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Study on the Spatial-Temporal Evolution Law of 4A and Above Tourist Attractions in Jiangsu Province

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ABSTRACT

The establishment of tourist attractions, especially high-grade tourist attractions, is very important for the development of tourism and the optimization of its structure. Taking 235 4A and above tourist attractions in Jiangsu Province as the research objects coupled with geospatial analysis method, the spatial-temporal evolution law of 4A and above tourist attractions in Jiangsu Province from 2001 to 2020 were analyzed to explore new ideas for the establishment of high-grade tourist attractions. The results show that: (1) Since the first 4A scenic attraction was established in 2001, the establishment of 4A and above tourist attractions in Jiangsu Province has been in a rapid growth stage; (2) The distribution of 4A and above tourist attractions in Jiangsu Province is unbalanced, showing an aggregation state of dense in the south and sparse in the north. The high-density areas are always concentrated in the south of Jiangsu Province, but with the development of the regional tourism, the degree of aggregation is gradually decreasing, and the high-density areas spread from the south of Jiangsu to the center and the north of Jiangsu; (3) Social economy, water system resources, transportation network, tourism policy and scenic spot drive, etc. have a certain impact on the spatial-temporal evolution of 4A and above tourist attractions in Jiangsu Province.

Keywords: *geospatial analysis; spatial-temporal evolution: 4A and above tourist attractions; Jiangsu Province*

1. INTRODUCTION

In 2001, the promulgation of the first list of 4A level tourist attractions marked the beginning of the establishment of China's A-level tourist attractions. With the continuous revision and improvement of relevant standards, China's A-level tourist attractions were finally divided into five levels: A, AA, AAA, AAAA and AAAAA. Tourist attractions are the main areas for tourism activities and the basis for the normal operation and development of tourism[1]. High grade tourist attractions mean higher quality and better service, which can bring rich tourist flow to the region, and improve the tourism influence and competitiveness of the region[2]. Therefore, the spatial distribution of tourist attractions has gradually become a research hotspot of scholars at home and abroad.

Foreign scholars focus on industrial clusters and rural communities to study the spatial distribution of tourist attractions[3-5]. Domestic scholars have made extensive research on the spatial distribution of tourist

attractions. From the research scale, they mainly include tourist areas[6], cities[7-9], urban agglomerations[10-11], provinces[12] and national scales[13]; From the perspective of research methods, it mainly focuses on spatial autocorrelation[14-15], kernel density analysis[16-17] and geographical concentration index[18]. The research on the spatial distribution of tourist attractions in China mostly focuses on the geospatial level, while the relevant dynamic research combining the spatial distribution of tourist attractions with the temporal and spatial evolution is relatively rare.

2. OVERVIEW OF THE STUDY AREA AND RESEARCH METHODS

2.1. Overview of the study area

Jiangsu is located in the eastern coastal area of the Chinese mainland, the Yangtze River Delta, and bordering Shanghai, Zhejiang, Anhui, Shandong and other provinces and cities. Jiangsu Province is named after Jiangning and Suzhou, with a total area of 107200

km², including 13 prefecture level cities. The provincial capital is Nanjing. Jiangsu Province is generally divided into three regions: northern Jiangsu, central Jiangsu and southern Jiangsu. Northern Jiangsu includes Xuzhou, Lianyungang, Suqian, Huai'an and Yancheng, central Jiangsu includes Yangzhou, Taizhou and Nantong, and southern Jiangsu includes Nanjing, Zhenjiang, Changzhou, Wuxi Suzhou. As of April 2021, there are 235 4A and above tourist attractions in Jiangsu Province, including 25 5A tourist attractions and 210 4A tourist attractions.

2.2. Data sources

The data source of this paper is the list of 4A and above tourist attractions in Jiangsu Province from 2001 to 2020 (excluding delisted tourist attractions) by querying the websites of the Ministry of Culture and Tourism of the People's Republic of China, the Department of Culture and Tourism of Jiangsu Province and the cultural and tourism bureaus of cities in Jiangsu Province. Obtain and sort out the geographic coordinate data of each scenic spot from Google Earth, and carry out visual processing through ArcGIS 10.2.

