

Analysis of spatial distribution and influencing factors of characteristic towns in Guangxi based on ArcGIS

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Abstract: *The spatial distribution of characteristic towns presents obvious regional characteristics. Exploring the regional characteristics of characteristic towns provides a theoretical basis for optimizing the spatial development pattern and achieving coordinated regional development. This article is based on the data of 62 characteristic towns in Guangxi Zhuang Autonomous Region, and uses ARCGIS average nearest neighbor index, Voronoi map, geographic concentration index, and kernel density analysis to conduct a study on the spatial distribution pattern and influencing factors of characteristic towns. The results show that the distribution of characteristic towns in Guangxi is uneven, showing a distribution pattern with different models, but in a concentrated distribution trend, with a greater number in northern Guangxi than in southern Guangxi, among them, there are many and scattered characteristic towns in the northern Guangxi region, and the degree of cohesion is not high, showing a phenomenon of clustering from northwest to southeast as a whole. The spatial distribution of characteristic towns is influenced by factors such as characteristic industries, terrain, transportation network, and tourism resources. Therefore, it is necessary to explore industrial characteristics, improve transportation network, and pay attention to ecological civilization, in order to optimize the spatial distribution pattern of characteristic towns in Guangxi.*

Keywords: *spatial distribution; Influencing factors; Characteristic towns; ArcGIS*

1. Introduction

The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China proposed to optimize the spatial layout of national territory, promote regional coordinated development, and promote new urbanization. As an important approach to the construction of new urbanization, characteristic towns play an important role in connecting cities and rural areas. The "Proposal of the Central Committee of the Communist Party of China on Formulating the 14th Five Year Plan for National Economic and Social Development and the Long Range Objectives for 2035" (hereinafter referred to as the "14th Five Year Plan") clearly states that we must adhere to the path of new urbanization with Chinese characteristics, deeply promote the strategy of new urbanization centered on people, and continuously improve the spatial layout of urbanization. Cultivating characteristic towns is beneficial for accelerating the transformation and upgrading of industrial structure, promoting the improvement and extension of industrial chain, better promoting supply side structural reform, and driving local economic development; On the other hand, a new path to promote regional economic development and new urbanization construction is a new development trend to promote rural revitalization in the context of the new era. In July 2016, the Ministry of Housing and Urban Rural Development, the National Development and Reform Commission, and the Ministry of Finance jointly issued a notice on the cultivation of small towns, leading and driving the construction of small towns nationwide. Guangxi actively responds to and accelerates the cultivation of characteristic towns, issuing the "Implementation Opinions on Cultivating Guangxi Characteristic Towns", which clearly points out the overall requirements and main tasks of cultivating characteristic towns in Guangxi. We will continue to use characteristic towns as carriers, cultivate characteristic industries, strengthen characteristic advantageous enterprises, enhance endogenous development momentum, and promote the overall improvement of the development level of small towns in the entire region. In April 2018 and December 2019, based on recommendations from local governments, the first batch of 45 and the second batch of 17 characteristic town cultivation lists were determined through on-site research, expert evaluation, and publicity.

At present, research on characteristic towns in China focuses on three aspects: firstly, studying the connotation of characteristic towns. There are studies that suggest that characteristic towns are neither administrative or traditional industrial parks (Hu Yakun et al., 2021).^[1] Their core purpose is to cultivate and develop leading characteristic industries, attract advanced elements such as talent, technology, and capital to gather (Zou Hui, 2020).^[2] Secondly, analyze the problems in the development of characteristic towns and propose new cultivation models. Research has shown that under the rapid development of characteristic towns, there have been many chaotic phenomena, such as homogenization of resource endowment dependence, blurred value function positioning, and incomplete industrial chain construction, which have gradually emerged (Liu Qingwen and Zhu Linan, 2021)^[3]. Thirdly, conduct research on typical regional characteristic towns or individual types. The research area mainly focuses on developed regions such as Jiangsu Province and Zhejiang Province (Zeng Zhihong et al., 2021)^[4], and analyzes the current development status and new directions of "sports characteristic towns" (Liu Jiwei, 2021; Yu Hao and Yu Hewen, 2021)^{[5][6]} and "characteristic tourism industry" (Li Bohua et al., 2021)^[7]. Although there are more and more research results on Chinese characteristic towns, existing spatial scale research is limited to national scale, a specific province, or a specific characteristic town. Analyzing the spatial pattern and main influencing factors of characteristic towns in remote mountainous areas of Guangxi is even rarer. Based on this, this study uses ArcGIS10.7 software, uses spatial natural breakpoint method, average nearest neighbor index, Tyson polygon, geographic concentration index, and kernel density analysis method to analyze the spatial distribution types and balance of Guangxi characteristic towns, and analyzes the main influencing factors of their spatial distribution pattern. In order to optimize the spatial development pattern of Guangxi characteristic towns and leverage regional resource advantages, provide theoretical basis for achieving regional coordinated development.

