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Distribution Characteristics and Spatial Correlation of Tourist Accommodation Spaces Based on Environment Information

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Abstract: When tourists choose their accommodation space, they tend to prefer areas with beautiful natural landscapes, or close to scenic spots, or those that have local styles. Based on existing research results of tourist accommodation space, some scholars proposed to design smaller spaces for tourist accommodation, however, in terms of the spatial correlation with tourism resources, relevant analysis is insufficient and needs to be supplemented. This paper studied the distribution characteristics and spatial correlation of tourist accommodation spaces based on environment information. At first, the paper analyzed the correlation between tourism resources and tourist accommodation spaces, gave the route of spatial correlation analysis, and analyzed the distribution characteristics of tourist accommodation spaces; then, this paper gave the determination process of optimal spatial distribution pattern of tourist accommodation spaces based on environment information, and adopted the kernel density estimation and the spatial attributes of tourist accommodation space points to study the spatial distribution characteristics. At last, combining with experiment, the distribution characteristics of the tourist accommodation spaces in the study area were given and analyzed.

Keywords: Environment information; Tourist accommodation; Spatial distribution; Spatial correlation analysis

1. Introduction

As people's living standards have been greatly improved in recent years, their tourism activities become more frequent and are carried out in multiple forms, and the tourists' choices of destinations, accommodation, and dining have become more diversified as well [1-6]. When tourists choose their accommodation space, they tend to prefer areas with beautiful natural landscapes, or close to scenic spots, or those that have local styles [7-11]. In this context, with their unique local features and special regional environment, the local style tourist accommodation and service have greatly satisfied modern tourists' personalized requirements for travel accommodation [12-19]. Therefore, to figure out related questions such as the distribution characteristics of tourist accommodation spaces, and the influencing factors of driving force, world field scholars have formulated various strategies for the planning of tourist accommodation spaces based on environment information, and their research results have provided certain references for transforming and upgrading regional tourism industry, improving accommodation environment, and developing accommodation conditions.

Cumo et al. [20] analyzed the feasibility of applying renewable energy in small and medium-sized tourist destinations that depend on independent energy supply systems, the study selected a few accommodation locations with different climate conditions and geographical features in Australia to conduct investigation, and the net present value cost, renewable factor, and payback period were taken as evaluation standards in the analysis. Lim and Chan [21] described a method for designing sustainable tourism accommodation facilities in areas with high environmental values, by minimizing the impact on surrounding environment and making users be more sensitive to natural resource conservation, in the proposed method, three aspects had been taken into consideration, namely the system components, building enclosure structures, and their integration. Tigan et al. [22] summarized the accommodation choices of international and domestic tourists in New Zealand into five categories: hotels, motels, guesthouses, hostels, and campsites. Ecolabel is an environmental policy introduced in Europe by the Ecolabel Regulation in 2000, with agricultural tourism as an example, Filimonau et al. [23] proposed to use Ecolabel to mark organic agricultural products with reduced pesticide use or controlled disinfectant use, so as to give more advantages to these products in the market. Marian et al. [24] discussed the potential of applying Life Cycle Assessment (LCA) to the evaluation of tourist accommodation facilities and its contribution to global carbon footprint, in order to prove its feasibility, this paper applied a simplified LCA tool to two tourist accommodation facilities located in Dorset of Britain to quantify their CO_2 emissions, aiming at reducing the energy consumption and carbon density of the hotel industry; besides, the study also proposed a method for analyzing the energy consumption and carbon footprint of outsourced laundry and breakfast services.

