STUDY ON SPATIAL DISTRIBUTION CHARACTERISTICS AND INFLUENCING FACTORS OF TRADITIONAL VILLAGES IN ZHANJIANG CITY BASED ON GIS

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ABSTRACT

Traditional villages are not only the biggest legacy left by agricultural civilization, but also the most historic and precious source of Chinese culture. However, with the acceleration of modernization and urbanization, traditional villages disappear at the rate of 100 every day, which has a great impact on China's traditional villages. Therefore, from the perspective of regional research of human geography, this paper uses Arc GIS technology and takes Zhanjiang City as an example to explore its spatial distribution characteristics and influencing factors, in order to provide research thinking and reference for the protection of traditional villages in Zhanjiang City. It is found that the distribution type of traditional villages in Zhanjiang is agglomerative, the distribution structure is unbalanced, concentrated in Leizhou City and Suixi County, and the distribution density is low. The main factors affecting its distribution are historical and cultural factors.

KEYWORDS: Traditional Villages; Geographic Information System (GIS）; Space Distribution; Zhanjiang City.

INTRODUCTION

According to the archaeological and confirmed findings of scholars on the origin of human agriculture, around 7000BC, agriculture and settlement in many parts of the world appeared at the same time in four major regions[i], and China was one of them. As a country with a long history of farming and farming culture, China has accumulated a rich and diverse agricultural cultural heritage for thousands of years[ii].Rural settlements, which arose at the same time as agricultural civilizations, are the places where agricultural producers lived together to work and multiply.

However, with industrialization and urbanizationrapidly developing in modern times, a large number of people have flowed out in rural areas, resulting in a serious "rural culture" fault phenomenon brought about by the hollowing out of rural areas. In addition, villagers in some backward areas have a weak awareness to protect the traditional buildings, and most of the modern built in the countryside are incompatible with the architecture of local traditional cultural characteristics. As a result, a lot of traditional houses with cultural imprints and great historical value have been quickly submerged by the same reinforced concrete buildings[iii].

Feng Jicai, chairman of the China Folk Writers Association, vigorously promoted the rescue project of Chinese folk cultural heritage and ancient villages in 2003. At that time, China was in the initial stages of urbanization, but the traditional villages were fading out at a rate of 100 per day, an unbelievable rate[iv]. Traditional villages, as carriers of cultural inheritance, develop in parallel with the modernization of life, so they urgently need to be protected. To this end, the Ministry of Housing and Urban-Rural Development, the Ministry of Culture, and the Ministry of Finance have been conducting a nationwide census of traditional villages since 2012[v].

With the proposal of the national "Rural Revitalization Strategy" and the awakening of people's awareness of traditional culture protection, Chinese scholars have also carried out a lot of research on traditional villages. The research content focuses on spatial distribution, restoration and protection, tourism development, and value mining; the research methods mainly use GIS analysis technology, spatial syntax, and information digitization. The research scale ranged from the large and medium scales of the whole country[13, 14], the local area [3-8], the urban area [15-22], and the micro scale of the village case study [23].However, at present, scholars' research on traditional villages in Guangdong Province is mainly concentrated in areas with more dense distribution of traditional villages in eastern Guangdong and the Pearl River Basin.

Thus, this paper aims to takes 12 traditional villages of Zhanjiang City as the study object and ArcGIS software as the means to analyze the spatial distribution characteristics and influencing factors of the traditional villages, Zhanjiang City by the methods such as kernel density analysis, the nearest neighbor index, the imbalance index, and the geographical concentration index etc., in order to provide a reference perspective for the protection and development of traditional villages and tourism development in Zhanjiang City.

STUDY AREA AND METHODS

Study Area

Zhanjiang City is located between 109°40′E~110°58′E and 20°13′N~21°57′N.It is bordered by the South China Sea to the east, the Qiongzhou Strait and Hainan Province to the south, the Beibu Bay to the west, the Maonan District of Maoming City of Guangdong Province, Dianba, and Huazhou Counties to the northeast, and near to the northwest is hepu, Bobai, and Luchuan counties of Guangxi Zhuang Autonomous Region. It is a prefecture-level city under the jurisdiction of Guangdong Province, located in the southern end of mainland China and southwest of Guangdong, with a tropical monsoon climate. It has a total area of 13,263 square kilometers, under the jurisdiction of 4 municipal districts (Chikan, Xiashan, Potou, and Mazhang District) two counties (Suixiand Xuwen County), escrow 3 county-level cities (Lianjiang, Leizhou, and Wuchuan City) (shown as Figure 1).
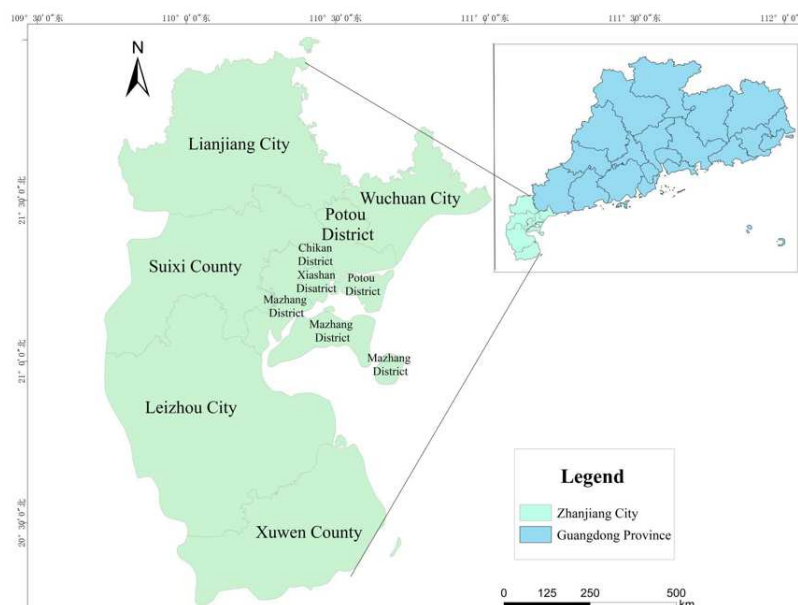

