

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

LI Xiaoying<sup>1</sup>, ZHANG Yunle<sup>2</sup>

**Author Affiliations** 1 Associate Professor, College of Landscape Architecture, Nanjing Forestry University, Email: 80553765@qq.com; 2 Graduate student at College of Landscape Architecture, Nanjing Forestry University

**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 irrepa-

rable 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,

[The format of citation in this article]

LI Xiaoying, ZHANG Yunle. Study on the Genetic Variation Mechanism and Restoration of the Water Village Landscape in Southern Jiangsu[J]. Journal of South Architecture. 2025(1): 81-92.

• **Fund Projects:** National Key R&D Program Project (2019YFD1100404); 2020 Jiangsu University Philosophy and Social Sciences Research General Project (2020SJA0154); Jiangsu Higher Education Institutions Advantageous Discipline Construction Fund Project (20181008)

**Document Identification Code A** DOI 10.33142/jsa.v2i1.15475

**Article number** 1000-0232(2025)05-081-12

Copyright © 2025 by author(s). This work is licensed under a Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License (<https://creativecommons.org/licenses/by-nc-nd/4.0/>).

<http://www.viserdata.com/journal/jsa>

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 of the 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.

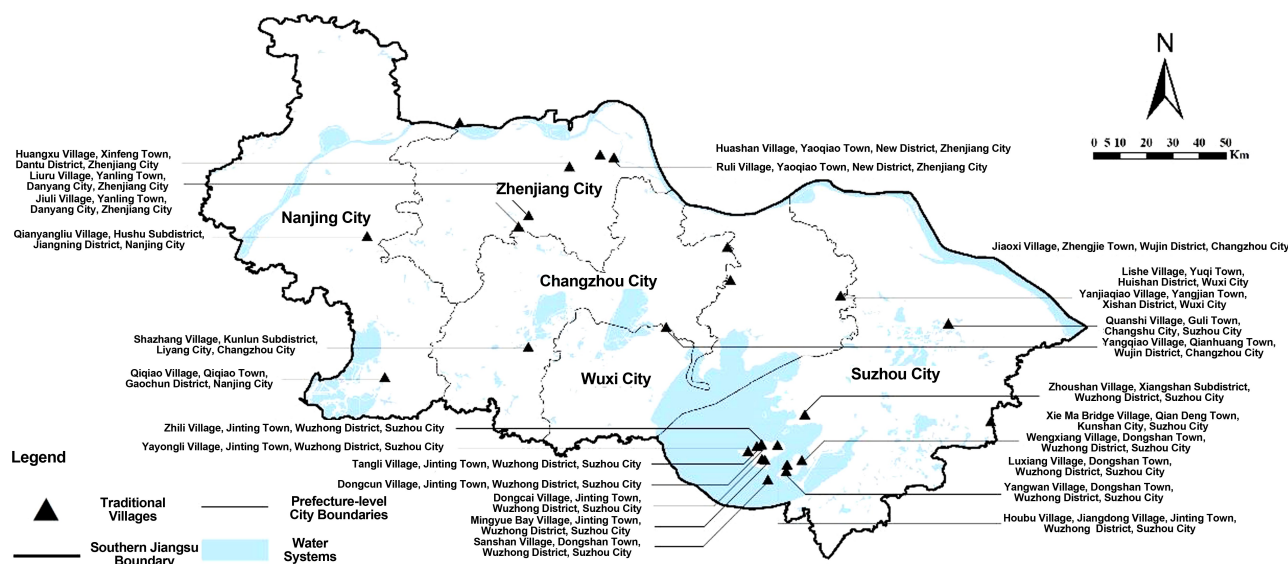







Figure 1 Distribution map of traditional villages in southern Jiangsu

### 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, environ-

mental 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.	<p>a. Residential buildings (Lihe Hall in Mingyuewan Village)</p>  <p>b. Main public building (Mingyuewan Village Bao Shizhao Memorial Hall)</p> 
		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	
Cultural genes	Main public buildings		Ancestral halls, memorial archways, temples, drum towers, watchtowers, circle gates, charitable halls, academies, bridges, well pavilions, docks, etc.	
	Cultural Beliefs		Religious worship such as Nuo and other shamanistic cultures, as well as surname-based clans.	<p>Dongcun Village Jingxiu Hall</p> 
	Folk customs and etiquette		Temple fairs, gatherings, horse lantern dances, dragon dances, sacrifices, etc.	
Environmental Genes	Traditional crafts		Embroidery, carving techniques, fine brick craftsmanship, pastry making, etc.	
	Terrain Environment		Mainly plains and hills, the terrain is flat and open, the altitude does not exceed 500m, and the slope is relatively gentle	<p>Qiqiao Village and its surroundings</p> 
	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	<p>Lishe Village's village form (buildings are arranged in clusters according to the shape of water)</p> 
	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]. Cul-

tural 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 tradi-

tional 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 culture have 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 of the 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

