,CIPOLLA R.SegNet: a Deepconvolutional Encoder-Decoder Architecture for Image Segmentation[J].IEEE Transactions on Pattern Analysis & Machine Intelligence,2017(12):2481-2495.

[28] CHEN L C,PAPANDREOU G,KOKKINOS I,et al.Deeplab: Semanticimage Segmentation With Deep Convolutional Nets, Atrous Convolution, and Fully Connected Crfs[J].IEEE Transactions on Pattern Analysis and Machine Intelligence, 2018, 40(4): 834-848.

[29] REDMON J, FARHADI A.YOLO9000: Better, Faster, Stronger [C]// 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR).IEEE,2017:6517-6525.

[30] ZHANG Ruifang. Evaluation and Analysis of Urban Street Space Quality[D].Hebei University of Engineering,2020.

[31] CHEN Shuai. Study on Behavior Vigor of Urban Leisure Square [D]. Central South University，2009.

[32] PENG Huiyun. Restorative Environmental Impact Mechanism and Spatial Optimization of Community parks [D]. Chongqing: Chongqing University, 2017.

[33] ZHAO Xiaolong,ZHAO Ruyue,HOU Yunjing,et al. Research on the Correlation Between Residential Street Spatial Characteristics and Pedestrian Flow Based on Multi-Source Open data [J]. Journal of Architecture, 2020 (S2): 110-114.

[34] YIN Yuchen. Study on the Design Strategy of Living Street Sharing in Hefei Old Town From the Perspective of "Urban repair" [D]. Hefei :Hefei University of Technology, 2020.

[35] MAO Zhirui,CHEN Xiaokui,XIANG Zhenhai,et al.Research on Street Vitality Measurement and Influencing Factors of Historical Blocks—Taking the Historical Block of Wenming Street in Kunming as an Example[J].Southern Architecture, 2021(4):54-61.

[36] ZENG Wei, ZHANG Yike. Protection and Utilization of Ancient Temples and Surrounding Areas in Urban renewal: a Reflection Based on Place theory. Southern Architecture, 2021(2): 83-89.

[37] Shanghai Municipal Planning and Land Resources Administration Bureau[M].Shanghai Transportation Commission,Shanghai Urban Planning and Design Institute, Shanghai Street Design Guidelines, Tongji University Press,2016.10.

[38] LUO Qi,WEN Zihan,YU Laiyan.Research on Strategies for Improving Street Space Vitality in Small Towns Under the Guidance of Environmental Behavior—Taking Zihu Town as an Example[J].Research on Urban Development,2019,26(2):20-24,30.

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Study on the Genetic Variation Mechanism and Restoration of the Water Village Landscape in Southern Jiangsu

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ABSTRACT: Traditional villages contain the internal spirit and external expression of Chinese traditional culture, which is the intermediary between cultural inheritance and tourism development. The study of its dynamic changes and the wisdom learned from it is conducive to the preservation and exploitation of its cultural values. Based on the theory of landscape genes in geography, we use the method of feature deconstruction and extraction to identify the genes of the water village landscape in Southern Jiangsu, and then analyze the variation characteristics of landscape genes and propose the variation mechanism to summarize the variation trend of traditional villages in southern Jiangsu. Finally, from the perspective of biological genetic variation, it is summarized into four types: inheritance variation, replacement variation, fusion variation, and deletion variation, and corresponding restoration strategies are proposed for different variation types, which provide methodological references for the theoretical cognition of existing traditional village conservation.

KEY WORDS: landscape architecture; water villages in Southern Jiangsu; landscape genetic variation; variation mechanism; restoration

Traditional village settlements were the most suitable living environments created by ancient people based on the historical context, material conditions, and cultural atmosphere of their time. They are a true reflection of the genetic essence of Chinese traditional culture. At present, traditional villages are gradually disappearing in the process of modernization. The country has vigorously carried out rural revitalization work, paying special attention to the protection and restoration of traditional villages. With the passage of time, the unique genetic characteristics of traditional villages are constantly changing, and the landscape genetic variation will inevitably have an impact on the overall landscape structure, and even cause irreparable damage. The different variation trends of landscape genes and improper restoration measures ultimately lead to traditional villages facing problems such as physical decay, disappearance of cultural customs, and destructive development. Therefore, how to comprehensively identify the landscape genetic variation of traditional villages at this stage and analyze their development mechanisms is of great significance for their restoration and inheritance.

Landscape gene theory originated in the modern West, but started late in China. Liu Peilin, a Chinese human geographer, combined his practical research to expand on aspects such as three-dimensional facade landscapes that were not covered by existing foreign research,

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and proposed a relatively complete landscape gene theory for the first time[1]. This theory has triggered new thinking about the traditional village landscape among scholars in various fields, and its research content mainly focuses on the identification and mapping construction of landscape genes[2,3], regional division of traditional village landscape genes[4,5], landscape gene inheritance and tourism development[6,7]. The research areas are concentrated in large-scale areas such as countries and provinces [5,8], or a small-scale area such as an ancient village or town with obvious features[9,10]. It can be seen from this that scholars are mostly concerned with static research such as landscape gene identification of a traditional village from a micro perspective, while there are relatively few explorations on the dynamic changes of landscape genes, especially the interpretation of landscape genetic variation from a regional perspective, which urgently requires theoretical research. In view of this, this paper attempts to adopt landscape gene theory, taking the water villages in southern Jiangsu as the research object, analyzes the characteristics and mechanisms of landscape genetic variation and proposes restoration strategies, providing theoretical suggestions and methodological references for maintaining the uniqueness of traditional village in future rural construction.