2.3. Research method

2.3.1 Nearest neighbor index

The nearest neighbor index is a geographical indicator of the degree of mutual proximity of point elements in geographical space, which is used to reflect the distribution characteristics of point elements[19]. Tourist attractions 4A and above are regarded as point elements, and their spatial distribution can be divided into three types: aggregate distribution, discrete distribution and random distribution. The calculation formula of the nearest neighbor index is:

$$R = \frac{\overline{r_1}}{\overline{r_E}} = 2\sqrt{D} \times \overline{r_1} \qquad \overline{r_E} = \frac{1}{2\sqrt{\frac{n}{A}}} = \frac{1}{2\sqrt{D}} \qquad (1)$$

In the formula, R is the nearest neighbor index; $\overline{r_1}$ is the distance r_1 between the nearest points; $\overline{r_E}$ is the theoretical nearest distance; D is the point density; A is the area of the study area. When $R > 1$, the distribution type of point elements is uniform distribution; when $R = 1$, the distribution type of point elements is random distribution; when $R < 1$, the distribution type of point elements is aggregation distribution.

2.3.2 Geographic concentration index

The geographic concentration index is used to represent the degree of dispersion of elements in the study area[20]. The calculation formula of geographical concentration index is:

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

In the formula, G is the geographical concentration index of tourist attractions of 4A and above; n is the total number of prefecture level cities; X_i is the number of 4A and above tourist attractions in the ith prefecture level city; T is the total number of tourist attractions. The range of G value is 0 ~ 100, and the greater the value, the more concentrated the degree of aggregation, and the smaller the value, the more dispersed the degree of aggregation. With $\bar{G}$ to represent the geographical concentration index when tourist attractions are evenly distributed in local cities, when $G > \bar{G}$, it means that 4A and above tourist attractions in the study area are concentrated; When $G = \bar{G}$, it means that 4A and above tourist attractions in the study area are evenly distributed; When $G < \bar{G}$, it indicates that 4A and above tourist attractions in the study area are distributed discretely.

2.3.3 Kernel density estimation

Kernel density estimation is a method that can be used to represent the spatial distribution hot spots of tourist attractions 4A and above, that is, the greater the kernel density value, the greater the distribution density of tourist attractions 4A and above[21]. The calculation formula is:

$$f_n(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x-x_i}{h}\right) \qquad (3)$$

In the formula, h is the bandwidth, the radius of the circular region; n is the number of samples; k ( ) is the kernel function; $x - x_i$ represents the distance from the valuation point x to the sample x_i.

2.3.4 Standard deviation ellipse

Standard deviation ellipse is a research method applied to the spatial development pattern in natural, social, economic and other fields, which is used to judge the spatial distribution characteristics such as aggregation, directionality and spatial form of geographical elements[22]. The long half axis of the ellipse represents the direction of data distribution, and the short half axis represents the range of data distribution. The greater the difference between the long half axis and the short half axis, the more obvious the direction of data.

3. ANALYSIS OF TEMPORAL AND SPATIAL EVOLUTION CHARACTERISTICS

3.1. Evolution analysis of quantity

The change trend of the number of 4A and above tourist attractions in Jiangsu Province from 2001 to

2020 is shown in Figure 1. Since the establishment of class a tourist attractions in China in 2001, the number of 4A tourist attractions in Jiangsu Province has been growing steadily. Especially from 2013 to 2016, the number of 4A tourist attractions has accelerated, with an average of more than 20 4A tourist attractions established every year. The establishment of 5A tourist attractions in Jiangsu Province began with the approval of the first batch of 5A tourist attractions in 2007. By 2020, the number of 5A tourist attractions in Jiangsu Province has been growing rapidly, becoming the province with the largest number of 5A tourist attractions in China.
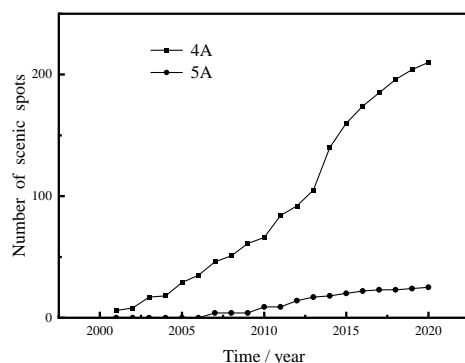