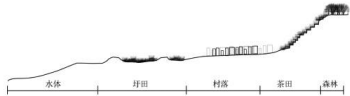

the core of the self-organization and construction of villages, humanistic context undoubtedly plays a vital role [22]. Based on this, this paper combines the research on influencing factors related to regional culture in landscape gene theory, and analyzes the landscape genetic variation mechanism by 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	<p>(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.</p> <p>(2) Some ancient residential buildings have fallen into disrepair and are no longer used.</p> <p>(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.)</p>	<p>Dongcun Village House      Zhili Village Houses</p> 
	Main public buildings	<p>(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.</p> <p>(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.</p>	<p>Mingyuewan Bao      Luxiang Ancient Village Ferry Hall</p> 
Cultural genes	Cultural Beliefs	The blood ties of the clans weakened, but the cultural belief of respecting literature and education did not change much.	<p>Luxiang Ancient Village Archway      Luxiang Ancient Village White Jade Square Cake</p> 
	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.	
	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.	 <p>Agricultural landscape pattern</p>
	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.	<p>Trail                      Gate</p> 
	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.	

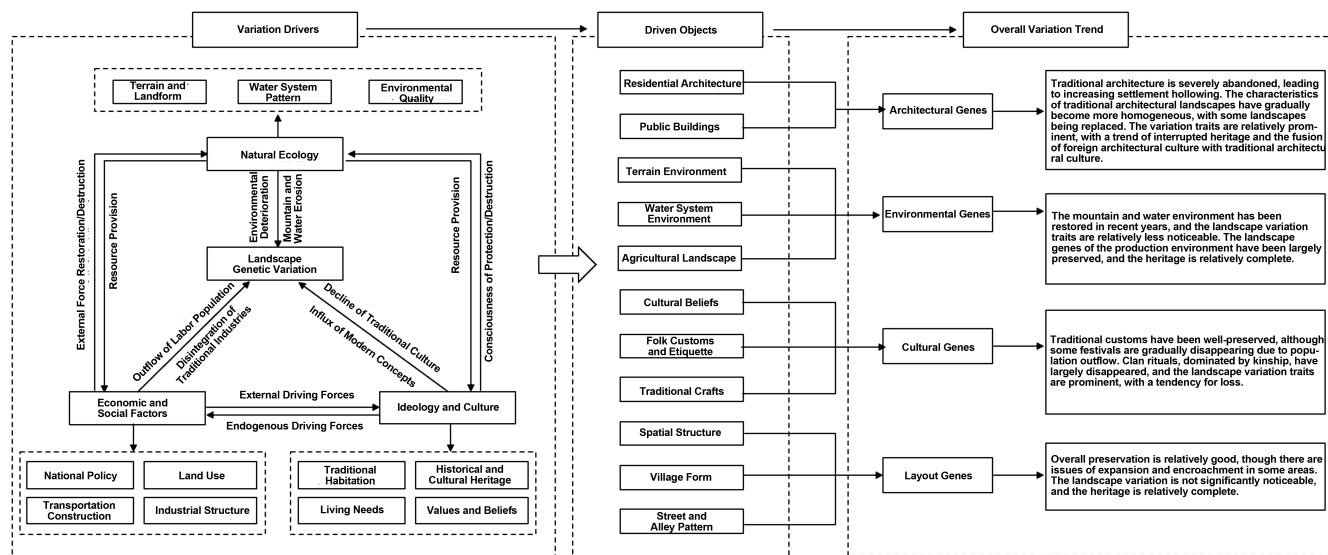


Figure 2 Genetic variation mechanism of the traditional village landscape in southern Jiangsu

### 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 hid-

den 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 so-

ciety 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 of the 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 ancient times 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 the city 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 Ligu, 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 Districts 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.