sustainability

MDPI

Article

Study on the "Space Gene" Diversity of Traditional Dong Villages in the Southwest Hunan Province of China

Huiwen Xiang †, Yu Qin †, Mingjing Xie * and Bo Zhou

School of Architecture and Art, Central South University, Changsha 410018, China
* Correspondence: xmj8051@163.com
† These authors contributed equally to this work.

Abstract: Traditional villages are essential carriers of traditional culture and ethnic culture. Hence, it is of great significance to study and protect them in the context of urban–rural integration. From the perspective of the "Space Gene", this study proposes the identification and extraction of the space gene. Then, we examine six traditional Dong villages in the Pingtan River Basin selected as cases to quantify their space gene diversity. The results show that (i) traditional Dong villages are rich and diverse in terms of their space types. (ii) The important value of the public space reflects the social cohesion of the Dong people. (iii) However, the sample villages still have differences in their space gene diversity index values. (iv) The characteristic culture encapsulated by the spaces of traditional Dong villages is facing disappearance. Furthermore, we propose a conservation strategy for traditional villages. Through the space gene diversity index, we can examine the current state of the protection and development of the village. The main objective of this study was to deepen our interpretation of the space in order to study the cultural value behind it.

Keywords: traditional village; space gene; diversity; Dong ethnic group; southwest Hunan

Citation: Xiang, H.; Qin, Y.; Xie, M.; Zhou, B. Study on the "Space Gene" Diversity of Traditional Dong Villages in the Southwest Hunan Province of China. *Sustainability* **2022**, *14*, 14306. https://doi.org/10.3390/su142114306

Academic Editor: Luca Salvati

Received: 16 September 2022
Accepted: 27 October 2022
Published: 1 November 2022

1. Introduction

Chinese traditional villages reflect a particular geographic region's society, culture, and customs. They are the result of thousands of years of farming civilization in China [1]. The location, layout, street texture, and architectural construction of the village are passed down from generation to generation, preserving the most authentic cultural heritage [2]. It has historical, cultural, artistic, and social value. With the development of urban–rural integration, many traditional villages have been generally modernized and enlarged [3]. Additionally, many valuable architectural cultural heritages have been demolished and destroyed. The internal space form of traditional villages has been impacted by external civilization. To conserve traditional villages, the Chinese government has enacted laws and regulations, such as the Rural Revitalization Strategy and the Historical Village Protection Plan [4,5]. Local bureaus generally focus on urban modernization, ignoring regional, humanistic, and cultural factors. Therefore, it is of great significance to explore the space type and diversity, applying these themes to traditional villages' protection and inheritance of the regional culture and national culture.

The application of the "gene" to the study of settlements was first introduced as a biogenetic concept by Clark and Kroeber. They pointed out that cultural areas formed by different regions have "genetic genes" similar to those in biology [6]. The culture gradually accumulates more distinctive characteristics within a mutually divided spatial area. On this basis, Rider Dawkins formally introduced the concept of the "meme" and defined it as the basic unit of culture for the purpose of communication [7]. Blackmore points out that the meme is similar to the genetic gene in living organisms, both in terms of its function and in terms of its role [8]. The meme has a DNA-like genetic function and plays an important role in the transmission of cultural information. The essence of the co-evolution

of genes and culture is the interaction between genes and the local culture. Taylor used a "genetic approach" to identify characteristics of settlement spatial patterns and extracted similar core genes by comparing villages in different regions [9]. Conzen believed that the traditional townscape is an important part of historical memory and has a special genetic pattern, which can be distinguished from the complex and multi-layered spatial patterns of the town. This research argument gradually developed into the "Conzean School of Morphology" [10]. In China, Duan, based on the urban morphology, defines the urban space genes as a record of key information that dominates the evolution and development of urban space forms [11]. Based on the concept of "genes" in biology, Huang defines the "space gene" as the basic unit that records the inherent natural laws, social relations, artistic principles, cultural connotations, and other genetic information of the settlement space [12]. The essence of space genes is their inheritance function. Space, as an inseparable part of the evolutionary organization of the settlement, has similarity with biological genetics. It plays the roles of the selection and transmission of the genetic inheritance. In the process of selection and transmission, space interacts with the local natural environment and human environment, which eventually leads to the evolution of the settlement into a stable organizational system [13]. In recent years, the theory of the "space gene" has gradually been applied to traditional village research. It has encouraged the development of traditional village space research, aiming to understand the needs of traditional villages from the perspective of the organic whole. The current research on traditional village space genes has achieved advancements [14,15]. Although research on space gene diversity is still lacking, the findings of earlier studies serve as a solid foundation for the current work.

The space gene of traditional villages has an individual and relatively stable space combination mode. It contains the fundamental law that ensures the stable inheritance of traditional villages. The fundamental law dictates that traditional villages can safely inherit. This study further interprets space genes on the basis of predecessors. Space genes have dual attributes, namely materiality (existence) and information (fundamental). Materiality is the morphological expression of different types of space. Informationality refers to the cultural, social, historical, and natural laws contained in a space. It plays a role in preserving the harmonious relationship between the traditional villages, nature, and history. This study is divided into three parts. Firstly, this study quotes the concept of the "space gene" to identify the space types of traditional villages. Secondly, we select the importance value and diversity to quantitatively analyze the space genes. The study aims to reveal the constituent elements and typological characteristics of traditional village spaces. Thirdly, it seeks to identify the problems of traditional village preservation and development and offer recommendations. The purpose of this study is to thoroughly examine the space features and cultural values of traditional villages. It is hoped that this research will contribute to traditional villages' protection.

2. Study Areas and Objects

2.1. Study Area

Tongdao County (109°25′–110°0′ E, 25°52′–26°29′ N) is located at the junction between the three provinces of Hunan, Guizhou, and Guangxi. It has a diverse topography and a total area of 2239 square km^2. Tongdao is a minority county, where 13 ethnic groups, such as the Dong, Han, Miao, and Yao, live together (Figure 1). As of the end of 2012, six Dong traditional villages in Tongdao County's Pingtan River Basin were listed on the "China Cultural Heritage Preliminary List". The existing Dong cultural heritage in the Pingtan River basin is rich and complete [16]. The Dong-style architectural complexes and local historic resources are well preserved. The Dong traditional village is a complex space system formed through self-organized evolution and self-generation within the natural environment. The question of how to control the influence of external modern culture in the context of rapid urban and rural construction is a problem that we are facing. [17]. Thus, it

is necessary to master the rules of the application of traditional culture in the material space. Additionally, we must strengthen the cultural connotations of traditional Dong villages.