Figure 1 Study Area of Zhanjiang City.

Zhanjiang is located in a low latitude area, belongs to the tropical monsoon climate, rain and heat at the same time. Due to being surrounded by the sea on three sides, it is regulated by the marine climate all year round, there is no severe cold in winter, no heat in summer, and the average annual temperature is around 22.7 °C ~ 23.5 °C, which increases from north to south. The average annual rainfall is 1395.5~1723.1 mm, and the frontal rain band landed in southeast China from April to September, and Zhanjiang City was affected by the rainy season, with the most rainfall in August.

From October to March of the following year, the rain belt withdrew from mainland China, and the amount of rainfall was relatively small. Affected by factors such as terrain, longitude and latitude, Leizhou Peninsula which is northeast-southwest direction is vulnerable to typhoons, so typhoon disasters in Zhanjiang City are frequent.

As a city surrounded by the sea on three sides, Zhanjiang has a relatively broken coastline, and its land is mainly composed of peninsulas and islands, and the overall terrain is undulating and gentle. The topography is roughly high on the south and low in the north, and the coastal edge is low, mostly plains and mesa[vi].

Zhanjiang city has a dense network of inland rivers, but most of them are small streams and rivers with short sources, small water volumes, and small catchment areas. Precipitation is unevenly distributed in time and space, because the terrain is mostly plain and the topography is relatively gentle, thus not only is it difficult for the air flow to stagnate in the Leizhou Peninsula, but to concentrate on vapor here. Therefore, the precipitation of the Leizhou Peninsula in many years is significantly less than that of its area.

Methodology

Study Objects

- Traditional villages: villages in this paper indicate those which were formed earlier, not only have rich natural and cultural resources, but have certain historical, cultural, scientific, artistic, economic and social values, and should be protected. Ancient villages were their original name, in order to highlight its historical and cultural value and the significance of inheritance, so they were renamed as traditional villages after the first meeting of the Expert Committee on the Protection and Development of Traditional Villages in 2012.Their cultural connotations are mainly reflected in three aspects:① The existing traditional architectural style is complete;② Village site selection and pattern maintain traditional characteristics;③ The living inheritance of intangible cultural heritage[vii].

- A historical and cultural village: It is a legal concept that belongs to a traditional village. Because of its great historical values or revolutionary commemorative significance, it was given a specific legal status by the state and received more compulsory protection.

According to the definition of above, the study objects of this paper are mainly concentrate on traditional villages (national level), excluding historical and cultural villages.

Data Sources

The research data used in this study includes the list of traditional villages, the longitude and latitude of places, vector layers and DEM data. The information on the list of traditional villages comes from the official website of the Ministry of Housing and Urban-Rural Development and the Department of Housing and Urban-Rural Development of Guangdong

Province. The latitude and longitude of the geographical coordinates of traditional villages are obtained through the Query of Baidu Pick Coordinate System. The vector map of Zhanjiang's administrative division boundaries is derived from the planning cloud website. Zhanjiang DEM data is derived from the geospatial data cloud website.

Study Methods

- **Nearest Neighbor Index Method**

The nearest neighbor index method (also known as nearest neighbor distance method) is a geographical indicator that describes the proximity of point-like things in geographic space by calculating the distance between the two nearest points of each point-like feature in a certain area[viii]. Its calculation method can be divided into the following two steps:

$$\overline{r}_e = \frac{1}{2\sqrt{n/A}} = \frac{1}{2\sqrt{D}}$$

$$R = \frac{\overline{r}_1}{\overline{r}_e} = 2\sqrt{D} \bullet \overline{r}_1$$

In the formula, $\overline{r}_E$ is the theoretical nearest distance, is the actual r_1 nearest distance, A is the area of the area, n is the number of study objects, and D is the density of the study object in the spatial distribution.

When R=1, it means that the dot-like elements are randomly distributed;

When R >1, it indicates that the dotted elements tend to be evenly distributed;

When R <1, it indicates that the dot-like elements are cohesive.