1 Analysis of related concepts

1.1 Landscape genes

The word "gene" was originally coined by the biological community. It is the basic unit for storing genetic information. Through replication in each generation, it ensures that offspring maintain certain characteristics while also being the core factor that distinguishes them from other individuals. The inheritance of traditional villages mirrors this concept. Liu Peilin, a Chinese scholar, believes that landscape genes refer to cultural factors that make each regional landscape different from other landscapes and have obvious particularity. They can pass on the essential characteristics of the local landscape from generation to generation through their own continuous replication and are the determining factors in the formation and development of a landscape[11]. Landscape genes are an abstract expression of the comprehensive characteristics of cultural landscapes based on semiotics. Their "genetic traits" often need to be expressed by deconstructing the characteristics of cultural landscapes in terms of residential architecture, layout, and environmental factors.

1.2 Variation of landscape genes

In biological concepts, genetic variation refers to the change in the arrangement order of the genome under certain conditions, leading to the existence of a new form. By extending its application to the study of the traditional village landscape, we can also discover "landscape genetic variation", that is, due to natural and human-induced factors such as the different historical backgrounds of the landscape and changes in the geographical environment, the landscape genes undergo spatial or cultural variations in the "inheritance" process to adapt to the current local environment. Traditional villages, after centuries of inheritance and development, inevitably experience variations in their landscape genes, which drive changes in the village's appearance. This process, akin to biological evolution, leads to either the decline or flourishing of the village landscape. Therefore, analyzing the characteristics and mechanisms of the genetic variation of the traditional village landscape can help us learn from the experience of adaptive variations, while also reducing the irreparable damage to the traditional village landscape caused by the recurrence of destructive variations.

1.3 Restoration of landscape genes

After variation, genes can be restored to their original genotype and phenotype in whole or in part through reverse mutation. Based on this, some scholars have tried to cross-integrate the landscape gene theory with theories from other fields to rationally repair the landscape genes of traditional villages. For example, the urban "Double Repairs" theory in the field of planning[11] and the precision repair theory in the field of biology[12] have been introduced into the research on the protection and inheritance of traditional village landscape genes. However, existing research results mainly focus on "material-immaterial" morphological restoration methods, landscape information chain restoration methods. There is limited research on restoration based on landscape genetic variation. Therefore, conducting research from this perspective can pro-

vide new theoretical methods for the study of traditional village landscape inheritance. In this paper, the restoration of landscape genes refers to the comprehensive assessment of landscape genetic variation in traditional villages, based on a complete understanding of the phenomenon, and the promotion of regional inheritance of the village landscape through means such as restoration and updating.

2 Analysis of landscape gene identification in southern Jiangsu water village

2.1 Overview ofthe traditional village landscape in southern Jiangsu

The southern Jiangsu region is located in the alluvial plain at the mouth of the Yangtze River. It has a flat terrain, crisscrossing rivers, prosperous village construction, and a large number of historical and cultural relics. By the end of 2022, there were 33 traditional Chinese villages in Jiangsu Province listed in the National Traditional Village Directory by the Ministry of Housing and Urban-Rural Development and other departments, 26 of which are in southern Jiangsu (Figure 1). The villages in this region are densely distributed, with similar natural and cultural environments, the same cultural origins, and the same customs. Therefore, this region is representative in the water village landscape.

"Water" is the core that distinguishes the traditional village landscape in southern Jiangsu from other regions. The villages were born from water and built along the water. The water network has given birth to diverse village patterns and elegant architectural appearances. The area around the water system has become the main public activity space for the villagers and highlights the hydrophilicity of the traditional village landscape in southern Jiangsu. At the same time, the water environment has also promoted the formation of a unique water cultural atmosphere in southern Jiangsu and the customs and habits closely related to the villagers and water.