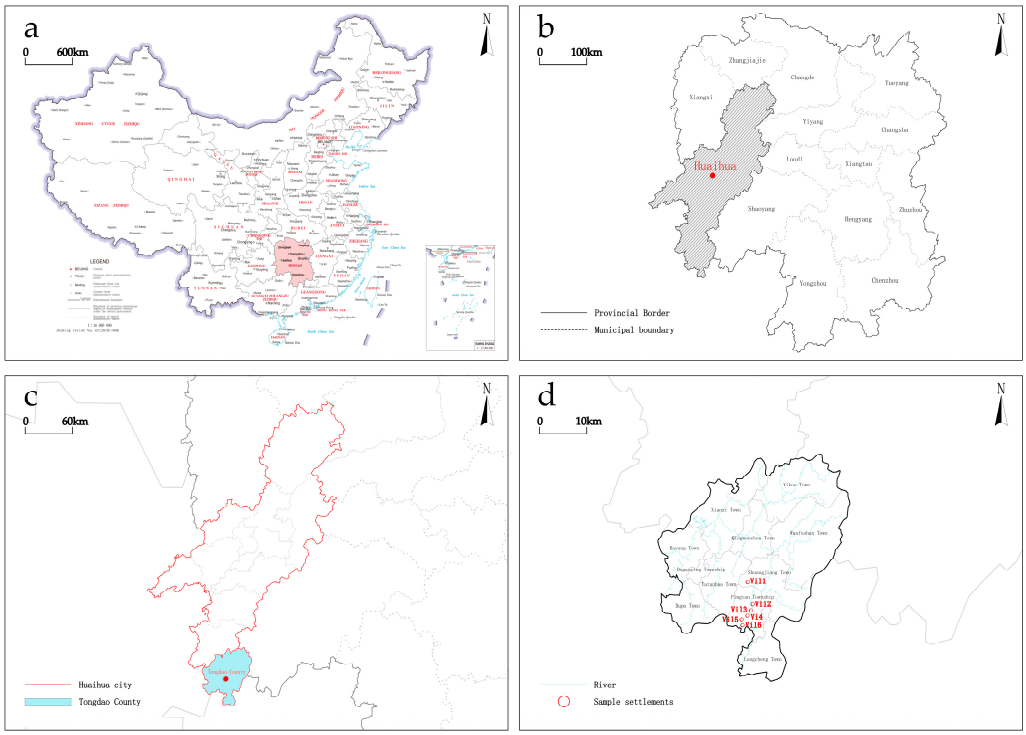


Figure 1. Location of the study area. (**a**) Location of Hunan Province in China; (**b**) location of Huaihua in Hunan Province; (**c**) location of Datong County, Huaihua City; (**d**) the location of the study sample villages in Datong County.

2.2. Research Objects

Tongdao has 28 villages which are listed as Chinese national traditional villages. This study selected six traditional villages as cases which belong to same ethnicity and same region (Figure 1, Table 1).

Table 1. Basic information on the sample villages.

Village Name	Latitude and Longitude	Altitude (m)	Basic Features
Hengling	109°72′ E; 26°06′ N	482	The village is small in scale and clustered in shape. The river flows around the village. There is cultivated land around the village.
Pingtan	109°72′ E; 26°04′ N	500	The village is small in scale and clustered in shape. The terrain is flat and the river runs parallel to the village. The cultivated land is on the west and south sides.
Yanglan	109°71′ E; 26°03′ N	481	The village is small in scale and has a belt-like shape. The river runs parallel to the village. The cultivated land is on the other side of the river and on the south side of the village.

Table 1. *Cont.*

Village Name	Latitude and Longitude	Altitude (m)	Basic Features
Gaotuan	109°71′ E; 26°03′ N	458	The village is small in scale and clustered in shape. The river runs parallel to the village. The cultivated land is on the east and west sides of the village.
Gaobu	109°68′ E; 26°02′ N	462	The village is large in scale and has a belt-like shape. The river passes through the village. The cultivated land is on the west side of the village.
Yutou	109°71′ E; 26°14′ N	527	The village is moderate in scale and has a belt-like shape. The river passes through the village. The cultivated land is on the east and west sides of the village.

3. Research Methods

The framework of this study is based on four parts. First, we must establish the research foundation, which contains the theoretical foundation and data resources. Secondly, we must delineate five spatial composition levels and identify the space genes of the sample villages. Thirdly, we must conduct an analysis of the types and diversity characteristics of the village space genes. Fourthly, we must combine the actual problems and propose feasible traditional village conservation strategies (Figure 2).

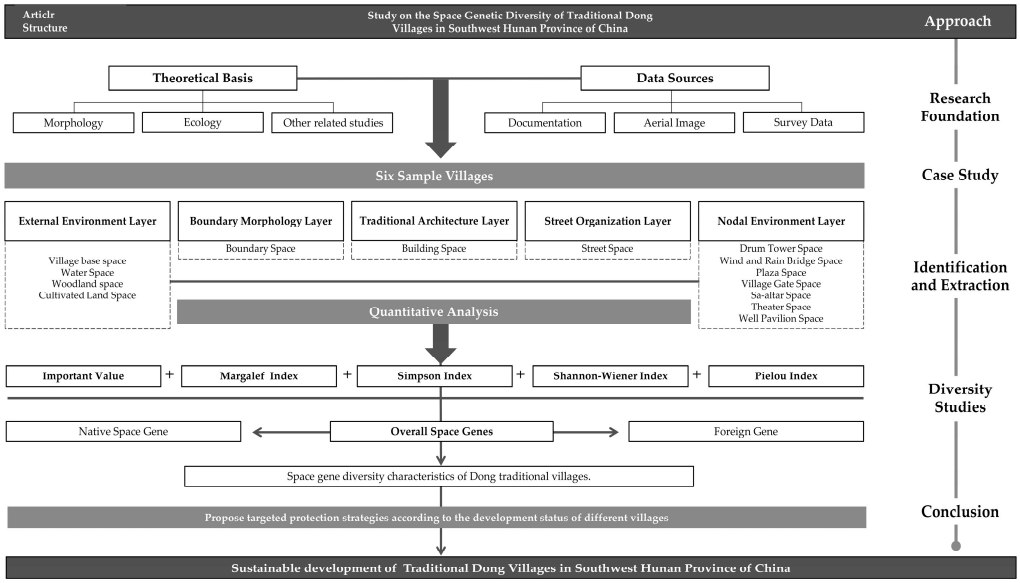


Figure 2. Analysis flowchart.

3.1. Space Gene Identification and Extraction

The traditional Dong villages in the Pingtan River Basin are divided into five layers from the outside to the inside. They include the external environment layer, village morphology layer, traditional architecture layer, street organization layer, and node environment layer (Figure 3) [18,19]. The space types inside are categorized in accordance with the five levels, and the constituent elements are examined and extracted [20]. The space types outside are categorized into five levels, and the constituent elements are identified and extracted. We proposed a framework of the space gene extraction method for traditional Dong villages, as shown in Table 2.

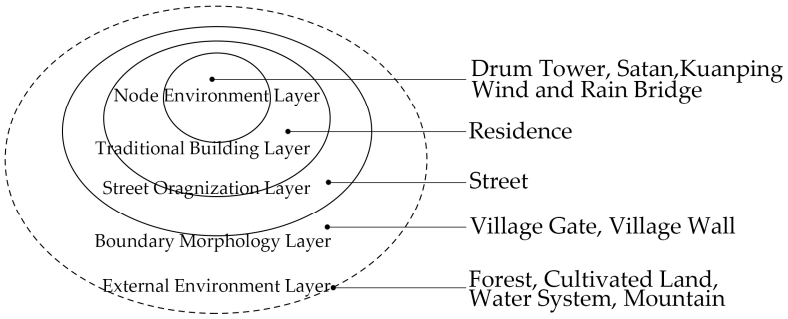


Figure 3. Space division of Dong villages.

Table 2. Classification of traditional village space gene extraction methods.