2. Research Area and Data Source

2.1. Overview of the research area

The total land area of Guangxi Zhuang Autonomous Region is 237600 square kilometers, accounting for 2.5% of the total land area in China. At the same time, Guangxi has extremely rich tourism resources and many high-quality natural landscape and cultural landscapes. It is famous for "green mountains, beautiful water, strange caves and beautiful rocks", providing unique natural environment resources for the construction of characteristic towns. Guangxi is a multi-ethnic region with a minority population accounting for 37.18% of the total population, ranking first in the country. It has rich and diverse ethnic cultural characteristics and ethnic tourism products, providing rich cultural and environmental resources for the creation of characteristic towns.

2.2. Research Data Sources

The research sample comes from the list of two batches of characteristic towns published by the Ministry of Housing and Urban Rural Development of Guangxi Zhuang Autonomous Region in April 2018 and December 2019, totaling 62. The basic geographic information data of Guangxi, such as maps, transportation routes, and elevation DEM data, are all from the Resource and Environmental Science and Data Center; The list of 5A and 4A tourist attraction was obtained through the Ministry of Culture and Tourism of Guangxi Zhuang Autonomous Region; Featured towns and tourist attraction use Baidu API to locate longitude and latitude, form point data and show them on the map.

3. Analysis of spatial distribution characteristics of characteristic towns in Guangxi

3.1. Overview of spatial distribution

From a municipal perspective, characteristic towns are distributed in all 14 prefecture level cities in Guangxi, but their concentration varies. From a micro perspective, Guilin has the largest number of characteristic towns and ranks first; Laibin City, Wuzhou City, and Fangchenggang City have the least number of characteristic towns, only 2. From a macro perspective, the distribution of characteristic towns in various states and cities is uneven, but they also exhibit clustering characteristics in certain regions; The number of characteristic towns in northern Guangxi is relatively large, above the average; The characteristic towns in the southern Guangxi region are characterized by a relatively small number on both sides, while in the central areas of Guigang City, Yulin City, and Beihai City, there are

relatively more characteristic towns.

3.2. Spatial distribution types

3.2.1. Spatial distribution measure based on average nearest neighbor index

The average nearest neighbor index describes the average distance between point like elements and their nearest neighbors in space, which can characterize the spatial clustering status of measured points and determine their spatial distribution types. The specific formula is as follows:

$$ANN = \frac{\bar{D}_0}{\bar{D}_E} \quad (1)$$

$$\bar{D}_0 = \frac{1}{n} \sum_{i=1}^n d_i \quad (2)$$

$$\bar{D}_E = \frac{0.5}{\sqrt{n/A}} \quad (3)$$

When, the spatial distribution type of point like features is random type; When, it is condensed; When, it tends to be uniformly distributed.

By using the average nearest neighbor distance tool of ArcGIS10.7 software to calculate the average nearest neighbor ratio of point data in characteristic towns in Guangxi, it can be concluded that the observed average distance is slightly greater than the expected average distance, approximately equal to 1; Meanwhile, given a score of 0.2641, this pattern does not seem to differ significantly from the random pattern. Therefore, it can be considered that the spatial distribution type of characteristic towns in Guangxi is random.

