

Article

Spatiotemporal Dynamic Analysis of A-Level Scenic Spots in Guizhou Province, China

Yuanhong Qiu ^{1,2}, Jian Yin ^{1,2,3,*}, Ting Zhang ¹, Yiming Du ¹ and Bin Zhang ^{1,2}

¹ College of Big Data Application and Economic, Guizhou University of Finance and Economics, Huaxi District, Guiyang 550025, China; yuanhongq@mail.gufe.edu.cn (Y.Q.); zhangti@mail.gufe.edu.cn (T.Z.); DuYiming@mail.gufe.edu.cn (Y.D.); gzcdbin@mail.gufe.edu.cn (B.Z.)

² Center for China Western Modernization, Guizhou University of Finance and Economics, Huaxi District, Guiyang 550025, China

³ School of Water Conservancy and Civil Engineering, Northeast Agricultural University, Xiangfang District, Harbin 150050, China

* Correspondence: jianyin@mail.gufe.edu.cn

Abstract: A-level scenic spots are a unique evaluation form of tourist attractions in China, which have an important impact on regional tourism development. Guizhou is a key tourist province in China. In recent years, the number of A-level scenic spots in Guizhou Province has been increasing, and the regional tourist economy has improved rapidly. The spatial distribution evolution characteristics and influencing factors of A-level scenic spots in Guizhou Province from 2005 to 2019 were measured using spatial data analysis methods, trend analysis methods, and geographical detector methods. The results elaborated that the number of A-level scenic spots in all counties of Guizhou Province increased, while in the south it developed slowly. From 2005 to 2019, the spatial distribution in A-level scenic spots were characterized by spatial agglomeration. The spatial distribution equilibrium degree of scenic spots in nine cities in Guizhou Province was gradually developed to reach the “relatively average” level. By 2019, the kernel density distribution of A-level scenic spots had formed the “two-axis, multi-core” layout. One axis was located in the north central part of Guizhou Province, and the other axis ran across the central part. The multi-core areas were mainly located in Nanming District, Yunyan District, Honghuagang District, and Xixiu District. From 2005 to 2007, the standard deviation ellipses of the scenic spots distribution changed greatly in direction and size. After 2007, the long-axis direction of the ellipses gradually formed a southwest to northeast direction. We chose elevation, population density, river density, road network density, tourism income, and GDP as factors, to discuss the spatiotemporal evolution of the scenic spots’ distribution with coupling and attribution analysis. It was found that the river, population distribution, road network density, and the A-level scenic spots’ distribution had a relatively high coupling phenomenon. Highway network density and tourist income have a higher influence on A-level tourist resorts distribution. Finally, on account of the spatiotemporal pattern characteristics of A-level scenic spots in Guizhou Province and the detection results of influencing factors, we put forward suggestions to strengthen the development of scenic spots in southern Guizhou Province and upgrade the development model of “point-axis network surface” to the current “two-axis multi-core” pattern of tourism development. This study can explain the current situation of the spatial development of tourist attractions in Guizhou Province, formulate a regulation mechanism of tourism development, and provide a reference for decision-making to boost the high-quality development of the tourist industry.



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Keywords: A-level scenic spots; spatiotemporal evolution; trend analysis; Geodetector

1. Introduction

The planning and development of tourist attractions have become a key link to promote the growth of the local tourist economy. As the important material carrier of tourist supply, tourist scenic spots provide a material basis for the development of the regional

tourism industry. Their projection in geographical space shows the spatial attributes and mutual relations of tourist activities, which influences and promotes the development of regional tourism resources and the tourist economy [1]. In order to strengthen the quality assessment and management of tourist scenic spots, the Chinese government has formulated the A-level scenic spot planning (http://zwgk.mct.gov.cn/zfxxgkml/zcfg/gfxwj/202012/t20201204_906214.html, accessed on 16 June 2021). The grade is divided into A, AA, AAA, AAAA and AAAAA. A-level scenic spots refer to scenic spots that can receive tourists, have the functions of sightseeing and entertainment, and have a relatively complete management system. A-level scenic spots must have a visitor center, basic visitor services, tourist consultations, tourist complaints, and management of all kinds of tourist affairs within the service radius of the visitor center and the visitor center itself. The rating of the scenic spot includes eight aspects: tourist transportation (14%), sightseeing (21%), tourist safety (8%), health (14%), post and telecommunications services (3%), tourist shopping (5%), comprehensive management (19.5%), and protection of resources and environment (15.5%); the rating agency will give a score on each aspect [2]. According to the standard “Classification and Evaluation of Tourist Areas (Spots) Quality Grade” (GB/T 17775–1999), the score of “service quality and environment evaluation system”, “landscape quality evaluation system”, and “tourist opinion evaluation system”, the level of participating scenic spots is divided [2].

Guizhou Province is a distinctive mountain tourist area in Southwest China. Its unique karst landform and climate characteristics make tourist scenic spots diverse in Guizhou. In the Fourteenth Five-Year Plan for National Economic and Social Development of Guizhou Province and the Outline of the Vision of the Year 2035, it is proposed to actively promote the construction and upgrading of scenic spots [3]. Recently, owing to the booming of tourist industry in Guizhou, it is urgent to explore the development process of scenic spots, especially A-level scenic spots. The study of the scenic spots’ spatial distribution and its influencing factors plays a positive role in formulating tourism planning, promoting traffic development, and alleviating the environmental pressure caused by tourism [4,5].

At present, scholars’ studies on the evolution pattern of scenic spots mainly focus on the network of scenic spots [6], the spatio-temporal influence of scenic spots on tourists’ behavior and emotion [7,8], demand prediction [9,10], optimization of tourists’ tourism experience [11–13], landscape changes of scenic spots [14], environmental impact [15–20] and intelligent tourism [21]. Since the China Tourism Administration issued the “A-level scenic spot assessment standard” in 2002, how to rationally plan and develop the A-level scenic spots has become a hot spot for domestic scholars to study scenic spots. From the perspective of research content, it mainly focuses on the spatial planning of scenic spots [22], spatial structure and optimization [23–27], influence factors of scenic spot distribution [28–35], and so on. In terms of research methods, exploratory spatial data analysis and geographic detector were mainly applied. For example, Liu and Hao [5] researched the influencing factors of the spatial distribution evolution of scenic spots in Shanxi Province with the help of a geographic detector model. Peng and Huang [21] analyzed the popularity distribution of Beijing’s scenic spots under different temporal and weather contexts. Li and Zhang [28] systematically sorted out the spatial distribution characteristics and influencing factors of 1010 scenic spots in the Yellow River Basin, China. Tang and Sun [29] explored the spatial layout of scenic spots in Beijing–Tianjin–Hebei urban agglomeration and its influencing factors by using spatial data analysis, the Gini coefficient, and geographical detector methods. Jia and Hu [34] used the average nearest neighbor index, kernel density analysis, and geographic detector to analyze the spatial distribution evolution and the influence mechanism of A-level scenic spots in the middle reaches of the Yangtze River through exploratory spatial data analysis and geographic detector. Lu and Zhang [35] explored the spatial distribution characteristics, differentiation trend, and driving mechanisms of A-level scenic spots. From the perspective of time scale, some studies analyzed the spatial evolution characteristics of scenic spot distribution from a single time node to a continuous-time point [23–36]. From the perspective of the study region, the studies

covered the evolution of the spatial pattern of national A-level scenic spots at the national, urban agglomeration, provincial, and urban levels [23–36]. Liu and Wang [37] analyzed the spatial distribution characteristics of scenic spots in Guizhou Province, China, while they lacked research on the evolution of the spatial pattern of tourism scenic spots.

Guizhou is a province with unique tourism characteristics in China, its tourism income accounts for a very large proportion of GDP. In recent years, the number of scenic spots in Guizhou Province has developed rapidly, but the research on scenic spots in Guizhou is very lacking. The current analysis methods for scenic spots distribution contain one or more of exploratory spatial data analysis, density analysis, direction analysis, spatial coupling analysis, and influencing factor analysis, but lack comprehensive analysis. Tourism is a complex spatial process. Multi angle analysis is more conducive to the exploration of the spatiotemporal dynamic processes.