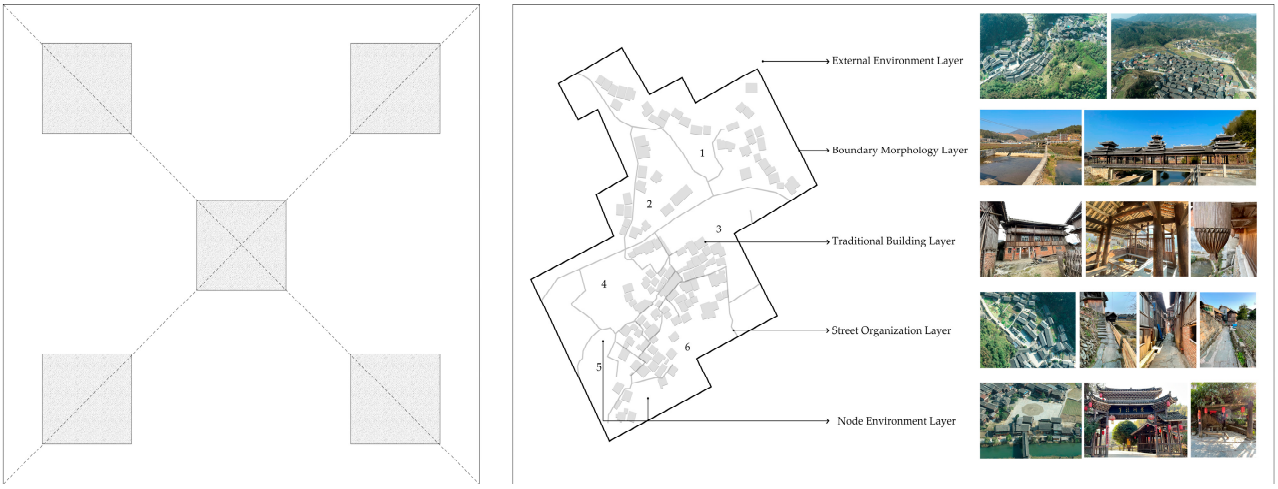
Space Level	Space Type	Extraction Content
External Environment Layer	Mountain Space	Element, Structure, Graphic, Text
	Water Space	Element, Structure
	Woodland Space	Element, Structure
	Cultivated Land Space	Element, Structure, Text
Boundary Morphology Layer	Boundary Space	Element, Structure
Traditional Building Layer	Building Space	Element, Structure, Graphic
Street Organization Layer	Street Space	Element, Structure
Nodal Environment Layer	Drum Tower Space	Element, Structure, Graphic, Text
	Wind and Rain Bridge Space	Element, Structure, Graphic, Text
	Plaza Space	Element, Structure, Graphic
	Village Gate Space	Element, Structure, Graphic
	Sa-altar Space	Element, Structure, Graphic, Text
	Theater Space	Element, Graphic, Structure
	Well Pavilion Space	Element, Graphic, Structure

3.2. Space Gene Diversity Determination

3.2.1. Quadrat Setup

The plant community presents with different levels at different heights. The plant distribution inside each basic level is divided into several sub-levels as required [21,22]. This pattern of hierarchical classification is consistent with Dong villages. The Dong villages are centered on the drum tower and unfold in layers with respect to the external environment [23]. The social organization and daily activities of the Dong people also revolve around the drum tower. In this study, we conducted a field survey with reference to plant community survey methods. The quadrats of the space gene extraction were established according to the morphological and functional characteristics of the five spatial levels [24] (Figure 4).

In the actual extraction process of space genes, the descriptive space genes in the external environment layer, such as mountains, water systems, cultivated land, forest land, etc., cannot effectively represent the individual number of space genes in terms of geographic space. Therefore, in order to facilitate the quantitative analysis of the diversity indicators, the spatial loci were divided into two categories: descriptive qualitative loci and quantitative loci [24].



(**a**) (**b**)

Figure 4. (**a**) The division of the plant community quadrat; (**b**) the division of traditional village space gene survey quadrats. The numbers in the figure are the numbers of the quadrats.

Quality gene loci: In the natural environment, quality genes usually exist in the form of plaques, which are part of the morphological boundary layer and the external environment layer. Regarding the survey method for recording such genes, "0" represents the absence of such genes, and "1" indicates the presence of such genes.

Quantitative gene loci: On the structural level, quantitative genes mainly exist in the traditional building layer, the street organization layer, and the node environment layer. The survey and record method is based on the notion that the number of space genes appearing in different buildings within the quadrat is the number of individuals of a certain space gene.

3.2.2. Space Gene Diversity Calculation

The space morphological characteristics of traditional villages are the comprehensive external manifestations of various elements [25]. They are jointly influenced by the internal "genetic information" and the external environment. The traditional villages' space gene diversity index accurately captures their spatial variety, uniformity of distribution, and relative dominance [26]. It also indicates the spatial structure, stability, organizational level, and developmental stage [27–30]. The diversity measurement indices used in this study are shown in Table 3.

3.3. Data Processing

The majority of the information in this study comes from field observations and numerous cycles of UAV photos. Additionally, earlier research was examined to support the quantitative index system. There are four main steps that form the specific steps:

1. The preliminary research includes a survey and record of the spatial elements. It aims to understand the history, spatial attributes, and folk culture of the villages.
2. Based on the previous research, we propose the principles of space gene identification and extraction. We establish a quantitative index system based on the space attributes of Dong villages. According to the five space levels, we identify and collect the village space gene dataset.
3. We perform a statistical analysis and vectorization of the space gene datasets using ArcGIS.
4. Based on the quantitative index system, the importance values and diversity of the space genes are calculated. EXCEL and origin are used for the index calculation and data mapping.

Table 3. The formula and description of the space gene diversity indices of traditional villages.

Index	Calculation Method	Description	
Margalef index (R)	$R = (S-1)/\ln N$	S: the number of species of space genes in the quadrat. N: the number of individuals of all space genes. The higher the R value is, the more abundant the space gene species in the study quadrat is.	(1)
Shannon–Wiener index (H)	$H = -\sum_{i=1}^{s}(p_i \ln p_i)$	p_i : the proportion of the ith space gene in the total amount of space genes in the overall survey quadrat. S: the number of species of space genes in the quadrat. The larger the H value is, the greater the amount of space gene information contained in the study quadrat.	(2)
	$p_i = n_i/N$	n_i: the number of individuals of the ith space gene. N: the number of individuals of all space genes.	(3)
Simpson index (D)	$D = 1 - \sum_{i=1}^{s} p_i^2$	The larger the D value is, the more abundant and diverse the gene types in the study quadrat are. The smaller the D value is, the more dominant a space gene is in the study quadrat.	(4)
Pielou index (J)	$J = H/\ln S$	J: the relative density of all the space gene species.	(5)
Important value (IV)	$IV(sg) = \frac{(A_r+F_r)}{2}$	A_r: the ratio of the number of space gene individuals to the total number of space gene individuals in the quadrat. F_r: The ratio of the number of quadrats in which this space gene appears to the total number of quadrats in which all the space genes appear. The larger the IV value is, the higher the importance of the space gene is in the study quadrat.	(6)

4. Results and Analysis

Through the field survey and data of the six sample villages, the space genes of 14 space types and 169 gene loci of traditional Dong villages were obtained. We further calculated the space gene importance values and diversity.

4.1. Space Type Diversity Characteristics

Table 4 shows that the values of the Margalef index are variable, with architectural spaces being the largest and mountain spaces the smallest. The results also reflect that the Dong architecture, the drum tower, streets, and bridges play important roles in Dong culture. Depending on the economic capacity and clan, the spatial features are different. The Margalef value of the mountain space is the lowest, which indicates that the mountain space is stable. It reflects the awe of nature and the basic cultural concept of harmonious coexistence with nature in Dong culture. Additionally, the Shannon index and Simpson index of the architectural space, drum tower space, wind-rain bridge space, street space, and square space are high. They are all spaces with Dong cultural elements, which are very unique. The highest Pielou index is that of the Sa-altar space, indicating that it is common in villages. In recent years, although the "worship ceremony of Sa" has gradually disappeared, the Sa-altar is still an essential part of the Dong villages in the Pingtan River Basin. The Pielou index of the well pavilion space is the lowest, which indicates that the number of well pavilions in each village varies greatly. According to the field survey, there are six well pavilions in Gaobu, and 1–2 well pavilions are established in the other villages. The well pavilion is an important space used by Dong residents to obtain domestic water. It can be seen that the number of well pavilion spaces reflects the demand for water and the overall population level of the village.

Table 4. Space type diversity index statistics.