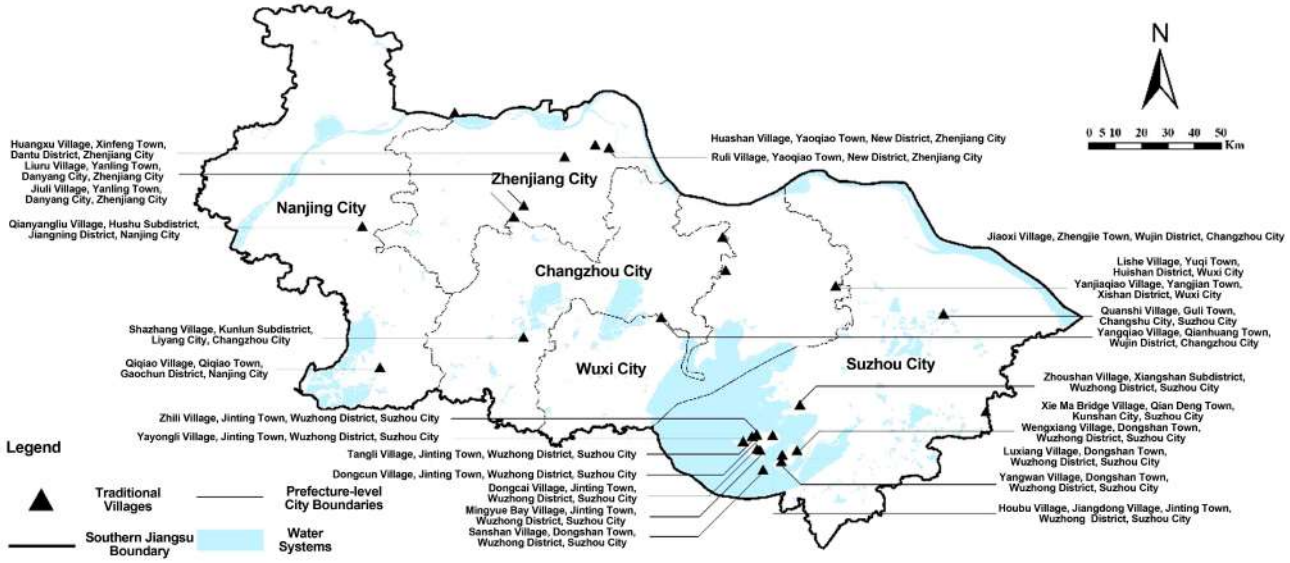


Figure 1 Distribution map of traditional villages in southern Jiangsu

2.2 Identification of landscape genes of water villages in southern Jiangsu

First, based on the traditional settlement landscape genetic identification and extraction methods developed by Hu Zui et al., and following the principles of intrinsic uniqueness, external uniqueness, local uniqueness, and overall dominance[13], a feature deconstruction method is used to categorize the landscape genes into architectural genes, cultural genes, environmental genes, and layout genes[14]. Secondly, the traditional village landscape gene characteristics are refined into 4 categories with a total of 16 indicators in the southern Jiangsu region. The landscape gene identification index system is combined with landscape gene extraction methods such as element extraction, graphic extraction, structure extraction, and meaning extraction[15], to identify and extract typical landscape gene features (Table 1) and further analyze the landscape genetic variation.

Table 1 Results of gene identification of typical landscapes of traditional villages in southern Jiangsu

Landscape feature identification factors	Identify indicators		Recognition result description	Example diagram
Architectural Genes	Residential buildings	Roof shape	Most of the roofs in southern Jiangsu are double-slope roofs, and the roofs are mainly in the traditional gable style.	a. Residential buildings (Lihe Hall in Mingyuewan Village)  b. Main public building (Mingyuewan Village Bao Shizhao Memorial Hall) 
		Gable shape	Including screen wall, Guanyin hood and gable	
		Roof form	Basically one to two floors	
		Plane structure	The buildings built along the river are parallel to the river, and the commercial and residential buildings built along the street include two types: "shop below and house above" and "shop in front and house behind". Most buildings adopt the multi-courtyard style with narrow patios, and the typical style is "three rooms and two wings".	
		Partial decoration	It adopts the forms of wood carving, stone carving, brick carving, and colored painting, and the themes include figures, landscape, flowers, birds, insects, fish, calligraphy, etc., and most of them have auspicious meanings of praying for blessings and auspiciousness.	
		Building materials	Wood materials are used for building support structures and doors and windows. The walls are primarily constructed with brick and stone, with bluestone slabs used for paving the roads, streets paved with flower-like materials, and the roofs covered with small blue tiles	
	Main public buildings		Ancestral halls, memorial archways, temples, drum towers, watchtowers, circle gates, charitable halls, academies, bridges, well pavilions, docks, etc.	
Cultural genes	Cultural Beliefs		Religious worship such as Nuo and other shamanistic cultures, as well as surname-based clans.	Dongcun Village Jingxiu Hall 
	Folk customs and etiquette		Temple fairs, gatherings, horse lantern dances, dragon dances, sacrifices, etc.	
	Traditional crafts		Embroidery, carving techniques, fine brick craftsmanship, pastry making, etc.	
Environmental Genes	Terrain Environment		Mainly plains and hills, the terrain is flat and open, the altitude does not exceed 500m, and the slope is relatively gentle	Qiqiao Village and its surroundings 
	Water environment		The water system is well developed, close to the Yangtze River and Taihu Lake, and there are scattered ponds or dense water systems outside the village	
	Agricultural landscape environment		polder fields, tea fields, fish ponds	
Layout Genes	Spatial structure		Living near water, expanding along waterways and roads	Lishe Village's village form (buildings are arranged in clusters according to the shape of water) 
	Village form		Clustered buildings + linear water system, "-" shape, " + " shape, chessboard shape, etc.	
	Street pattern		The water streets run parallel to each other, mostly in the shape of fishbone or chessboard.	

2.2.1 Architectural genes

Most of the traditional residential buildings in southern Jiangsu villages are one- or two-story hall-style buildings, and some buildings built by water retain the form of stilt houses. In ancient times, the dense population was reflected in the compact layout, the linked houses, and the narrow lanes formed by the extension of buildings in depth[16]. Most of the roofs are made of two-slope gable roofs, covered with small green tiles, and have large eaves, giving people a light and airy feeling. Since the Ming and Qing Dynasties, gentry and literati in southern Jiangsu have gathered and settled here. Their noble and elegant style is reflected in the residential buildings through detailed decorations, such as carvings. In addition, there are different types of main public buildings distributed in the villages, such as commemorative ancestral halls and archways, defensive watchtowers and circle gates, and educational academies. It can be said that from its layout to its appearance, the exquisiteness and elegance of the Suzhou and Southern Jiangsu dwellings are typical features of the local landscape genes.

2.2.2 Cultural genes

In terms of religious beliefs in the traditional village landscape of southern Jiangsu, in addition to some more popular religions such as Buddhism and Catholicism, Nuo culture is also particularly prosperous in southern Jiangsu. For thousands of years, Nuo and other shamanistic cultures have been intertwined with local regional culture and expressed in the form of folk customs. Every year, the villages hold collective sacrificial activities during a fixed time period, such as Nuo dance in the form of horse lantern dances[17]. Sacrificial activities also include temple fairs, city god fairs, etc. In addition, traditional crafts are also one of the manifestations of the landscape and cultural characteristics of ancient villages in southern Jiangsu. For example, Suzhou Xiangshan Gang has exquisite craftsmanship in water-milled bricks. Many of their works remain in the gable brick buttresses of traditional village residential buildings in southern Jiangsu, such as the relatively simple flying brick style and pattern head style, as well as the more complex and delicate swallowing gold style, scroll style, and pot-narrow mouth style[18]. Cultural beliefs, folk customs and traditional crafts constitute the cultural characteristics of the landscape genes of traditional villages in southern Jiangsu.