3.2.2. Spatial distribution measure based on Voronoi diagram

In order to avoid the inability of the nearest point index to accurately reflect the spatial distribution of things when measuring the spatial distribution of point elements, Voronoi diagrams are further used for spatial distribution measurement, in order to obtain a relatively accurate spatial distribution form of characteristic towns in Guangxi. The basic idea is to partition a spatial plane with only one resource point within each polygon, and the area where the point is located is the closest set to that point. In the Voronoi diagram, the calculation formula for the coefficient of variation CV of its area is:

$$CV \text{ value} = \text{standard deviation of polygon area} / \text{average polygon area} * 100\%$$

Generally, when the area variation coefficient CV of the Voronoi plot is between 33% and 64%. According to Duyckaerts' research results, when point clusters are uniformly distributed, $CV \leq 33\%$; When randomly distributed, $33\% < CV < 63\%$; When distributed in clusters, $CV \geq 64\%$.

Using the ArcGIS10.7 spatial statistical tool module, a Voronoi map of a characteristic small town in Guangxi was obtained. Each characteristic small town divided the target area into 62 polygons, with an average polygon area of 4557.89 square kilometers and a standard deviation of 2938.67 square kilometers. The coefficient of variation calculated using the CV formula was 64.47%, slightly greater than 64%. The 62 point like elements are condensed and distributed in the geographical spatial dimension, but the degree of agglomeration is not high, and the overall phenomenon shows aggregation from northwest to southeast.

3.3. Spatial distribution balance

Due to the fact that the average nearest neighbor index and Voronoi can only reflect the overall distribution type of characteristic towns in Guangxi, it is not possible to distinguish the distribution balance at the spatial scale of the city. Therefore, this article uses the geographic concentration index to analyze the spatial balance of characteristic towns in Guangxi. The geographic concentration index is an important indicator that reflects the degree of concentration of point data in spatial distribution, and the formula is as follows:

$$G = 100 \times \sqrt{\frac{\sum_{i=1}^n (P_i/Q)^2}{n}} \quad (4)$$

The numerical range of is between 0 and 100, and the closer it approaches 100, the more concentrated the distribution of characteristic towns; On the contrary, the farther away from 100, the more dispersed the distribution of characteristic towns. If the geographical concentration index of 62

characteristic towns in Guangxi is evenly distributed in various cities, and the actual geographical concentration index obtained is, the actual geographical concentration index is slightly higher than the geographical concentration index of the average distribution. Furthermore, based on statistical data, the Lorentz curve is generated. The Lorentz curve is relatively close to the uniform distribution line and has a small protrusion arc, indicating a more balanced distribution within each municipality. Among them, the total proportion of characteristic small towns in five prefecture level cities, Guilin, Yulin, Baise, Beihai, and Guigang, reached 48.3%, indicating that the distribution of characteristic small towns in Guangxi at the city scale is relatively ideal and uniform, and tends to be slightly concentrated.

3.4. Spatial distribution density

The kernel density analysis method is a measure of the spatial distribution density of point like elements, which visually reflects the spatial distribution and agglomeration characteristics of characteristic towns through spatial visualization. The kernel density estimation formula is as follows:

$$f_n(x) = \frac{1}{nh} \sum_{i=1}^n k\left(\frac{x-x_i}{h}\right) \quad (5)$$

The higher the current value, the denser the distribution of characteristic towns, and the higher the probability of regional events occurring. The study used the Kernel Density tool of ArcGIS10.7 software to generate a kernel density analysis graph. From the perspective of the entire province of Guangxi, characteristic towns in Guangxi have obvious clustering characteristics, presenting a high-density core area centered in the northern part of Yulin City, and four secondary core areas centered in the southern part of Qinzhou City, the border between Hechi and Baise, the southern part of Liuzhou City, and Guilin Hezhou. They are mainly distributed in economically developed areas in the southeast of Guangxi, tourist cities in the east, and coastal areas, while characteristic towns in mountainous cities in the western region are relatively sparse. Characteristic towns are densely distributed in the southern plains and hilly areas in terms of geographical space, and are closely related to the industrial distribution of various cities, mostly distributed in areas with obvious industrial characteristics in the city.