Space Type	Diversity Index			
	Margalef	**Shannon**	**Simpson**	**Pielou**
Boundary Space	3.286	1.629	0.735	0.837
Wind and Rain Bridge Space	5.237	2.695	0.926	0.951
Cultivated Land Space	3.183	1.862	0.836	0.957
Drum Tower Space	10.680	2.926	0.941	0.947
Plaza Space	4.518	2.277	0.887	0.917
Building Space	18.587	2.982	0.942	0.846
Street Space	10.063	2.552	0.908	0.901
Well Pavilion Space	2.156	1.533	0.739	0.788
Woodland Space	2.259	1.696	0.802	0.946
Sa-altar Space	1.848	2.215	0.881	0.962
Mountain Space	1.540	1.581	0.758	0.882
Water space	1.848	1.590	0.770	0.888
Theatre Space	1.951	1.752	0.806	0.900
Village Gate Space	4.005	2.078	0.847	0.867

4.2. Space Gene Quantity Features

4.2.1. Space Gene Statistics of Different Village Quadrats

Table 5 shows that Gaobu has the highest number of space gene species, followed by Yutou and Pingtan. Yanglan has the lowest number of space gene species. In terms of the number of space gene loci, Pingtan, Yutou, and Gaobu have the highest number of space gene loci, while Yanglan and Gaotuan have the lowest. In terms of the space gene type, there is little difference between the six villages. Based on the field survey, Gaobu has the highest number of space genes among the six Dong villages and the richest number of gene loci and space types. This is mainly because Gaobu is composed of three natural villages, namely Gaosheng, Gaoshang, and Kezhong. Gaobu has a prominent lead in the number of samples compared with the other five villages.

Table 5. Quantitative statistics of space genes in different village quadrats.

Project	Hengling Village	Pingtan Village	Yanglan Village	Gaotuan Village	Gaobu Village	Yutou Village
Space Type	14	14	13	13	14	14
Gene Loci	61	62	54	58	62	62
Space Gene Type	118	123	103	111	130	121

4.2.2. Space Gene Statistics of Different Space Types

Table 6 shows that the numbers of gene loci and gene types in the four types of spaces of traditional villages, namely the building space, street space, drum tower space, and wind and rain bridge space, are relatively large. This indicates the importance of these four types of space to traditional Dong villages. This degree is consistent with the village survey records. The number of space genes in these four types of spaces far exceeds that of the other types. It indicates the richness of the spaces' constituent elements. Thus, they are also more diverse in terms of their structure and morphological expression. The building materials, wall forms, building structures, roof forms, building colors, and paving materials all have variable genes. For example, we can observe the use of modern industrial materials such as cement and bricks. Combined with the fieldwork, we found that there are two main reasons for the emergence of modern architectural elements. First of all, there is a great deal of rain in Tongdao County. Under the external force of the natural environment, such as wind and rain, the main structure of traditional buildings inclines and becomes seriously corroded, making it challenging to ensure the personal safety of the users. In addition, with the remarkable achievements in national poverty alleviation, the economic and material level of the villagers has been continuously improved, and the

functions of traditional wood structure buildings can no longer meet the users' needs. This is why modern formal elements have emerged in the form of residential buildings. The Sa-altar represents Dong beliefs, but its space genes are smaller than those of the square space with respect to the number of loci and types. This may be due to the simple and primitive form of the Sa-altar's decoration and shape. As the modernization of the country advances, the Sa-altar is gradually dying out, and the status of the Sa-altar in Dong villages is gradually becoming reduced.

Table 6. Quantity statistics of genes in different space types.

Space Type	Number of Gene Loci	Number of Gene Species	Number of Gene Individuals
Mountain Space	2	6	16
Water Space	3	6	19
Woodland Space	2	6	23
Cultivated Land Space	3	7	32
Boundary Space	2	7	50
Building Space	12	34	14,998
Street Space	5	17	1216
Drum Tower Space	8	22	271
Wind and Rain Bridge Space	7	17	77
Village Gate Space	4	11	84
Satan Space	3	10	19
Plaza Space	4	12	85
Theater Space	4	7	24

4.3. Space Gene Importance Features

The important value of space genes reveals the extent to which a certain type of gene impacts the study quadrats of the traditional villages. The higher the importance value is, the more significant it is to the space of the sample villages. The importance values of various space levels and types of the sample villages were calculated using the information collected from the field survey. Due to the large number of space gene species, only the top 15 species with comprehensive importance values are compared here.

4.3.1. Comprehensive Importance Values of Space Genes in Different Space Types

The importance values of each space gene type are summed to obtain a comprehensive importance value (Figure 5). Figure 5 shows that the most important genes were those of the five space types of the architectural space, street space, drum tower space, square, and wind and rain bridge space in the traditional villages of the Dong nationality. They play an important role in the space features of the traditional villages of the Dong nationality. Among them, the importance value of the comprehensive space gene of the architectural space is much larger than those of the other space gene types. This indicates that the architectural space gene occupies the highest position in the Dong village. The comprehensive importance value indices of the mountain space, altar space, stage space, and well pavilion space are low. The Han settlements in the same area are different. Some studies have found that the ranking of the comprehensive importance values of the space types of Han traditional villages follows the order of the architectural space, street, watchtower, mountain, and woodland. The ranking of the comprehensive importance values of the space types of Han ancient towns follow the order of the architectural space, street, mountain, wall, and woodland. Dong settlements show a higher importance value at the nodal environment level, including drum towers, squares, and wind-rain bridges. Meanwhile, Han settlements show higher importance values at the external environment and boundary space levels, including towers, walls, mountains, and woodlands. The settlements of the Han in southwest China have always followed the ritual system and geomancy. Thus, the mountain space and forest space have high comprehensive importance values in terms of their space genes. Unlike the Han, the Dong focus on the construction of public spaces. For the Dong people, the drum tower is a symbol of the family name but also a symbol

of national consciousness. The wind-rain bridge and square are important spaces for the Dong people's ritual activities and social interactions. Thus, the Dong clan culture and social cohesion are contained in the drum tower, wind-rain bridge, and square space, possessing a space gene of an integrated importance value. Moreover, it is unfortunate that the degrees of the use of the Satan, theater, and well pavilion are gradually decreasing. They are gradually losing their attributes as traditional trait space genes.

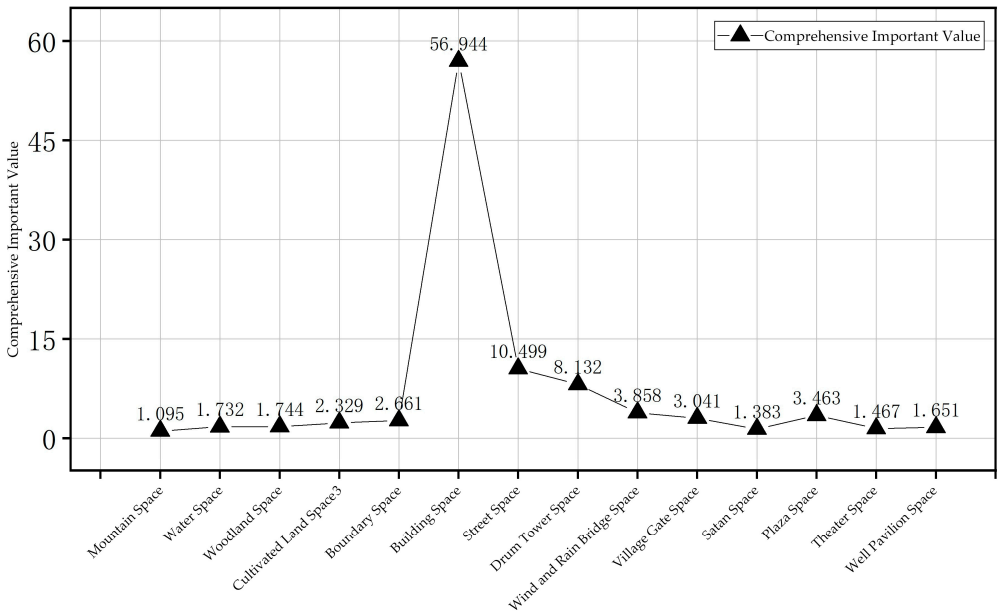


Figure 5. Comprehensive importance value statistics of space genes in different space types.