2.2.3 Environmental genes

The landscape and environmental characteristics of traditional villages in southern Jiangsu are mainly reflected in their location. In ancient times, people generally chose their settlements according to the principle of "back to the mountains and facing the water" in Feng Shui theory. In waterless hilly areas, people often settle in the foothills between two mountains, while in areas near water systems, villages are mostly built on high ground to avoid flooding. The farmlands developed based on the water village environment have the unique landscape gene morphological characteristics of southern Jiangsu. In the low-lying areas, people built embankments and reclaimed polder fields in low-lying areas for the convenience of irrigation and drainage, which gradually developed into polder areas and formed an agricultural landscape pattern of water-polder-village-field. In hilly areas such as the area around Taihu Lake, people transformed the mountains into stepped terraces to grow tea, forming an agricultural landscape pattern of water-polder-village-tea-forest. In general, the unique water network topography of southern Jiangsu, the location of villages, and the formation of polder fields and tea mountains under its influence have jointly shaped the environmental characteristics of the traditional village landscape in the area.

2.2.4 Layout genes

The water network of water villages in southern Jiangsu is dense, and the water system is the core factor that needs to be considered in village layout. Therefore, most ancient villages are located near water, and the spatial layout is generally based on water.Roads are arranged along the direction of the water system, and then buildings are constructed along waterways or streets to facilitate water collection, eventually forming an overall village shape such as "—", "+ ", or chessboard. At the same time, due to living and defense needs, the villages as a whole are inward-facing, with a lower degree of openness on the outer boundary and a higher degree of openness on the water side. The village roads naturally grow into alleys from the

main roads, and the street and alley layout is mainly in fishbone shape, comb shape, etc. In ancient times, almost every household had a small boat, and waterways were also one of the important transportation routes. Water docks are often set up near water to facilitate washing clothes, etc., which can be seen as public spaces for villagers to engage in social interaction. In general, traditional villages in southern Jiangsu have gradually developed into a landscape gene layout with compact layout and obvious hydrophilicity due to the large population, small land area and dense water network.

3 Analysis of the landscape genetic variation of water villages in southern Jiangsu

3.1 Characteristics of the landscape genetic variation of water villages in southern Jiangsu

After thousands of years of inheritance, the landscape genes of traditional villages in southern Jiangsu have undergone corresponding changes and are externalized in their material appearance (Table 2). Since there have been no major changes in the mountain and river topography in the area, the overall layout of the ancient villages built according to the terrain has remained basically the same. The development of modern transportation and technology has greatly reduced people's dependence on water. Water is no longer a core consideration in village planning, and traditional water transportation is gradually dying out. Different from the above situation, the inheritance of agricultural landscape environmental characteristics is relatively good, and polder fields and tea mountains, as unique landscape genes in southern Jiangsu, can still be identified and utilized.

In terms of traditional architecture preservation, buildings that have not been remodeled have suffered significant wear and tear due to age, and the newly built buildings are mostly influenced by foreign cultures, which are incompatible with the traditional village style. For example, traditional two-story courtyard buildings have been converted into Western-style villas. It can be said that some landscape genetic variations in architectural features have had an adverse impact on the inheritance of traditional villages in southern Jiangsu. However, from the perspective of the main public buildings, the variation of their landscape genes is relatively conducive to the development of village culture. Most public buildings are completely preserved and regularly repaired, while being given new functions to revitalize them.

The inevitable hollowing out and the impact of modern culturehave had a significant impact on the cultural landscape genes of the ancient villages in Southern Jiangsu. Traditional festivals and customs are no longer widely observed, and certain activities, such as dragon boat races and sacrificial gatherings, ceased to be held by the end of the 20th century. As a comprehensive cultural event, temple fairs, which once included sacrificial rituals and craft performances, have gradually lost their original functions. Instead, their commercial trade function has taken prominence, and temple fairs have essentially become gatherings for the exchange of agricultural and sideline products.

Although the inheritance of landscape genes in traditional villages in southern Jiangsu has remained stable overall, some of them have shown a trend of destruction. Among them, the mutant genes that cause adverse effects urgently need to be repaired to reverse the trend of weakening or extinction of landscape gene characteristics.

3.2 The genetic variation mechanism ofthe water village landscape in southern Jiangsu

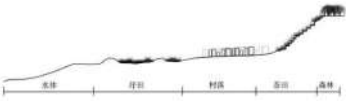
It is not difficult to see from the analysis of the variations of the genetic characteristics of the traditional village landscape in southern Jiangsu that the changes in the village landscape are the result of the interaction of multiple systems, and its inducing factors are complex and diverse. Existing research focuses more on the impact of economic and industrial development and basic geographical environment under different historical backgrounds[19, 20]. However, the rural regional system is a complex system composed of various factors such as natural resource endowment, location and transportation conditions, economic foundation, human resources, and cultural customs[21]. The role of geographical material conditions in the formation and evolution of traditional villages is obvious, while the influence of social and cultural conditions is subtle. As

the core of the self-organization and construction of villages, humanistic context undoubtedly plays a vital role [22]. Based on this, this paper combines the research on influencing factors related to regional culture in landscape gene theory, and analyzes the landscape genetic variation mechanism by taking natural ecology, economic society, and ideological culture as the main driving factors. In the process of inheritance and development of the village landscape, natural ecology provides basic material resources for economic society and ideological culture, and economic society and ideological culture will in turn provide positive or negative feedback to natural ecology. At the same time, ideology and culture, as an endogenous driving factor, interact with economic society, as an exogenous driving factor, and jointly promote the variation trend of village landscape genes (Figure 2).

