Cultural Diversity of Traditional Settlement Landscape Gene

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Abstract As a crucial channel for understanding traditional settlements culture, traditional settlement landscape gene is of vital importance to figure out status quo of traditional Chinese culture, to protect cultural heritage of settlements, and to help residents establish cultural confidence. This paper adopts diversity index, schema analysis, and qualitative analysis methods to identify cultural diversity and construct diversity map of cultural landscape genes. It shows that cultural diversity of landscape genes refers to the various forms of cultural factors in architecture, environment, culture, and layout, including type diversity, combination diversity, and functional diversity.

Keywords Traditional settlement, Cultural landscape gene, Cultural diversity, World cultural heritage
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In 2015, the United Nations resolution adopted the *Transforming Our World:* 2030 *Agenda for Sustainable Development*, which pointed out that natural and cultural diversity are important driving forces for sustainable development. In 2020, the United Nations Human Settlements Programme stated at the 10th World Urban Forum that culture should be regarded as the fourth pillar of sustainable development. Cultural diversity, as a fundamental issue related to the survival of human civilization, is the source of sustainable development of human society[1]. As the preservation sites of human material cultural heritage, fossil gardens of intangible cultural heritage, and cultural gene banks of new villages, traditional settlements carry excellent traditional culture that is related to national cultural security[3], economic growth[4], and national community awareness[5]. Therefore, China's rich traditional settlements are an important carrier of human civilization and an important object of cultural diversity research.

Liu Peilin[6] proposed the cultural landscape gene identification method to promote the protection of cultural diversity in traditional settlements. The cultural landscape gene analogizes cultural factors with specific historical and cultural information and structured features into basic units similar to biological gene units, and analyzes the characteristics of traditional settlements[7]. Chinese scholars have conducted relevant research on the cultural landscape gene theory of traditional settlement[8-9], and the theoretical achievements involve the identification and extraction of traditional settlement cultural landscape genes[10], feature expression[11-12], gene inheritance and variation[13], information map construction[14], and flora division[15]. The theory of cultural landscape genes is conducive to solving the problems of cultural fragmentation, low quality, and the loss of rural characteristics, which is consistent with the goal of cultural diversity. At present, landscape gene maps tend to the study of the distribution characteristics of large-scale landscape differences, but neglect the analysis of differences and similarities. Similarity and differences form the basis of diversity, and diversity analysis is conducive to mining the patterns of similarity and differences.

In response to the insufficient research on the diversity characteristics of cultural landscape genes of traditional settlement, focusing on the sustainable development of traditional settlements, 20 typical villages with dual attributes of world cultural heritage and traditional villages are selected. Drawing on the theories of cultural landscape genes and cultural diversity, a diversity analysis system of cultural landscape genes is constructed through cultural diversity index, schema analysis method, and qualitative analysis method. The following questions are proposed: ① what is the diversity of cultural landscape genes; ② how to measure the diversity of cultural landscape genes of traditional settlements; ③ how to construct a diversity map of cultural landscape genes of traditional settlements. This study will reveal the content and measurement methods of diversity in cultural landscape genes of traditional settlements, providing theoretical basis for the protection and sustainable development of traditional settlements.

1 Research area, data sources and processing

1.1 General situation of research area

As of September, 2023, China has 57 world cultural and natural heritage sites on the *World Heritage List*, ranking first among the countries on the world heritage list. World heritage sites in China are generally distributed in a strip and cluster shape in space, with cultural heritage mainly distributed in the central and eastern regions; natural heritage is concentrated in the southwest region[16]. The cultural heritage of traditional villages has the characteristics of cultural inheritance, integrity, authenticity of historical relics, and harmony of the natural environment[17]. The research cases in this paper are all important world cultural heritage sites in China, including the Old Town of Lijiang in Yunnan Province confirmed in 1997; Xidi Village and Hong Village, ancient villages in southern Anhui confirmed in 2000; Guangdong Kaiping Watchtower confirmed in 2007; Hakka Earth Building in Fujian Province confirmed in 2008; Chinese Tusi Site confirmed in 2015; Hani Terraces of Honghe State in Yunnan confirmed in 2013 and Pingyao Ancient City in Shanxi confirmed in 1997. The selection principles and basis are as follows: in terms of village attributes, the World Cultural Heritage List and the Chinese Traditional Village List are overlaid, and villages with dual attributes are selected for research; in terms of village distribution, 1−2 traditional villages within the same area of each world cultural heritage site are selected, with a total of 20 traditional villages selected. The villages basically cover the traditional villages included in the national world cultural heritage site (Table 1).

1.2 Data source

20 traditional Chinese villages with the aforementioned dual attributes are selected from the World Cultural Heritage website (https://zh.unesco.org/themes/world-heritage) and the China Village website (http://www.chuantongcunluo.com/). Through Digital Museum of Traditional Chinese Villages (http://www.dmctv.cn/), survey form for traditional villages and planning data, cultural landscape genes are identified, and data on nationality, permanent population, area, and altitude of

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village are obtained, thereby carrying out evaluation of cultural landscape gene diversity.

1.3 Data processing

Using cultural landscape gene theory, according to its identification principle[18], identification factor[19], and extraction method[11], the landscape gene identification results of the case are as follows (Table 2).