Field scholars employed various research methods, such as literature analysis, visual analysis, statistical analysis, and Analytic Hierarchy Process (AHP), to analyze the evolution process and the influencing factors of tourist accommodation spaces in different regions during their development process. Some scholars proposed to design smaller spaces for tourist accommodation, however, in terms of the spatial correlation with tourism resources, relevant analysis is insufficient and needs to be supplemented. To fill in this research gap, this paper studied the distribution characteristics and spatial correlation of tourist accommodation spaces based on environment information. The second chapter analyzed the correlation between tourism resources and tourist accommodation spaces, and gave the route of spatial correlation analysis. The third chapter analyzed the distribution characteristics of tourist accommodation spaces. The fourth chapter proposed the determination process of optimal spatial distribution pattern of tourist accommodation spaces based on environment information, and adopted the kernel density estimation and the spatial attributes of tourist accommodation space points to study the spatial distribution characteristics; based on the distance between the tourist accommodation space points to be estimated and the tourism resources, the probability density was estimated. At last, combining with experiment, the distribution characteristics of tourist accommodation spaces in the study area were given and analyzed.

2. Correlation Between Tourism Resources and Tourist Accommodation Spaces

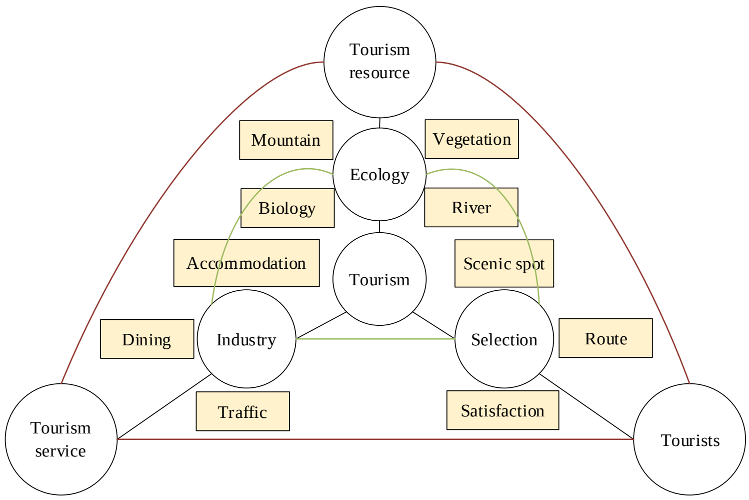

Figure 1. Correlation between tourism resources and tourist accommodation spaces

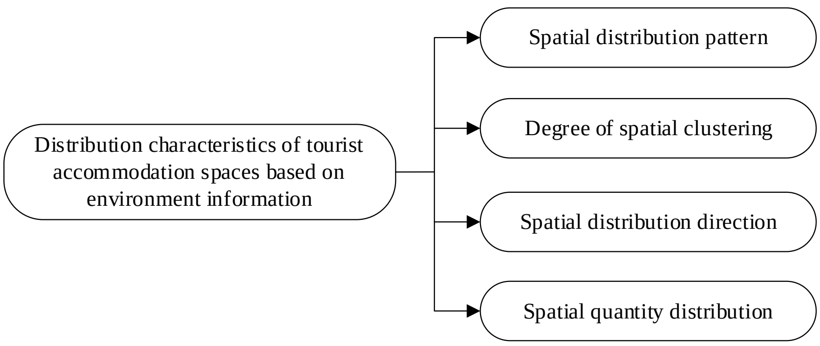

Figure 2. Route of correlation analysis

Figure 1 shows the correlation between tourism resources and tourist accommodation spaces. The concept of tourism development based on environment information is the development route for the integration of regional tourism service and tourism resource, and it runs through all fields of production, life, and ecology. With tourism as impetus, the development of relevant industries could be promoted, and the "tourism+" development mode could be expanded to other industries, forming an integrated industrial development pattern. At the same time, tourist accommodation also involves three aspects of production, life, and ecology, so the environment information-based tourism development mode has fully integrated tourism with other industries and promoted them to develop rapidly.