4.3.2. Comprehensive Importance Value of Space Genes in Different Loci

We summed the space gene comprehensive importance values of each gene loci (Figure 6). The results show that, among the top ten gene loci of comprehensive importance, the building space ranks first. This suggests that traditional Dong villages' building space plays a significant role.

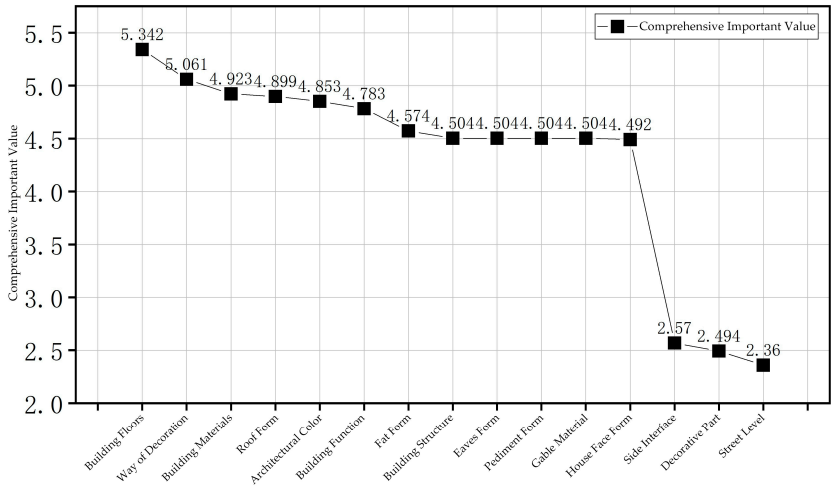


Figure 6. Comprehensive importance value statistics of space genes in different loci.

4.3.3. Importance Values of Different Space Genes

As shown in Figure 7, the top ten in the ranking of the space genes' importance value data also indicate the dominance of the building space in terms of the space type. This is consistent with the comprehensive importance value index of the space type and

gene locus. That is, the building space plays a vital role in identifying the traditional Dong villages.

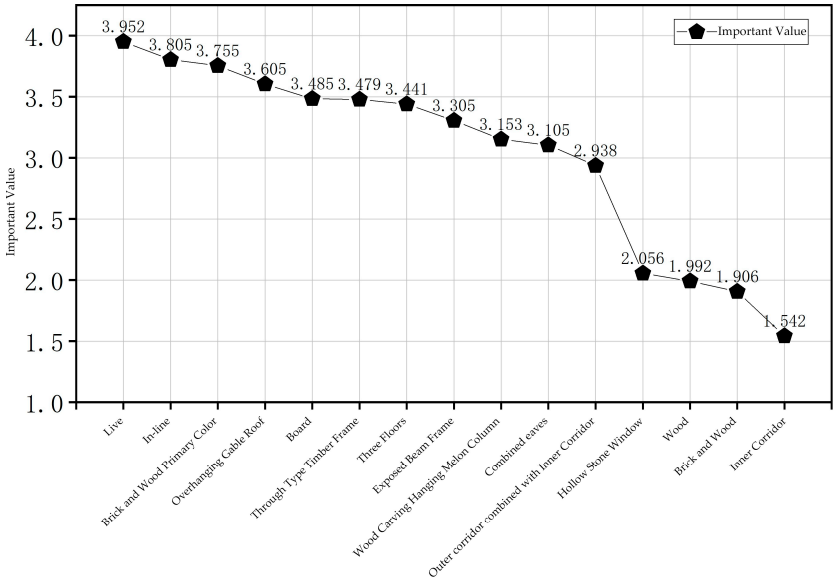


Figure 7. Importance value statistics of different space genes.

4.4. Space Gene Diversity Characteristics

In order to analyze the influence of foreign genes on the space gene diversity of traditional villages, the total space genes of the traditional Dong villages are divided into two categories: native genes and foreign genes. The native gene has a long history, which represents traditional cultures, as well as the features of a certain era. It has local characteristics. The foreign gene is formed over a short period. It is characterized by modern industrial traits and does not correspond to the local traits.

4.4.1. Overall Space Gene Diversity Characteristics

Figure 8 shows that the diversity indices of each village are quite different. However, the overall space gene diversity index is still at a high level, indicating that the space gene diversity of traditional Dong villages in the Pingtan River Basin has a relatively high level. Pingtan has the highest Margalef value. Pingtan Village is the first traditional Dong village to be listed among the traditional villages. This highest space gene Margalef value results from the relatively extensive adoption of pertinent protection and repair programs. The Shannon value of the sample villages is above 3.0, indicating that the traditional Dong villages in the Pingtan River Basin are affluent in terms of their space genes. In addition to the public buildings and structures such as drum towers, village gates, and wind and rain bridges, traditional Dong villages also have religious buildings, such as ancestral halls, palaces, and altars. The rich space types increase the overall diversity values of the space genes of traditional Dong villages in Pingtan River Basin. The Shannon value of Gaotuan is the highest, which might be due to the fact that the county government has issued special protection laws to effectively protect its environment and architectural style. The Simpson indices for the sample villages do not differ significantly. The Pielou values of the sample villages are all around 0.7, indicating that the space gene distribution of the traditional Dong villages in the Pingtan River Basin is relatively uniform.