Against this backdrop, we selected the A-level scenic spots in Guizhou, established a database of A-level scenic spots from 2005 to 2019 and explored the spatiotemporal distribution characteristics and influencing factors of the A-level scenic spots in Guizhou Province, by using direction analysis, the Gini coefficient method, trend analysis, and geographical detector. The aim is to reveal the evolution of the scenic spots' distribution law, clear the driving mechanism of its spatial dynamic characteristics, and put forward suggestions for optimizing the layout of scenic spots, in order to provide decision support for the upgrading of A-level scenic spots and promoting the development of regional tourism quality of Guizhou Province.

2. Materials and Methods

2.1. Data and Area

Guizhou Province is located in the hinterland of the southwest of China, which owns 88 counties and districts (Figure 1). There have been many ethnic minorities living in Guizhou for generations, and the ethnic culture is profound. Guizhou is an important transportation hub in Southwest China, and it is a world-famous mountain tourist destination with a livable climate, good ecological environment, and tourism conditions. Affected by the South Asian monsoon, Guizhou Province has distinct dry and wet seasons. It is a typical low-latitude plateau climate, warm and humid. Due to many clouds throughout the year, it has less sunshine and more cloudy days, an obvious rainy season, abundant precipitation, and the rainy and hot periods are mostly concentrated in summer. The average annual precipitation is 682–1134 mm, and the average annual temperature is 14–16 °C [38]. By 2020, it had seven national 5A-level scenic spots, including famous scenic spots such as Huangguoshu Waterfall, Loong Palace, Zhenyuan Ancient Town, Qingyan Ancient Town, National Forest Park of Azalea, and Mount Fanjing.

The data of scenic spots mainly contained the distribution, rating, and geographical coordinates of A-level scenic spots in Guizhou Province from 2005 to 2019, and the influencing factors included tourist income, GDP, the river system, altitude, population distribution, and vegetation coverage rate. With the help of the Baidu API coordinate pickup system, particle coordinates of each scenic spot were calibrated as the spatial position of the scenic spot. Among them, A-level scenic spots in the Guizhou directory data mainly came from the culture and tourism section of the Guizhou hall official website (<http://whhly.guizhou.gov.cn/>, accessed on 16 June 2021); part of the scenic spot data was from the municipal state tourism administration network. The administrative boundaries, digital elevation, normalized difference vegetation index (NDVI), and population distribution came from the resources and environmental science and data center of the Chinese Academy of Sciences (<http://www.resdc.cn>, accessed on 16 June 2021). The river data and road data were from an open-source map website (<http://www.openstreetmap.org>, accessed on 16 June 2021); the tourism income data came from the macroeconomic database (<http://hgk.guizhou.gov.cn/index.vhtml#>, accessed on 16 June 2021).

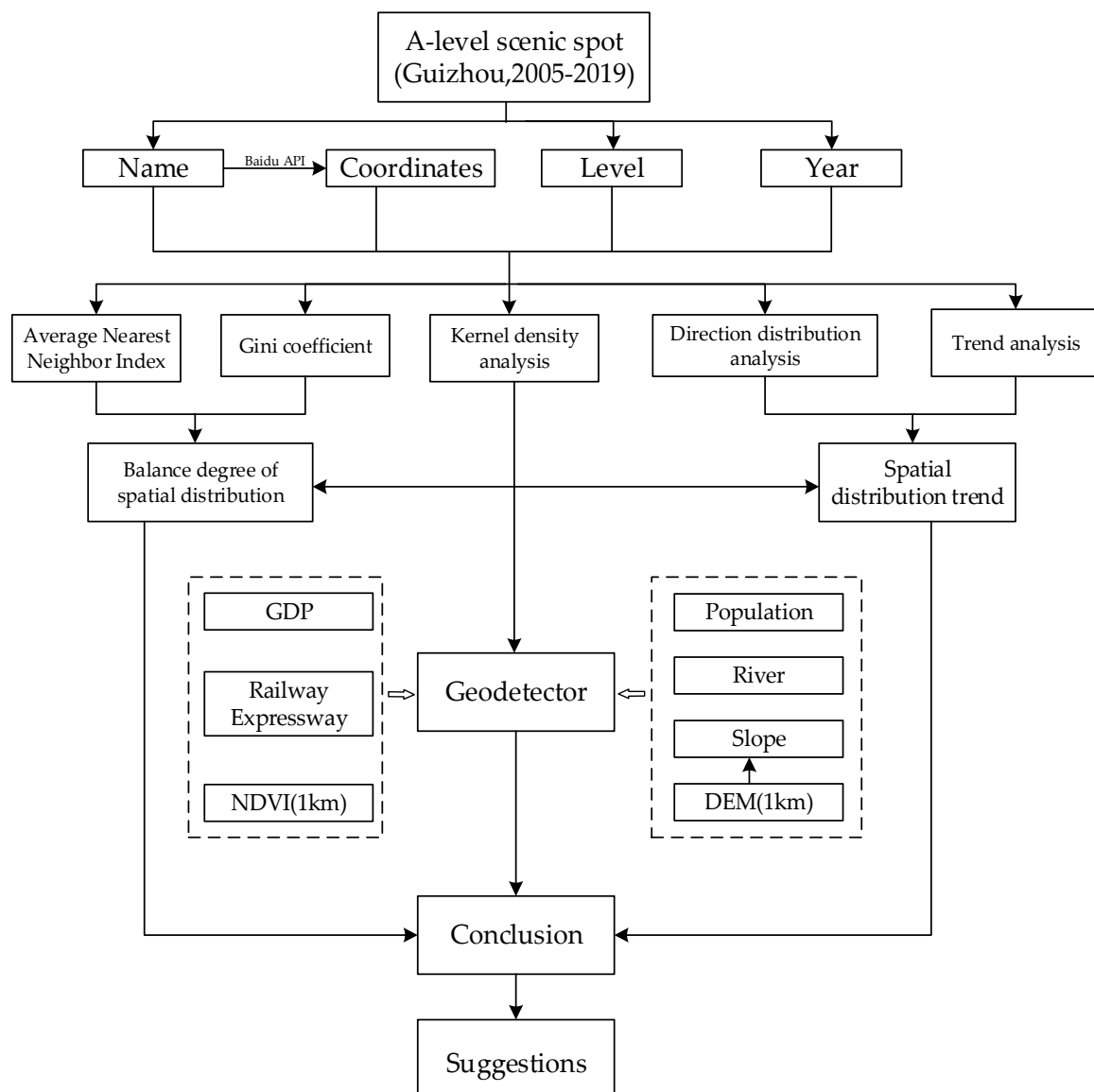


Figure 2. Workflow of the study.

2.2.2. Gini Coefficient

The Gini coefficient was originally used as a common indicator to measure regional economic income differences, and was later improved by relevant scholars and applied to the measurement of geographic spatial distribution. In this study, the Gini coefficient algorithm proposed by Zhang [39] was used to ensure the accuracy of the measurement of spatial distribution balance degree of A-level scenic spots in nine cities and states of Guizhou Province. According to Liu's paper, the Gini coefficient values of scenic spots can be divided into different equilibrium types of the spatial distribution of scenic spots [40].

$$G = 1 - \frac{\sum_{i=1}^{d=1} W_i + 1}{d} \quad (2)$$

where, d is the number of cities and state scenic spots. G is the Gini coefficient from 0 to 1, and G was also close to 1, indicating that the balance of distribution of A-level scenic spots in Guizhou Province was smaller.

2.2.3. Kernel Density Analysis

The spatial distribution density of regional elements can clearly reflect their spatial dispersion or agglomeration characteristics and the change of this form. The spatial distribution density of regional elements is usually expressed by kernel density estimation method [24–27]. Kernel density clearly reflected the spatial dispersion and agglomeration characteristics of A-level scenic spots in Guizhou Province. Then, the evolution law of its characteristics was obtained by analyzing the annual kernel density of scenic spots. The analytical formula for kernel density is

$$f_z(k) = \frac{1}{nx} \sum_{i=1}^n h\left(\frac{k - K_i}{x}\right) \quad (3)$$

where, n represents the number of sample points, $h(\)$ represents the kernel function, $x > 0$ and represents the bandwidth, and $(k - K_i)$ represents the distance from k to the event K_i . This formula was tested many times, and the data selection bandwidth was 3 km to more intuitively reflect the spatial distribution of tourism resources.