Figure 2 shows the route of correlation analysis. At first, this paper adopted the average nearest neighbor method to calculate the average distance between each tourist accommodation space point and its nearest neighbor, so as to get the nearest neighbor index which can reflect the spatial distribution pattern of tourist accommodation space points. Assuming *BI* represents the nearest neighbor distance coefficient; *M* represents the area of the study region; *v* represents the number of sample space points; h_{ij} represents the distance between space point *i* and space point *j*; h_{AV} represents the average nearest neighbor distance; h_E represents the expected average distance, then the calculation formula of *BI* could be expressed as:

$$BI = h_{AV} / h_E = \frac{\sum_{i=1}^{v} \frac{\min\left(h_{ij}\right)}{v}}{0.5\sqrt{\frac{M}{v}}} \tag{1}$$

When *BI*>1, the tourist accommodation space points distribute uniformly and discretely; when *BI*=1, the space points distribute randomly; and when *BI*<1, the space points distribute in a clustered state.

For different research space scales, the tourism accommodation space points show different clustering patterns. In order to explore their spatial distribution characteristics under the conditions of various distance values, this paper adopted the multi-distance spatial clustering analysis method, namely the Ripley's K function to analyze the multi-distance spatial clustering characteristics of the spatial distribution of tourism resources and tourist accommodation spaces. Assuming: *r* represents the number of tourism resources in the study area; *h* represents the distance threshold; $s_{ab}(h)$ represents the distance between tourism resources *a* and *b* within distance *h*, then the calculation formula could be given by Formula 2 below:

$$RK\left(h\right) = M\sum_{a}^{r}\sum_{b}^{r}\frac{s_{ab(h)}}{r^2} \tag{2}$$

The spatial clustering characteristics *SK* (*h*) of various regional tourism resources within distance *h* can be calculated by the following formula:

$$SK\left(h\right) = \sqrt{\frac{SL\left(h\right)}{\pi}} - h \tag{3}$$

If *SK* (*h*)>0, the tourism resources in this region are in a clustered state; if *SK* (*h*)<0, the tourism resources in this region distribute dispersedly; if *SK* (*h*)=0, the tourism resources in this region distribute randomly.

This paper used the co-location quotient *Ω* to measure the spatial proximity characteristics of the spatial direction of regional tourism resources and tourist accommodation spaces in areas with high environmental quality, in this way, the closeness of the correlation between different tourist accommodation space points could be measured quantitatively. Assuming: $\Omega_{M\text{-}N}$ represents the co-location quotient of *M* attracted by *N*; $DN_{M\text{-}N}$ represents the number of *M*-type regional tourism resources that are close to the *N*-type tourism accommodation spaces; V_M and V_N represent the number of *M*-type regional tourism resources and the number of *N*-type tourism accommodation spaces; *V* represents the total number of tourism resources and tourism accommodation spaces, then, the calculation formula of *Ω* is given by Formula 4:

$$\begin{gathered} CLQ_{A\to B} = \frac{C_{A\to B} / N_A}{N_B / \left(N-1\right)} \\ \Omega_{M\to N} = \frac{DN_{M\to N} / V_M}{V_N / \left(V-1\right)} \end{gathered} \tag{4}$$

If $\Omega_{M\text{-}N}$<1, M tends to being away from N; if $\Omega_{M\text{-}N}$ =1, M and N distribute randomly; if $\Omega_{M\text{-}N}$>1, M tends to get close to N.

Then, from the perspectives of supple side and demand side, this paper considered the interaction between the number of regional tourism resources and the tourist accommodation space points, and adopted the 2-step floating catchment area (2SFCA) method to carry out the two searches. In the first search, search the study area, count the number, and calculate the ratio of the number of tourism resources to the number of tourist accommodation space points G_Q. Assuming: A_l represents the number of tourist accommodation space points; O_m represents the number of tourism resources within search domain m; h_{lm} represents the walk distance between locations l and m, then the calculation formula of G_Q is shown as Formula 5:

