Evaluation on the Development Level and Spatial Pattern of Tourism Industry in Guangdong-Hong Kong-Macao Greater Bay Area Based on Spatial Dependence Analysis

Dengbin Huang[1*], Yangchun Song[2], Pengliang Qiao[1]

[1]School of Management, Guangzhou College of Technology and Business, Guangzhou, China

[2]School of Accounting, Guangzhou College of Technology, Guangzhou 510850 China

Abstract:

In this paper, firstly, the evaluation indicator system of the development level of Guangdong-Hong Kong-Macao Greater Bay Area tourism industry was established based on the principal component analysis method. Secondly, from the three dimensions of tourism support, tourism demand supply and tourism openness, the development level of tourism industry in Guangdong-Hong Kong-Macao Greater Bay Area was comprehensively evaluated. Then, based on the spatial dependence analysis, the spatial distribution characteristics and corresponding classification of tourism industry in 11 cities of Guangdong-Hong Kong-Macao Greater Bay Area in three dimensions of tourism support, tourism demand supply and tourism openness were explored. Finally, the research results showed that: (1) The development level of tourism industry in Guangdong-Hong Kong-Macao Greater Bay Area has obvious spatial differentiation characteristics, and the overall comprehensive scores of the three dimensions show the spatial characteristics of decreasing from "Shenzhen-Hong Kong-Guangzhou-Foshan" as the center axis to the surrounding; (2) The development level of tourism industry in Guangdong-Hong Kong-Macao Greater Bay Area has a certain degree of spatial dependence on the whole; (3) Tourism support in Guangdong-Hong Kong-Macao Greater Bay Area is negatively correlated with tourism demand & supply, positively correlated with tourism openness, and positively correlated with the comprehensive development level of the three indicators. (4) In Guangdong-Hong Kong-Macao Greater Bay Area, tourism support, tourism demand supply, tourism openness and comprehensive development level of the three dimensions show obvious cluster characteristics in space.

Keywords: principal component analysis; spatial dependence; development level evaluation; Guangdong-Hong Kong-Macao Greater Bay Area; tourist industry.

I. INTRODUCTION

The Guangdong-Hong Kong-Macao Greater Bay Area (GBA) is a city cluster composed of Zhaoqing, Jiangmen, Foshan, Zhuhai, Hongkong, Shenzhen, Guangzhou, Macau, Zhongshan, Dongguan and Huizhou, with a land area of 55,910 square kilometers, a total population of 72.6693 million people in 2019, a total production value of 11,600.16 billion yuan, and a total import and export value of 14,332.67 billion yuan. The GBA has a total economy ranking first among the world four Greater Bay Areas, and an annual tourism income of more than 1 trillion yuan in 2019, receiving more than 400 million tourists [1]. The construction of Guangdong-Hong Kong-Macao Greater Bay Area is a national strategy. As a strategic industry, tourism has strong openness, drive and compatibility among numerous national economic industries, whose fundamental attribute is spatial attribute, so spatial optimization is the fundamental guarantee of regional tourism development. Besides, tourism, as a first-mover industry in the GBA varies culturally and naturally among the 11 cities in the whole area, so as to form tourism attractions with different characteristics and various complementation, thus further promoting the integration and development of the tourism industry in the Area. The development level of tourism economy has a significant and far-reaching impact on the development level of the whole regional economy within a certain time and space. The GBA has become the bay area with the largest economy in the world, in which the tourism industry has always been one of the important green industries to promote the development of regional economy. It is of vital theoretical significance and practical value to objectively quantify the development level and spatial distribution characteristics of tourism in the GBA by using the method of spatial statistical analysis, and to give scientific guidance from the perspective of spatial effect, which is also the research direction and possible marginal contribution of this paper.