2 Identification methods for diversity in cultural landscape genes

In response to the lack of quantitative calculation and comprehensive analysis of the diverse characteristics of traditional settlement cultures, the concept of cultural landscape gene diversity is proposed, which helps to provide a new perspective for the sustainable development of traditional settlements. The concept of cultural landscape gene diversity originates from cultural diversity in cultural ecology and is the foundation for the survival and development of cultural landscape genes. The diversity of cultural landscape gene in traditional settlements refers to the diverse expressions of cultural factors of traditional settlement in architecture, environment, layout, and culture, which not only reflect cultural inheritance but also cultural variation, thereby inheriting cultural content and diversifying cultural forms, including type combination, and functional diversity. Type diversity refers to the type diversity of cultural landscape genes at a certain scale; combination diversity refers to the fact that cultural landscape genes do not always appear in a single form, and their combination forms are also diverse; functional diversity refers to the attachment of cultural landscape genes to different functional carriers, promoting the preservation and inheritance of cultural landscape genes. From the perspective of content expression, cultural landscape gene diversity refers to the presentation and expression of traditional settlement culture in rich form, as well as the diversity of different combinations and types. From the perspective of functional effects, the diversity of cultural landscape genes refers to the multiple functions that cultural landscape genes provide for traditional settlements. The measurement and scale of landscape diversity are closely related, and spatial scale is an important perspective for examining diversity[20]. From the perspective of dynamic evolution, culture continues in renewal or declines. From the perspective of element content, the components of cultural landscape genes have both material and non-material forms; from the perspective of cultural complexity, the various characteristics of cultural landscape genes interact and influence each other.

The characteristics of cultural diversity in traditional villages calculated by diversity of cultural landscape genes is a comprehensive external manifestation of multiple cultural landscape genes in traditional villages. In this paper, drawing on the calculation method of spatial gene diversity of traditional village[21], the diversity index of cultural landscape genes is calculated through the Margalef index, Shannon-Wiener index, Simpson index, and Pielou index.

2.1 Richness index (Margalef index)

The number of cultural landscape genes within a village is used as an indicator to describe its richness. In the application of cultural landscape gene diversity, the higher the value, the richer the types of regional cultural landscape genes.

$R = (S - 1)/\ln N$

where N is the total number of types of cultural landscape genes in all cases; S is the number of types of cultural landscape genes in a certain village; ln is natural logarithm, and base number is 2.718 283 8. The number of cultural landscape gene types in traditional villages in the region is defined as the diversity index, taking into account the total number of cultural landscape gene types and the total number of cultural landscape genes.

2.2 Information index (Shannon–Wiener index)

It is derived from information theory. The increase in the types of cultural landscape genes represents an increase in the cultural complexity of traditional settlements. That is, the larger the H' value, the greater the amount of cultural landscape gene information contained in the settlement. The formula is as follows:

Table 1 Sample details

Region	Name	Batch	Nationality	Village area km^2	Permanent population//persons	Altitude m
Qihe Township, Gucheng District, Lijiang City, Yunnan Province	Gonghe Xiguan Village	1	Naxi Minority	2.00	726	2,240
Liangmei Village Committee, Kainan Street Office, Gucheng District, Lijiang City, Yunnan Province	Qiliang Village	2	Naxi Minority	12.20	700	2,347
Yangjian Village Committee, Qihe Town, Gucheng District, Lijiang City, Yunnan Province	Jin'an Village	2	Naxi Minority, Miao Nationality	6.00	52	1,319
Xidi Town, Yi County, Huangshan City, Anhui Province	Xidi Village	1	Han Nationality	10.70	1,200	254
Hongcun Town, Yi County, Huangshan City, Anhui Province	Hong Village	1	Han Nationality	2.89	1,850	350
Tangkou Town, Kaiping City, Jiangmen City, Guangdong Province	Zili Village	1	Han Nationality	0.25	162	20
Baihe Town, Kaiping City, Jiangmen City, Guangdong Province	Majianglong Village	4	Han Nationality	–	506	–
Xuanhe Township, Liancheng County, Longyan City, Fujian Province	Peitian Village	1	Han Nationality	13.40	1,598	400
Jiufeng Town, Pinghe County, Zhangzhou City, Fujian Province	Huangtian Village	5	Han Nationality	6.86	3,100	275
Jinxing Township, Zhaoan County, Zhangzhou City, Fujian Province	Hunei Village	5	Han Nationality	51.59	3,566	19
Shuyang Town, Nanjing County, Zhangzhou City, Fujian Province	Taxia Village	4	Han Nationality	5.68	1,600	565
Hukeng Town, Yongding District, Longyan City, Fujian Province	Hongkeng Village	1	Han Nationality	1.11	1,900	400
Shuyang Town, Nanjing County, Zhangzhou City, Fujian Province	Tianluokeng Village	1	Han Nationality	2.60	477	788
Lingxi Town, Yongshun County, Xiangxi Tujia and Miao Autonomous Prefecture	Laosicheng Village	1	Tujia Nationality	1.50	1,100	1,032
Jianshan Township, Xianfeng County, Enshi Tujia and Miao Autonomous Prefecture	Tangyasi Village	5	Tujia Nationality	5.13	2,280	1,320
Gaoping Street, Huichuan District, Zunyi City	Hailongtun Village	5	Tujia Nationality	1.59	–	1,300
Aichun Village Committee, Xinjie Town, Yuanyang County, Honghe Hani and Yi Autonomous Prefecture, Yunnan Province	Azheke Village	3	Hani Nationality	1.43	481	1,880
Tuguozhai Village Committee, Xinjie Town, Yuanyang County, Honghe Hani and Yi Autonomous Prefecture, Yunnan Province	Jingkou Village	4	Hani Nationality	0.86	1,000	1,660
Buyi Township, Pingyao County, Jinzhong City, Shanxi Province	Liangjiatan Village	5	Han Nationality	6.00	310	1,078
Zhukeng Township, Pingyao County, Jinzhong City, Shanxi Province	Liuhe Village	5	Han Nationality	8.24	450	1,130