Table 2 Analysis of the landscape genetic variation of water villages in southern Jiangsu

Landscape feature identification factors	Identify indicators	Variation characteristics	Illustration
Architectural Genes	Characteristics of residential buildings	(1) Most newly built residential buildings are renovated or constructed in a similar distribution and appearance, while the less dilapidated ancient buildings are basically kept in their original state. (2) Some ancient residential buildings have fallen into disrepair and are no longer used. (3) In addition to the historical and cultural buildings that are strictly protected, the houses that are still used for living have been rebuilt by local residents in recent years, using new building forms, styles, and materials (the original wood materials have been replaced by reinforced concrete), and some local decorations have also undergone major changes (such as aluminum alloy doors and windows, etc.)	Dongcun Village House  Zhili Village Houses 
	Main public buildings	(1) Most ancestral halls have undergone functional transformation, mainly focusing on cultural education and tourism services. The general layout remains the same, and the interior has been transformed into exhibition spaces such as museums or gathering spaces for villagers. (2) Public buildings used for defense in ancient times, such as watchtowers, and buildings used for clan production and life, such as the Ninety-nine and a Half Rooms, and docks, have lost their original functions and are more of a display and commemorative function.	Mingyuewan Bao Shizhao Memorial Hall  Luxiang Ancient Village Ferry 
Cultural genes	Cultural Beliefs	The blood ties of the clans weakened, but the cultural belief of respecting literature and education did not change much.	
	Folk customs and etiquette	Folk festivals, as part of traditional culture, are increasingly undervalued by modern young people, and sacrificial activities are rarely held. The functions of some comprehensive festivals have gradually become more singular.	Luxiang Ancient Village Archway  Luxiang Ancient Village White Jade Square Cake 
	Traditional crafts	Few people are willing to undertake the inheritance of traditional crafts due to their high investment costs and low economic returns. The architectural skills of Suzhou Xiangshan Gang are gradually lost. Brick carvings, stone carvings, and wood carvings in southern Jiangsu have basically disappeared in newly built residential buildings. The traditional craftsmanship in food is relatively well inherited.	

(Continued)

Landscape feature identification factors	Identify indicators	Variation characteristics	Illustration
Environmental Genes	Terrain Environment	The mountain terrain has not changed significantly.	Agricultural landscape pattern 
	Water environment	The overall pattern of the water system is basically the same as in ancient times. Some villages have damaged the water bodies. Although they have recovered in the later period, the water system is still shrinking. For example, the water system of Lishe Village in Wuxi has changed from "Nine Ponds and Thirteen Bays" to "Seven Ponds and Ten Bays".	
	Agricultural landscape environment	The landscape genes of the polder landscape in the waterside area and the tea mountain landscape in the Taihu Lake area have been effectively inherited.	
Layout Genes	Spatial structure	The spatial structure of some villages has changed due to changes in the water network, but the overall pattern remains basically the same.	Trail  Gate 
	Village form	The village morphological landscape genes are basically unchanged, and the marginal areas tend to move closer to the main traffic roads.	
	Street pattern	The street pattern has basically not experienced variation. The paving of some village streets has changed from bluestone slabs to cement floors, which has affected the atmosphere of traditional villages. The lane gates used for public safety defense in ancient villages are well preserved.	

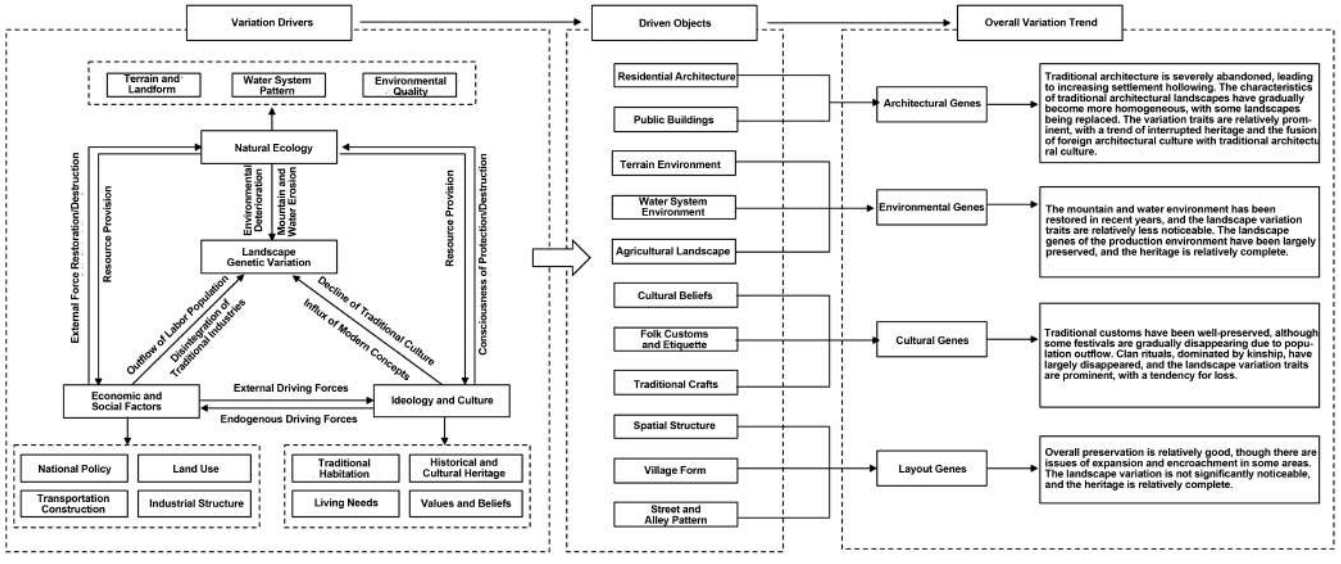


Figure 2 Genetic variation mechanism ofthe traditional village landscape in southern Jiangsu