II. LITERATURE REVIEW

The research on regional tourism spatial economy abroad started earlier than China's and began in the 1960s. Among the classical regional theories, Johan Heinrich von Thunen (1826), a famous German economist, made a systematic and theoretical summary on the spatial differentiation of agriculture [2]. Then Alfred Weber (1909) put forward the industrial location theory, hoping to explore the location principle of industrial production activities to explain the reasons for the emergence of urban population and industrial cluster and the large-scale migration of population among regions [3]. The classical theories of market location put forward by Muish and theory of central place by Christopher were later widely used in the study of spatial location of tourism industry. Foreign studies on the spatial structure of regional tourism

include the analysis of the constituent elements, the characterization and evolution of the spatial structure of tourism, the mechanism of the spatial distribution of regional tourism. However, there are relatively few studies on the development level of tourism from the perspective of tourism spatial economy, and the research focuses are mainly on the micro-aspects of tourism resources evaluation, tourism products evaluation, tourism supporting environment evaluation and tourism competitiveness evaluation, etc. Besides, there are few reports on the evaluation of tourism development level from the meso-regional perspective [4].

Domestic scholars' research on regional tourism spatial economy began in the 1980s, mainly focusing on the identification of tourism spatial structure elements[5], Huang Hua, et al., 2012), spatial distribution characteristics of tourism elements[6], regional tourism spatial planning research[7], spatial distribution mechanism of tourism supply factors, spatial distribution mechanism of tourists [8], study on spatial behavior motivation of tourists [9, 10], study on spatial relationship between tourist source and destination, research on the spillover of regional tourism economy [11], analysis on the spatial difference of influencing factors of provincial tourism [12]. However, in recent years, domestic scholars have relatively increased their research on the development level of tourism industry from the perspective of tourism spatial economy, mainly focusing on the spatial dislocation between tourism resources and tourism economic development [13], spatial spillover effect and spatial characteristics of tourism industry development [14], study on the spatio-temporal evolution law and spatial structure optimization of tourism development [15, 16], study on the change of tourism policy and the spatio-temporal response of regional tourism industry [17], measurement of high-quality development level of tourism and spatio-temporal evolution analysis [18], factors affecting the development of tourism industry and spatial dislocation [19-21], the impact of tourism on economic growth and its spatial difference effect [22], etc. In terms of research scale, relevant literatures are mainly reflected in macro-national scale and meso-regional scale, as well as micro-city scale or county scale, covering case areas mainly including Northeast China, six central provinces, 11 coastal provinces, southeast Guizhou, Yangtze River Economic Belt, Pearl River Delta, Silk Road Economic Belt, Guangdong, Guangdong-Hong Kong-Macao Greater Bay Area, etc. From the perspective of spatial analysis methods, spatial statistical analysis and spatial econometric analysis are mainly used by most scholars to explore the spatial correlation and spatial heterogeneity of tourism industry.

To sum up, at present, the related research on the evaluation of regional tourism development level at home and abroad has achieved fruitful results, and scholars at home and abroad regard the evaluation of tourism support system, tourism supply and demand, and tourism competitiveness as important related contents of the evaluation of tourism development level. In the comprehensive evaluation of the development level of tourism industry at the

meso-scale, it is mainly clustered in the northeast, central and southeast regions, but relatively few in the western region, and there is relatively high homogeneity among the evaluation micro-cases, but there is still a lack of relevant achievements from the perspective of Guangdong-Hong Kong-Macao Greater Bay Area, which has a relatively high degree of internal heterogeneity. Although there are many and complicated indicators in the selection of evaluation indicators for regional tourism development level, most of them can be classified into three major aspects: tourism demand, tourism supply and tourism support, so as to reflect the important supporting role of these three indicator systems. There are few reports on the research results based on the evaluation of the spatial pattern of development level in the spatial research of tourism industry in the GBA.

