# Analysis of Spatial Distribution Pattern of Main Tourism Resources in Hainan Island Based on GIS

**Jie-hua Song, Ping Wang and Cong-ju Zhao**

**Abstract** This chapter takes Hainan main tourism resources as research object, GIS as platform, and the nearest neighbor index ($R$), geographic concentration index ($G$), Gini coefficient (Gini), Equilibrium ratio (ER) as calculation model to quantitatively analyze spatial distribution characteristics of main tourism resources in Hainan Island. The result shows that the nearest neighbor index $R = 0.728$, illustrating main tourism resources in Hainan Island are of clustered distribution; geographic concentration index $G = 27.322$, illustrating main tourism resources in Hainan Island are spatially concentrated; gene coefficient Gini = 0.945 m, illustrating main tourism resources are of unbalanced distribution between administrative regions. Economic equilibrium ratio coefficient ER = 16.13, area balance ratio coefficient ER = 13.041, suggesting that economy and area play little influence on the distribution of main tourism resources in Hainan Island. To better compare the differences between all the cities and counties, the equilibrium ratio coefficient is decomposed, the result shows that the maximum value of area balance ratio coefficient is in Wushizhang, the minimum value is in Haikou, the maximum value of economic equilibrium ratio is in Sanya, the minimum value is in Ledong.

**Keywords** GIS · Hainan Island · Main tourism resources · Spatial distribution pattern

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## 1 Introduction

The research on spatial distribution characteristics of tourism resources has important significance for exploration of spatial distribution law of tourism resources, rational use and development of tourism resources, scientific planning tourism layout, optimizing tourism resources allocation, and providing scientific advice and decision making for tourism development. Hainan Island, an international tourism island, has extremely rich and unique tropical tourism resources, which spread all over 1,528 km of the coast and can be developed into a world-class tourist resort. Currently, scholars mainly focus on qualitative analysis of classification, evaluation, development and protection, and development strategy of Hainan tourism resources [1–7], but play little attention to quantitative research of the spatial structure of tourism resources in Hainan. Therefore, this chapter proposes to quantitatively analyze spatial structure of tourism resources in Hainan using survey data of Hainan tourism resources as basic data, ARCGIS as analysis platform, to reveal the spatial distribution of main tourism resources in Hainan, as well as provide decision-making basis for the evaluation and development of them.

## 2 Research Scope and Data Sources

Hainan province includes Hainan Island and Sansha Islands (islands and sea area of Xisha, Zhongsha, and Nansha). The scope of this study is Hainan Island; considering tourists tend to choose higher-class tourism destinations and take little attention to lower-class tourism destinations in large-scale tourism space [8], this chapter mainly takes those influential tourism resources (i.e., comprehensive tourism resources of national A-level scenic spots, main natural tourism resources, main humanities tourism resources, and national key cultural relics protection units) as research object to analyze the spatial structure of tourism resources. The research data includes Hainan Island administrative zoning map, relevant data of Hainan Island tourism resources, and the statistical yearbook of Hainan Province in 2010.

## 3 Analysis of Spatial Distribution Pattern of Main Tourism Resources in Hainan Island

In order to quantitatively show the distribution differences and pattern change of main tourism resources between administrative areas of Hainan Island, the administrative boundaries of the cities and counties in Hainan Island and the distribution center points of main tourism resources are extracted from Hainan Island administrative zoning map and tourism resource distribution map using

ARCGIS10.0 software. On this basis, the calculation models—the nearest neighbor index, geographic concentration index, Gini coefficient, and equilibrium ratio index—are used to analyze the spatial distribution characteristics of tourism resources in Hainan Island.