3.2.1 Key variation inducing factors

Natural ecology is the material basis for the formation and development of the village landscape. The investigation of natural base was the first step for ancient Feng Shui masters to select sites and shapes. In addition, the stability of the natural pattern will also affect the development of the villages. The superior terrain and water shape provide the villages with a relatively safe and hidden environment. The geographical conditions of being backed by mountains and facing water, as well as surrounded by mountains and water make the village less susceptible to external influences, thus retaining a relatively complete internal landscape gene of the villages. In terms of social economy, the southern Jiangsu region is located in the center of the Yangtze River Delta. Due to its geographical location, its surrounding shipping and land

transportation are relatively developed. Therefore, the traditional villages in southern Jiangsu have relatively frequent exchanges with the outside world. The defensive nature of the village boundaries has gradually disappeared, and it has gradually changed from introversion to extroversion. The introduction of cultural and tourism industries has gradually changed the industrial and economic structure of the villages. In terms of ideology and culture, due to the integration of urban and rural cultures, traditional concepts are gradually weakening and people's life needs are also changing. At the same time, most of the young and middle-aged labor force in the village has migrated for work, leading to the disappearance of sacrificial activities, the lack of participation in folk festivals, and the loss of traditional crafts. The cultural characteristics of traditional villages in southern Jiangsu, which are based on blood ties, have undergone significant changes and are facing the crisis of inheritance discontinuity.

3.2.2 Interactive driving mechanism

In the early stages of the formation and development of traditional villages in southern Jiangsu, the natural ecology played a decisive role as the foundational factor. It helped foster an agricultural-based economic development model and a traditional culture bound by kinship ties. However, with the advancement of modern economic construction and development, the hollowing out of villages and the disintegration of traditional industrial structures caused by economic and social development have had a direct impact on the scale layout, natural and cultural landscape of villages. Some industrialized villages have destroyed the surrounding natural environment due to mining and factory production. For example, in the early 20th century, Jiaoxi Village straightened the natural river channel for irrigation, which changed the traditional water system texture, and also eroded the Heshan mountain to mine ore. In addition, some villages have filled in rivers, fish ponds and other water bodies for the expansion of construction land. Industrial construction has caused water quality to deteriorate, changing the environmental characteristics of traditional villages. In recent years, with the vigorous promotion of ecological policies, people have repaired and rebuilt mountain water systems, and the trend of variation has been curbed.

As an exogenous driving force, the economy and society gradually infiltrate lifestyles outside the village into the traditional culture of the village through policy publication and transportation updates. The rapid economic development has led to the outflow of village labor, thus diluting blood ties and causing the decline of clan consciousness. At the same time, the state's governance of ancient villages has promoted the transformation of the agricultural-based industrial structure to cultural tourism. The business relationships derived from the commercial industry based on the cultural tourism background have been integrated into the villages. This has led to a shift in the village's cultural structure from being solely based on kinship to incorporating both kinship and economic relations. Its external manifestation is the functional replacement and transformation of clan buildings, the conversion of residential buildings into homestay inns, etc. In addition, ideology and culture play an endogenous driving role in the genetic variation mechanism of the entire traditional village landscape in southern Jiangsu. The collision between foreign culture and traditional village culture has brought about changes in production and lifestyle. The villagers' spontaneous transformation of the village landscape has caused different types of variations in the landscape genes. In some villages, with the implementation of national policies such as the repair of traditional ancient buildings and the protection of intangible cultural heritage, villagers have a certain understanding of the value of traditional villages, thereby strengthening their sense of local identity and the awareness of protecting the village landscape, so that some mutated landscape genes have been repaired.

3.2.3 Overall variation trend

The intertwined influences of natural ecology, economic society, and ideology and culture have driven the changes in the landscape genes of traditional villages in southern Jiangsu, which are mainly reflected in the following trends: (1) In terms of architectural genes, the hollowing out of settlements has intensified. Some ancient buildings have been seriously abandoned during the inheritance process, and their style has been lost. Most of them have been well restored under the government's protection policies. The modern materials and construction techniques used in the newly built houses have yet to be integrated with the traditional forms. (2) In terms of environmental genes, there is no obvious change in the overall mountain and water environment, and the water network

has been slightly reduced. Due to the different levels of protection and development of villages, agricultural production still accounts for a large proportion of economic income in most villages. In addition, agricultural landscapes have gradually become one of the main attractions of rural tourism. The production and living environment of the villages is well preserved, especially the polder landscape in waterfront areas and the tea mountain landscape in the Taihu Lake area. The effective inheritance of their landscape genes has a positive effect on the development of local agriculture and tourism. (3) In terms of cultural genes, traditional folk festivals are facing an overall trend of extinction. For example, the house construction ceremonies held during the construction of residential houses in ancient times have gradually disappeared with the modernization of construction methods. Some traditional crafts are no longer practiced, facing a crisis of inheritance. The introduction of the cultural tourism industry has brought in modern, diverse cultures, which, while infiltrating traditional villages, has also helped slow down the disappearance of traditional culture. (4) In terms of layout genes, the overall pattern has been largely preserved, although there are issues of expansion and encroachment in some areas. The streets and alleys still generally maintain their traditional style.

4 Restoration-type and inheritance strategy of the landscape genes of water villages in southern Jiangsu

In biological terms, due to the replacement, addition and loss of base pairs in DNA molecules, the gene structure undergoes corresponding changes, resulting in heritable mutations in the gene. In view of the problem that the uniqueness ofthe traditional village landscape is gradually disappearing, the concept of gene mutation in biology is extended and applied to the theory of traditional village landscape genes. The landscape genetic variation of traditional villages in southern Jiangsu can be divided into four types: inheritance-type variation, replacement-type variation, fusion-type variation and loss-type variation according to the characteristics of landscape gene variation trends. Targeted restoration strategies are proposed based on the accurate identification of the nature of landscape genetic variation.