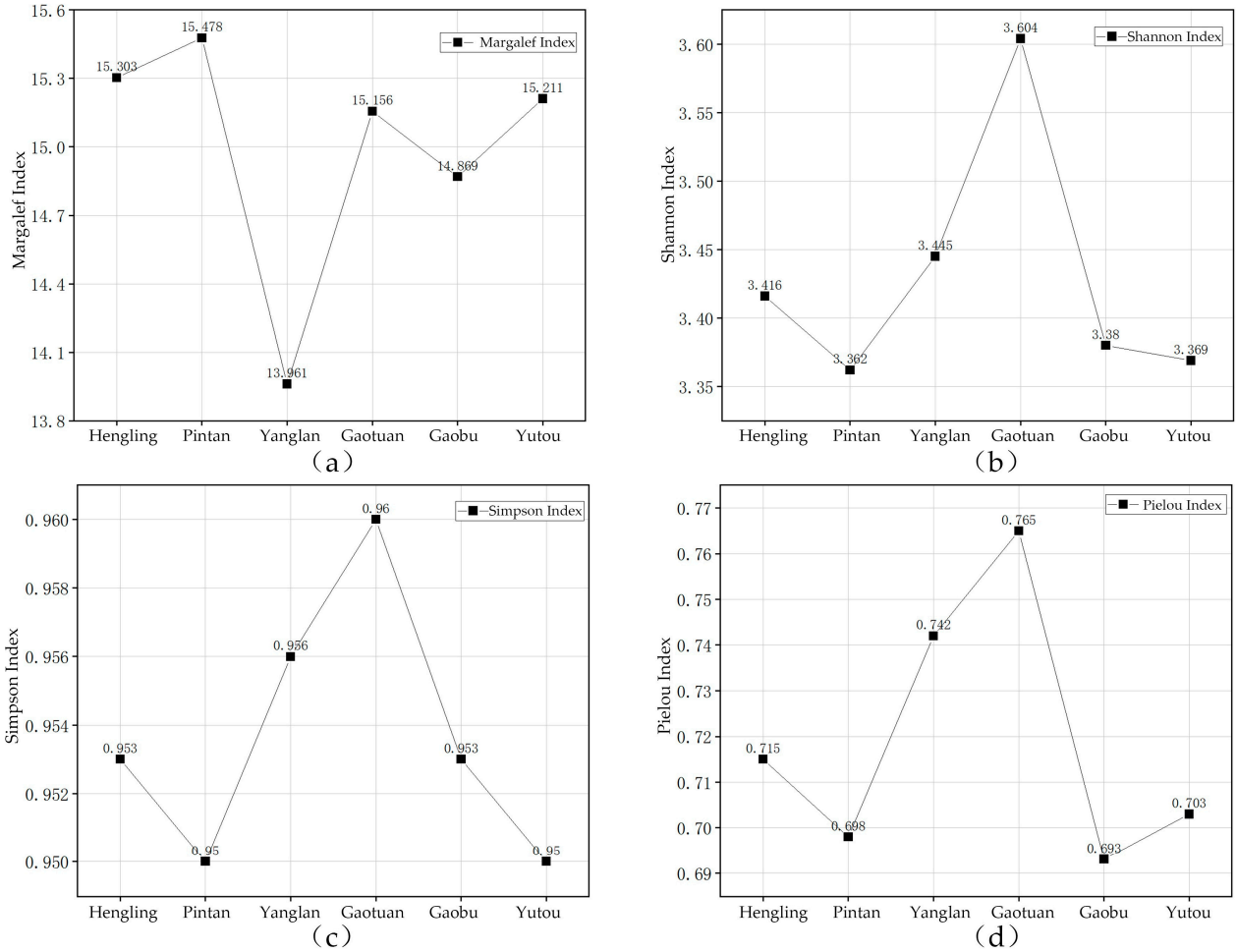


Figure 8. Diversity index of the sample villages: (**a**) Margalef index of the sample villages; (**b**) Shannon index of the sample villages; (**c**) Simpson index of the sample villages; (**d**) Pielou index of the sample villages.

4.4.2. Analysis of the Margalef Indices of Native and Foreign Space Genes

Figure 9 shows that the Margalef values of the native space genes of the sample villages were higher than those of the foreign space genes. Pingtan (14.196) and Yutou (14.197) had higher Margalef values of their native space genes. This suggests that the number of native gene species was relatively large in these two villages. Their preservation was relatively complete. Yanglan's Margalef value (12.469) was the lowest and showed substantial damage with respect to its native genes. Hengling (13.358), Gaotuan (13.227), and Gaobu (13.497) had similar Margalef values, indicating that they have similar degrees of native gene protection. Comparing the Margalef indices of the foreign genes in each village, Gaotuan (1.791), Hengling (1.686), and Yanglan (1.355) had the highest values. This means that the three traditional villages have a relatively rich variety of foreign genes. Yutou (1.371) and Pingtan (1.071) had the lowest foreign gene Margalef values. This indicates that the degree of the invasion of foreign genes is not high in Yaotou and Pingtan.

4.4.3. Native and Foreign Space Gene Diversity

Table 7 shows that the native gene diversity index of the six sample villages is close to the overall gene diversity index, which is higher than that of the foreign space gene diversity. It can be seen that foreign genes are at a disadvantage. The traditional villages in the Pingtan River Basin are well protected as a whole. Gaotuan has the highest native space gene diversity index, while the other five villages show little difference in terms of their native gene diversity indices. The Pielou index of the native genes in the six sample

villages was higher than that of foreign genes. Gaotuan, Gaobu, and Yanglan all have a relatively high level of foreign gene diversity. Through the field survey, it was discovered that, due to the lack of scientific and effective management measures, the local features of these three villages have been damaged to varying degrees, resulting in large differences in their appearance.

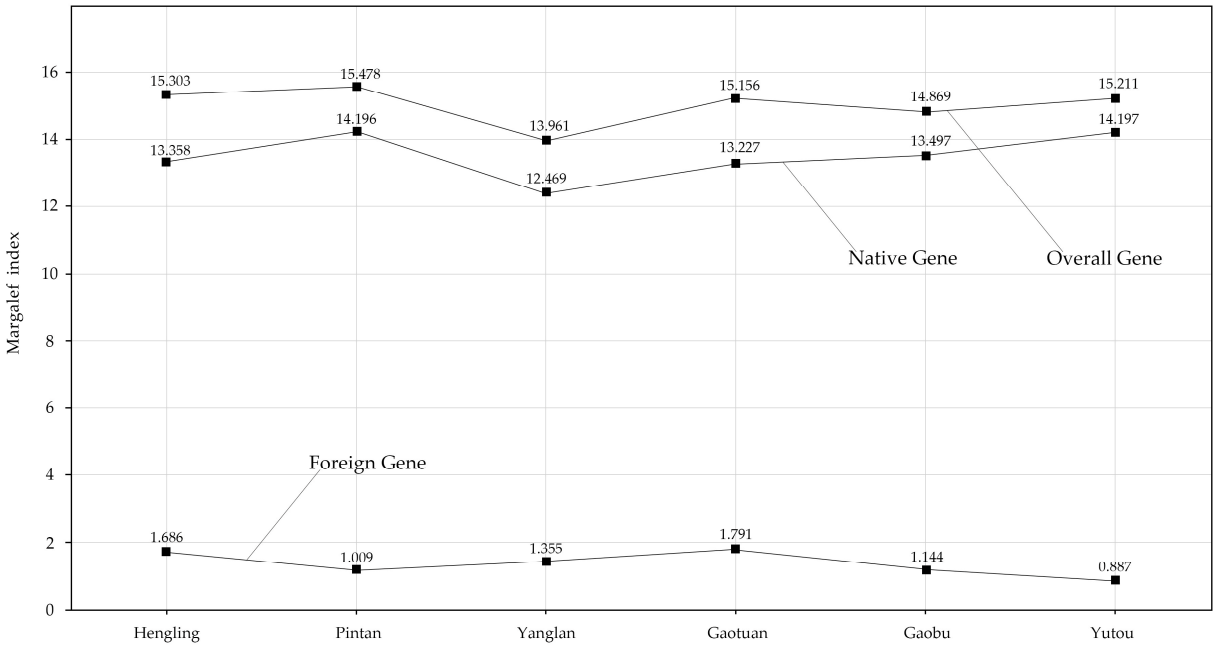


Figure 9. The Margalef indices of native and foreign space genes in the sample villages.

Table 7. Native and foreign space gene diversity indices [24].

Village Name	Shannon Index			Simpson Index			Pielou Index		
	Native Gene	Foreign Gene	Overall Gene	Native Gene	Foreign Gene	Overall Gene	Native Gene	Foreign Gene	Overall Gene
Hengling	3.274	1.525	3.416	0.946	0.636	0.953	0.705	0.578	0.715
Pingtan	3.240	1.071	3.362	0.945	0.649	0.95	0.689	0.607	0.698
Yanglan	3.262	1.780	3.445	0.947	0.769	0.956	0.719	0.742	0.742
Gaotuan	3.420	1.950	3.604	0.952	0.802	0.96	0.747	0.738	0.765
Gaobu	3.193	1.808	3.38	0.944	0.794	0.953	0.668	0.754	0.693
Yutou	3.291	1.371	3.369	0.947	0.610	0.95	0.696	0.659	0.703

5. Discussion

5.1. The Ecological Wisdom Connotations of Traditional Dong Village Spaces

In the construction of the traditional spatial pattern, the Dong villages pursue the concept that man is an integral part of nature—that is, the harmonious coexistence of the living environment and the natural environment. The Dong village is the result of centuries of ecological wisdom. The Dong village is a combined spatial model of "mountain-forest-house-field-water" [31]. There are material circulation and energy flows among the space gene elements, which maintain the stability of social organization and protect the ecological diversity. In terms of social organization, the Dong village space displays a clear 'circle' layout, with the drum tower at its center. That is, the drum tower, houses, wind and rain bridges, lawns, farmland, forests, rivers, and mountains are distributed in circles from the inside to the outside. The drum tower is a place for discussion, culture, entertainment, and leisure activities. It occupies a central position in the village's social structure. The Dong people adhere to the principle of "respecting and conforming with nature" during

construction. This aims to minimize the impacts on mountain terrain and the natural environment. As a result, a unique Dong stilt-style architecture was formed, and the building materials are local trees and stones. The space gene of the Dong's external environment also reflects ecological wisdom. The mountain space can block the cold wind from the north in the winter. The river space can not only receive the cool wind from the south in the summer but also solves the problems of drinking water and irrigation. Woodland space is also called "Feng Shui Forest" in Dong villages. Its vegetation includes pine and fir, which have the functions of water conservation, soil-water conservation, and microclimate regulation. The Dong village is connected or adapted to the natural environment by virtue of its ecosystem and the deep wisdom of its residents, who seek to create a livable living space under low-technology conditions [32]. In essence, the ecological wisdom of the Dong village space is based on "respecting nature and using resources sparingly". It is a kind of survival wisdom of sustainable development.