2.2.4. Direction Distribution Analysis

Direction distribution can reflect the degree of dispersion and evolution of the spatial distribution of scenic spots from time and space dimensions. The standard deviation ellipse which is a common direction distribution analysis method, was employed to reflect the spatial distribution characteristics and the spatial distribution variation of research elements [25–30]. This method can reflect spatial characteristics such as the centrality, distribution, and directionality of the spatial distribution of scenic spots in each year by using index parameters such as the center, long axis, short axis, and azimuth of the standard deviation ellipse.

2.2.5. Geodetector

The geographical detector was originally based on the geographical perspective proposed by Wang [41]. This study used the Wang's Geodetector model for calculation [42,43]. An algorithm is about detecting the spatial difference of the influence factors on the dependent variables [42–46].

$$q = 1 - \frac{\sum_{x=1}^L N_x \sigma_x^2}{N \sigma_x^2} \quad (4)$$

where, the q value represents the influence degree of each detection factor on the distribution of A-level scenic spots in Guizhou. L represents the variable stratification, that is, classification or partition; N_x and N represent the number of units in layer h and the entire area, respectively. σ^2 refers variance.

2.3. Data Preprocessing

2.3.1. Data of Scenic Spots

Based on the collected data, we built a space database containing the name, grade, counties and cities, geographic coordinates, and evaluation time of scenic spot grade in Guizhou from 2005 to 2019. Figure 3 shows the spatial distribution of A-level scenic spots in 2005, 2009, 2013, 2016, and 2019 as examples.

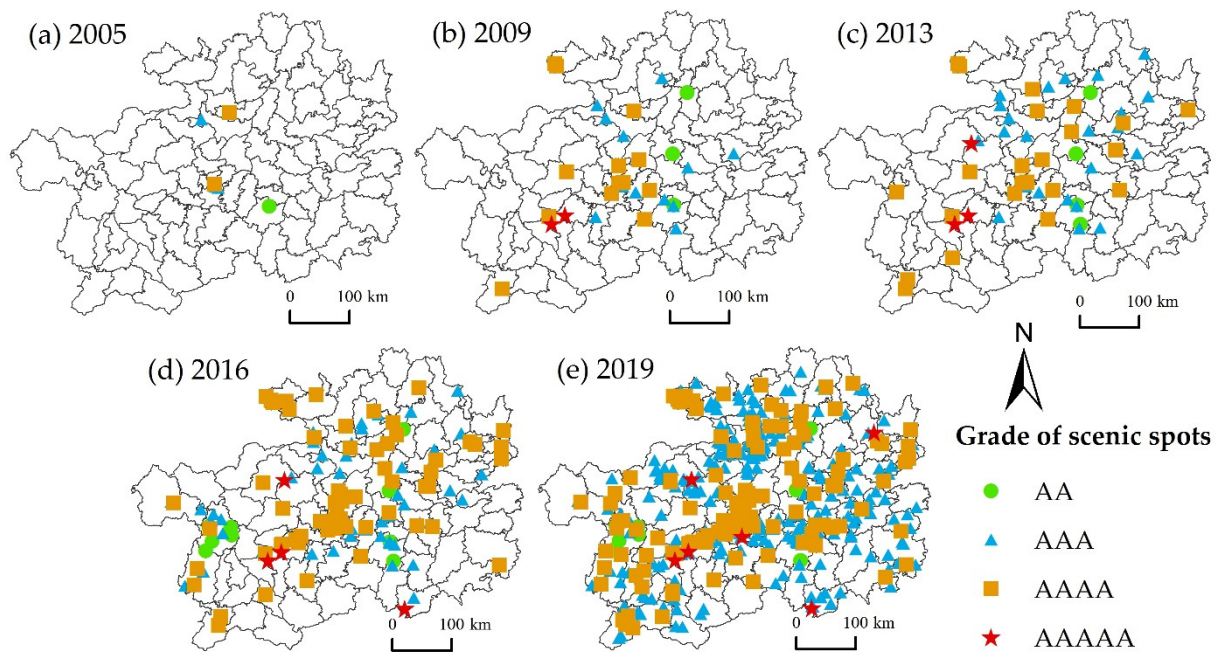


Figure 3. Spatial distribution of A-level scenic spots in Guizhou Province, (a) Spatial distribution of A-level scenic spots in 2005, (b) Spatial distribution of A-level scenic spots in 2009, (c) Spatial distribution of A-level scenic spots in 2013, (d) Spatial distribution of A-level scenic spots in 2016, (e) Spatial distribution of A-level scenic spots in 2019.

2.3.2. Geodetector Data

In the explanatory variables of the Geodetector model, tourism income and Gross Domestic Product (GDP) were the statistical data of 88 counties (districts) in Guizhou, while altitude, population density, river density, and highway network density were vector data. The kernel density of scenic spots in Guizhou Province over the years was the explained variable of the model. All data in the model were reclassified using the natural breakpoint method. Considering the long construction cycle of scenic spots, the dependent variables in the model were all data with one lag period.

3. Results

3.1. Spatial Distribution Characteristics of A-Level Scenic Spots

3.1.1. A-Level Scenic Spots Development

According to the line chart of the number of A-level scenic spots in Guizhou Province in Figure 4, the number of A-level scenic spots increased from 6 to 406 during 2005–2019. As can be seen from the line chart, the number of A-level scenic spots increased little from 2005 to 2011, and the number of scenic spots only increased by 35 in six years. From 2011 to 2015, the growth rate of the number of A-level scenic spots increased slowly. With the improvement of Guizhou's tourism policy, market, and system, the number of A-level scenic spots increased steadily. From 2016 to 2019, Guizhou Province clearly proposed to improve in the three “long boards” of big data, big ecology and big tourism. Scenic spots had “blowout” growth, the scenic spots increased, respectively, by 73, 122, and 80 in 2017, 2018, and 2019.

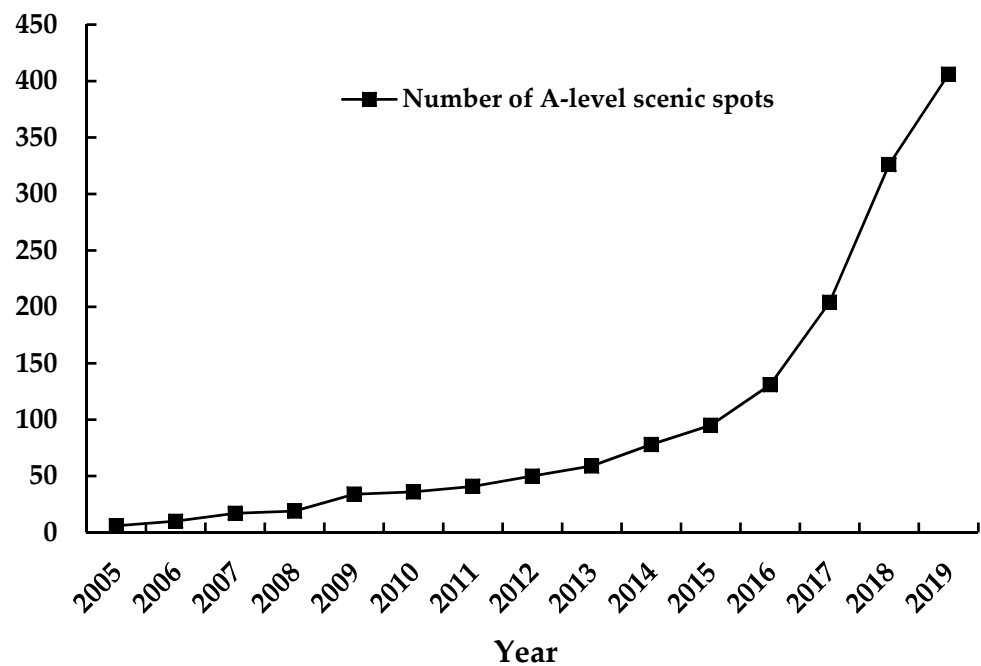


Figure 4. Changes in the number of A-level scenic spots in Guizhou Province (2005–2019).