- **Geographical Concentration Index Method**

The geographic concentration index is an index that describes the degree of distribution concentration of point-like features in a certain area, which can reveal the basic pattern of the spatial distribution of research objects in different regions. Its calculation formula is expressed as follows:

$$G = 100\% \times \sqrt{\sum_{i=1}^{n}\left(\frac{X_i}{T}\right)2}$$

n is the total number of jurisdictional cities (districts, counties) in the study area, Xi is the number of study subjects in the ith county (city, district), and T is the total number of study subjects. The G value is between 0 and 100, and the closer the G value is to 100, the more concentrated the distribution.

- **Imbalance Index Method**

The imbalance index method measures the spatial distribution of villages at different administrative levels or geographical divisions. This paper, selected the centralized exponential model of the Lorentz curve to analyze the equilibrium degree of the village distribution:

Study on Spatial Distribution Characteristics and Influencing Factors of Traditional
Villages in Zhanjiang City Based on GIS

15

$$S = \frac{\sum_{i=1}^{n} Y_i - 50(n+)}{100n - 50(n+1)}$$

S is the imbalance index, n is the number of study areas, and Yi is the cumulative percentage of the number of traditional villages in the study area to the total number of villages in the city, sorted from largest to smallest.

- **Kernel Density Analysis**

The distribution density of geographical phenomena is often described as the degree of agglomeration of geographical data distribution. Kernel density analysis can be used to calculate the unit density of point and line feature measurements within a specified neighborhood, visually reflecting the agglomeration of study subjects within a continuous area. Its calculation formula is expressed as follows:

$$f(x) = \frac{1}{nh} \sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right)$$

f (x) is the kernel density value, n is the total number of counties (cities, districts) in the study area, x-xi is the distance from the valuation point x to the data point xi, and h is the bandwidth. The higher the f(x) value, the higher the distribution density of traditional villages near that point.

Study Flow Chart

At first, this study using the literature approach to collected and analyze relevant data, thus the relevant research theories and literature collection are consulted from the library, CNKI, Wanfang and other websites. Meanwhile, the GDP and population data of Zhanjiang cities (counties and districts) was collected from the "Zhanjiang 2020 Yearbook", and the imbalance index and geographical concentration index of traditional villages, Zhanjiang City was calculated by Excel and using relevant formula, combining with DEM data and image data, Zhanjiang City which was obtained from Geospatial Data Cloud website, then making Kernel density analysis, Nearest neighbor analysis, and also drawing maps of topographic, water system, population density and per capita GDP distribution through ArcGIS software (study flowchart shown as figure2).
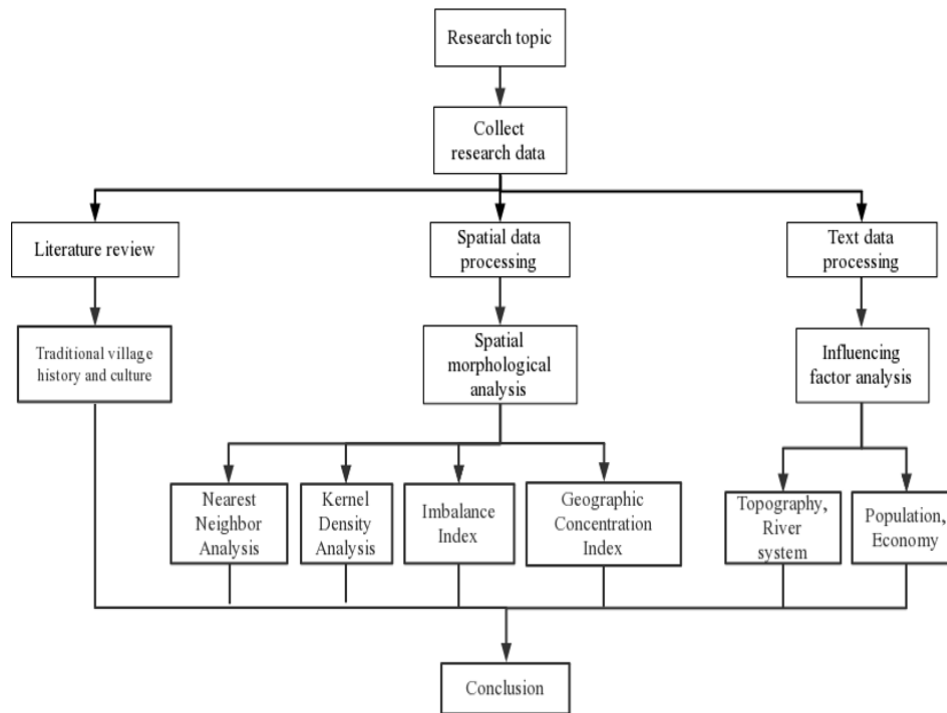
Figure 2: The Flowchart of the Study.

SPATIAL DISTRIBUTION CHARACTERISTIC ANALYSIS

Types of Spatial Distributions

This paper mainly studies the spatial distribution law of traditional village complexes in Zhanjiang from the perspective of human geography. Thus, the nearest neighbor index, which is often used in geography to analyze spatial distribution characteristics, was used to quantitatively analyze the traditional villages of Zhanjiang City. This method can reflect the spatial distribution types of point-like features in a certain area, mainly in three types: uniform, random, and cohesive.