Based on this, 11 cities in the GBA were selected as the research objects in this paper. Firstly, SPSS26.0 statistical analysis software and principal component analysis method were used to establish the evaluation indicator system of the development level of tourism industry in the Area. Then, the development level of tourism industry in 11 cities in the Area was comprehensively measured and evaluated from three dimensions: tourism support, tourism supply and tourism opening degree. Next, based on the spatial dependence analysis, the spatial distribution characteristics and corresponding classification of tourism industry in 11 cities of the area were explored in three dimensions: tourism support, tourism demand supply and tourism opening degree. Finally, according to the research results, the corresponding countermeasures and suggestions were put forward.

III. RESEARCH METHODS AND DATA SOURCES

3.1 Research Methods

3.1.1 Principal component analysis

In this paper, firstly, the analyzed data are standardized by range method. Secondly, the principal component analysis method provided by SPSS26.0 statistical analysis software was used to analyze the dimension reduction factors, and orthogonal rotation was used to extract the common factors that can comprehensively and objectively reflect the characteristics of the development level of tourism industry in the GBA. Finally, the comprehensive score was calculated according to the contribution results of each factor, so as to provide data support for the spatial dependence analysis part below. The calculation formula for the score of the development level of the tourism industry in the Area is as follows:

$$F_n = \sum_{j=1}^{m} P_j Z_{nj} \qquad (1)$$

Where,

F_n = the development level score of the n-th city in the GBA; (1)

P_j = the variance contribution of the extracted principal component variables; (2)

Z_{nj} = the score of j principal component in the n-th city of the area. (3)

3.1.2 Spatial dependence analysis

Spatial dependence is also known as spatial correlation. Because the spatial attribute of tourism industry in the GBA is related to the development level for summary analysis, the spatial dependence analysis method in spatial statistics was adopted. The spatial dependence analysis method is an analysis tool to verify whether there is a correlation between a feature element in a geospatial unit and adjacent spaces [23]. In this paper, it is used to verify whether there is a spatial dependence or correlation on the development level of tourism industry among 11 cities in the GBA. In addition, based on spatial autocorrelation analysis, the development level of tourism industry in each city in the GBA was objectively explored by the impact direction and degree of the surrounding cities in the Area.

3.1.3 Global spatial correlation analysis

In this paper, based on the global spatial autocorrelation analysis, the development level scores and comprehensive scores of the three dimensions of tourism industry in 11 cities in the GBA were objectively analyzed in the whole Area, so as to further explore the overall spatial differences and correlation degree of tourism industry in 11 cities there. Therefore, based on the calculation of global Moran's I index of univariate, further analysis was carried out, and the specific operation formula is as follows [24]:

$$I = \frac{n}{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}} \times \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} \left(X_i - \overline{X} \right) \left(X_j - \overline{X} \right)}{\sum_{i=1}^{n} \left(X_i - \overline{X} \right)^2} \qquad (2)$$

Where,

W_{ij} = the spatial weight matrix; (1)

$$X_i = \text{a certain development level score of city } i \, ; \, (2)$$

$$\bar{X} = \text{the average value of the score. (3)}$$

Generally speaking, Moran's I index is within the range of [-1, 1], and a positive value (greater than 0) indicates that the development level score or comprehensive score is spatially clustered and significant. If the final calculated index result is closer to 1, it indicates that the clustering degree of similar cities is higher, that is, the high score is adjacent to the high score, and the low score is adjacent to the low score. If the final calculated index result is less than 0 (negative value), it means that the development level score or comprehensive score shows that the difference scores are clustered and significant in space. If the final calculated index is closer to -1, it means that the clustering degree of difference units is higher, that is, the low score and low comprehensive score are adjacent to the high score and high comprehensive score. If the Moran's I index result is 0, it indicates that the city score and comprehensive score are in a random distribution in space.