4.1 Inheritance-type Variation: traditional restoration and digital supplementation

Inheritance-type variation refers to the variation that occurs in the process of inheriting landscape genes. The landscape genes are basically consistent with the tradition but slightly different from it. Traditional buildings and ancient streets are where the cultural atmosphere of the villages is concentrated. Currently, the government's repair and maintenance are only aimed at public historical buildings or historical sites designated by cultural relic protection units. Some ancient buildings are looked after as ancestral homes, especially by heirs. Inadequate protection work may cause damage to the heritage of the ancient buildings. When restoring ancient buildings in traditional villages to their original state, experts can identify and extract the landscape genes of the building features and enter them into the database. At the same time, they can measure the plan, facade, etc. of the buildings to facilitate future repairs. For buildings that require minor renovations, their appearance must remain the same as before to avoid secondary damage to their authenticity caused by functional updates. For buildings that are severely damaged and on the verge of disappearing, they can be repaired in a digital way, presenting their appearance in images to enhance their educational, commemorative and warning significance. In the inheritance of village layout in recent years, the land use has expanded significantly and the boundaries of streets and lanes have become blurred. When carrying out protective development, we can consider standardizing the land use red line, use the main public buildings as the center of the spiritual space to delineate the scope of the protection area and carry out graded management, and at the same time rectify the illegal expansion of villagers' houses to enhance the cultural atmosphere of the ancient village.

4.2 Replacement-type variation: removal restoration and organic updating

Replacement variation means that a certain landscape gene of a village is replaced by an alien gene, resulting in a fundamental change in the landscape structure. For example, in the architectural features of the villages, villagers rarely use the green bricks and tiles that are symbolic of the southern Jiangsu region in their new residential buildings. In order to meet the requirements of ventilation and lighting, the roof form has also changed, such as increasing the window area. In the protection and renewal of traditional villages, the living needs of local villagers and the cultural heritage of the villages are equally important. The places that are inconsistent with the village style can be covered up by using characteristic decorations with traditional cultural style on the facades, such as traditional

wood carvings, brick carvings, and stone carvings in southern Jiangsu. At the same time, obviously unreasonable modern illegal buildings can be demolished to maintain the traditional style of the ancient villages. In some streets and alleys where commercialization is prominent, traditional styles have been replaced by modern ones. This problem can be addressed by restoring them to their original state, effectively restoring the appearance of traditional village streets and alleys.

4.3 Fusion-typevariation：symbiotic restoration and cultural inheritance

Fusion-type mutation means that under the impact of the invasion of foreign landscape genes, the village landscape genes coexist, integrate and develop collaboratively with them. The southern Jiangsu region makes full use of its unique agricultural landscape, integrating the production and living environment with cultural tourism. The trinity of production, commerce and tourism drives the development of village economy and provides economic support for protection and development. In terms of cultural genes, the traditional villages in southern Jiangsu have integrated the educational concepts of "emphasizing both nurturing and teaching" and "passing down the family through farming and learning" since ancienttimes with modern educational concepts. In addition to the villagers' focus on educating their children, the government has also incorporated educational functions into the development plans for village protection. Efforts should be made to promote parts of the traditional culture worth passing down, thereby increasing villagers' cultural confidence and enhancing their self-awareness of protecting their heritage. In the future, protection and development will gradually transition to a model that combines self-organization and external organization, giving the villagers, as the primary stakeholders, an active role in facilitating the positive variation in the village landscape genes.

4.4 Loss-type mutations：derivative restoration and digital media dissemination

Loss-type variation means that under the induction of multiple factors, the village landscape genes gradually disappear in the variation process. In the context of economic development, young people are more influenced by modern culture and hold a negative attitude towards traditional folk culture. The inheritance of cultural characteristic landscape genes should not be a simple copy. Instead, it can be combined with modern technology to transcend the traditional context. By preserving the cultural core, it allows for formal innovation, thereby deriving peripheral folk culture and festive experience activities. Examples include organizing art photography exhibitions for thecity god festival, dragon dances, and horse lantern dances art festivals, etc., to change young people's views on traditional culture. In terms of traditional crafts, experts can organize and collect ancient books and documents, and seek out skilled craftsmen. At the same time, they can make use of the advantages of modern media communication to promote through images, art exhibitions, etc., to enhance the cultural identity of the villages and continue the inheritance.

5 Conclusion

In order to adapt to the development of the times, traditional villages have continuously updated their landscape genes in the inheritance of thousands of years. Through literature verification and field investigation, it is not difficult to find that even the traditional villages approved by the state have problems such as dilapidated damage, improper protection, and disappearance of uniqueness. Based on this, this paper starts from the perspective of landscape genetic variation, identifies and extracts the landscape genes of traditional villages in southern Jiangsu, and proposes a three-dimensional variation mechanism of "natural ecology-economic society-ideological culture" for traditional villages. On this basis, the landscape genetic variation is divided into four categories: inheritance-type variation, replacement-type variation, fusion-type variation and loss-type variation. For each type, the paper presents corresponding repair strategies, including traditional restoration and digital supplementation, removal restoration and organic updating, symbiotic restoration and cultural inheritance, and derivative restoration and digital media dissemination. These strategies aim to provide theoretical support for the effective protection of traditional villages and the continued inheritance of traditional culture.