In this paper, the nearest neighbor analysis tool in ArcGIS 10.2 is mainly used to calculate the traditional villages of Zhanjiang City, and the results are as follows: the actual value of the nearest neighbor distance is r1=13337.83, the theoretical value is r2=16622.65, and the ratio is R=r1/r2=0.8<1, so the traditional villages in the study area showed the characteristics of cohesion.

Spatial Distribution Structure

- **Geographical Concentration Index**

According to formula ③. The actual concentration index of traditional villages in Zhanjiang City is G=79, assuming that 12 villages are evenly distributed in 12 counties and urban areas. Then there is 1 traditional village in each county, and the geographical concentration index in the uniform state is $\overline{G} = 6.5$, $G > \overline{G}$ .Therefore, it can be seen that the distribution of traditional villages in Zhanjiang City is relatively concentrated.

- **Imbalance Index**

According to formula ④.The imbalance index of traditional villages in Zhanjiang City is S=1, indicating that the traditional villages are concentrated in this area of Leizhou City.

Spatial Distribution Density

According to the principle in formula⑤, the traditional villages of Zhanjiang City are abstracted into point-like elements. Analyzing the kernel density of the study object by the Spatial Analyst tool of ArcGIS10.2 and visualize the abstract spatial distribution. Designing the bandwidth value as 10km, the cell value as 1km, and the kernel density value is reclassified into 5 categories by the natural breakpoint method, and the kernel density distribution map of Zhanjiang villages is obtained (shown as Figure 3).

The traditional villages of Zhanjiang City show significant spatial agglomeration characteristics, and the area with extremely high kernel density (purple dots) is distributed in the middle of Zhanjiang City in a dotted manner, mainly located in Leizhou City and Suixi County, while the extremely low value (pink area) occupies a large area of Zhanjiang City. Judging from the distribution of Figure 3, the overall distribution pattern of the central connection and the scattered distribution of north and south is a dotted spatial distribution pattern.
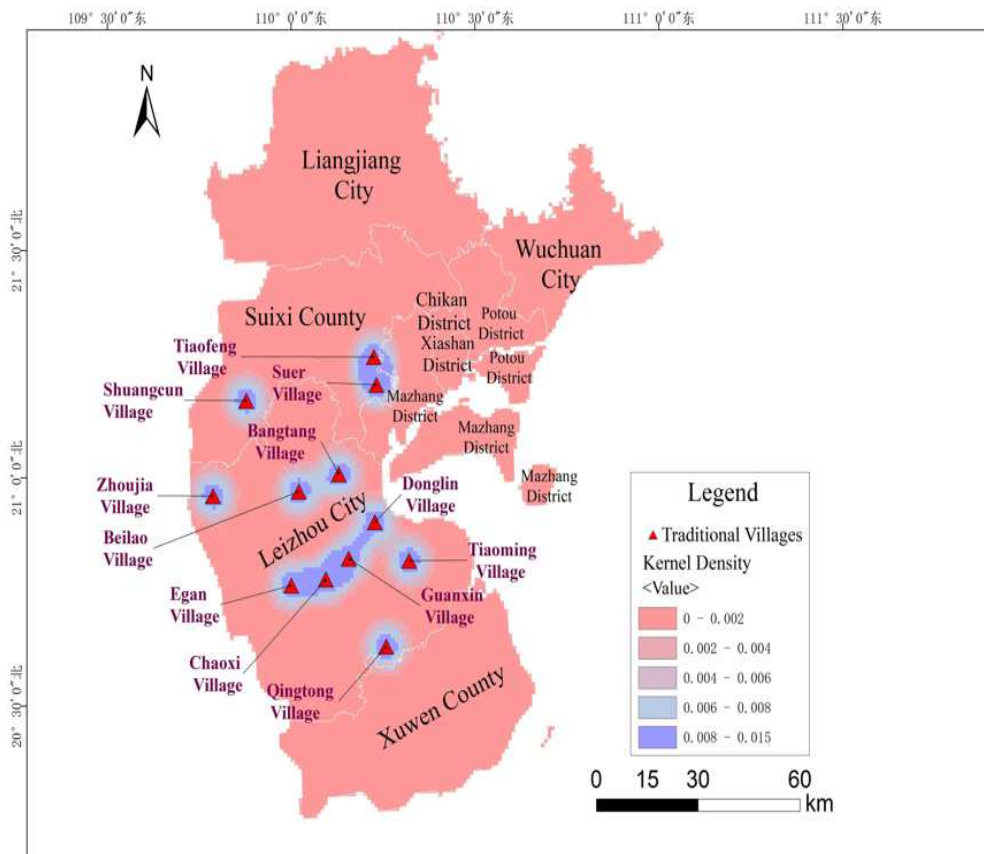

Figure 3: Kernel Density Map of Traditional Villages in Zhanjiang City.