## 3.1 Distribution Types

Spatial distribution of points is usually divided into three types: "uniform distribution," "random distribution," and "clustered distribution." At present, the nearest neighbor index, neighborhood average, Lorenz curve, statistical number of cells are main methods for measuring spatial distribution pattern of points [9–12]. The most commonly used method is the nearest neighbor index method, whose formula is as follows:

$$R = \frac{\overline{r_1}}{\overline{r_E}}$$

$$\overline{r_E} = \frac{1}{2\sqrt{\frac{N}{A}}}$$

$\overline{r_1}$ is the average distance of each point with its nearest neighbor point, $\overline{r_E}$ is the nearest neighbor distance in theory, $N$ is the number of points, $A$ is area. $R$ indicates the distribution type of points. When $R = 1$, points are of "random distribution," when $R > 1$, points are of "uniform distribution," and when $R < 1$, points are of "clustered distribution." The calculations for main tourism resources in Hainan Island are that $\overline{r_1} = 4775.436$ m, $\overline{r_E} = 6555.0467$ m, $R = 0.728 < 1$, which indicate that main tourism resources in Hainan Island are of "clustered distribution" in space. See from Fig. 1, the distribution of main tourism resources in Hainan Island can be divided into two dusters: Haikou, Wenchang, Dingan, Qionghai, Wanning, Sanya, and Danzhou are clumped together into one duster, which are rich in main tourism resources; the other 11 cities and counties are clumped together into one duster, which are relatively insufficient in main tourism resources.

## 3.2 Spatial Distribution Balance

### 3.2.1 Concentration Degree

Geographic concentration index is an important index to measure the degree of concentration of geographic objects. The formula is as follows:

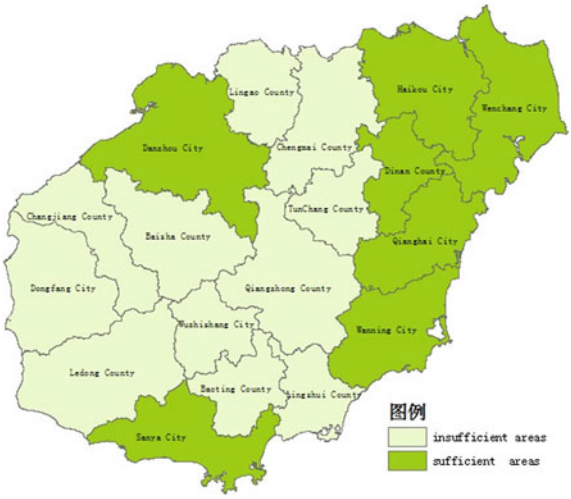


**Fig. 1** Duster diagram of main tourism resources in Hainan Island

$$G = 100 \times \sqrt{\sum_{i=1}^{K} \left(\frac{N_i}{N}\right)^2}.$$

In the formula: $G$ is the geographic concentration index, $N_i$ is the quantity of main tourism resources in the region $i$, $N$ is the total quantity of main tourism resources, and $K$ is the number of regions. The value of $G$ is more close to 100, main tourism resources' distribution is more concentrated; the value of $G$ is more close to $G = 100 \times \sqrt{\frac{1}{K}}$, main tourism resources' distribution is more uniform. According to the above formula, concentration index of main tourism resources in Hainan Island is 27.322 (greater than 7.071, the value when main tourism resources in Hainan Island is uniform distribution), which indicates main tourism resources in Hainan Island are concentrated in spatial distribution.

### 3.2.2 Equilibrium Degree

The Gini coefficient is an important geography method to describe spatial distribution of discrete areas, and can be used to compare regional distribution differences between different subjects, so as to find the distribution regularity of the regions. In theory, the value of Gini coefficient is between 0 and 1, the higher the greater of the concentration degree. The calculation formula is as follows:

$Pi$ is the proportion number of main tourism resources in $i$ region accounted for total numbers of main tourism resources, $K$ is the total number of regions, and $C$ is the distribution uniform degree. According to the above formula, the Gini coefficient of main tourism resources in Hainan Island is 0.945, the value of $C$ is 0.055,

which show that main tourism resources in Hainan Island are of concentrated and spatially unbalanced distribution between administrative regions.