Figure 1 The number of 4A and above tourist attractions in Jiangsu Province from 2001 to 2020

3.2. Evolution analysis of spatial structure

Taking 2005, 2010, 2015 and 2020 as time nodes, the nearest neighbor index analysis is carried out with the help of ArcGIS, and table 1 is obtained. Figure 2 shows the distribution changes of 4A and above tourist attractions in Jiangsu Province from 2001 to 2020. In 2005, the number of 4A and above tourist attractions in Jiangsu Province was small, and they were all 4A tourist attractions. The spatial distribution showed aggregation distribution, mainly distributed in Xuzhou and Lianyungang in northern Jiangsu, Yangzhou, Nantong in central Jiangsu and five cities in southern Jiangsu, of which the five cities in southern Jiangsu were the most distributed, accounting for 72.41% of the total tourist attractions. By 2010, the number of 4A and above tourist attractions in Jiangsu Province has increased to a certain extent, and the spatial distribution is clustered. 13 prefecture level cities have 4A tourist attractions, and

the number of 5A tourist attractions has also made a zero breakthrough. Among them, 8 5A tourist attractions are located in four cities in southern Jiangsu, and only one is located in Yangzhou in central Jiangsu. By 2015, the number of 4A and above tourist attractions in Jiangsu Province has increased explosively, an increase of 104 compared with 2010. The spatial distribution of 4A and above tourist attractions is clustered. The construction of 4A and above tourist attractions in northern Jiangsu and central Jiangsu has been accelerating, but the five cities in southern Jiangsu are still the areas with the largest number of 4A and above tourist attractions in Jiangsu Province. By 2020, the distribution of 4A and above tourist attractions in Jiangsu Province becomes more intensive, and the spatial distribution becomes concentrated. Jiangsu Province has become the province with the largest number of 5A tourist attractions in China, and 13 prefecture level cities have at least one 5A scenic spot.

Taking 2005, 2010, 2015 and 2020 as time nodes, the geographical concentration index is analyzed with the help of ArcGIS, and table 2 is obtained. Table 2 shows the geographical concentration index and scenic spot distribution of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020，the geographic concentration index G is always greater than the average geographic concentration index $\bar{G}$, however, the G value decreases with the passage of years, indicating that the spatial distribution of 4A and above tourist attractions in Jiangsu Province is still concentrated, which is consistent with the results of the nearest neighbor index analysis, but the concentration of 4A and above tourist attractions in Jiangsu Province is decreasing

From 2001 to 2020, the distribution characteristics of 4A and above tourist attractions in Jiangsu Province spread from northern Jiangsu and southern Jiangsu to central Jiangsu. The hierarchical structure of tourist attractions tends to be reasonable, and the spatial distribution is always in a state of aggregation, but the degree of aggregation is gradually decreasing. The five cities in southern Jiangsu have always been the areas with the most 4A and above tourist attractions and the most concentrated 4A and above tourist attractions in Jiangsu Province.

Table 1. The nearest neighbor index and spatial distribution types of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020

year	Number of tourist attractions	Observation nearest distance $\bar{r}_1/m$	Theoretical nearest neighbor distance $\bar{r}_E/m$	Nearest neighbor index R	Spatial distribution type
2005	29	19974.9141	30399.6370	0.6571	Aggregation
2010	75	10969.8515	18903.2625	0.5803	Aggregation
2015	179	8881.6420	12236.0398	0.7259	Aggregation
2020	234	7871.3039	10701.8650	0.7355	Aggregation