3.1.2. Evolution of Spatial Distribution Types

Table 1 shows the analysis results of the average nearest neighbor index of A-level scenic spots in Guizhou Province over the years. p values were less than 0.05, that is, they passed the significance test in 95% of cases. From 2005 to 2019, the nearest neighbor index was less than 1, and the spatial distribution types of scenic spots were all concentrated. From 2005 to 2009, the value of the nearest neighbor index increased gradually, from 0.356 to 0.717. From 2009 to 2016, the value of the nearest neighbor index increased in an “M” shape, showing an overall upward trend. In 2012, the value of the nearest neighbor index reached the highest value of 0.854, and in 2017–2019, the value changed slightly, all around 0.81, which was relatively stable.

Table 1. The nearest neighbor index of the average spatial distribution of A-level scenic spots in Guizhou Province.

Year	Average Observation Distance (m)	Expected Mean Distance (m)	Nearest Neighbor Index	p Values	Type of Spatial Distribution
2005	30,488.682	85,675.502	0.356	0.003	agglomeration
2006	33,731.608	66,363.959	0.508	0.003	agglomeration
2007	24,046.061	50,898.833	0.472	0.000	agglomeration
2008	21,825.061	48,145.476	0.453	0.000	agglomeration
2009	25,812.507	35,990.910	0.717	0.002	agglomeration
2010	24,552.270	34,976.877	0.702	0.001	agglomeration
2011	24,341.123	32,774.823	0.743	0.002	agglomeration
2012	25,332.103	29,678.865	0.854	0.048	agglomeration
2013	22,627.417	27,321.609	0.828	0.012	agglomeration
2014	20,253.575	23,762.109	0.852	0.013	agglomeration
2015	17,576.858	21,531.311	0.816	0.001	agglomeration
2016	14,396.817	18,335.664	0.785	0.000	agglomeration
2017	11,953.753	14,693.227	0.814	0.000	agglomeration
2018	9444.529	11,623.140	0.813	0.000	agglomeration
2019	8467.087	10,415.240	0.813	0.000	agglomeration

3.1.3. Equilibrium of Spatial Distribution

Table 2 shows the calculation results of the Gini coefficient. The spatial distribution equilibrium degree of A-level scenic spots in Guizhou has changed greatly, developing towards the “relatively equality” type [40]. From 2005 to 2019, the Gini coefficient values showed a downward trend on the whole, but the coefficient values were all greater than 0.2 (below 0.2 is the “absolute equality”), with the maximum coefficient value of 0.741 in 2005 and the minimum coefficient value of 0.2 in 2017. For the A-level scenic spots, the space distribution equilibrium degree was mainly “inequality” from 2005 to 2006, the degree was “relative inequality” from 2007 to 2011, the degree was “reasonable” from 2012 to 2016, and the degree was “relative equality” after 2017. The development process of spatial distribution equilibrium degree could be divided into three periods: “great disparity—relatively reasonable—relative equality”.

Table 2. Gini coefficient calculation results of A-level scenic spots in Guizhou.

Year	The Gini Coefficient	Type of Equilibrium Degree	Year	The Gini Coefficient	Type of Equilibrium Degree
2005	0.741	Inequality	2013	0.399	Relatively reasonable
2006	0.667	Inequality	2014	0.379	Relatively reasonable
2007	0.549	Relative inequality	2015	0.386	Relatively reasonable
2008	0.573	Relative inequality	2016	0.327	Relatively reasonable
2009	0.542	Relative inequality	2017	0.215	Relative equality
2010	0.556	Relative inequality	2018	0.249	Relative equality
2011	0.493	Relative inequality	2019	0.285	Relative equality
2012	0.359	Relatively reasonable			

According to the line chart of the Gini coefficient change of grade A-level scenic spots in Guizhou Province from 2005 to 2019 (Figure 5), the Gini coefficient dropped sharply in the three years from 2005 to 2007, which indicates that the regional gap of the scenic spots’ spatial distribution balance was narrowing. From 2007 to 2011, the Gini coefficient was stable at around 0.55, and the balance of spatial distribution of scenic spots was not significantly improved. In 2012, the Gini coefficient dropped below 0.4, reaching 0.359. From 2013 to 2016, the Gini coefficient was in the range of 0.3–0.4. In 2017, the Gini coefficient dropped to the lowest level over the years, reaching 0.215. From 2018 to 2019, the Gini coefficient rose and finally stabilized at 0.285. In general, the Gini coefficient of the spatial distribution of A-level scenic spots in the nine cities and states of Guizhou Province showed a decreasing trend from 2005 to 2017 and an increasing trend from 2018 to 2019. Moreover, the Gini coefficient showed a significant decrease in 2012 and 2017. With the steady growth of the number of A-level scenic spots in Guizhou Province, the spatial distribution of the scenic spots gradually shifted from highly concentrated in 2005 to balanced development. However, due to the rapid growth of A-level scenic spots after 2012 and 2017, the spatial distribution of the scenic spots showed the characteristics of small concentration.

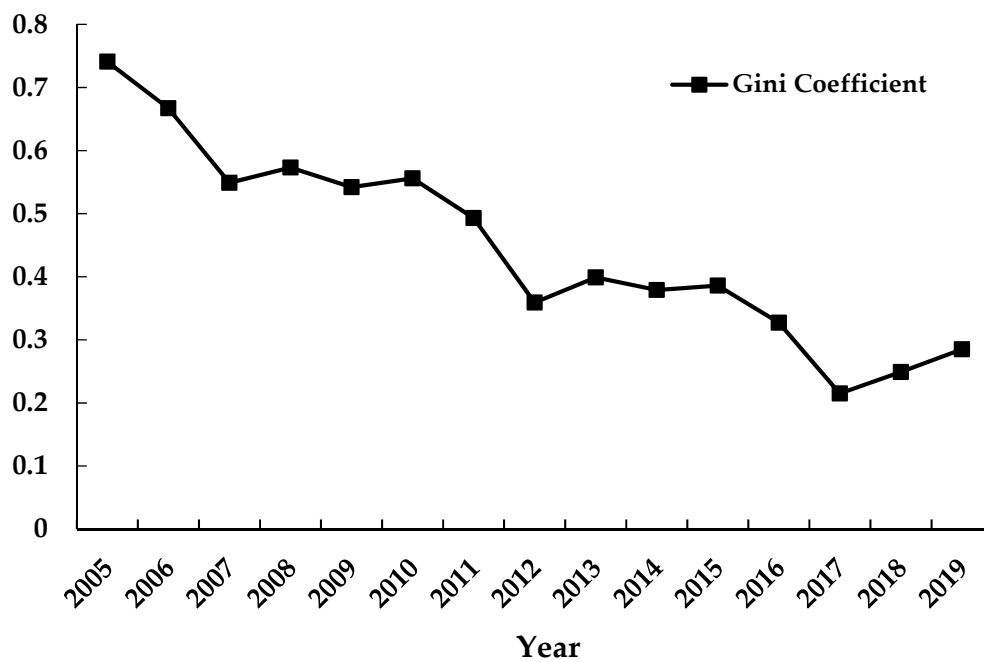


Figure 5. Change process of the Gini coefficient (2005–2019).

3.2. Spatial Distribution Evolution Processes of A-Level Scenic Spots

3.2.1. Density Change Process

The data of A-level scenic spots in Guizhou Province in 2005, 2009, 2013, 2016, and 2019 were selected for the density analysis. The density evolution of scenic spots each year was investigated to reveal the evolution law of spatial nuclear density of A-level scenic spots in Guizhou Province. The result is shown in Figure 6.