## *3.3 Spatial Distribution Difference*

### 3.3.1 Analysis of Overall Difference

Because of the existence of some differences of administrative area, it is necessary to consider the differences in itself to better reflect the spatial distribution of tourism resources in Hainan Island. Based on this, the area equilibrium ratio index and economy equilibrium ratio index are used to calculate the equilibrium of spatial distribution, the formulae is as follows:

In the formula, ER is equilibrium ratio index; $R_i$ is equilibrium ratio of main tourism resources in the $i$ administrative area; $X_i$ is the number of main tourism resources in $i$ administrative area; $X$ is the total number of main tourism resources; $Ai$ is the area (or economic index) of the $i$ administrative region; $A$ is the total area (or total economic output) of the administrative regions; and $K$ is the total number of administrative regions. If the distribution ratio of main tourism resources in the administrative areas is consistent with the area ratio (or economic ratio) of study areas, the equilibrium ratio is 0. Therefore, the closer to 0 the equilibrium ratio is, the more balanced the spatial distribution of main tourism resources is. According to the above formula, the economic equilibrium ratio coefficient for main tourism resources in Hainan Island is 16.13, area balance ratio coefficient is 13.041, indicating that the economy and area play small influence on the distribution of tourism resources in Hainan Island.

### 3.3.2 Analysis of Regional Differences

As it is difficult to find the internal differences between all cities and counties from the overall balance ratio, the equilibrium coefficient is broken down to get equilibrium ratios of all cities and counties (Figs. 2, 3), which is beneficial for analysis of their contribution degree to equilibrium and distribution coordination between tourism resources. As can be seen from Fig. 2, economic equilibrium coefficient of 13 cities and counties are greater than 0, indicating that this 13 cities and counties have the advantage in economy, where the maximum value is 2.765, in Wuzhishan City, followed by Baoting County, Ding'an County, Qiongzhong County, Baisha County, Wenchang City, Wanning City, Lingshui County, Danzhou City, Qionghai, Tunchang County, Sanya City, and Changjiang County, whose coefficients are 1.7585, 1.539, 1.451, 0.953, 0.932, 0.818, 0.775, 0.461, 0.351, 0.171, 0.0425, and 0.039; the remaining five cities' and counties' economic equilibrium ratio are less than 0, indicating that this five cities and counties are relatively lack advantage, of which the smallest value is −2.34, in Haikou. The area equilibrium