(a) 2005
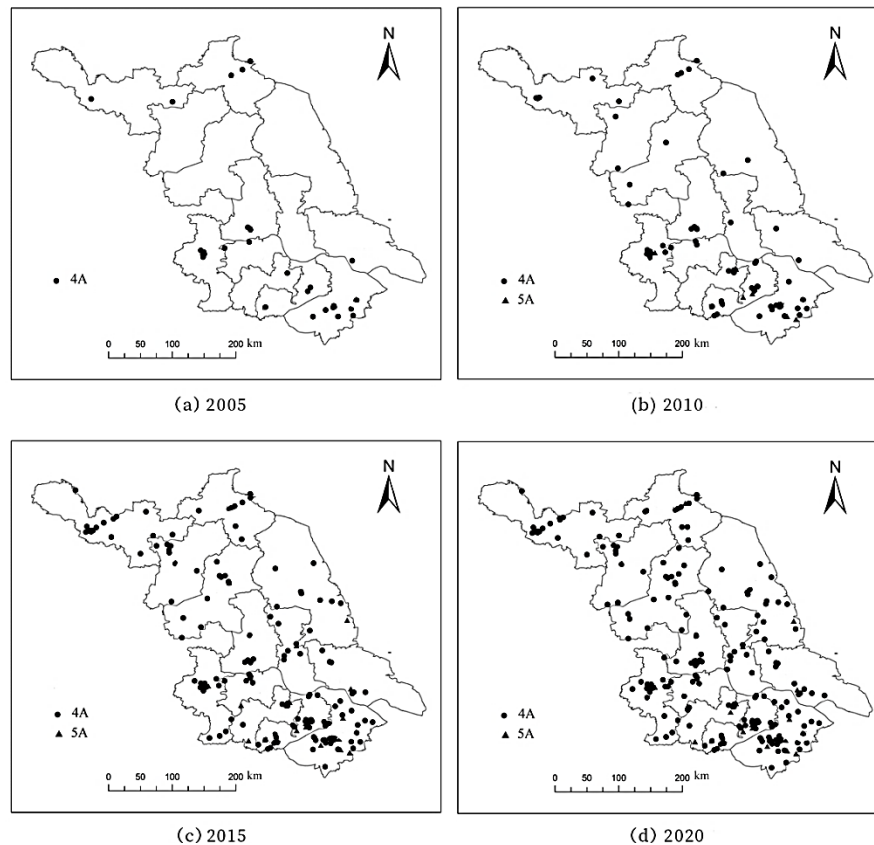
(b) 2010

(c) 2015

(d) 2020

Figure 2 Distribution of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020

Table 2. Geographical concentration index and distribution of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020

year	Geographic concentration index G	Average geographic concentration index $\bar{G}$	Distribution state
2005	41.24	27.72	centralization
2010	36.00	27.74	centralization
2015	32.52	27.74	centralization
2020	30.88	27.73	centralization

3.3. *Evolution analysis of spatial density*

Taking 2005, 2010, 2015 and 2020 as time nodes, the nuclear density analysis is carried out with the help of ArcGIS, and figure 3 is obtained. In 2005, the high-density areas centered on Nanjing and Suzhou were concentrated in southern Jiangsu, except the central part of Lianyungang and the southern part of Yangzhou, the other areas in northern Jiangsu and southern Jiangsu were low-density areas. By 2010, high-density areas were still located in southern Jiangsu, but the area of high-density areas was gradually expanding, Changzhou and Wuxi joined the ranks of high-density areas, and most areas in northern Jiangsu and central Jiangsu were still low-density areas. By 2015, with the increase of the number of tourist attractions, high-density areas radiate to the periphery of the original high-density areas. At the same time, medium and high-density areas appear scattered in some areas in northern and central Jiangsu, and the distribution of 4A and above tourist attractions in Jiangsu Province show a diffusion trend. By 2020, with the further increase in the number of 4A and above tourist attractions in cities of Jiangsu Province, medium and high-density areas are distributed in blocks and have a trend of further diffusion, but the core area is still dominated by southern Jiangsu.