4. Analysis of influencing factors

The characteristic town integrates production, life, and ecology, driving local economic development through the development of characteristic industries, and driving the economic development of surrounding areas through radiation effects. Since the announcement of the first batch of characteristic towns by the Ministry of Housing and Urban Rural Development in 2016, Guangxi has actively responded and selected 62 characteristic towns one after another. Under the leadership of the government, characteristic towns focus on the degree of local industrial characteristics, while also considering factors such as regional transportation conditions and natural tourism resource endowments.^[8]

4.1. Topographic and geomorphological factors

4.1.1. Elevation factors

The terrain and landforms deeply affect the spatial distribution of different characteristic towns, and can also inhibit or promote the distribution of transportation networks, tourism resources, and economic and cultural exchanges. The study utilized ArcGIS10.7 software to overlay the feature town point feature layer onto the Guangxi Elevation (DEM) layer. On the whole, Guangxi is located at the southeast edge of the Yunnan-Guizhou Plateau in the second step of China's terrain, in the west of the hills of Guangxi and Guangxi, and in the south of the Beibu Gulf. The overall terrain is high in the northwest and low in the southeast, with a northwest to southeast slope. There is a strong inverse relationship between the distribution density of characteristic towns and the altitude of the terrain. The high-altitude areas on the first staircase only have two characteristic towns, namely the Colorful Ethnic Town and the Orchid Forest Town located in Baise City. Although the regional cultural landscape is unique, the terrain is dangerous and surrounded by mountains, which is not conducive to the development of agriculture, industry, and tourism. The distribution of characteristic towns in northern Guangxi is basically in line with the mountain trend, mainly arranged in the foothills or valleys intertwined with mountains and plains. This is because flat terrain is conducive to agricultural production, industrial layout, and town construction. However, in mountainous and hilly areas, the

terrain conditions are complex and the natural environment is relatively harsh, resulting in a sparser population and relatively backward economic development level. Therefore, overall, the number of characteristic towns in the northwest is relatively small. Low altitude plains are mainly distributed in eastern, southern, and western Guangxi, presenting a large flat area with gradually dense characteristic small town elements. This area has advantages over northern Guangxi, with low and flat terrain and fertile soil, which is conducive to agricultural production. Moreover, relying on dense waterways, waterways, and land transportation lines, it is easy for cultural exchange and dissemination between regions, cultural infiltration, and regional differences are constantly narrowing, making it a good location for small towns.

4.1.2. Slope factors

Slope is an important indicator of macroscopic terrain fluctuations. Guangxi has many mountainous areas and undulating terrain, and the slope has a significant impact on the distribution of characteristic towns. The slope of the mountainous areas in the northwest of Guangxi is relatively large, mostly above 20°. The larger the slope, the greater the difficulty of town construction, and the fewer towns are distributed. From the slope map of Guangxi, it can be seen that agricultural service oriented and industrial manufacturing oriented small towns are mainly distributed in areas with smaller slopes. This is because too steep slopes are not conducive to the construction of small towns and park buildings. Most traditional villages in northern Guangxi tend to be distributed in valley plains, while traditional villages in southern Guangxi are mostly distributed on river impact plains. These areas have low and relatively flat terrain, good hydraulic resources, fertile soil, and have a positive impact on agricultural production, making them good areas for town selection. The northwest of Guangxi is close to the the Yunnan-Guizhou Plateau, with many mountains, which is not conducive to agricultural production activities. There is a higher risk of natural disasters, which is not conducive to the development of towns. Therefore, there are fewer characteristic towns in this area.^[9]