$$G_Q = \frac{O_m}{\sum_{l\in\{h_{lm}\le h_0\}} A_l} \tag{5}$$

In the second search, search the study area, count the number, calculate the ratio of the number of tourism resources to the number of tourist accommodation space points, and sum up. Assuming: $M^J{}_m$ represents the spatial accessibility of tourism resources within tourism accommodation space area n, the greater the value of m, the better the spatial accessibility of space area n; G represents the ratio of the number of tourism resources to the number of tourist accommodation space points within search domain m in the tourism accommodation space area n; and k_{nm} represents the travel distance between space locations n and m, then the calculation formula of $M^J{}_m$ is shown as Formula 6:

$$M_m^J = \sum_{m\in\{k_{nm}\le k_0\}} G_j = \sum_{j\in\{k_{nm}\le k_0\}} \frac{O_m}{\sum_{l\in\{k_{nm}\le d_0\}} A_l} \tag{6}$$

3. Spatial Distribution Characteristics of Tourist Accommodation Spaces

There’re three common spatial distribution patterns of space points: the clustered type, the uniform type, and the random type. This paper employed the nearest neighbor index method to study the spatial distribution patterns of tourist accommodation space points, that is, to describe and measure the proximity of tourist accommodation space points. In this paper, the ratio of average nearest neighbor distance to theoretical nearest neighbor distance was defined as the nearest neighbor index, denoted as VG, this parameter can reflect the spatial distribution characteristics of tourist accommodation space points. Assuming: $g^*{}_i$ represents the average nearest neighbor distance; g_F represents the theoretical nearest neighbor distance; q represents the number of space points, then the calculation formula of VG is shown as Formula 7:

$$VG = \frac{g_i^*}{g_F}; g_F = \frac{1}{2\sqrt{q/M}} \tag{7}$$

If VG<1, the spatial distribution of tourist accommodation space points exhibits the clustered distribution pattern; if VG>1, it exhibits the uniform distribution pattern; if VG=1, it shows the random distribution pattern; if VG=0, it means that all tourist accommodation space points are concentrated in one point.

Spatial autocorrelation is mainly measured by the locations and attribute values of tourist accommodation space points, specifically, it includes the global spatial autocorrelation and the local spatial autocorrelation. For global spatial autocorrelation, the global Moran's index is used for clustering test; while for local spatial autocorrelation, the local Moran’s index is used for clustering test, and the relevant formula is given by Formula 8:

$$M.I = \frac{\sum_{i=1}^{q}\sum_{j=1}^{q} S_{ij}(c_i - \bar{c})(c_j - \bar{c})}{U^2 \sum_{j=1}^{q} S_{ij}} \tag{8}$$

Assuming: c_i and c_j represent observed values in the i-th and j-th area units; S_{ij} represents the spatial weight matrix, which is a binary function that describes whether two spatial areas are adjacent, 1 indicates yes, and 0 indicates no. The value range of Moran’s index $M.I$ is [-1, 1]. If the value of $M.I$ > 0, it indicates that the areas with more or less tourist accommodation space points exhibit a clustered state; the closer the value of $M.I$ to 1, the more obvious the clustering of tourist accommodation space points; if value of $M.I < 0$, it indicates that there is a significant difference in the number of tourist accommodation space points between the study area and the surrounding area, the closer the value of $M.I$ to -1, the more obvious the difference.

In order to accurately measure the uniformity of tourism resource distribution in the study area, this paper analyzed the differences in the distribution of tourist accommodation space points in different regions and sub-regions based on the Gini coefficient and explored the law of space point distribution in different regions and in the entire study area. Assuming: ϕ_i represents the proportion of the number of regional tourism accommodation space points in the city's total number of tourism accommodation space points; SV represents the number of regions in the study area; TK represents the uniformity of tourism resource distribution in the study area, then the calculation formula of TK is:

$$GN = \frac{-\sum_{i=1}^{SV} \phi_i In \phi_i}{LnSV} \tag{9}$$

$$TK = 1 - GN \tag{10}$$

Generally, the value range of the Gini coefficient is [0, 1], and the size of the value is inversely proportional to the distribution uniformity of tourist accommodation space points, the greater the value, the higher the clustering degree of tourist accommodation space points. When the value of GN is 0, it means that the tourist accommodation space points distribute uniformly in each region; when the value of GN is 1, it means that the distribution of space points is too concentrated and extremely unbalanced; when $O<GN<0.2$, it means the distribution of space points presents an absolute equilibrium state; when $0.2<GN<0.3$ is, the distribution is relatively uniform; when $0.3<GN<0.4$, the distribution is relatively reasonable; when $0.4<GN<0.5$, the distribution is relatively uneven; and when $GN \geq 0.5$, the distribution is extremely unbalanced.