From 2001 to 2020, the nuclear density distribution of 4A and above tourist attractions in Jiangsu Province is characterized by the binuclear aggregation state in southern Jiangsu diffuses to northern and central Jiangsu as a polynuclear aggregation state, however, the high-density areas are always concentrated in southern Jiangsu.
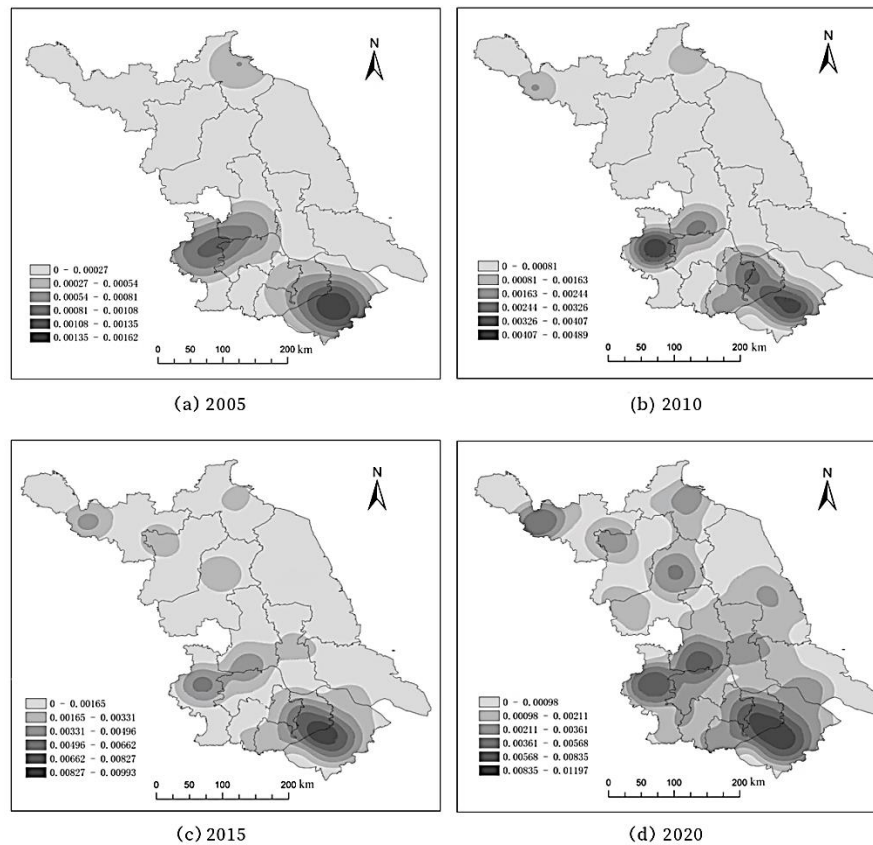
(a) 2005   (b) 2010

(c) 2015   (d) 2020

Figure 3 Nuclear density map of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020

3.4. Evolution analysis of spatial distribution, directional difference and development

Taking 2005, 2010, 2015 and 2020 as time nodes, the standard deviation ellipse is processed with the help of ArcGIS to obtain Fig. 4. By comparing the center of gravity coordinates and relevant parameters of the standard deviation ellipse (Table 3), it can be found that the direction of the standard deviation ellipse is always northwest southeast, which is consistent with the map direction of Jiangsu Province. The radius of the standard deviation ellipse has little change, but the center of gravity of the standard deviation ellipse gradually shifts to the north. The main reason is that with the rapid development of tourism in Jiangsu Province, the number of tourist attractions 4A and above has increased greatly in northern and southern Jiangsu with the help of relevant tourism policies, and tourist attractions 4A and above in southern Jiangsu also gradually tend to be saturated, the control force on the standard deviation ellipse decreases slightly, resulting in the northward shift of the center of gravity of the standard deviation ellipse, which is also consistent with the results of nuclear density analysis.
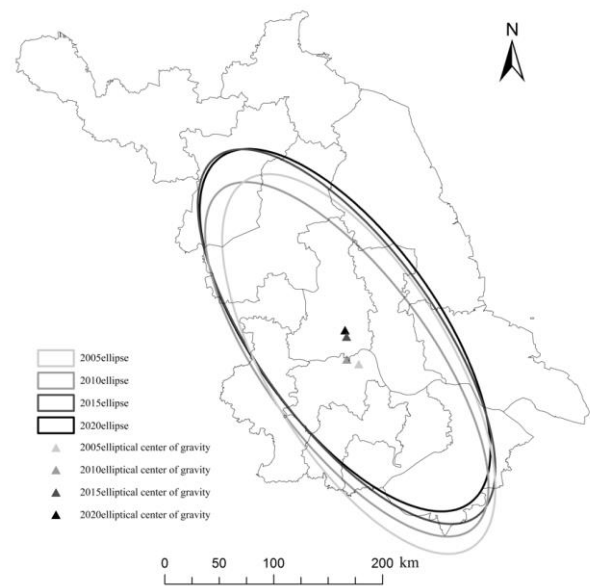