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

where i is specific category; p_i is the proportion of the i^{th} cultural landscape gene type in all cultural landscape gene types; n_i is the number of the i^{th} cultural landscape gene type; N is the total number of types of cultural landscape genes in all cases, and $p_i = n_i/N$; S is the total number of cultural landscape gene types in a certain village, and is a uniformity measurement of the diversity of cultural landscape gene types and the distribution of cultural landscape gene types in terms of quantity.

2.3 Dominance index (Simpson index)

It describes the probability that individuals of cultural landscape genes obtained from two consecutive sampling in a settlement belong to the same type. That is, the higher the D value, the richer and more diverse the types of cultural landscape genes, and the lower the D value, the more advantageous a certain cultural landscape gene is in the village.

$$D = 1 - \sum_{i=1}^{S} p_i^2$$

where i is specific category; p_i is the proportion of importance of the i^{th} cultural landscape gene type in the overall cultural landscape gene of the village; n_i is the number of individuals of the i^{th} cultural landscape gene type; N is the total number of types of cultural landscape genes in all cases, and $p_i = n_i/N$; S is the number of types of cultural landscape genes in a certain village. It investigates the probability of randomly selected two cultural landscape genes from a sample village belonging to the same cultural landscape gene type.

2.4 Uniformity index (Pielou index)

It can represent the relative density of all cultural landscape gene types in the settlement, and reflect the degree of uniformity of each cultural landscape gene in the number distribution.

$$P = H/H_{max}$$

where H is actual observed cultural landscape gene diversity index; H_{max} is the maximum possible cultural landscape gene diversity index in the study area, and $H_{max} = \ln S$ (S is the number of cultural landscape gene types in villages). It can be used as an indicator of the development status of cultural landscape gene diversity, to compare cultural landscape gene diversity at different time points and evaluate the development trend of cultural landscape gene diversity.

Combination diversity is identified through graphical analysis. Remote sensing images of traditional settlement are vectorized using AI Earth and ArcGIS 10.2, to extract environmental and layout features of cultural landscape genes. Functional diversity is identified through spatial function, and spatial functions and specific types of traditional settlement are summarized through induction.

3 Identification results of cultural landscape gene diversity

3.1 Identification features of type diversity

From the perspective of richness index, the richness index ranges from 4.68 to 6.79, with a range of 2.11, a mean of 6.08, and a standard deviation of 0.58. The richness indexes in Majianglong Village, Liangjiatan Village, Tianluokeng Village, Zili Village, Laosicheng Village, Azheke Village, Hailongtun Village, and Hongkeng Village are below average (6.08). Jin'an Village, Tangyasi Village, and Hong Village have rich cultural landscape genes.

From the perspective of information index, the information index ranges from 2.92 to 3.48, with a range of 0.56, a mean of 3.27, and a standard deviation of 0.15. The information indexes in Jin'an Village, Qiliang Village, Gonghe Xiguan Village, Tangyasi Village, Hong Village, Majianglong Village, Azheke Village, and Taxia Village are below average (3.27). The cultural landscape gene information of Tianluokeng Village, Zili Village, Hailongtun Village, Laosicheng Village, and Hongkeng Village is relatively large.

From the perspective of dominance index, it ranges from −1.22 to 0.4, with a range of 1.62, a mean of −0.41, and a standard deviation of 0.44. The dominance indexes in Jin'an Village, Qiliang Village, Tangyasi Village, Hong Village, Gonghe Xiguan Village, Liuhe Village, Xidi Village, and Hunei Village are below average (−0.41). Hongkeng Village, Zili Village, Laosicheng Village, Liangjiatan Village, and Majianglong Village have obvious advantages.

From the perspective of uniformity index, it ranges from 0.94 to 1.26, with a range of 0.32, a mean of 1.12, and a standard deviation of 0.09. The uniformity indexes in Huangtian Village, Azheke Village, Hailongtun Village, Tianluokeng Village, Zili Village, Hongkeng Village, Laosicheng Village, Liangjiatan Village, and Majianglong Village are higher than the average. The cultural landscape genes of Laosicheng Village, Liangjiatan Village, and Majianglong Village are relatively uniform.

From a horizontal comparison of villages, the mean values of Jin'an Village (2.36) and Qiliang Village (2.37) are relatively low, while the mean values of Peitian Village (2.61), Xidi Village (2.62), and Hongkeng Village (2.62) are relatively high (Table 3).