4. Determination of Optimal Accommodation Space Distribution Pattern

Starting from the perspective of environment information, this paper compared four types of tourist accommodation spaces: random type (randomly scattered), axis-belt type (scattered around axes and form belts), ray type (scattered like homocentric rays), and single-kernel type (clustered around each single kernel). The random type is developed based on the self-organization form, most of these accommodation spaces are built by the residents themselves. The axis-belt type is formed along rivers and roads that have advantages in locations and landscape resources, the accommodation spaces cluster around them but their development space is limited, so it is not the optimal type. The ray type is formed based on the advantages of central urban areas in traffic, resources, supporting facilities, and population density, etc., however, similar to the axis-belt type, its development space is limited as well, and it is not the optimal type either. The single-kernel type has the same advantages as the ray type, the accommodation spaces mainly distribute in urban, rural areas or in scenic spots, they form separate regions around each single cluster center, this type meets the development requirements of tourism industry based on environment information, and it is relatively ideal.

In the research on the spatial distribution characteristics of tourism accommodation space points based on environment information, to a certain extent, the concentration index of tourism resources with high environmental quality can reflect the concentration degree of spatial distribution of tourist accommodation space points under different environmental quality conditions (Figure 3). Assuming: FR represents the concentration index of tourist accommodation space points in the study area, its value range is [0, 100]. The closer the value of FR is to 100, the more concentrated the spatial distribution of tourism accommodation space points in regions with high environmental quality; the closer the value of FR is to 0, the more scattered the tourism accommodation space points. Assuming SC_i represents the number of tourist accommodation space points distributed in the i-th region, TI represents the total number of tourist accommodation space points distributed in the study area, SV represents the number of regions in the study area, then the calculation formulas are:

$$FR = 100 \times \sqrt{\sum_{i=1}^{SV} \left(\frac{SC_i}{TI} \right)^2} \tag{11}$$

$$\overline{FR} = 100 \times \sqrt{SV \left(\frac{\overline{SC}}{TI} \right)^2} \tag{12}$$

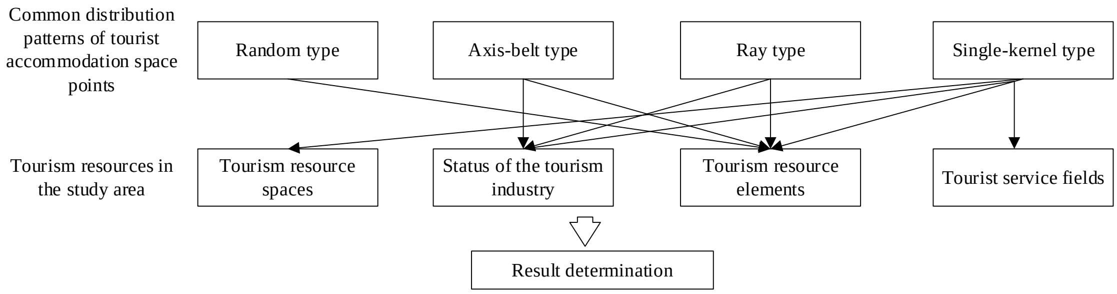

Figure 3. The determination process of optimal tourist accommodation space pattern based on environment information

When the concentration index of tourist accommodation space points is greater than the average value, it means that the spatial distribution of tourist accommodation space points is more concentrated in regions with better environmental quality; when the concentration index of tourist accommodation space points is smaller than the average value, it means that the spatial distribution of tourist accommodation space points is more dispersed in regions with better environmental quality.