Figure 4 Nuclear density map of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020

Table 3. The barycentric coordinates and related parameters of standard deviation ellipse of 4A and above tourist attractions in Jiangsu Province in 2005, 2010, 2015 and 2020

year	Barycentric coordinate	Minor axis /km	Major axis /km	Rotation angle	position
2005	119.70°E，32.20°N	83.35	197.82	148.51°	Jingkou District, Zhenjiang
2010	119.58°E，32.24°N	76.44	193.73	143.71°	Dantu District, Zhenjiang
2015	119.59°E，32.43°N	81.84	203.74	144.11°	Jiangdu District, Yangzhou
2020	119.57°E，32.48°N	84.84	195.67	144.21°	Jiangdu District, Yangzhou

4. ANALYSIS OF INFLUENCING FACTORS OF TEMPORAL AND SPATIAL EVOLUTION

4.1. Rapid social and economic development

The development of tourist attractions, especially 4A and above tourist attractions, is closely related to the economic development level of the region. Jiangsu is located in the Yangtze River economic belt. Its total GDP ranks among the top in China all year round. It is one of the provinces with the highest comprehensive development level in China. In order to explore the relationship between GDP and the number of 4A and above tourist attractions in Jiangsu Province, the GDP of cities in Jiangsu Province in 2005, 2010, 2015 and 2020 and the number of 4A and above tourist attractions were selected for correlation analysis with the help of SPSS software. At the significant level of 0.01, the number of tourist attractions 4A and above in Jiangsu Province shows a strong positive correlation with the local economic development level, and has always maintained a high situation. The high-level economic development promotes the construction and improvement of relevant tourist attractions and tourism facilities, and high-quality tourist attractions attract a large number of tourists to visit and visit, Drive the development of local economy. The two complement each other and are closely related.

Table 4. The correlation between the number of 4A tourist attractions and the level of economic development in Jiangsu Province

year	GDP	
	Pearson coefficient	Significance
2005	0.830**	0.000
2010	0.901**	0.000
2015	0.881**	0.000
2020	0.862**	0.000

4.2. Rich water resources

Jiangsu has many coastal rivers and lakes, with vertical and horizontal ditches and dense rivers. There are also two provinces crossing the Yangtze River and Huaihe River. Rich and high-quality water resources have become an important support for many tourist attractions in Jiangsu Province. Water system is selected as the influencing factor for the distribution of 4A and above tourist attractions in Jiangsu Province. Through the superposition analysis of water system map of Jiangsu Province and 4a and above tourist attractions in Jiangsu Province (Fig. 5), it is found that more than 90% of 4A and above tourist attractions in Jiangsu Province are related to water system, and in the Yangtze River Huaihe River and other water systems are densely distributed, especially in southern Jiangsu,with the help of unique and high-quality water system resources, a large number of ancient town tourist attractions represented by Zhouzhuang Ancient Town and Tongli ancient town have been established, which has become a major local feature.
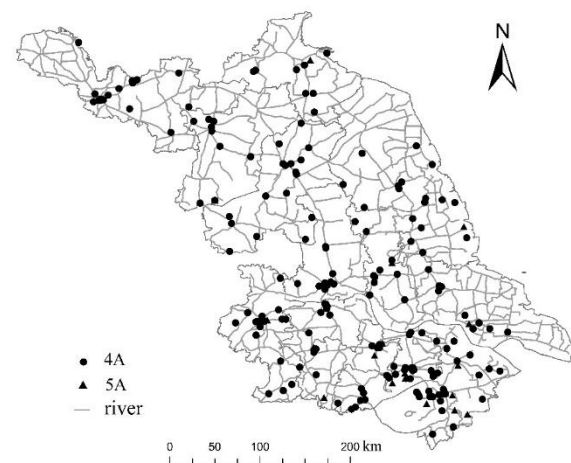