ANALYSIS OF INFLUENCING FACTORS

Human activities have created various human phenomena on the surface of the earth, and all human life is carried out in a specific region. In this paper, the reasons for the spatial distribution of traditional villages are analyzed from the perspectives of natural factors and socio-economic (history), and the influencing factors such as altitude, terrain, rivers, population, GDP, history and culture are mainly analyzed.

Natural Environmental Factors

Topographic

Due to the relative backwardness of the productive forces, in the agricultural era, most of the production and life of human beings were limited by natural factors. The elevation of the altitude and the undulating conditions of the terrain directly affect the size and distribution of the settlement form, on the other hand, the former affects the hydrothermal combination conditions of the local area, which in turn affects the agricultural production mode of the region, and finally forms a specific historical culture under the influence of human activities. Therefore, the topographic factor of altitude is one of the important factors for studying the formation of cultural landscapes[ix].

The study area's elevation information was extracted by the surface analysis method of the spatial analysis module in ArcGIS10.2 based on the DEM with a resolution of 90m.It was reclassified into 8 categories, then superimposed with the traditional villages to obtain the elevation map of the traditional villages in Zhanjiang City.

From the picture of the topographic analysis we can recognize the Zhanjiang City has a gentle topography, as seen from Figure 4, the terrain is high in the south and low in the north, and the southern area is mainly the basalt plateau, and the highest stone ridge in the area is distributed on the terrace. The central and western regions and the north are mostly shore terrace with slopes below 5 °, with low-lying valleys among the slopes, which are suitable for cultivation; the central and eastern parts are alluvial plains and marine plains, which are the largest plains in the city, and most of the traditional villages are located here.
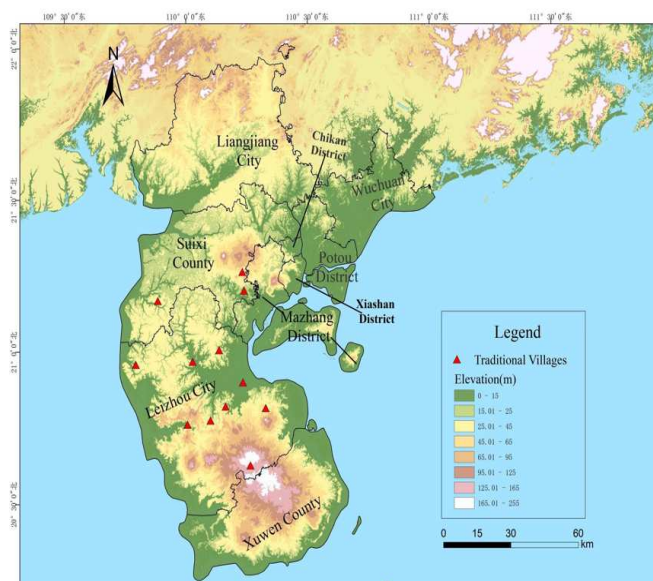

Figure 4: Topographic of Zhanjiang City.

Hydrology

Water is the source of life, and rivers, as the birthplace of human civilization, not only provide human beings with necessary living resources such as fresh water and food, but also provide natural conditions for water transportation since ancient times.

Using ArcGIS software to generate a hydrology map of Zhanjiang City, and then superimposed with traditional villages to obtain Figure 5.From Figure 5, it can be seen that Zhanjiang has a dense inland river network, but most of them are small streams or rivers with small water volume, small catchment area and short length. The Nandu River, a main water supply river in Leizhou City, originates from Pozai in Hetou Town, Suixi County, while the water system in Xuwen County is relatively weak[x]. It indicates that the mountain water resources in the Leizhou area are extremely precious.
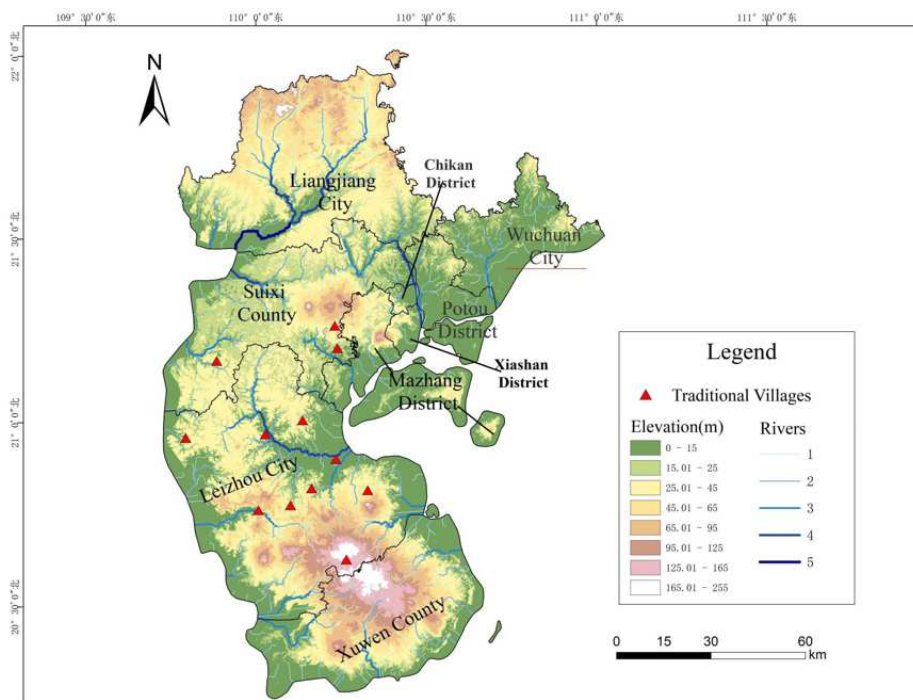


Figure 5: Hydrology of Zhanjiang City.