3.1.4 Local spatial correlation analysis

Local spatial autocorrelation analysis can be used to objectively measure the degree of local spatial dispersion and aggregation between the tourism industry development level score of each city in the GBA and the surrounding cities. However, the above global spatial autocorrelation analysis can only be used to measure the spatial distribution characteristics of the development level score and comprehensive score of the urban tourism industry within the scope of the GBA, rather than the degree of spatial dependence within the local space, so that the local spatial autocorrelation analysis should be used to supplement it below. The methods of local autocorrelation analysis mainly include Moran scatter plot and local index of spatial connection (LISA) [25], both of which were used for fitting calculation in this paper, and the specific calculation formula is as follows:

$$I_i = Z_i \sum_{i=1}^{n} W_{ij} Z_j \tag{3}$$

In the formula, Z_i means the score of the development level of tourism industry in city i; the spatial weight matrix is expressed by W_{ij}, $\sum_{n}^{i} W_{ij} = 1$, $i \neq j$. When the calculation result I_j is greater than 0, then Z_i is greater than 0, indicating that the city is in the high-high quadrant, that is, a city with high scores is surrounded by cities with high scores; Or Z_i is less than 0,

indicating that city i is in the low-low quadrant, that is, a low-score city is surrounded by low-score cities. When the calculation result I_i is less than 0, then Z_i is greater than 0, it indicates that a city with high score is surrounded by cities with low scores, that is, the city i is in the high-low quadrant; Z_i is less than 0, indicating that a city with a low score is surrounded by cities with high scores.

3.2 Data Sources

As the GBA is an urban cluster composed of 11 cities including Dongguan, Guangzhou, Shenzhen, Foshan, Hong Kong, Zhuhai, Macau, Zhaoqing, Jiangmen, Zhongshan and Huizhou, the cross-sectional data index in this paper refers to the index data of tourism support, tourism demand & supply, and tourism openness of these 11 cities in 2018. The reason for choosing the above three-dimensional indicators is mainly due to the comprehensive screening and determination based on the actual availability of indicators data of each city in the GBA and the construction of the evaluation indicator system for the development level of the tourism industry and the analysis of spatial dependence. It also refers to the three-dimensional indicators frequently used by scholars in China when studying the development level of the tourism industry in different regions in the previous literature review For example, scholars Zhang Mingyue et al. [4] put forward three dimensional indicators when studying the Yangtze River Economic Belt region, namely, tourism supply, tourism demand and tourism support. However, combined with the special situation of the GBA with a high degree of openness and learning from scholars Jiao Ronghui and Bao Fuhua et al[26]., it was found that there is a significant positive influence between export trade and inbound tourism. Moreover, there are relatively consistent spatial distribution characteristics between the two variables of import and export trade and inbound tourism. According to this, in this paper, nine criteria of three dimensions, namely, tourism support, tourism demand supply and tourism opening degree, were finally optimized to evaluate, measure and analyze the development level of tourism industry in the Area. The specific data comes from Guangdong Statistical Yearbook, Macau Statistical Yearbook, Hong Kong Statistical Yearbook, Guangzhou Statistical Yearbook, Foshan Statistical Yearbook, Zhongshan Statistical Yearbook, Zhaoqing Statistical Yearbook, Shenzhen Statistical Yearbook, Zhuhai Statistical Yearbook, Jiangmen Statistical Yearbook, Huizhou Statistical Yearbook, Dongguan Statistical Yearbook and Guangdong-Hong Kong-Macao Greater Bay Area Statistical Network, etc. from 2018 to 2020.