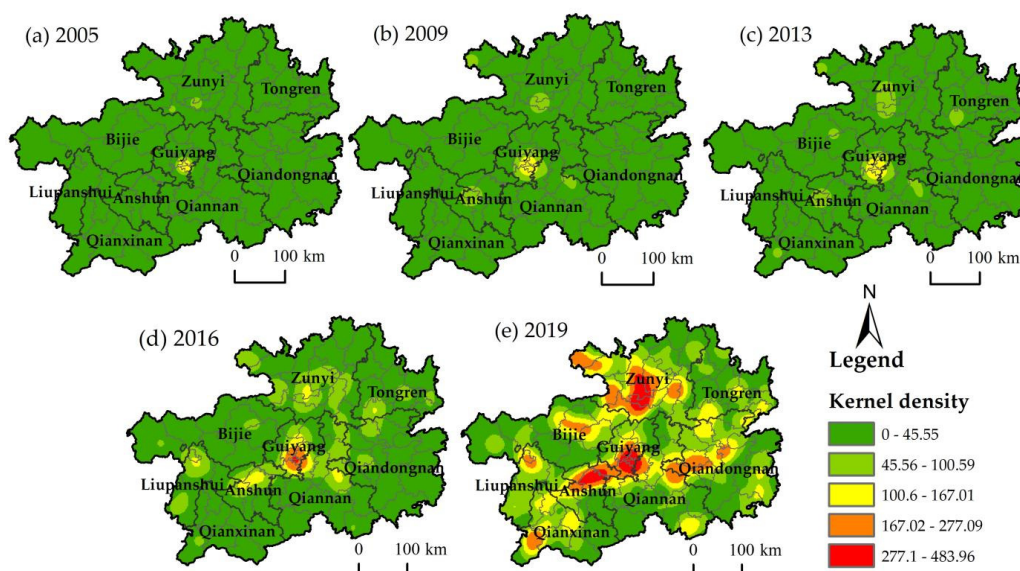


Figure 6. Kernel density map of spatial distribution of A-level scenic spots in Guizhou Province, (a) Kernel density of spatial distribution of A-level scenic spots in 2005, (b) Kernel density of spatial distribution of A-level scenic spots in 2009, (c) Kernel density of spatial distribution of A-level scenic spots in 2013, (d) Kernel density of spatial distribution of A-level scenic spots in 2016, (e) Kernel density of spatial distribution of A-level scenic spots in 2019.

According to Figure 6, the spatial distribution of A-level scenic spots in Guizhou had obvious changes in the kernel density map. In 2005, there were three high-density areas in Guizhou Province, which were located in Guiyang City, Zunyi City, and the junction of Zunyi–Bijie City, and the spatial core density of the scenic spots was relatively small on the whole. In 2009, the high-density area of A-level scenic spots was expanded. Compared with 2005, two high-density areas were added at the junction of Anshun–Liupanshui City and the junction of Qiannan Zhou–Qiandongnan Prefecture, while the high-density area at the junction of Zunyi–Bijie disappeared. In 2013, the main core density area in Guiyang City and Zunyi City was still expanding. Compared with 2009, three high-density areas were added in Bijie, Tongren, and Qianxinan Prefecture. At this time, high-density areas of scenic spots appeared in all nine cities and prefectures in Guizhou Province. In 2016, one main core area and three secondary core areas appeared, and the Zunyi, Qiannan and Anshun core areas also gradually formed. Other high-density areas expanded significantly, and the overall spatial pattern of “one axis and multiple cores” was formed. The “one axis” was located in the central part of Guizhou, spanning Anshun, Guiyang, southern Guizhou, and southeast Guizhou. By 2019, the spatial distribution of A-level scenic spots in Guizhou Province had formed the feature of “two-axis, multi-core”. One axis is located in the north of Guizhou Province, ranging from Bijie to Zunyi. The other axis crosses the middle of Guizhou, along with the distribution of “Anshun–Guiyang–Qiannan–Qiandongnan”. The core areas were mainly distributed in Liupanshui, Xingyi, Qiandongnan, and Zunyi. The southern and eastern parts of Guizhou Province are mostly low-density areas.

3.2.2. Directional Distribution

Figure 7 and Table 3, respectively, represent the standard deviation ellipse plot and its attribute table after directional distribution analysis. According to Figure 7, the overall spatial distribution of A-level scenic spots in Guizhou Province showed the obvious southwest to northeast trend. On the whole, the coverage of the ellipse tended to expand. This trend was more obvious after 2007. The standard deviation ellipses in 2005 and 2006 showed significant morphological differences compared with other years. The ellipse range of standard deviation in 2005 includes parts of Guiyang, Zunyi, Bijie, and Qiannan Prefecture. In 2019, it overlapped with some areas of all nine cities in Guizhou Province. In 2005, the standard deviation ellipse was located in the central part of Guizhou Province, its main axis was in the north–south direction, which indicated that the scenic spot expanded and developed more greatly in the north–south direction than in the southeast and northwest directions. In 2006, the shape of the standard deviation ellipse was close to the circle, which indicated that the expansion and development direction of the scenic spot was relatively uniform. From 2017 to 2019, the ellipse centered on Guiyang, the capital of Guizhou Province, and expanded mainly along the east–west direction. According to the migration map of the ellipse center (Figure 7), the migration scope of the center was small from 2005 to 2019, and the centers were almost located in Guiyang.

According to the structure calculated in Table 3, the standard deviation ellipse area increased significantly in 2006, 2007, and 2009. The standard deviation ellipse area in 2006 increased by 132.27% compared with that in 2005, 21.16% compared with that in 2006, and 34.49% compared with that in 2008. From 2005 to 2019, the standard deviation ellipse area increased year by year, except that there was no change in 2011. The minimum standard deviation ellipse area in 2005 was 9121.892 km², the standard deviation ellipse area reached the maximum of 70589.659 km² in 2019. The area of the standard deviation ellipse increased year by year, with an increase of 61467.767 km² from 2005 to 2019. From the point of view of the scenic spot distribution center, the central location was moving in Xiuwen County, Kaiyang County, Wudang District, and Baiyun District of Guiyang City. The standard deviation ellipse center of most years was located in Kaiyang County from 2005 to 2019.

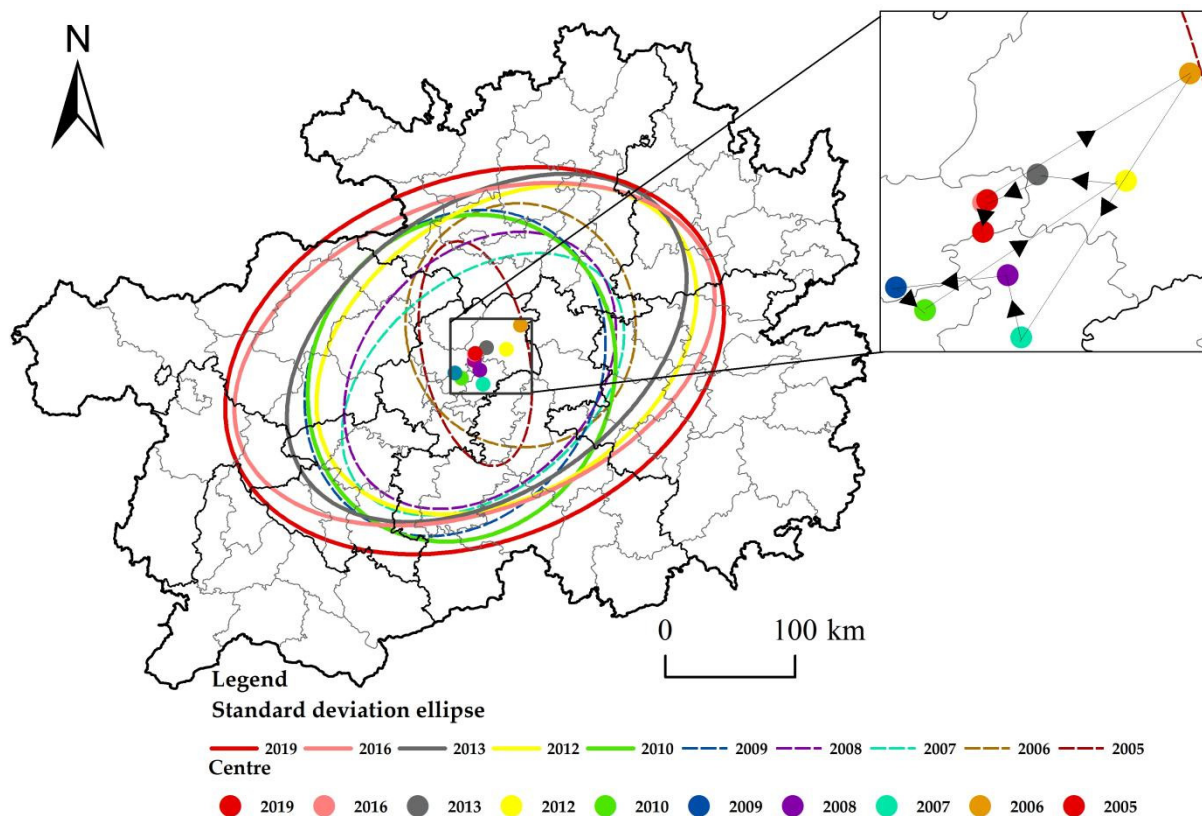


Figure 7. Standard deviation ellipse of the spatial distribution of A-level scenic spots in Guizhou Province.