3.2 Combination diversity recognition features

Combining the identification method of

Table 2 Identification of cultural landscape gene

Cultural landscape gene	Classification	Identification result
Architectural characteristic	Roof style	Overhanging gable roof, flat roof, pitched roof, gable roof, gable and hip roof, mixed type
	Gable design	Herringbone shape, corbel-steps, not obvious
	Timbering	Earth, stone, wood, bamboo, brick, brick concrete
	Partial decoration	Wood carving, stone carving, brick carving, porcelain carving, clay sculpture, painting
	Public building	Traffic category, belief category, defense category, leisure category, production category, education category, business category
Cultural characteristic	Local dialect	Naxi language, Wu dialect, Cantonese language, Southwest dialect, Jin dialect
	Religious belief	Ancestor worship, deity worship, denominational faith, polytheism
	Habit and custom	Traditional festival, folk customs during the New Year, etiquette and folk customs, marriages and funerals, folk art, clothing customs
	Food product	Special products, local staple food, noodles and pastries, specialty drinks
	Craftsmanship	Carving and cutting techniques, weaving technique, tea and wine craftsmanship, construction technique, food preparation, other skills
Environmental characteristic	Terrain	Mountain, plain, basin, river valley, hill
	Village site selection	Be situated at the foot of a hill, be situated beside a stream, be situated at the foot of a hill and beside a stream
Layout characteristic	Village morphology	Scatter type, stripped, clustered form
	Street and alley layout	Street—lane—building, square—lane—building, place—Cheng—pond, lane—field—building

cultural landscape genes, the graphic extraction method is used to extract prototypes of the site selection and layout, village morphology, and street layout of traditional settlements.

Site selection and layout can be divided into four categories: backed by hills, beside streams, backed by hills and beside streams, and not backed by hills and not beside streams (Table 4). ① Backed by hills. The settlement extends along the mountain, with irregular boundaries and is greatly affected by the mountainous terrain, such as Hailongtun Vliiage, Jin'an Village, Liangjiatan Village, Majianglong Village, Qiliang Village, and Tianluokeng Village. ② Beside streams. The settlements extend along the river and are greatly affected by the river, such as Huangtian Village and Zili Village. ③ Backed by hills and beside streams. The settlements are influenced by both mountains, rivers, and water bodies, and are distributed along rivers in a strip-shaped pattern, such as Azheke Village, Gonghe Xiguan Village, Hong Village, Hongkeng Village, Hunei Village, Jingkou Village, Laosicheng Village, Peitian Village, Taxia Village, Tangyasi Village, Xidi Village. ④ Not backed by hills and not beside streams. The settlements are distributed in areas with flat terrain and irregular boundaries, such as Liuhe Village.

The village morphology presents a distribution of strip, cluster, and scattered patterns (Table 5). ① Striped settlements are greatly influenced by mountains and rivers, and are distributed along the river, such as Hongkeng Village. ② Clustered settlements are composed of multiple architectural clusters, connected by streets and alleys between clusters, such as Azheke Village, Gonghe Xiguan Village, Hong Village, Hunei Village, Huangtian Village, Jin'an Village, Liangjiatan Village, Liuhe Village, Majianglong Village, Peitian Village, Qiliang Village, Jingkou Village, Taxia Village, Tianluokeng Village, Xidi Village, Zili Village. ③ Scattered settlement buildings are scattered, with long distances between buildings and dotted connections, resulting in fewer residents, such as Hailongtun Village, Laosicheng Village, Tangyasi Village.

The layout of streets and alleys presents branching, banded, and network distribution (Table 6). ① The branching pattern of streets and alleys is formed by the main streets, secondary streets, and alleys, with a clear hierarchy of streets and alleys, such as Azheke Village, Hailongtun Village, Huangtian Village, Jin'an Village, Laosicheng Village, Peitian Village, Qiliang Village, Taxia Village, Tangyasi Village, Tianluokeng Village. ② The buildings in the strip street pattern are distributed along the main streets in a regular and orderly manner, such as Hong Village, Hongkeng Village, Hunei Village, and Xidi Village. ③ In the network street and alley pattern, the streets form a network, and buildings are scattered in the street network, such as Gonghe Xiguan Village, Liangjiatan Village, Liuhe Village, Majianglong Village, Jingkou Village, and Zili Village.

3.3 Identification features of functional diversity

Through historical literature review and field investigation, the public building spaces

Table 3 Type diversity of cultural landscape gene

Case site	Total number of cultural landscape genes *S*	Richness index *R*	Information index *H'*	Dominance index *D*	Uniformity index *P*
Gonghe Xiguan Village	20	6.34	3.05	−0.70	1.02
Qiliang Village	21	6.57	3.00	−1.06	0.98
Jin'an Village	22	6.79	2.92	−1.22	0.94
Xidi Village	21	6.57	3.36	−0.56	1.10
Hong Village	22	6.79	3.23	−0.87	1.05
Zili Village	17	5.65	3.38	−0.05	1.19
Majianglong Village	13	4.68	3.24	0.40	1.26
Peitian Village	20	6.34	3.36	−0.37	1.12
Huangtian Village	19	6.11	3.33	−0.40	1.13
Hunei Village	20	6.34	3.30	−0.44	1.10
Taxia Village	19	6.11	3.26	−0.39	1.11
Hongkeng Village	18	5.88	3.48	−0.08	1.20
Tianluokeng Village	17	5.65	3.38	−0.13	1.19
Laosicheng Village	17	5.65	3.44	−0.03	1.22
Tangyasi Village	22	6.79	3.06	−1.06	0.99
Hailongtun Village	18	5.88	3.43	−0.17	1.19
Azheke Village	18	5.88	3.26	−0.32	1.13
Jingkou Village	19	6.11	3.31	−0.36	1.12
Liangjiatan Village	14	4.93	3.31	0.32	1.25
Liuhe Village	21	6.57	3.30	−0.66	1.08