5.2. The Current Dilemma of the Dong Traditional Village

The traditional Dong villages have environmental coordination due to the stability of their ecosystems. Each element of the village ecosystem changes in response to external information and energy flows. This has a significant impact on the spatial pattern of Dong villages. In turn, the change in the spatial form of Dong villages leads to the imbalance between the natural ecosystem and residential ecosystem. The development of the economy and transportation has contributed to cultural exchange and material exchange. This has led to the impact on the traditional style of Dong village architecture. As the space gene diversity shows, modern elements have appeared in the spatial form's function, architectural shape, color, decorative symbols, and even the structure of traditional Dong villages. The common problem of the sample villages is the combination of old and new buildings. Additionally, we can cite the destruction of the village fabric and aesthetic traditions. This illustrates the conflict between the traditional rural culture and modern culture. Villagers have a lower sense of identification with local cultural values and lack a sense of belonging. Secondly, villagers pay more attention to their own living needs. The new residential site selection trend in Gaotuan Village and Gaobu Village is to build close to the road, thereby compressing the original woodland space and cultivated space. Finally, the boundary of the village space form continues to spread outward. Additionally, the internal space is divided into multiple groups. This has a strong interfering effect on other biological populations and environmental factors. If we do not confront and acknowledge the changes in the ecosystem and their impacts, the integrity and ecology of the external environment space genes will be seriously jeopardized. Therefore, the dilemma facing traditional Dong villages is the lack of targeted measures for the inheritance of local space genes, ignoring the coordination and ecological protection of the overall space environment. This has gradually led to a lack of village space and cultural decline.

5.3. Protection and Development Strategy

The traditional village space is diverse, regional, and comprised of inherited morphological types and ethnic cultures. The protection and construction of traditional villages should obey the principles of applicability, coordination, and continuity [33,34], as well as the demand for functional spaces. The results show that the type and number of space genes of Dong traditional villages are changing in the process of development. The traditional space genes are constantly disappearing, and new space genes are constantly appearing. Under the impacts of external factors, the traditional space of Dong villages faces many problems, such as the lack of targeted conservation measures, the designers' lack of historical knowledge, and cultural elements. Based on this, we make the following recommendations:

1. The space gene diversity index of traditional villages can reflect the development status of traditional villages in terms of quantitative results. We suggest applying the space gene diversity index to the evaluation of the traditional village space. First, we

can identify and extract the space genes and then choose the genes with basic roles influencing the development and protection status of traditional villages. Secondly, the diversity index values of the genes performing these basic roles are calculated to evaluate the current status of the villages. Finally, the construction objectives and specific components of the village are determined.

2. Next, we can establish the space gene information database of the traditional villages. The sequence relationships of the space genes at the loci are extracted through ArcGIS, UAV, and field surveys. We can assemble the characteristic space genomes of the traditional villages at different structural space levels. This enables us to apply the digital board for real-time monitoring, which means recording space data intermittently.
3. Next, we can implement the dynamic balance system of the traditional village space genes. We suggest scientifically judging whether the new type of alien space gene is consistent with the traditional space style. Thus, we can reasonably guide the behavior, avoiding damage to the appearance of the space's regional characteristics. In this way, the new space genes can also reflect the regional characteristics of the culture and environment in terms of their morphology. Thus, we can ensure and maintain the relatively stable inheritance of space genes.

Traditional villages are not immutable, and the assimilation of foreign genes and erosion are normal developments [35,36]. The village's protection and development cannot be evaluated in absolute terms. The ultimate goal is not to completely retain the original space of the village, nor is this a mandatory intervention. It is necessary to guide future planning trends based on the current state of development of the village. We should maintain the dynamic balance between cultural protection and construction. This is the goal of sustainable development in traditional villages.

5.4. Limitations of the Study

In this study, the traditional Dong village was the research object, and we introduced the concept of space gene diversity to traditional village space gene research in an attempt to reveal its inherent law. However, this study is one-sided, according to the following considerations:

1. The theoretical system of the traditional village space gene is not yet mature, and it is still in the preliminary exploration stage. The introduction of the space gene concept and the quantitative method is relatively simple. We will continue to pay attention to the theoretical research on space genes in the future, including its concepts and applications. Secondly, in terms of research methods, we will conduct in-depth discussions and optimization.
2. In this study, six traditional Dong villages were taken as research cases, which is insufficient for representing Dong villages in all regions, much less all traditional villages. Further research is required to confirm whether the space gene characteristics of different ethnic groups and regions vary significantly.
3. The classification table of "gene loci" proposed in this study is not complete. There are many other space forms, such as the courtyard space, green space, light, and architectural decoration. The study of space genes from the perspectives of policy, law, aesthetics, philosophy, etc., is also worth considering. In the next stage of our research, we will deepen the identification of different types of space genes and add other space gene loci.

Therefore, we recognize that the analysis and conclusions of this study are limited. In further studies, we will increase the types and number of traditional villages. In addition, we have yet to compare the regions, economies, cultures, or lifestyles of various traditional villages.

6. Conclusions

In this study, the Pingtan River Basin Dong traditional villages were taken as the research object. We introduced the 'space gene' concept and a diversity of quantitative meth-

ods to this study, designed to reveal the space gene diversity of traditional Dong villages. The conclusions are as follows:

1. The space types of traditional Dong villages in the Pingtan River Basin are rich and diverse. A total of 169 space genes were extracted based on five spatial levels, including 25 external environment layers, 7 boundary morphology layers, 34 traditional building layers, 17 street organization layers, and 86 node space layers.
2. The types and number of architectural space genes are high, which indicates their dominant position in traditional Dong villages. The drum tower and the wind-rain bridge are unique public spaces of the Dong villages, which represent the cultural cohesion of the Dong people.
3. The overall space gene diversity analysis indicated that there are differences between the sample villages. They are related to the degree of the implementation of protection and management regulations. In general, the richness index is higher, and the evenness index is lower.
4. The gene diversity of the classified space indicates that these sample villages were affected by foreign genes to varying degrees. The Magerlef index value of foreign genes can reflect the degree of the influence of local genes.