4.2. Traffic network factors

Traffic is the driving force for the formation of a city, plays a role in connecting cities, and has an extremely important impact on Urban morphology, industrial layout, and the flow of production factors. Establish buffer zones based on traffic routes with buffer radii of different scales, and use intersection tools to analyze the intersection of point to line zones, forming Guangxi characteristic towns and national road buffer zone maps, provincial road buffer zone maps, and highway buffer zone maps, respectively. Among the 62 characteristic towns, there are a total of 42 demonstration points within the 15km buffer zone of the national highway, accounting for 67.74% of the total; There are a total of 55 characteristic towns within the 40km buffer zone of the national highway, accounting for 88.71% of the total. There are a total of 40 characteristic towns within the 15km buffer zone of the provincial road, accounting for 64.52% of the total; There are a total of 60 characteristic towns within the 40km buffer zone of the provincial road, accounting for 96.77% of the total. There are a total of 32 characteristic towns within the 15km buffer zone of the expressway, accounting for 51.61% of the total; There are a total of 48 characteristic towns within the 40km buffer zone of the expressway, accounting for 77.42% of the total. From the above data, it can be seen that the spatial layout of characteristic towns in Guangxi is basically consistent with the traffic direction of national roads, provincial roads, and expressways, showing a clear clustering and parasitic pattern. This indicates that the creation of characteristic towns fully considers the influence of transportation factors, and the highway transportation location is relatively more advantageous. The terrain of Guangxi fluctuates greatly, and the construction of railway projects in mountainous areas is difficult. Therefore, transportation is mainly by road. The main transportation line in Guangxi is centered around the provincial capital city of Nanning, radiating outward in a radial manner, covering the vast majority of characteristic towns; The characteristic towns have a high spatial alignment with the transportation axis, and the closer they are to the transportation axis, the more characteristic towns there are; Relatively speaking, the farther away from the transportation axis, the fewer characteristic towns there are. This indicates that the distribution of transportation networks has a guiding role in the spatial distribution of characteristic towns in Guangxi, which often converge towards the transportation axis.

4.3. Tourism resource factors

As of December 16, 2020, the Guangxi Ministry of Culture and Tourism has announced a total of 281 5A and 4A level scenic spots, which basically cover all of Guangxi's core tourism resources. Therefore, these 281 scenic spots are selected as indicators to represent the distribution of tourism

resource endowment in Guangxi region. Using ArcGIS10.7 software, natural breakpoint analysis was conducted on point data of scenic spots. Kernel density analysis and contour analysis were used to analyze the distribution density and contour of characteristic towns and scenic spots, respectively. The distribution density and contour values were combined to form a coupling diagram. The distribution of 4A and 5A level scenic spots in Nanning, Liuzhou, and Guilin cities in Guangxi is relatively concentrated. The long coastline in the southern coastal areas of Guangxi endows Beihai with abundant marine resources, forming a highly distinctive tourist attraction with regional characteristics. The combination of contour lines between characteristic towns and scenic spots in the above regions is well coupled, indicating that the selection process of characteristic towns in these regions fully considers the distribution of tourism resources, and plays a good role in the edge effect and resource complementarity effect of scenic spots. Areas such as Baise City and Chongzuo City have abundant scenic resources, but the distribution of characteristic towns is relatively limited, indicating that there is still room for improvement in the coupling and interactive development of scenic resources and characteristic towns in these areas.

5. Conclusion

In the new economic era, the development of characteristic towns should be in line with the new development concept of innovation, coordination, green, openness, and sharing. It is necessary to explore local industrial characteristics, improve the transportation network in mountainous areas, pay attention to ecological environment protection, and further optimize the spatial distribution pattern of characteristic towns in Guangxi. In the process of promoting the development of characteristic towns in Guangxi, the spatial layout should be coordinated with the surrounding natural environment, relying on the beautiful natural environment of the autonomous region to explore, protect, and inherit regional traditional culture, applying advanced concepts (establishing the concept of protecting nature and emphasizing ecology in the construction process of characteristic towns), strengthening reform and innovation, and optimizing the spatial layout and functional positioning of small towns with institutional guarantees, creating distinctive features and obvious advantages. A beautiful town that showcases individuality and is livable and suitable for business has injected innovative impetus into urban construction and development.

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