Table 4 Site selection and layout

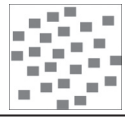
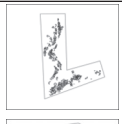
Site selection and layout	Graph form	Characterization
Backed by hills		The settlement extends along the mountain, with irregular boundaries and is greatly affected by the mountainous terrain
Beside streams		The settlement extends along the river and is greatly affected by the river
Backed by hills and beside streams		The settlement is influenced by both mountains and rivers, and is distributed along the river in a strip like pattern
Not backed by hills and not beside streams		The settlement is distributed in areas with flat terrain and irregular boundaries

Table 5 Village morphology

Village morphology	Graph form	Characterization
Strip form		It is influenced by mountains and rivers, and distributed along the river
Clustered form		It is composed of multiple architectural clusters, and the clusters are connected by streets and alleys
Scattered pattern		Buildings are scattered and located far apart, with dotted connections and fewer residents

in 20 case villages are divided into living space, access space, belief space, defense space, leisure space, production space, education space, and commercial space based on their functional use (Table 7). Living space provides living functions and is the main place for residents to live, such as courtyards, cottages, halls, buildings, houses, etc. Access space plays a role in connecting other spaces, such as bridges, ancient roads, etc. Belief space refers to the space where residents engage in religious activities, such as temples, ancestral halls, monuments, tombs, etc. Defense space refers to the virtual and actual spaces used to defend against external enemies entering, such as village gates, city walls, and watchtowers. Leisure space provides residents with a space for rest and communication, such as stages, pavilions, etc. Production space serves production activities, such as workshops. Living space serves daily life, such as ancient wells. Educational space is a place for transmitting knowledge and educating people, such as academies, private schools, etc.

4 Construction of cultural landscape gene diversity atlas

The diversity map of cultural landscape gene of traditional settlement is a comprehensive expression of its architectural, environmental, cultural, and layout characteristics, elucidating the inherent laws of traditional settlement culture. Based on the extraction of cultural landscape genes, landscape gene maps of 20 traditional villages are constructed (Table 8–10).

Table 6 Street and lane pattern

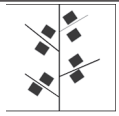
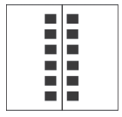
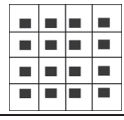
Street and alley layout	Graph form	Characterization
Dendritic		The main streets, secondary streets, and alleyways form a branching pattern
Banding		The buildings are distributed along the main streets in an orderly manner
Nets		The streets form a network, with buildings scattered throughout the street network

Table 7 Space function

No.	Spatial category	Characterization
1	Living space	Residents' permanent living space, such as courtyard, cottage, hall, storied building, and house, etc.
2	Access space	Connecting to other spaces, such as bridge, ancient road, etc.
3	Belief space	Space for religious belief activities, such as temple, ancestral hall, monument, grave, etc.
4	Defense space	Used for village defense, such as village gate, city wall, etc.
5	Leisure space	Space for residents to rest and communicate, such as stage, pavilion, etc.
6	Production space	Serving production activities, such as workshop, etc.
7	Living space	Serving daily life, such as ancient well, etc.
8	Educational space	A place for transmitting knowledge, teaching and educating people, such as academy, private school, etc.