In order to estimate the probability density based on the distance between the tourist accommodation space points to be estimated and the tourism resources, this paper used the kernel density estimation method and the spatial attributes of tourist accommodation space points to study their spatial distribution characteristics, so as to better describe the concentration degree of the spatial distribution of tourist accommodation space points. Assuming: $KD(c)$ represents the kernel density function at a spatial location c, y represents the analysis threshold, ξ represents the number of points within the analysis threshold, ω represents the default spatial weight kernel function, then, there is:

$$KD(c) = \frac{1}{\xi y} \sum_{i=1}^{\xi} \omega_q \left(\frac{c - c_i}{y} \right) \tag{13}$$

Buffer analysis can intuitively show the spatial distribution of tourist accommodation space points in regions with high environmental quality and its change trends with the distance, then, for a certain tourist accommodation space point X, Formula 14 gives the formula of its buffer analysis:

$$W = \{c \,\|\, h(c, U)\} \tag{14}$$

5. Experimental Results and Analysis

According to the development pattern of the tourism industry, in this paper, the study area was divided into four main regions: A, B, C, and D, and region A was further divided into sub-regions A1 and A2. From the perspective of each region, the number of tourist accommodation space points in region A was the most, accounting for 62.52% of the total number; followed by region B, accounting for 20.15%; while for regions C and D, the numbers were close, and neither exceeded 10%. According to these results, it’s known that the development scale of tourist accommodation space points in region A was significantly greater than that of the other regions (Table 1).

ArcGIS10.2 was used to calculate the nearest neighbor index of tourist accommodation space points in the study area and in each region, the results are given in Table 2. The calculation results passed the 1% significance test. The values of the nearest neighbor index of the spatial distribution of tourism accommodation spatial points in the entire study area and in each region were far less than 1, so the spatial distribution patterns of tourism accommodation space points were all the clustered type. The aggregation of tourist accommodation space points can cause the scale effect more easily, and it is conducive to the rational distribution of tourism resources with higher environmental quality.

Table 1. Number and proportion of tourist accommodation space points in each region

Region	A	B	C	D
Number of space points	8 1585	1 628	13 223	5 281
Proportion	62.52	20.15	7.18	9.57
Rank	2	1	4	3

Table 2. Nearest neighbor index of tourist accommodation space points in each region

Study area	Region	A	B	C	D
Average observed distance	932.8574	315.0195	1528.1473	1857.3269	3625.1748
Average expected distance	3628.5412	962.481	3928.4758	5284.7261	7485.2419
Nearest neighbor index	0.326282	0.301527	0.392547	0.574855	0.415827
Distribution pattern	Clustered type	Clustered type	Scattered type	Clustered type	Scattered type

Table 3. Gini coefficients of spatial distribution of tourist accommodation space points in different regions

Study area	Region	A	B	C	D
Gini coefficient	0.52	0.41	0.32	0.41	0.48
Distribution uniformity	0.41	0.77	0.69	0.77	0.51

Table 4. Concentration index of spatial distribution of tourist accommodation space points in each region

Study area	Region	A	B	C	D
Geographic concentration index (*G*)	26.35	41.28	36.14	33.51	62.59
Average geographic concentration index (*G*')	15.82	32.93	28.26	31.42	41.07

Table 5. Statistics of standard deviational ellipses and mean center data of different types of tourist accommodation spaces

Year	Type of the tourist accommodation space	Type I		Type II		Type III	
		Short	Long	Short	Long	Short	Long
2010	Longitude and latitude mean center	101.52	524.17	115.39	612.74	112.72	583.64
		21.0637	70.31	22.5824	94.16	24.1901	86.37
	Difference between long and short axes	0.3658	3	0.4185	5	0.3268	53.01
	Azimuth	185.02	75	162.03	87	142.51	89.5
2015	Longitude and latitude mean center	----		102.85	603.41	133.52	568.47
		----		23.6255	95.04	23.6248	85.62
	Difference between long and short axes	----		0.2518	4	0.4152	42.15
	Azimuth	----		0.0415	3	0.3625	110.27
2020	Longitude and latitude mean center	112.035	78.5	115.827	362.5	111.742	0.06
		23.85	76.24	23.16	715.2	22.57	556.23
	Difference between long and short axes	0.058	785	0.036	62	0.042	653
	Azimuth	11.52	174	9.326	845	1.623	805