Table 3. Calculation results of the standard deviation ellipse.

Year	The Area of the Ellipse Per Square Kilometers	X-Axis Standard Deviation	Y-Axis Standard Deviation	Center Position	Rotation Angle
2005	9121.892	36.767	78.980	Xiuwen County	168.590
2006	21,187.468	79.757	84.564	Kaiyang County	171.932
2007	25,671.735	111.409	73.352	Kaiyang County	50.423
2008	27,092.553	79.496	108.487	Wudang District	43.288
2009	36,438.113	97.806	118.595	Xiuwen County	32.793
2010	37,758.833	103.422	116.219	Baiyun District	29.979
2011	37,758.833	103.422	116.219	Wudang District	29.979
2012	44,658.750	143.451	99.102	Kaiyang County	56.846
2013	48,231.594	154.432	99.421	Kaiyang County	54.761
2014	52,959.536	161.470	104.407	Kaiyang County	64.671
2015	54,510.220	162.984	106.467	Kaiyang County	64.768
2016	58,713.324	173.958	107.442	Xiuwen County	68.437
2017	66,098.563	184.158	114.257	Wudang District	66.537
2018	69,953.237	183.143	121.589	Wudang District	69.048
2019	70,589.659	179.377	125.272	Xiuwen County	68.204

According to Figure 7 and Table 3, the standard deviation ellipse area was minimum and the scenic spots were along the north and south direction in 2005. This showed that the development scope of scenic spots in Guizhou Province was increasing. Since 2007, the development direction of scenic spots gradually formed a trend of extending along the southwest and northeast, and tended to disperse along the northwest and southeast. Both the short axis and the long axis of the standard deviation ellipse showed a “growing trend in fluctuations” during the process of change from 2005 to 2019.

3.2.3. Spatial Differentiation Characteristics

Trend surface analysis can intuitively show the general trend of the number of A-level scenic spots in the spatial layout of each county (district) in Guizhou Province [47]. The results are shown in Figure 8, where x and y axes point to the east and north directions respectively, and the z-axis represents the number of A-level scenic spots in each county of Guizhou Province.

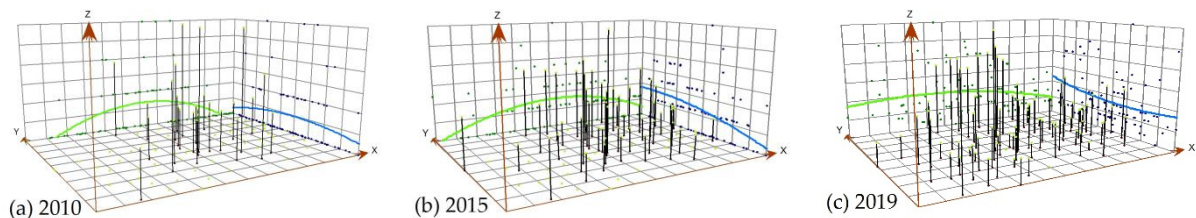


Figure 8. The spatial distribution trend surface analysis plots of A-level scenic spots in Guizhou, (a) 2010, (b) 2015, (c) 2019.

In the east–west direction, the A-level scenic spots in 2010 and 2015 presented an inverted U-shaped distribution, and the growth rate of the number of scenic spots was greater in the central counties. In 2019, the distribution of A-level scenic spots tended to be uniform, and the number of A-level scenic spots in the western counties such as Xingyi, Panzhou, and Shuicheng increased significantly. The trend curve in the east–west direction was more flat than in the north–south direction. In 2010, the trend curve was relatively flat, and its central part was slightly higher. In 2015, the distribution of scenic spots showed a “parabola” in the form of higher in the north and lower in the south. The growth rates of scenic spots in northern counties such as Xishui, Renhuai, and Chishui were greater. In 2019, the distribution of scenic spots showed a “concave” pattern with a high level in the north and a low level in the south, but the overall number of scenic spots was significantly higher than that of 2015, and the growth rate of the number of scenic spots in the south was higher than that in the north. On the whole, A-level county scenic spots in Guizhou Province were distributed in the east–west direction, and the curve gradually changed from a relatively steep inverted U-shaped curve to a gentle curve with high height in the west and low height in the east. In the north–south direction, the steepness of the trend curve gradually changed from a gentle curve to a steep curve, and finally formed a concave curve with high height in the north and low value in the south.

3.3. Factors Influencing the Spatial Distribution of A-Level Scenic Spots

The spatial distribution of A-level scenic spots in Guizhou Province changed significantly from 2005 to 2019. By the end of 2019, there had been 18 scenic spots selected into the fifth batch of the Chinese national representative catalog of intangible cultural heritage.

The distribution of scenic spots is mainly affected by natural and cultural factors. Both natural resources and cultural resources are important driving forces for the development and construction of scenic spots, and the density of scenic spots in resource rich areas will increase accordingly. The study was based on the perspective of time and space, and summarized the evolution law of the quantitative and spatial differentiation characteristics of A-level scenic spots in Guizhou Province. In addition, we discussed the coupling relationship between natural and human factors and the distribution of scenic spots and put forward some suggestions for the optimization of decision-making of the development planning and layout of scenic spots in Guizhou on the basis of detecting the impact of various factors on the development and construction of scenic spots in Guizhou Province.

3.3.1. Coupling Analysis of Natural/Human Elements and Scenic Spots Distribution

The distribution of the A-level scenic spots is greatly affected by the factors of topography and altitude, and the scattered topography can create a stronger visual impact and appreciation. Water and vegetation are also important elements of scenic spots, and

different water and vegetation landscapes create natural scenic spots with different characteristics. Guizhou Province is located in the Yunnan–Guizhou Plateau in Southwest China with an average altitude of 1100 m. More than 50% of the area is karst landform. The unique climate of “one mountain has four seasons and ten miles with different days” has become one of the natural advantages for the development of regional scenic spots. Based on the terrain slope of Guizhou (Figure 9a), the central and northern parts of the terrain are relatively gentle and the surrounding terrain is relatively steep. There was no obvious coupling phenomenon between the newly added scenic spots and the slope area in 2019. Guizhou is the main birthplace of the Yangtze River Basin and the Pearl River Basin, with a dense river network and broad watershed, and the distribution of A-level scenic spots is highly coincident with the 3 km buffer zone of the rivers (Figure 9b). The NDVI was high in the southeast and northern regions and low in the central and western regions in 2018 (Figure 9c). The A-level scenic spots in Guizhou in 2018 and the new A-level scenic spots in 2019 were mainly distributed in areas with high NDVI value.