Author Contributions: H.X. and Y.Q. contributed equally to this paper, and they are joint first authors. Conceptualization, H.X., Y.Q. and M.X.; methodology, H.X., Y.Q. and M.X.; software, H.X. and Y.Q.; validation, H.X., Y.Q. and B.Z.; formal analysis, H.X., Y.Q. and B.Z.; investigation, H.X., Y.Q. and B.Z.; resources, H.X. and Y.Q.; data curation, B.Z.; writing—original draft preparation, H.X. and Y.Q.; writing—review and editing, M.X.; visualization, H.X. and Y.Q.; supervision, M.X.; project administration, M.X.; funding acquisition, M.X. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Key Research and Development Program of Hunan Province of China, grant number 2018NK2053. Funder: The Department of Science and Technology of Hunan Province.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all participants involved in this study.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Wang, J.; Liu, Y. Research progress on the spatial distribution of traditional villages in China. *Sichuan Archit.* **2016**, *36*, 39–41. [CrossRef]
2. Fu, J.; Zhou, J.L.; Deng, Y.Y. Heritage values of ancient vernacular residences in traditional villages in Western Hunan, China: Spatial patterns and influencing factors. *Build. Environ.* **2021**, *188*, 107473. [CrossRef]
3. Sun, J.X. Traditional Village: Theoretical Connotation and Development Path. *Tour. Trib.* **2017**, *32*, 1–3. [CrossRef]
4. Gao, J.; Wu, B. Revitalizing traditional villages through rural tourism: A case study of Yuanjia Village, Shaanxi Province, China. *Tour. Manag.* **2017**, *63*, 223–233. [CrossRef]
5. Chen, C.; Woods, M.; Chen, J.; Liu, Y.; Gao, J. Globalization, state intervention, local action and rural locality reconstitution-a case study from rural China. *Habitat Int.* **2019**, *93*, 102052. [CrossRef]
6. Kroeber, A.L. The Culture-Area and Age-Area Concepts of Clark Wissler. In *Americanist Culture History: Fundamentals of Time, Space, and Form*; Lyman, R., Michael, L., O'Brien, J., Dunnell, R.C., Eds.; Springer: Boston, MA, USA, 1997; pp. 121–138. [CrossRef]
7. Dawkins, R.L. *The Selfish Gene*; Oxford University Press: Oxford, UK, 1976; Volume 32. [CrossRef]
8. Blackmore, S. *The Meme Machine*; Oxford Paperbacks; Oxford University Press: Oxford, UK, 2000; Volume 25.
9. Taylor, G. Environment, Village and City: A Genetic Approach to Urban Geography; with Some Reference to Possibilism. *Ann. Assoc. Am. Geogr.* **1946**, *32*, 1–67. [CrossRef]
10. Conzen, M.P. *Thinking about Urban Form: Papers on Urban Morphology, 1932–1998*; Peter Lang: Brussels, Switzerland, 2004.
11. Duan, J.; Shao, R.; Lan, W.; Liu, J.; Jiang, Y. Space gene. *City Plan. Rev.* **2019**, *43*, 14–21. (In Chinese)

12. Huang, Z.S.; Wang, Z.T.; Gong, B.; Xiang, H.W.; Zhao, M.W.; Liu, Y.F.; Zhang, E.W.; Xiang, X.X.; Dai, F.H. The Conceptual Connotation and Prospect of Space Gene. *Huazhong Archit.* **2020**, *38*, 19–21. [CrossRef]
13. Hill, M.R. *Rural Settlement and the Urban Impact on the Countryside*; Hodder & Stoughton: London, UK, 2003.
14. Duan, J.; Jiang, Y.; Li, Y.G.; Lan, W.L. Space Gene: Connotation and Functional Mechanism. *City Plan. Rev.* **2022**, *46*, 7–14. (In Chinese)
15. Shao, R.Q.; Duan, J.; Jiang, Y.; Qian, L.Y.; Wang, L. The Research of Space Gene: A New Method Used in Comprehensive Urban Design to Improve the Locality. *Planners* **2020**, *36*, 33–39. (In Chinese)
16. Yang, L. On Perceptibility and Recognizability of Traditional Settlements' Landscape Genes in Chinese Minority Areas: A Case Study in Yutou Dong Minority Village of Tongdao. *J. Landsc. Res.* **2015**, *7*, 34–42.
17. Long, H.L.; Tu, S.S.; Ge, D.Z.; Li, T.T.; Liu, Y.S. The allocation and management of critical resources in rural China under restructuring: Problems and prospects. *J. Rural Stud.* **2016**, *47*, 392–412. [CrossRef]
18. Hu, Z.; Strobl, J.; Min, Q.W.; Tan, M.; Chen, F.L. Visualizing the cultural landscape gene of traditional settlements in China: A semiotic perspective. *Herit. Sci.* **2021**, *9*, 115. [CrossRef]
19. Li, X.; Li, W.; Smith, K.S.; Smith, A.C. Hidden from the wind and enjoying the water (藏风得水): The traditional cosmology of fengshui and the shaping of Dong villages in Southwestern China. *Landsc. Res.* **2019**, *44*, 614–627. [CrossRef]
20. Wang, P.J.; Zhang, J.H.; Sun, F.; Cao, S.S.; Kan, Y.; Wang, C.; Xu, D. Spatial Distribution and the Impact Mechanism of Traditional Villages in Southwest China. *Econ. Geogr.* **2021**, *41*, 204–213. [CrossRef]
21. Watt, A.S. Pattern and process in the plant community. *J. Ecol.* **1947**, *35*, 1–22. [CrossRef]
22. Hopkins, B. Pattern in the plant community. *J. Ecol.* **1957**, *45*, 451–463. [CrossRef]
23. Xie, B.J.; Jiang, Y.C. A Study on the Geographical Features of Rural Settlements in the Pingtan River Basin. *J. Huaihua Univ.* **2016**, *35*, 6–9. [CrossRef]
24. Xie, M.J.; Xiang, H.W.; Huang, Z.S. Study on the spatial genetic diversity of traditional villages under the construction of land transportation construction. *J. Railw. Sci. Eng.* **2022**, *14*, 14306. [CrossRef]
25. Xu, J.H.; Liu, S.; Mao, Z.; Hou, Q.Q. A Study on Spatial Distribution Characteristics and Protection System Scheme of Chinese Traditional Village. *J. Hunan Univ. Soc. Sci.* **2021**, *35*, 152–160. [CrossRef]
26. Zhou, H.; Liu, W.Y.; Gong, L.; Huang, Z.S. Analysis on Spatial Gene Diversity of Traditional Villages of Dong Ethnic Group in Southeast Guizhou Province. *Guizhou Ethn. Stud.* **2020**, *41*, 99–104. [CrossRef]
27. Margalef, R. On Certain Unifying Principles in Ecology. *Am. Nat.* **1963**, *897*, 357–374. [CrossRef]
28. Strong, W.L. Biased Richness and Evenness Relationships within Shannon–Wiener Index Values. *Ecol. Indic.* **2016**, *67*, 703–713. [CrossRef]
29. Wilson, J.B.; Habiba, G.; John, B.S.; Warren, M.G.K. Relative Abundance Distributions in Plant Communities: Effects of Species Richness and of Spatial Scale. *J. Veg. Sci.* **1998**, *9*, 213–220. [CrossRef]
30. Mouillot, D.; Lepretre, A. A comparison of species diversity estimators. *Res. Popul. Ecol.* **1999**, *41*, 203–215. [CrossRef]
31. Zhou, Z.; Jia, Z.; Wang, N.; Zhang, M. Sustainable mountain village construction adapted to livelihood, topography, and hydrology: A case of Dong villages in southeast Guizhou, China. *Sustainability* **2018**, *10*, 4619. [CrossRef]
32. Wang, N.; Zheng, W.; Tian, M.; Lin, L. The Wisdom of Adaptation of Dong's Traditional Residential Space Environment from the Perspective of Health—A Case Study of Gaoxiu Dong Village in Guangxi. In Proceedings of the E3S Web of Conferences, Xiamen, China, 5–7 March 2021; Volume 251, p. 02069. [CrossRef]
33. Nakamura, N. Towards a culturally sustainable Environmental Impact Assessment: The protection of Ainu cultural heritage in the Saru River cultural impact assessment, Japan. *Geogr. Res.* **2013**, *51*, 26–36. [CrossRef]
34. Xiao, Y.; Zhao, J.; Sun, S.; Guo, L.; Axmacher, J.; Sang, W. Sustainability dynamics of traditional villages: A case study in Qiannan Prefecture, Guizhou, China. *Sustainability* **2019**, *12*, 314. [CrossRef]
35. Liu, P.L.; Liu, C.L.; Deng, Y.Y.; Shen, X.Y.; Li, B.H.; Hu, Z. Landscape Division of Traditional Settlement and Effect Elements of Landscape Gene in China. *Acta Geogr. Sin.* **2010**, *65*, 1496–1506. [CrossRef]
36. Svensson, E. Consuming nature–producing heritage: Aspects on conservation, economical growth and community participation in a forested, sparsely populated area in Sweden. *Int. J. Herit. Stud.* **2009**, *15*, 540–559. [CrossRef]