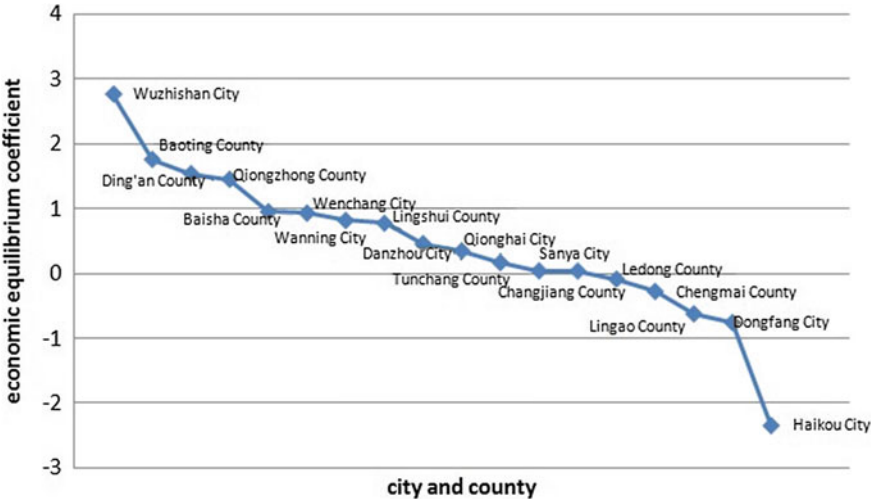


**Fig. 2** Economic equilibrium coefficient of main tourism resources in each city and country

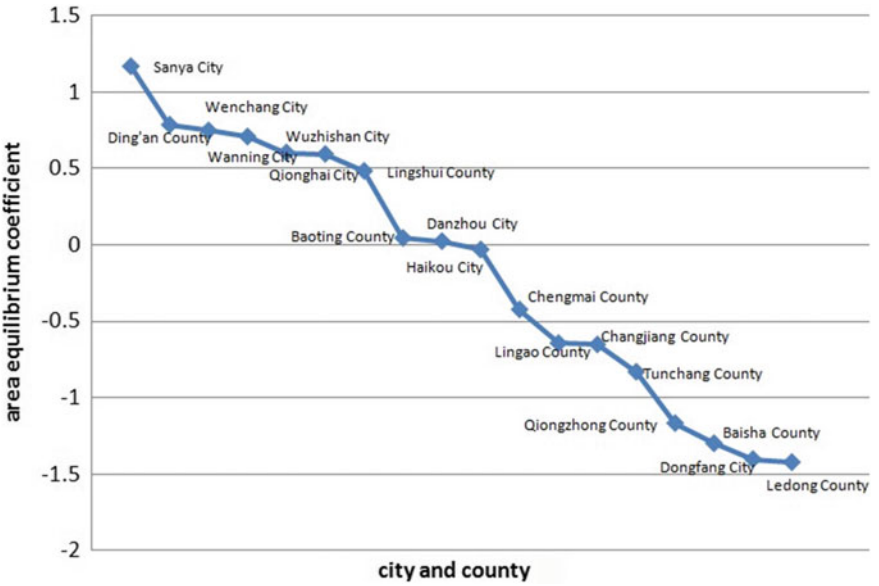


**Fig. 3** Area equilibrium coefficient of main tourism resources in each city and country

coefficients of nine cities and counties are greater than 0, indicating that this nine cities and countries have the advantage in area, where the maximum value is 1.169, in Sanya, followed by Ding'an County, Wenchang City, Wanning City, Wuzhishan City, Qionghai City, Lingshui County, Baoting County, and Danzhou

City, whose coefficients are 0.7859, 0.748, 0.708, 0.6038, 0.594, 0.483, 0.0436, and 0.022; the other nine cities' and counties' area equilibrium ratio are less than 0, indicating that these nine cities and counties relatively do not have advantage, of which the smallest value is −1.425, in Ledong County.

## 4 Conclusion

The nearest neighbor index $R$ of main tourism resources in Hainan Island is 0.728, explaining that main tourism resources in Hainan Island are of clustered distribution pattern in space; Sanya has a clear lead in the number and intensity of main tourism resources, which is closely related with Sanya's advantaged geographic condition, climate, regional culture, and others; the second city is Wenchang, one of Hainan tourism powerhouse, integrating eight tourism resources—sunshine, sea, beach, vegetation, air, island, flirtatious expressions, and countryside. So, it is rich in main tourism resources; the one also rich in main tourism resources is Danzhou City, which is a county-level city with the largest land area and the largest population of Hainan Province, and has the world of Lanyang hot springs, Shihua water tunnel, Guanyin cave, and so on.

From the perspective of spatial distribution balance of tourism resources in Hainan Island, the geographic concentration index $G = 27.322$, explaining main tourism resources in Hainan Island are concentrated in the spatial distribution; gene coefficient Gini = 0.945 m, explaining the distribution of main tourism resources in Hainan Island is concentrated and spatially unbalanced between administrative regions.

From the perspective of the balanced ratio of main tourism resources, economic equilibrium ratio coefficient ER = 16.13, area balance ratio coefficient ER = 13.041, suggesting that economy and area play small influence on the distribution of tourism resources in Hainan Island. The decomposition of equilibrium coefficient by cities and counties shows that the biggest area balance ratio coefficient is in Wuzhishan City, the smallest is in Haikou city, the biggest economic equilibrium ratio is in Sanya, and the smallest is in Ledong.

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