Table 8 Building gene maps

Building gene	Specific factor	Village
Roof style	Overhanging gable roof	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Taxia Village
	Gable roof	Xidi Village, Hong Village, Peitian Village, Huangtian Village, Tianluokeng Village
	Gable and hip roof	Laosicheng Village, Tangyasi Village, Hailongtun Village
	Hip roof	Azheke Village, Jingkou Village
	Mixed type	Zili Village, Majianglong Village, Hunei Village, Hongkeng Village, Liangjiatan Village, Liuhe Village
Gable design	Herringbone shape	Gonghe Xiguan Village, Qiliang Village, Jin'an Village
	Corbel-steps	Xidi Village, Hong Village
	Not obvious type	Zili Village, Majianglong Village, Peitian Village, Huangtian Village, Hunei Village, Taxia Village, Hongkeng Village, Tianluokeng Village, Laosicheng Village, Tangyasi Village, Haikongtun Village, Azheke Village, Shankou Village, Liangjiatan Village, Liuhe Village
Timbering	Mixed materials	Earth, stone, wood, bamboo, brick, brick concrete (irregular, therefore not listed)
Partial decoration	Wood carving	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Xidi Village, Hong Village, Zili Village, Peitian Village, Huangtian Village, Taxia Village, Hongkeng Village, Laosicheng Village, Tangyasi Village, Hailongtun Village, Liangjiatan Village, Liuhe Village
	Stone carving	Xidi Village, Hong Village, Majianglong Village, Taxia Village, Hongkeng Village, Laosicheng Village, Tangyasi Village, Hailongtun Village
	Brick carving	Xidi Village, Hong Village, Huangtian Village, Liangjiatan Village, Liuhe Village
	Porcelain carving	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Hunei Village
	Clay sculpture	Zili Village
	Painting	Zili Village, Majianglong Village, Peitian Village, Tianluokeng Village, Liuhe Village
	Without decoration	Azheke Village, Jingkou Village
Public buildings	Residential category	Residents' permanent living space, such as courtyard, cottage, hall, storied building, house, etc. Each village has residential public spaces, so the name of each village is not listed
	Traffic category	Gonghe Xiguan Village, Jin'an Village, Taxia Village
	Belief category	Qiliang Village, Jin'an Village, Xidi Village, Hong Village, Majianglong Village, Peitian Village, Huangtian Village, Hunei Village, Taxia Village, Hongkeng Village, Laosicheng Village, Tangyasi Village, Hailongtun Village, Azheke Village, Shankou Village, Liangjiatan Village, Liuhe Village
	Defensive category	Gonghe Xiguan Village, Zili Village, Majianglong Village, Hunei Village, Tangyasi Village, Haikongtun Village, Azheke Village, Shankou Village, Liuhe Village
	Leisure category	Zili Village, Hunei Village, Taxia Village, Laosicheng Village, Tangyasi Village, Liuhe Village
	Production category	Huangtian Village, Azheke Village, Jingkou Village
	Life category	Qiliang Village, Huangtian Village
	Educational category	Xidi Village, Hong Village, Peitian Village, Hongkeng Village, Tianluokeng Village

Table 9 Cultural gene maps

Cultural gene	Specific factor	Village
Local dialect	Naxi language	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Azheke Village, Jingkou Village
	Wu dialect	Xidi Village, Hong Village
	Cantonese language	Zili Village, Majianglong Village
	Hakka dialect	Peitian Village, Huangtian Village, Hunei Village, Taxia Village, Hongkeng Village, Tianluokeng Village
	Southwest dialect	Laosicheng Village, Tangyasi Village, Hailongtun Village
	Jin dialect	Liangjiatan Village, Liuhe Village
Religious belief	Ancestor worship	Qiliang Village, Jin'an Village, Xidi Village, Hong Village, Zili Village, Majianglong Village, Peitian Village, Huangtian Village, Hunei Village, Taxia Village, Hongkeng Village, Laosicheng Village, Tangyasi Village, Haikongtun Village, Azheke Village, Jingkou Village
	Deity worship	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Huangtian Village, Hunei Village, Tianluokeng Village, Azheke Village, Jingkou Village, Liuhe Village
	Denominational faith	Qiliang Village, Hailongtun Village, Liangjiatan Village, Liuhe Village
	Totemism	Qiliang Village, Jin'an Village
	Polytheism	Qiliang Village, Jin'an Village, Huangtian Village, Hunei Village, Hailongtun Village, Azheke Village, Jingkou Village, Liuhe Village
Habits and customs	Traditional festival	Peitian Village, Hongkeng Village, Tangyasi Village, Azheke Village, Jingkou Village, Liuhe Village
	Folk customs during the New Year	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Zili Village, Hunei Village, Taxia Village, Hongkeng Village, Tangyasi Village, Azheke Village, Jingkou Village, Liuhe Village
	Etiquette and folk customs	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Xidi Village, Hong Village, Hunei Village, Tianluokeng Village, Laosicheng Village, Azheke Village, Jingkou Village
	Marriages and funerals	Azheke Village, Jingkou Village
	Folk art	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Zili Village, Majianglong Village, Peitian Village, Huangtian Village, Hunei Village, Taxia Village, Hongkeng Village, Tianluokeng Village, Laosicheng Village, Tangyasi Village, Hailongtun Village, Liangjiatan Village
	Clothing customs	Laosicheng Village, Tangyasi Village, Hailongtun Village,
Food products	Special products	Gonghe Xiguan Village, Xidi Village, Hong Village, Huangtian Village
	Local staple food	Gonghe Xiguan Village, Qiliang Village, Zili Village, Majianglong Village, Hunei Village, Taxia Village, Hongkeng Village, Laosicheng Village, Hailongtun Village, Azheke Village, Liuhe Village
	Specialty snacks	Qiliang Village, Jin'an Village, Hong Village, Zili Village, Peitian Village, Taxia Village, Hongkeng Village, Tianluokeng Village, Laosicheng Village, Azheke Village, Jingkou Village, Liangjiatan Village, Liuhe Village
	Specialty drinks	Qiliang Village, Jin'an Village, Xidi Village, Hong Village, Tianluokeng Village, Tangyasi Village
Craftsmanship	Carving skills	Xidi Village, Hong Village, Peitian Village
	Weaving skills	Gonghe Xiguan Village, Qiliang Village, Jin'an Village, Tianluokeng Village, Laosicheng Village, Tangyasi Village, Hailongtun Village, Azheke Village, Jingkou Village
	Tea and wine craftsmanship	Peitian Village, Huangtian Village, Hunei Village, Hongkeng Village, Jingkou Village
	Construction techniques	Xidi Village, Hong Village, Zili Village, Majianglong Village, Peitian Village, Taxia Village, Hongkeng Village, Tianluokeng Village, Laosicheng Village, Tangyasi Village, Hailongtun Village
	Food preparation	Xidi Village, Hong Village, Liangjiatan Village, Liuhe Village
	Other skills	Jingkou Village