According to statistics, the villages in the distant mountains and far waters are distributed in various areas of the Leizhou area, while the villages in the distant mountains and near the water are concentrated on both sides of the Nandu River and its tributaries, and a small number are located on the inner side of the western coastline, relying on the excavation of ditches to introduce seawater to form river resources. Villages with mountains and rivers are the same as villages near mountains and waters, which are basically located in the area south of the central part of the Leizhou area, which should be related to the high south and low north of the terrain in the Leizhou area.

Historical and Cultural Factors

Traditional villages are one of the important types of residential settlements, and their cultural landscapes reflect the accumulation of production practices of people adapting to and transforming nature, condensing the architectural aesthetic accumulation of different cultures, and showing the community spatial relationship of specific regions. Using the remains left by the cultural landscape of the past, you can explore the development process of a place's cultural history.

In 1945, China reclaimed the territory of "Guangzhou Bay" and set up a municipal administration within its original scope, named "Zhanjiang City", when Zhanjiang City was part of the land, islands and Maxia Bay (now Zhanjiang Port) under the jurisdiction of Suixi and Wuchuan counties in the Qing Dynasty. In this study, the definition of Zhanjiang City was established in 1981 after the People's Republic of China repeatedly adjusted the jurisdiction of western Guangdong, and evolved into the territory in Figure 6 after the merger Zhanjiang City and Zhanjiang District in 1983.

Although the present-day city of Zhanjiang was not established for a long time, the history of Suixi County, Xuwen County, and Leizhou City can be traced back to the middle and late Neolithic period. During the Qin Dynasty, the territory under the jurisdiction of present-day Zhanjiang entered China as a dependency of Xiang County; during the Han Dynasty, Suixi County, Xuwen County, and Leizhou City belonged to Xuwen County, jiaotong Province, and later to Donghe Prefecture. During the Tang Dynasty, Donghe Prefecture was renamed Leizhou and ruled over the three counties of the Leizhou Peninsula until the Qing Dynasty (see figure 6 in the upper right corner)
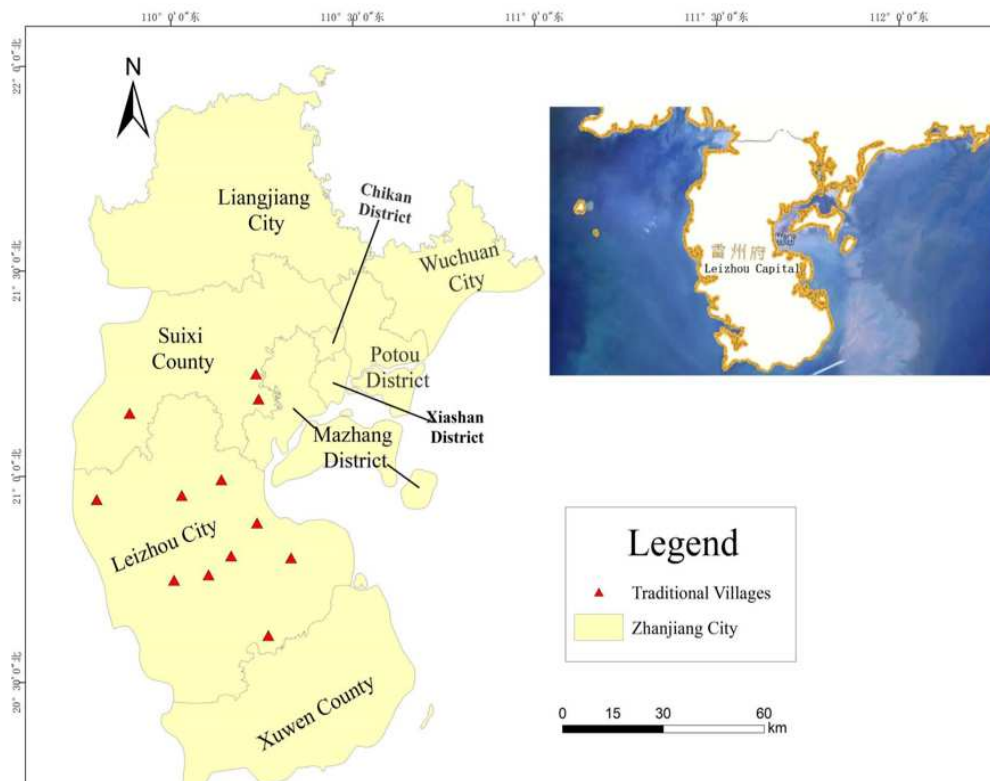
Figure 6: Comparison of the Administrative Regions of the Chinese Republic of Leizhou Peninsula to the Administrative Regions of the Qing Dynasty.