The development of the regional economy is the basis to promote the development of tourism and is also a powerful guarantee to strengthen the construction of tourism infrastructure. From 2005 to 2019, the GDP of Guizhou Province increased from 2005 billion yuan to 16,769 billion yuan. Rapid economic development promotes the rapid development of tourism, and the proportion of tourism income makes the tourist industry become one of the indispensable key industries to promote the economic development of Guizhou Province. By 2019, the total tourism income of Guizhou Province had jumped to third place in China, and the added value of tourism income had increased to 11.6% of the province’s GDP. The spatial distribution of scenic spots was not only closely related to topography, rivers, and economic development but also the population distribution and road network were important factors affecting the distribution of scenic spots. In this study, GDP, population, and traffic were selected to conduct coupling analysis with the distribution of A-level scenic spots. Based on the spatial distribution chart of GDP in 2018 (Figure 9d), it can be seen that the areas with high GDP value in Guizhou Province mainly appeared in Guiyang and Zunyi. However, there was no significant coupling between the A-level scenic spots in 2018 and the new A-level scenic spots in 2019. The areas with high population in 2018 were mostly concentrated in central and northern Guizhou, and the A-level scenic spots in 2018 and the new A-level scenic spots in 2019 were also mostly concentrated in the same areas (Figure 9e). It can be seen in Figure 9e that the railway network mainly runs through Guizhou along the east–west direction and extends northward and westward in the centre of Guizhou. The railway density in southern Guizhou is relatively low. There was a high spatial distribution correlation between A-level scenic spots and the railway network. The expressway distribution in Guizhou Province is more uniform, more intensive in the middle and north. The distribution of the areas with concentrated population density, dense railway, and expressway network in Guizhou Province is consistent with that of the areas with dense A-level scenic spots. The A-level scenic spots are built in the areas with high road network accessibility, which will also increase the accessibility of scenic spots, thus improving the travel time efficiency of tourists, and become one of the advantages of attracting tourists.

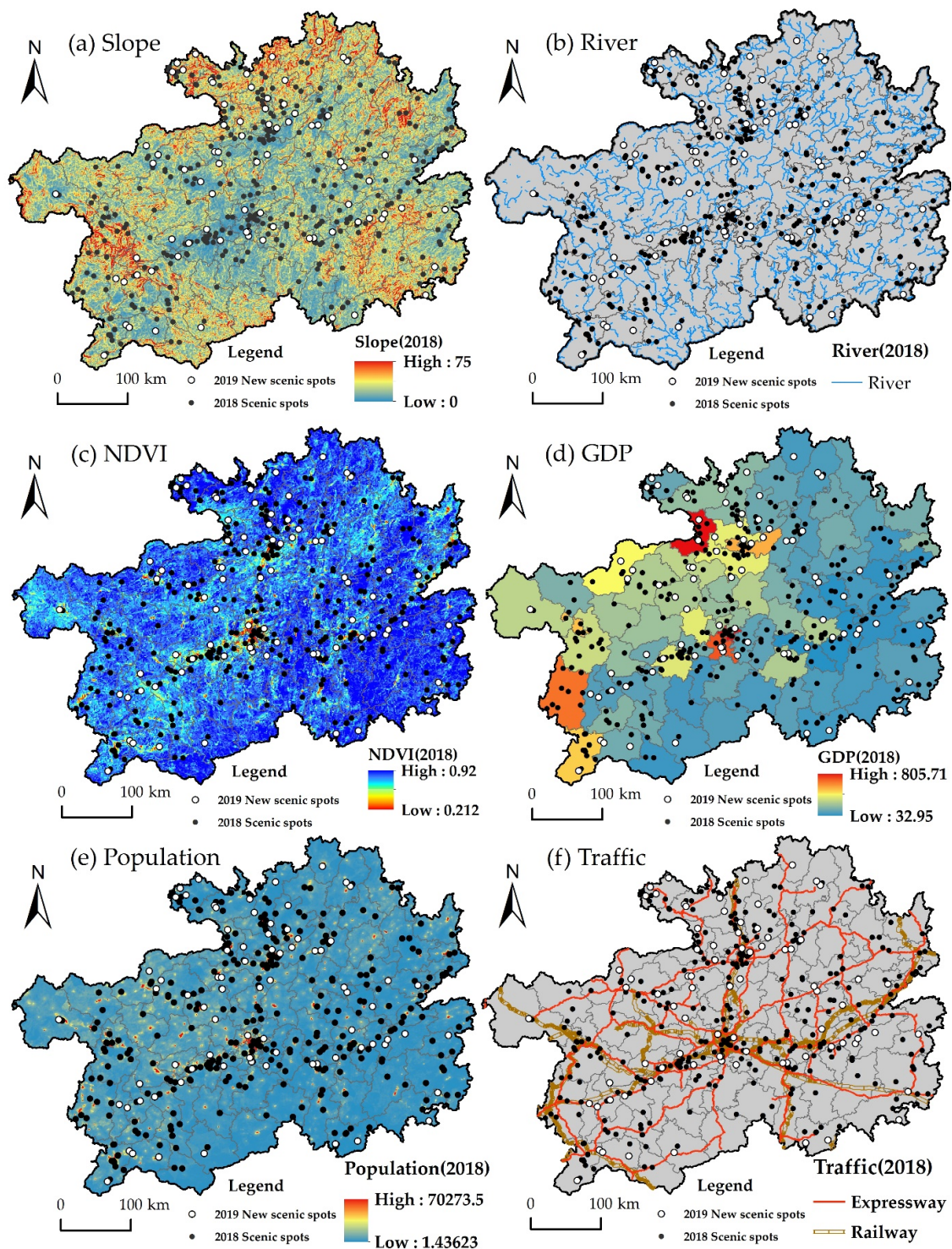


Figure 9. The typical factors influencing the spatial distribution of A-level scenic spots in Guizhou, (a) Slope, (b) Rivers, (c) NDVI, (d) GDP, (e) Population, (f) Traffic.

According to the topography of Guizhou Province, the elevation is divided into four grades: below 791 m, 792–1169 m, 1170–1682 m and 1683–2885 m (Table 4). From 2015 to 2019, the number of A-level scenic spots at the four different elevations increased. In the areas with an elevation below 791 m, the proportion of scenic spots decreased from 2015 to 2016, then, the number of scenic spots increased gradually from 2016 to 2019. In the areas with an elevation of 792–1169 m, the proportion of A-level scenic spots decreased slowly

year by year. In the areas with an elevation of 1170–1682 m, the proportion of A-level scenic spots increased gradually. In the areas with an elevation of 1683–2885 m, the number of A-level scenic spots increased firstly and then decreased, showing an inverted U-shaped downward trend. Generally, the areas with an altitude of less than 791 m and 1170–1682 m gradually became the preferred areas for the construction of A-level scenic spots. The development degree of A-level scenic spots in areas with an altitude of 792–1169 m and 1683–2885 m decreased.

Table 4. Distribution of A-level scenic spots at different elevations.

Year	<791 m		792–1169 m		1170–1682 m		1683–2885 m	
	The Number of Scenic Spots	Proportion	The Number of Scenic Spots	Proportion	The Number of Scenic Spots	Proportion	The Number of Scenic Spots	Proportion
2015	28	29.47%	43	45.26%	20	21.05%	4	4.21%
2016	33	25.19%	55	41.98%	29	22.14%	14	10.69%
2017	57	27.94%	76	37.25%	51	25.00%	20	9.80%
2018	92	28.22%	124	38.04%	82	25.15%	28	8.59%
2019	116	28.57%	151	37.19%	110	27.09%	29	7.14%

3.3.2. Analysis of Detection Factor Interaction Results

Coupling analysis failed to quantify the influence of various factors on the distribution of scenic spots. A geographical detector model [41] was used to explore the influence mechanism of the spatial distribution of A-level scenic spots from 2013 to 2019. The p values of all influencing factors in the measurement results were less than 0.01, which means that all factors passed the significance test. Table 5 showed that six detection factors influenced the A-level scenic spots development and construction, the road network density and tourism income factor explanatory power (q) averaged over 20%, GDP and the altitude factor explanatory power averaged around 10%, population density and river density factor explanatory power averaged small, under 5%.

Table 5. Detection results of the spatial evolution influencing factors of A-level scenic spots in Guizhou Province.

Year	The Altitude	The Population Density	River Density	Road Network Density	Tourism Income	GDP
2013	0.103	0.028	0.010	0.130	0.253	0.085
2014	0.093	0.027	0.012	0.169	0.238	0.054
2015	0.064	0.033	0.013	0.201	0.240	0.100
2016	0.066	0.028	0.021	0.249	0.241	0.095
2017	0.068	0.037	0.013	0.287	0.220	0.174
2018	0.078	0.037	0.013	0.325	0.217	0.156
2019	0.080	0.038	0.018	0.277	0.199	0.135
Mean	0.079	0.032	0.014	0.234	0.230	0.114

Both the density of the road network and tourism income have a great influence on the spatial layout of scenic spots. The factor explanatory power of road network density increased year by year from 2013 to 2018, reaching more than 20% after 2015, and reached its highest value in 2018, which was 32.5%. The explanatory power of the tourism income factor from 2013 to 2019 was above 20%, and its influence degree fluctuated slightly with the year and finally decreased. Tourism income feeds into local economic growth.