Also, the Gini coefficients of the spatial distribution of tourist accommodation space points in the study area and in different regions were calculated, and the results are listed in Table 3, wherein the Gini coefficient of the study area was 0.52, and the degree of distribution uniformity was 0.41, indicating the spatial distribution of tourist accommodation space points in the study area was extremely unbalanced, and there's a huge difference in the number of tourist accommodation space points in each region. The Gini coefficients of regions A and C were both 0.41, and the degree of distribution uniformity was 0.77, indicating that the distribution of tourist accommodation space points in these two regions was reasonable, and the difference in the number of space points between the two regions was small. the Gini coefficient of region D was 0.48, which was the highest among the four regions, indicating that the spatial distribution of tourist accommodation space points in this region was unbalanced, and there's a big difference in the number of space points between the sub-regions. The Gini coefficient of region A was 0.32, which was the lowest among the four regions, indicating that the spatial distribution of tourism accommodation space points in this region was uniform, and there wasn't a big difference in the number of space points between the sub-regions. According to above analysis, on the whole, the spatial distribution of tourism accommodation space points in the study area was quite different, however, with in each region, the spatial distribution of tourism accommodation space points in each sub-region was not that different.

The concentration index of spatial distribution of tourist accommodation space points in the study area and in each region was calculated, the results are shown in Table 4. Overall speaking, the concentration index of tourism accommodation space points in the study area was greater than the average concentration index, the distribution of tourism accommodation space points was concentrated. In terms of the four regions, their concentration index values were all greater than the average value of concentration index, and the spatial distribution pattern of tourism accommodation space points in all these four regions was the clustered type.

Except for the increase in the number of tourist accommodation space points distributed with in distance interval 2~5 km, overall speaking, as the distance from 4A-level scenic spots increases, the number of tourist accommodation space points decreases, and this trend is clearly shown in Figure 4.

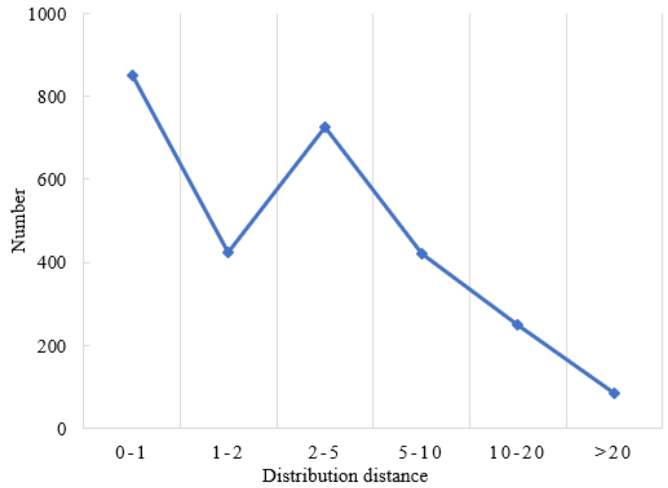

Figure 4. The change of the number of tourist accommodation space points distributed in the study area with the distance from 4A-level scenic spots