Population movement is a form of population statistics that usually involves a permanent or long-term change in the place of residence of the population from the place of emigration to the place of emigration. Large-scale population movements have led to economic development in backward areas on the one hand, and increased cultural diversity in the places of migration on the other hand. Zhanjiang has developed from the "Hundred Vietnamese Borders" to the present, after thousands of years of historical changes, and its population composition is extensive and complex. According to historical records, the population of Zhanjiang City has moved in four main times:

- The Qin Dynasty was the first time migration began with Large-Scale

- During the Han Dynasty was the second time large-scale population migration occurred.

- During the Tang and Song Dynasties was the third time a large population migration occurred.

- During the Ming and Qing Dynasties was the fourth time population migration took place.

Culture is the product of human activities, and the population migration of successive dynasties has injected diverse cultures into the Leizhou area. From the pre-Qin to the Qin and Han dynasties, the slang culture brought by the Luoyue peoples was derived here, and the basic components of "Lei culture" took shape. During the Tang and Song dynasties, the Central plains culture and Minhai culture brought by the Central Plains and Min people were integrated with the slang culture and evolved into the early Leizhou regional culture. During the Ming and Qing dynasties, the immigrants from the Guangfu area brought The Cantonese culture, and the collision and integration of diverse cultures eventually realized the integration of cultures to form a new culture- Lei culture, which also left a unique cultural landscape[10].

Socio-Economic Factors

Based on the population data at the end of 2021, the population density distribution map of Zhanjiang City was obtained by using ArcGIS data processing (shown as Figure 7).
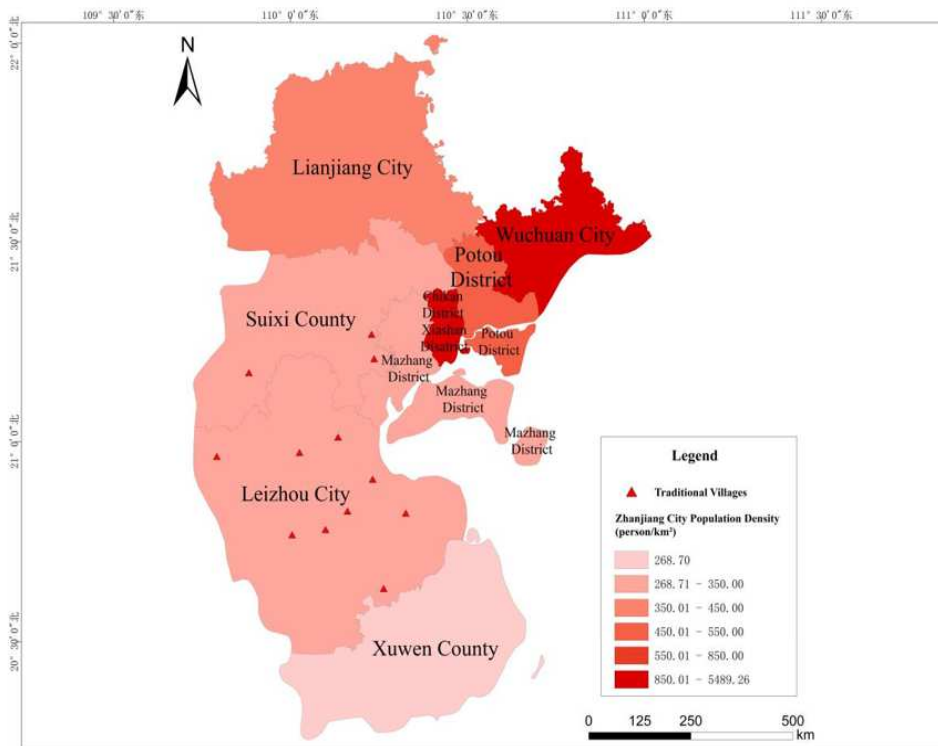
Figure 7: The Population Density of Zhanjiang City.

It can be seen that the population density distribution of Zhanjiang City shows a pattern of "more north than south". The larger population density is Chikan District, Xiashan District, Potou District, Wuchuan City, followed by Lianjiang City, Potou District, Suixi County and Leizhou City, and Xuwen County has the smallest population density. Traditional villages are mainly distributed in Suixi County and Leizhou City, which rank low in population density.

In the era of agricultural civilization, the economic development level of Zhanjiang City was low, in order to effectively use the tight land resources and strengthen foreign communication, most people chose to settle in the mountain valley with relatively abundant water sources and low terrain[xi].

The change from agricultural production theory to modern production concept reflects the re-examination of rural functions in today's society, and the rapid development of urbanization and modernization has also changed the internal mechanism of social and economic development level and the spatial distribution of traditional villages, and the link between the spatial layout of traditional villages and the direction of social development has been broken[xii].