The influence of GDP on the distribution of A-level scenic spots showed an inverted U-shaped growth, increasing from 2013 to 2017 and decreasing from 2017 to 2019. The influence of altitude on the distribution of A-level scenic spots showed a V-shaped growth, and the explanatory power of the factor reached its highest in 2013, 10.3%, and showed a significant decline from 2014 to 2015, and began to rise from 2016.

The influence of population density on the spatial distribution of A-level scenic spots showed a fluctuating upward trend. The explanatory power of population density showed a W-shaped fluctuation from 2013 to 2017 and changed to stabilize after 2017. The influence

of river density on the spatial distribution of A-level scenic spots in Guizhou showed a fluctuating upward trend. From 2013 to 2015, the impact was relatively stable. The impact was significantly higher in 2016 than in 2015. The impact began to decline in 2017.

During the study period, the influences of altitude, river density, and population density on the spatial distribution of A-level scenic spots in Guizhou Province were relatively stable. The q value of road network density and GDP increased significantly, indicating that these two influencing factors had a significant increase in the distribution of A-level scenic spots. The influences of tourism income on the distribution of A-level scenic spots decreased slightly. Compared with other detection factors, road network density and tourism income had a higher influence on the spatial distribution of A-level scenic spots.

4. Discussion and Suggestions

4.1. Discussion

From 2005 to 2019, the number growth of A-level scenic spots in Guizhou Province can be divided into three stages: the early development period from 2005 to 2010, the moderate development period during 2011–2015, and the rapid development period after 2016. According to the calculation through the average nearest neighbor index, the spatial distribution of A-level scenic spots in Guizhou Province has been concentrated for many years. During China's 13th Five Year Plan period, Guizhou Province launched the integration policy of 'big tourism', 'big data' and 'big ecology'. The number of scenic spots has ushered in a blowout development, and tourism income has also achieved considerable growth. Tourism development in Southern Guizhou still lags behind relatively.

The Gini coefficient of the spatial distribution of A-level scenic spots in Guizhou Province showed a significant downward trend from 2005 to 2017. The Gini coefficient increased slightly from 2017 to 2019. It showed that the equilibrium degree of the scenic spot distribution was developing towards equality from 2005 to 2017, and the equilibrium degree was closest to absolute equality in 2017. While the spatial distribution equilibrium of scenic spots tended to be inequality from 2017 to 2019, with the characteristics of small-scale concentration.

Based on the spatial distribution kernel density of A-level scenic spots in Guizhou Province from 2005 to 2019, the number and scope of high-density areas in the scenic spots increased year by year, forming the spatial distribution characteristics of "one axis and two cores" in 2017 and "two axes and multiple cores" in 2019. According to the standard deviation ellipse of the distribution of A-level scenic spots in Guizhou Province, the size of the ellipse increased year by year, and Guiyang was always in the center of the ellipse. The long axis direction of the standard deviation ellipse changed significantly from 2005 to 2007, and the long axis direction from 2007 to 2019 was mainly southwest to northeast.

In the east–west direction, the number of county-level scenic spots in Guizhou Province was a gentle curve with high in the West and low in the East. In the north–south direction, the steepness of the trend curve was a concave curve with high in the north and low in the south. The distributions of rivers and scenic spots showed coupling phenomenon. The distributions of slope, NDVI, and scenic spots showed a significant coupling phenomenon. The population distribution, the road network, and the scenic spot distribution were highly correlated. In recent years, with the continuous improvement of China's GDP, the government's investment in transportation and tourism has promoted the development of regional tourism and the construction of scenic spots [48–50]. At the same time, the development of tourism promotes the development of transportation and regional economy [48–50]. It has also driven GDP growth and local investment.

With the help of Geodetector, it was found that the road network density and tourism income had a strong impact on the distribution of A-level scenic spots. The density of road network will directly affect the accessibility of scenic spots, thus affecting the tourism planning of tourists in selecting scenic spots, and then affect the maintenance income and brand effect of scenic spots. Tourism income will stimulate local attention and investment

in the tourist industry, and further affect the construction and development of local scenic spots. The influence of altitude on the distribution density of scenic spots in the early years was stronger than that in the later years. The possible reason is that in the early years, the construction of scenic spots with high altitude was difficult and relatively inexperienced, while in the later years, with the progress of technology, the construction difficulty was no longer a large problem in determining the construction of scenic spots. With the growth and change of the regional economy, the mode of economic growth will gradually promote the tourism industry. Therefore, the impact of GDP on the distribution of scenic spots is increasing year by year. The population density is mainly affected by the city, and scenic spots are mainly used as a tourist destination for non-local visitors. The rivers are distributed widely and evenly in Guizhou Province. So, the impact of population density and river distribution on the spatial distribution of scenic spots is relatively weak.

4.2. Suggestions

Based on the analysis of the spatiotemporal evolution characteristics and influencing factors of A-level scenic spots in Guizhou Province, combined with the regional resource endowment, we put forward suggestions for the development, construction, and layout optimization of scenic spots in Guizhou Province.

According to the evolution characteristics of the spatial distribution of A-level scenic spots, the lagging development of scenic spots in the south of Guizhou is the important problem existing in the development of scenic spots in Guizhou Province. Traffic conditions are one of the main factors affecting scenic spot planning. However, the road network density is small in the south of Guizhou. Therefore, strengthening the traffic construction of Qianxinan, Qiannan, and Qiandongnan can effectively improve the regional accessibility of the three prefectures, strengthen the convenience for tourists in the southern scenic spots, promote the growth of local tourism, and promote the development and construction of scenic spots in the region. The tourism resource endowment in the southern region has not been effectively developed. There are abundant river valleys with excellent water resources. Using river resources to build hydrological scenic spots can be one of the effective ways to develop southern scenic spots.

The construction of A-level scenic spots is an important starting point for tourism development, regional coordination, and urban–rural integration. Therefore, Guizhou should make full use of the regional resources advantages to optimize the layout of the scenic spots. At present, A-level scenic spots in Guizhou present a spatial layout of “two axes and multiple cores”. Guiyang has always been the core of scenic spot planning and development. Guizhou can take the advantage of the “two axis and multi-core” pattern, combined with the development mode of “point axis and network”, explore relying on the big data technology advantage platform to expand the radiation scope of each A-level scenic spot, so as to strengthen inter regional tourism industry cooperation and eliminate a regional tourism market fortress, promote the development of global tourism in Guizhou Province, and finally realize the effective allocation and rational utilization of tourism resources.

5. Conclusions

This paper studied the temporal and spatial evolution characteristics of A-level scenic spots in Guizhou Province from 2005 to 2019, including spatial distribution, density, balance degree, temporal change trend, and direction characteristics, and analyzed the natural and human factors influencing the scenic spots’ distribution qualitatively and quantitatively.

Overall, the A-level scenic spots in Guizhou Province have shown a good development trend in recent years. However, the development in southern Guizhou province is less optimistic. The rapid growth in the number of A-level scenic spots led to small-scale agglomeration in spatial distribution from 2017 to 2019. Guiyang has always been the center of A-level scenic spots planning in Guizhou Province. The kernel density distribution of A-level scenic spots in Guizhou Province forms the “two-axis, multi-core” layout.

The road network density, tourism income, and GDP had a higher influence on the A-level scenic spots distribution. As time goes by, the influence of terrain height on scenic spot construction was gradually reduced. The area with an altitude of 1170 m to 1682 m has gradually become the first choice for the construction of scenic spots in Guizhou Province. Because of the unique terrain and water system in Guizhou Province, population distribution and rivers have little impact on the planning and construction of A-level scenic spots. Finally, we have provided some suggestions for scenic spot layout optimization in Guizhou Province on the basis of the perspective of regional resource endowment and scenic spot spatial layout.

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