Figure 5 Distribution map of 4A and above tourist attractions and water system in Jiangsu Province

4.3. Developed transportation network

Transportation is not only the lifeblood of tourism, but also the prerequisite for tourists to complete tourism activities. According to statistics, as of January 2021, the railway operating mileage in Jiangsu Province has reached 3998 kilometers, the main framework of "four vertical, four horizontal and four connection" expressway network has been fully completed, and the expressway mileage has reached 4924 kilometers,

gradually building a complete and developed modern transportation network throughout the province. In order to explore the relationship between 4A and above tourist attractions and traffic layout in Jiangsu Province, the railway, national highway and expressway traffic network in Jiangsu Province and 4a and above tourist attractions are superimposed and analyzed to obtain the distribution map of 4A and above tourist attractions and traffic network in Jiangsu Province (Fig. 6).

The buffer zone is analyzed by driving 5km to the entrance of the scenic spot within 10 minutes. The results show that there are 193 tourist attractions of 4A and above in the buffer zone, accounting for 82.13% of the total number of tourist attractions of 4A and above, including 176 tourist attractions of 4A, accounting for 83.81% and 17 tourist attractions of 5A, accounting for 68.00%. Overall, there is a strong correlation between 4A and above tourist attractions and transportation network in Jiangsu Province.
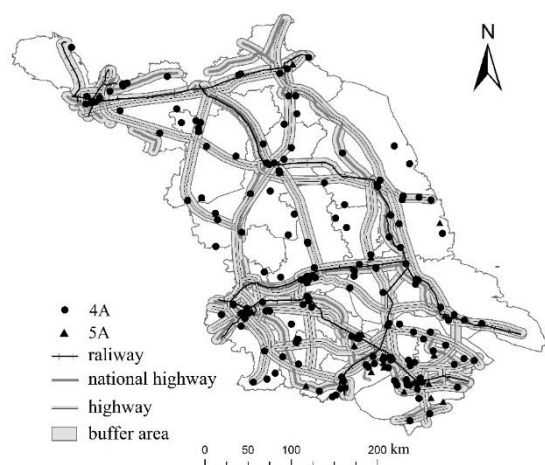

Figure 6 Distribution map of 4A and above tourist attractions and traffic network in Jiangsu Province

4.4. Tourism policy incentives

As a strong tourism province in China, Jiangsu Province has many high-quality tourism resources and always walks in the front of tourism development. Since 2011, Jiangsu Province has adhered to the combination of government guidance and market promotion, paid attention to the use of market mechanism to promote tourism development, and vigorously promoted the integration of tourism with culture, education, sports, agriculture, industry, water conservancy, marine, geology and other related industries; implement the grand tourism strategy, make full use of foreign affairs, business, civil aviation, railway and other channels, carry out cultural exchange activities, widely carry out tourism publicity, and successively create a series of high-quality tourism brands such as "famous city around Shanghai", "Wu Yunhan style" and "Oriental wetland". With the continuous support and encouragement of many tourism policies, Jiangsu Province has cultivated a

large number of competitive large-scale tourism groups. It is from this period that the number of 4A and above tourist attractions in Jiangsu Province has increased rapidly.

4.5. Driven by leading scenic spot

Driven by the leading tourist attractions, it is also an important reason for the aggregation and distribution of 4A and above tourist attractions in Jiangsu Province. Taking southern Jiangsu as an example, Nanjing, as the "ancient capital of the Six Dynasties", and Suzhou, as the representative of the "land of fish and rice", occupied a huge advantage in the early stage with its own high-quality and unique tourism resources. In 2005, the number of 4A and above tourist attractions in the two cities was close to half of that in Jiangsu Province. The 4A and above tourist attractions in Nanjing and Suzhou not only bring huge tourist traffic to the local area, but also drive the development of tourism in the city. With the continuous enhancement of the tourism influence of the two cities, its driving role gradually radiates to the whole southern Jiangsu. Zhenjiang, Changzhou and Wuxi have joined the "fast track" created by 4A and above tourist attractions with the help of the scenic spot driving role of the two cities and made effective use of their own tourism resources. By 2020, The number of 4A and above tourist attractions in southern Jiangsu has exceeded half of that in Jiangsu Province.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