Currently, there is limited research on landscape genetic variation in the field of landscape architecture. This paper only conducts a qualitative analysis of landscape genetic variation in traditional villages in southern Jiangsu,

which may lead to omissions due to insufficient data. Future research will require more quantitative studies to supplement and verify the findings. It is hoped that further data analysis and practical applications in future studies will help advance related theoretical research.

Source of pictures, tables and figures

All the pictures, tables and figures in this paper are drawn or photographed by the author.

References

[1] LIU Peilin. On Construction and Utilization of Chinese Traditional Settlements Landscape's Genetic Map[D]. Beijing: Peking University. 2011.

[2] YIN Zhiyi, LI Jingqi. Identification and Mapping of Landscape Gene in Historic and Cultural Villages and Towns: a Case Study of Dayuwan Village, Huangpi District[J/OL]. City Planning Review: :1-10[2022-11-07].

[3] WANG Cheng, ZHONG Hong, SU Weibin. Identification and Mapping of Cultural Landscape Gene in Villages: a Case Study of Traditional Villages in Northern Guangxi[J]. Social Scientist,2022 (2):50-55.

[4] LIN Runze, YANG Fan, ZHANG Dan. et al. Landscape Feature Extraction and Floristic Division of Traditional Villages in the Minjiang River Basin[J]. South Architecture, 2022(4):54-60.

[5] ZHENG Wenwu, LI Bohua, LIU Peilin. et al. Gene Identification and Zoning of Traditional Village Landscape Groups in Hunan Province[J]. Economic Geography, 2021,41(5):204-212.

[6] ZHAN Lin, HUANG Jia, WANG Chun. et al. Three-Dimensional Digital Presentation of Red Tourism Resources Based on Landscape GeneTheory: Taking the Former Residence of Mao Zedong and Yang Kaihui in Qingshuitang as an Example[J]. Tourism Tribune,2022,37(7):54-64.

[7] YANG Liguo, PENG Ziming. Evaluation on the Integration of Traditional Village Cultural Landscape Gene Inheritance and Tourism Development: A Case Study of the First Batch of Dong Traditional Villages[J]. Journal of Natural Science of Hunan Normal University,2022,45(2):74-82.

[8] ZHAI Zhouyan, CHANG Fang, LI Tongsheng. et al. Research on the Cultural Heritage Landscape Genome Maps of Traditional Villages in Shanxi Province[J]. Geography and Geo-Information Science,2018,34(03):87-94,113.

[9] DOU Yindi, XU Chongli, LI Bohua. Study on Residents' Perception of Landscape Gene Restoration in Traditional Villages—Taking Huangdu Village of Huaihua City in Hunan Province as an Example [J]. Resource Development & Market, 2021,37(12):1441-1447.

[10] FENG Yan, ZHANG Hanxue, WANG Dongmeng. et al. Study on Style and Features of Traditional Villages in Xinyang Mountainous Area Based on Landscape Gene Information Chain—Taking Maopu Village in Xinxian County as an Example[J]. Jiangsu Agricultural Sciences,2021,49(14):175-183.

[11] LI Bohua, ZHENG Shinian, DOU Yindi. et al. Transformation and Development Mode of Traditional Village Human Settlement Environment from the Perspective of "Double Repairs" :A Case Study of Two Typical Villages in Hunan Province[J]. Progress in Geography,2019,38(09):1412-1423.

[12] XIANG Yuanlin, CAO Mingming, QIN Jin. et al. Study of Traditional Rural Settlements Landscape Genetic Variability in Shaanxi Province Based on Accurate-Restoration[J]. Progress in Geography, 2020,39(9):1544-1556.

[13] LIU Peilin. Gene Expression and Landscape Identification of Traditional Village Cultural Landscape[J]. Journal of Hengyang Normal University(Social Science),2003(4):1-8.

[14] HU Zui, LIU Peilin, DENG Yunyuan. et al. A Novel Method for Identifying and Separating Landscape Genes from Traditional Settlements[J]. Scientia Geographica Sinica, 2015,35(12):1518-1524.

[15] SHEN Xiuying, LIU Peilin, DENG Yunyuan. Seeking the Landscape's Genes Atlas: One Kind of New Angle of View about Settlement's Cultural Landscape Distrcicts Research[J]. Human Geography,2006(4):109-112.

[16] LI Li.Rural Settlement: Form, Type and Evolution[M].Nanjing: Southeast University Press,2007:42-48.

[17] TAO Siyan. Nuoji rite in South Jiangsu[J]. Journal of Southeast University(Philosophy and Social Science),2015,17(3):113-117+148.

[18] SHI Hong, FU Zhenshan. Analysis on the Technical Beauty of Traditional Folk House Gable Construction in Southern Jiangsu [J]. Art Panorama,2019(06):136-139.

[19] LI Bohua, ZHOU Lu, DOU Yindi. et al. Evolution Characteristics and Influence Mechanism of Ethnic Traditional Settlement Landscape Based on Rural Multifunctional Theory: A Case Study of Huangdu Village in Huaihua City, Hunan[J]. Scientia Geographica Sinica,2022,42(8):1433-1445.

[20] LI Hongbo, ZHANG Xiaolin, WU Jiangguo. et al. Spatial Pattern and Its Driving Mechanism of Rural Settlements in Southern Jiangsu[J]. Scientia Geographica Sinica, 2014,34(4):438-446.

[21] TU Shuangshuang, LONG Hualou, LI Tingting. et al. The Mechanism and Models of Villages and Towns Construction and Rural Development in China[J]. Economic Geography, 2015, 35(12): 141-147,160.

[22] LUO Yuyan, SHEN Yi, ZHAO Zhihong. The Cultural Elements of Rural Settlement of Jiangxi Han Nationality Base on the Theory of Amos Rapoport[J]. Journal of Civil and Environmental Engineering,2016,38(S1):67-71.

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