5 Conclusions and discussion

5.1 Conclusions

(1) The diversity of cultural landscape gene of traditional settlement refers to the diverse expressions of cultural factors of traditional settlement in architecture, environment, layout, and culture, which not only reflect cultural inheritance but also cultural variation, thereby inheriting cultural content and diversifying cultural forms, including type diversity, combination diversity, and functional diversity. The construction of diversity map of cultural landscape genes provides an analytical basis for cultural inheritance and variation, and new methods for exploring regional cultural similarities and differences.

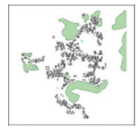
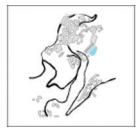
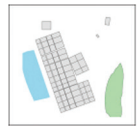
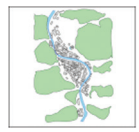
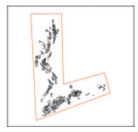
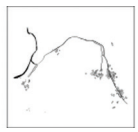
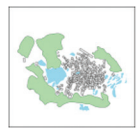
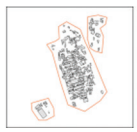
(2) The diversity of cultural landscape genes of traditional settlement is identified through cultural diversity index, schema analysis, and qualitative analysis. After calculation, the cultural diversity index results are as below: richness index between 4.68 and 6.79, information index between 2.92 and 3.48, dominance index between −1.22 and 0.4, and uniformity index between 0.94 and 1.26. In terms of combination diversity, site selection and pattern can be divided into four categories: backed by hills, beside streams, backed by hills and beside streams, and not backed by hills and not beside streams. The village presents a distribution of strip, cluster, and scattered shapes. Functional diversity includes various functions such as living function, access function, belief function, defense function, leisure function, production function, education function, and commercial function.

5.2 Discussion

(1) Traditional settlement is a natural and cultural multi-body system, and the protection of traditional settlements is a comprehensive and complex system engineering that requires multiple parties to work together, interdisciplinary participation, multi technology collaboration, multi-source data reconstruction, and multi platform co construction. The construction of diversity maps for cultural landscape genes of traditional settlement helps to explore cultural similarities and differences, thereby seeking deeper cultural connections and promoting the protection and development of traditional settlements.

(2) In this paper, taking cultural landscape genes as the starting point, the concept and identification methods of cultural landscape gene diversity are proposed, and a diversity map of cultural landscape gene is constructed, which is a new exploration of exploring cultural characteristics. However, due to the rich cultural heritage and large scale of the case villages,

Table 10 Environmental and layout gene maps

Village name	Environmental gene	Layout gene		Village name	Environmental gene	Layout gene	
	Site selection and layout	Village morphology	Street and alley layout		Site selection and layout	Village morphology	Street and alley layout
Gonghe Xiguan Village				Qiliang Village			
Jin'an Village				Hailongtun Village			
Xidi Village				Hong Village			
Zili Village				Majianglong Village			
Peitian Village				Huangtian Village			
Hunei Village				Taxia Village			
Hongkeng Village				Tianluokeng Village			
Laosicheng Village				Tangyasi Village			
Azheke Village				Jingkou Village			
Liangjiatan Village				Liuhe Village			

this paper has not yet conducted a similarity and difference analysis on different cultures. Therefore, it needs to explore the similarity and diversity characteristics of cultural landscape genes in subsequent research, in order to enrich the research on cultural landscape genes.

References

[1] Zhang, X. (2021). An interpretation of Marxist historical philosophy on cultural diversity. *Journal of Chongqing University of Science and Technology* (*Social Sciences Edition*), (6), 18-23.

[2] Liu, P. L. (2011). *Construction and application of gene atlas of traditional Chinese settlement landscape* (*Master's thesis*). Retrieved from China National Knowledge Infrastructure.

[3] Shi, Z. Y. (2004). Cultural security in China. *Journal of Beijing Normal University* (*Social Sciences*), (3), 5-14.

[4] Wei, Y. G. (2021). The power of culture: Does cultural diversity of trading partners affect the growth of China's export trade. *World Regional Studies*, *30*(4), 757-768.

[5] Xie, Z. M., Feng, M. J. & Fang, H. et al. (2022). A study on the sense of community for the Chinese nation and ethnic cultural diversity. *Ethno-National Studies*, (2): 21-35, 138-139.

[6] Liu, P. L. (2003). The gene expression and the

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shopper cock-fighting. To protect such folk culture, attract tourists and stimulate vitality, folk activity venues can be established at the entrance of the market. Specific planning strategies are shown as below:

(1) In front of the entrance of the market, a folk activity venue of "singing, reading and playing" is set up to attract foreign tourists, stimulate the development of the market, and inherit the market culture.

(2) A rest square with corresponding area is designed in front of the market area to meet people's rest needs, viewing needs for folk activities, and daily communication needs.

(3) Non-motorized lanes and sidewalks are set up in the site, and people routes with good traffic capacity is organized to reduce the interference to urban road traffic. In the landscape design of the site, the visibility of market space and image should be valued to attract people.