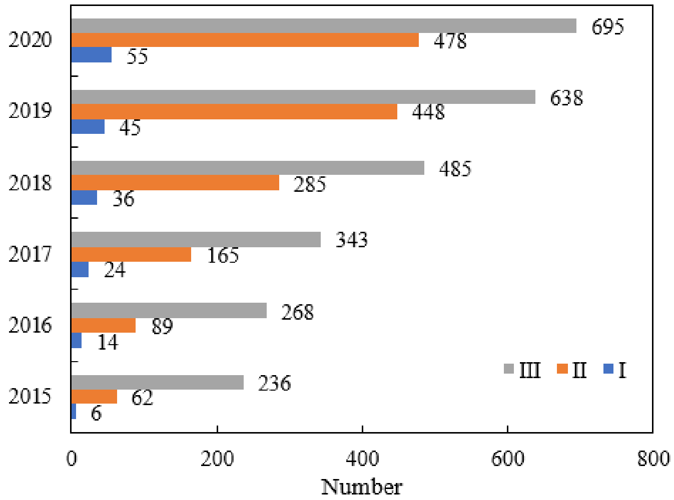

Figure 5. The change of the number of tourist accommodation space points over time

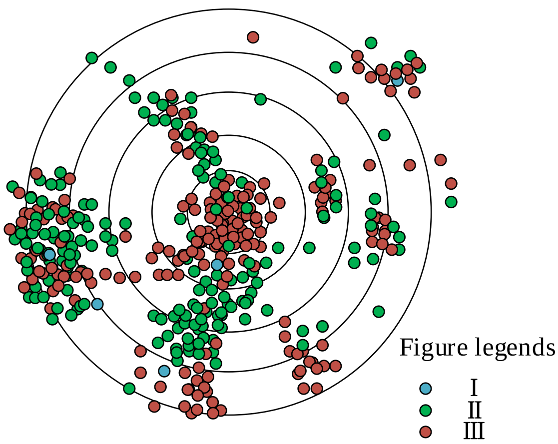

Figure 6. The spatial distribution pattern of tourism accommodation spaces in the study area

Figure 5 shows the change of the number of tourist accommodation space points over time. In terms of the overall number, from year 2015 to 2020, the number of tourist accommodation space points in the study area showed a fast growth, with an average increase of about 200 new points each year. The study area is a famous tourist destination in China, under the support of national tourism policy, tourism industry, as well as the relevant industries developed rapidly, especially the tourist accommodation industry. In terms of the type of tourist accommodation spaces, since 2015, the three types of tourist accommodation spaces: luxury type I, comfortable type II, and economic type III all showed fast development trend, and the growth rate peaked in 2017-2018.

With the help of the standard deviational ellipse tool in ArcGIS, taking year 2010, 2015 and 2020 as three time nodes, the directionality, dispersion degree, and evolution trajectory of the spatial distribution of the three types (luxury type I, comfortable type II, and economic type III) of tourist accommodation space points could be revealed, and the evolution law of their geographical space distribution could be figured out (Table 5). The long and short axes of ellipses represent the development direction and clustering range of the tourist accommodation space points. The greater the value difference between the long and short axes, the more obvious the directionality of clustering distribution; on the contrary, the smaller the value, the less obvious the directionality. Moreover, the shorter the short axis of the ellipse, the more obvious the directionality of the clustering distribution. Figure 6 gives the spatial distribution pattern of tourist accommodation spaces in the study area.

6. Conclusion

This paper studied the distribution characteristics and spatial correlation of tourist accommodation spaces based on environment information, gave the route of the correlation analysis, and analyzed the distribution characteristics of tourist accommodation spaces. Also, based on environment information, the determination process of the optimal distribution pattern of tourist accommodation spaces was given, and kernel density estimation was adopted to study the spatial distribution characteristics based on the spatial attributes of tourist accommodation space points.

The experimental results obtained in this research gave the number and proportion of tourist accommodation space points in each region, also, the Gini coefficient and concentration index of the distribution of tourist accommodation space points in each region were calculated, the change of the number of tourist accommodation space points distributed in the study area with the distance from 4A-level scenic spots, and the change trend of the tourist accommodation space points over time were plotted. After that, the directionality, dispersion degree, and evolution trajectory of the spatial distribution of different types of tourist accommodation space points were revealed, and at last, the distribution pattern of tourist accommodation space points in the study area was obtained.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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