From Zhanjiang Year book data (shown as Table 1), it can be seen that the traditional villages in Zhanjiang are mostly distributed in areas with medium economic development levels, and there are 3 traditional villages in Suixi County which ranks third per capita in 2020, and 9 traditional villages in Leizhou City which ranks fifth in the region.

Table 1: Total GDP of Zhanjiang Municipal Administrative Districts in 2020

City/ District/ County	Number of villages /piece	GDP		GDP per capita		Theurbanization rate term	
		Amount/ Ten thousand yuan	Rank	Million yuan	Rank	Index	Rank
Chikan District	0	325240	6	0.84	2	97.82	1
Xiashan District	0	401540	2	0.76	3	95.05	2
Potou District	0	334000	4	0.99	1	43.42	4
Mazhang District	0	179850	9	0.55	4	45.17	3
Suixi County	3	386770	3	0.47	5	35.11	7
Xuwen County	0	198140	8	0.31	7	37.65	6
Liangjiang City	0	483500	1	0.35	6	32.55	8
Leizhou City	9	327360	5	0.25	8	31.21	9
Wuchuan City	0	278500	7	0.31	7	42.84	5

(Data Source: Zhanjiang Yearbook)

According to Table 1 and related literature, it can be inferred that the spatial distribution of traditional villages has a significant correlation with the level of regional social and economic development, while the spatial distribution of traditional villages in Zhanjiang City has an inverse relationship with regional economic development.

CONCLUSION

This study that using the method of spatial statistical analysis through ArcGIS, analyzing the spatial distribution characteristics of 12 traditional villages in Zhanjiang City and discussing its influence factors, the results were indicated as follows.

Spatial Distribution Characteristics

The spatial distribution type of traditional villages, Zhanjiang City is condensed, and the distribution structure is concentrated distribution, and it is mainly concentrated in the valley and low area in the middle of Zhanjiang City.

Influencing Factors

- Natural environment: According to the information consulted and the analysis of ArcGIS, Zhanjiang City is located in a low-latitude area, which belongs to the subtropical monsoon climate, and it is suitable for planting rice in the same period of summer rain and heat. In addition, the overall area is less than 300 meters above sea level, and the terrain is gentle, which is conducive to crop growth and is a natural fertile field for residents to grow crops. Thus, in the agricultural era, people choosing to settle down in Leizhou Peninsula can be described as "the time is right for people and authenticity"

- Socio-economic: From the analysis of this study, it can be seen that the traditional villages of Zhanjiang City are concentrated in Suixi County and Leizhou City, where the population distribution density is small and the per capita GDP ranking is relatively low. According to literature on the distribution characteristics of traditional villages, it is indicated that most of the traditional villages are located in more backward areas. Perhaps due to the reason of backward economy and the slower urbanization process, the traditional villages have been better protected and have not been quickly overwhelmed by reinforced concrete.

- History and culture: "Lei culture" is a representative of the history and culture of Zhanjiang City, and its evolution process can be traced back to the Neolithic Era, which has undergone thousands of years of evolution from the Qin Dynasty to the Qing Dynasty. With the change of four large-scale population migrations, the cultural landscape of Leizhou has undergone the promotion process of three leading cultures "Slang Culture - Fujian Culture - Guangfu Culture". Chinese culture mainly originated in the Yellow River Basin (that is, the Central Plains), very far from the Leizhou Peninsula. Although the Lei culture can be traced back to the Neolithic Period, the Qin, Han and Tang Dynasties were constantly in war, economic backwardness, small settlements are difficult to develop into traditional villages that have been passed down to this day. Thus, most of the traditional villages that are classified as state-level villages today are preserved during the Ming Dynasty when most of the Min immigrants moved, and it can be verified that history and culture are one of the main factors affecting their distribution.

Human-environment relationships are the core content of human geography research, and the pattern of traditional villages, Zhanjiang City being concentrated in Leizhou City fully reflects the results of the interaction between human activities and the natural environment. The Zhanjiang City's traditional villages are not only the spatial expression form of Leizhou culture, but also the witnesses in the evolution of Chinese culture, and the cultural landscape printed with historical traces needs the protection of every citizen.

However, besides the above study results, all elements of the landscape reflect culture, and in this sense all elements are equally important [1]. Due to the lack of relevant data sources, this study still has a lot of work that needs to be completed. Here only analyzes the spatial layout of traditional villages in Zhanjiang City, and the evaluation factors are not comprehensive enough, and the influencing factors such as slope and aspect are also lacking. In the near future, the internal morphological characteristics of traditional villages have to be analyzed, and more in-depth research on each detail is needed, such as the micro level of architectural layout. Meanwhile, we can also use questionnaire surveys, visits and other methods to collect data and deeply analyze the historical and cultural factors affecting the distribution of traditional villages in Zhanjiang, so as to better understand the reasons which affect the distribution of traditional villages Zhanjiang City, and provide a reference for the protection of traditional villages in Zhanjiang City.

ACKNOWLEDGEMENTS

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