4 Conclusions

Jane Jacobs once noted that vibrant streets and public space are full of diverse activities, so the development of urban space environment should be diversified and efficient, and the urban environment should reflect the concern for people's emotional needs[10]. China's rural markets have a strong historical inheritance and spontaneous organization, and compared with a "tall and powerful" new supermarket, a good market space has a stronger affinity and appeal, and provides people with a diverse and efficient urban environment. By analyzing the case of Xin'an Grand Market in Qingdao, the present situation and feasibility of the remaining market under the background of urbanization are given. However, the planning strategies of other different types of markets in the whole process of urbanization still need to be further studied.

References

[1] Fan, W. C. (2018). *Survey of urban market space and optimization strategies* (*Master's thesis*). Retrieved from China National Knowledge Infrastructure.

[2] Gehl, J. (2002). *Communication and space*. Beijing: China Architecture Industry Press.

[3] Barton, K. J. *Institute of Urban Economics* (*translator*). (1986). Urban economics. Beijing: The Commercial Press.

[4] Wen, G. W. (2007). *Urban transportation and road system planning*. Beijing: Tsinghua University Press.

[5] Li, H. X. (2010). *Discussion on the development of rural markets and spatial layout strategies of small towns*. Beijing: China Architecture Industry Press.

[6] Dai, S. Z. (2018). *Urban engineering system planning*. Beijing: China Architecture Industry Press.

[7] Long, D. Y. (2008). Spatial narratology: A new field of narratology. *Journal of Tianjin Normal University* (*Social Sciences*), (6), 54-60.

[8] McHarg. Rui, J. W. (translator) (1992). *Design with nature*. Beijing: China Architecture Industry Press,

[9] Norberg-Schulz. (1984). *Place spirit*: *Towards architectural phenomenology*. Taiwan: Shanglin Publishing House.

[10] Jacobs, J. Jin, H. S. (translator). (2005). *The life and death of great American cities*. Nanjing: Yilin Publishing House.

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sight identification of the ancient villages' cultural landscape. *Journal of Hengyang Normal University*, (4), 1-8.

[7] Hu, Z. (2020). A research on the geographical information features of traditional settlement landscape gene and the related understanding approaches. *Journal of Geo-information Science*, *22*(5), 1083-1094.

[8] Hu, Z., Liu, C. L. & Deng, Y. Y. et al. (2012). Research progress on traditional settlements landscape's gene. *Progress in Geography*, *31*(12), 1620-1627.

[9] Jiang, S. H., Fan, Y. M. & Zheng, W. J. (2021). Research progress on landscape's gene theory and its utilization in China. *Journal of Human Settlements in West China*, *36*(1), 84-91.

[10] Hu, Z., Liu, P. L. & Deng, Y. Y. et al. (2015). A novel method for identifying and separating landscape genes from traditional settlements. *Scientia Geographica Sinica*, *35*(12), 1518-1524.

[11] Hu, Z., Liu, P. L. & Cao, S. Q. (2013). Spatial pattern of landscape genes in traditional settlements of Hunan Province. *Acta Geographica Sinica, 68*(2), 219-231.

[12] Yin, L. C., Li, B. H. & Liu, P. L. et al. (2022). Biological characteristics of landscape gene cells in traditional settlements. *Economic Geography*, *42*(3), 182-189.

[13] Xiang, Y. L., Cao, M. M. & Qin, J. et al. (2020). Study of traditional rural settlements landscape genetic variability in Shaanxi Province based on accurate-restoration. *Progress in Geography*, *39*(9), 1544-1556.

[14] Hu, Z., Zheng, W. W. & Liu, P. L. et al. (2018). The forms and structures of traditional landscape genome maps: A case study of Hunan Province. *Acta Geographica Sinica*, *73*(2), 317-332.

[15] Zheng, W. W., Li, B. H. & Liu, P. L. et al. (2021). Gene identification and zoning of traditional village landscape groups in Hunan Province. *Economic Geography*, *41*(5): 204-212.

[16] Mu, Z. B., You, W. B. & Zhang, X. F. et al. (2020). Spatial patterns and transportation accessibility analysis of world heritages in China. *Mountain Research*, *38*(3), 436-448.

[17] Liu, Z. H. (2021). Research on the evaluation of the world cultural heritage from value of Chinese traditional villages. *Journal of Southwest Minzu University* (*Humanities and Social Science*), *42*(11), 52-58.

[18] Liu, P. L. (2003). The gene expression and the sight identification of the ancient villages' cultural landscape. *Journal of Hengyang Normal University*, (4), 1-8.

[19] Liu, P. L., Liu, C. L. & Deng, Y. Y. et al. (2010). Landscape division of traditional settlement and effect elements of landscape gene in China. *Acta Geographica Sinica*, *65*(12), 1496-1506.

[20] Meng, Z. Y., Shen, Z. P. & Qu, A. X. et al. (2015). Review and prospect of cultural diversity. *Journal of Jiangsu Ocean University* (*Humanities & Social Sciences Edition*), *13*(4), 74-81.

[21] Xie, M. J., Xiang, H. W. & Huang, Z. S. (2023). Spatial genetic diversity of traditional villages under construction of land transportation construction. *Journal of Railway Science and Engineering*, (7), 2708-2717.