With the help of relevant theories and data, this paper studies the temporal and spatial evolution and influencing factors of 4A and above tourist attractions in Jiangsu Province by using the method of geospatial analysis, the results show that:

(1)The number of 4A and above tourist attractions in Jiangsu Province increases rapidly, but the distribution is uneven, showing a strong aggregation distribution on the whole.

(2)Tourist attractions 4A and above in Jiangsu Province are distributed in the form of "dense in the South and sparse in the north". The high-density areas are always dominated by southern Jiangsu, but with the development of time, the aggregation degree is gradually decreasing, and the high-density areas begin to spread to central and northern Jiangsu.

(3)The temporal and spatial evolution distribution of 4A and above tourist attractions in Jiangsu Province has a strong positive correlation with social economy, water

system distribution, transportation network and tourism policy incentive.

5.2. Recommendation

5.2.1 Build smart tourist attractions

With the development of times and technology, high-grade tourist attractions should be equipped with high-quality and "intelligent" services. The scenic spot can comprehensively apply mobile Internet, Internet of things, wireless communication, positioning monitoring, real-time interaction and other technologies to improve the intelligence of tourist service, build a tourist behavior analysis platform, master key data such as tourist flow in real time, and reasonably guide tourist consumption; Establish a tourism supervision platform, receive tourists' complaints in real time, carry out tourists' satisfaction evaluation, and improve the quality of tourism services; We will promote the construction of tourism information infrastructure and provide various tourism information interaction terminals in major places, so that tourists can more easily access and use Internet information services and online interaction. The "intelligence" of the scenic spot can not only improve the comfort and satisfaction of tourists during sightseeing, but also help the scenic spot improve its tourism taste and optimize its tourism service system.

5.2.2 Promote regional cooperation

Driven by cities, counties and relevant leading tourist attractions with rich tourism resources, good foundation for tourism development, high status of tourism industry and relatively developed economy, promote the establishment and development of tourist attractions in surrounding areas and build a regional tourism demonstration area. Build a number of large-scale tourism functional areas through the path of "point, line and area", realize the full coverage of tourism attractions in the tourism functional area, and form a whole area scenic spot. Tourist attractions with connected regions, the same level and similar landscape types can cooperate and complement each other, learn from each other, and jointly apply for higher-level tourist attractions

5.2.3 Deep excavation of tourism resources

Jiangsu Province has flat terrain, numerous rivers and lakes, faces the Yellow Sea in the East, a land of fish and rice in the south, and the Beijing Hangzhou Grand Canal passes through the province in the middle. It can give full play to the advantages of Jiangsu Province with long history and culture, developed regional economy, superior ecological environment, strong market demand and broad development space, deeply tap potential high-quality tourism resources and

improve tourism infrastructure, Create a boutique scenic spot. For example, relying on resources such as oceans, islands, beaches, wetlands and cherished wild animals, Lianyungang, Yancheng and Nantong are linked to build a coastal ecotourism area with the characteristics of leisure and vacation; Relying on the Yangtze River and river systems, and taking history and culture as the connotation, explore and protect characteristic ancient towns, and build a tourism area of water towns in the south of the Yangtze River.

5.2.4 Improve the transportation network

Although some tourist attractions have high-quality resources, they are remote and have weak accessibility, resulting in a waste of resources. On the basis of the existing high-speed rail framework and expressway network, the connection between high-speed rail and county roads, township roads and village roads can be optimized and improved. The scenic spot can also open up the "last kilometer" and improve the transportation network of the scenic spot by setting up its own tourism shuttle bus, building characteristic scenic roads, opening cruise ship and yacht routes, setting up its own driving RV camp and other characteristic transportation modes, promoting the development of all-for-one tourism.

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