IV. EVALUATION ON THE DEVELOPMENT LEVEL OF TOURISM INDUSTRY IN THE GBA BASED ON SPATIAL DEPENDENCE ANALYSIS

4.1 Evaluation Indicator System of Tourism Industry Development Level in the GBA

In this paper, firstly, the range method was used to standardize the data, and then the principal component analysis was used to carry out the factor dimension reduction analysis. Before the factor dimension reduction analysis, the precondition test of exploratory factor analysis was carried out, in which the KOM value obtained by the final test was 0.604, ranging from 0.6 to 0.7, which was greater than 0.5, and the P value of Bartlett spherical test was close to 0.000, indicating that the indicators selected in this paper can be analyzed by principal component analysis. In addition, it should be added that the reason why the data did not reach the high KOM value in the precondition test is mainly due to the small number of cases in the study area, which does not affect the reliability of the statistical analysis results in this paper [27]. The total variance of explanation was 96.214%, which met the criterion of factor validity. Finally, three principal component factors were obtained. According to the analysis of the principal factor load matrix (Table I): ①Four indicators, namely, the number of patent applications A1, the number of permanent residents A2, the retail sales A3 and the number of mobile phone users A4, were a class of principal factors, which were summarized as representing the tourism support F1. ② The total tourism revenue B1, the number of museums B2 and the number of star-rated hotels B3 were summarized as tourism demand supply F2. ③ The two indicators of export value C1 and import value C2 were a class of principal factors, which were summarized as the degree of tourism openness F3. To sum up, the three principal component factors finally extracted after the rotation covered the three dimensions of the development level of tourism industry, namely, the development level F1 tourism support, the development level F2 tourism demand supply and the development level F3 tourism opening degree, so as to measure the development level of tourism industry in the Area based on multi-dimensional comprehensive evaluation. According to Bartlett's method, the scores of each factor were calculated, and the development level scores and comprehensive score data of three tourism industries of 11 cities in the GBA were further obtained for the following analysis of spatial distribution characteristics.

TABLE I. Principal component factors and rotated load values of tourism industry development level

First-level indicators	Second-level indicators	Principal factor load values		
		F1	F2	F3
Tourism support F1	Number of patent applications A1	0.956	0.212	-0.087

	Number of permanent residentsA2	0.936	0.049	0.296
	Retail sales A3	0.879	0.414	0.204
	Number of mobile phone users A4	0.856	0.336	0.356
Tourism supply& demand F2	total tourism revenue B1	0.169	0.945	0.267
	Number of museums B2	0.294	0.899	-0.067
	Number of star-rated hotels B3	0.248	0.763	0.507
Tourism openness F3	Amount of exports C1	0.108	0.170	0.973
	Amount of imports C2	0.236	0.135	0.955

4.2 Spatial Distribution Characteristics of Tourism Industry Development Level in the GBA

The spatial characteristics of the development level of tourism industry in the GBA were studied based on tourism support, tourism demand & supply and tourism openness. Therefore, the spatial distribution of the three tourism industries and their comprehensive development level in the Area was obtained by using the five-digit method. (Figs. 1-4)

4.2.1 Spatial distribution characteristics of tourism support level in the GBA
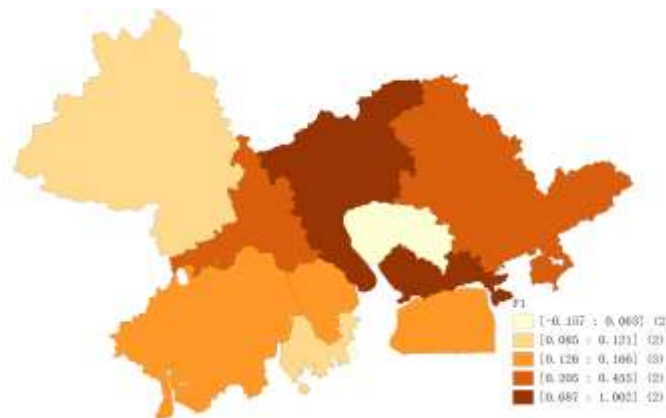
Fig 1: Spatial distribution of tourism support (F1) in the Area

The analysis by using GeoDa software shows that the scores of tourism support level in the GBA specifically present five grades with distinct levels. Shenzhen and Guangzhou have the spatial distribution characteristics of tourism support level (F1) in the first grade (higher), Foshan and Huizhou in the second grade (high), Hong Kong, Zhongshan and Jiangmen in the third grade (middle), Zhuhai and Zhaoqing in the fourth grade (low), Dongguan and Macau in the fifth grade (lower) (Fig. 1). The cities with high and low scores of tourism support level in the Area show scattered spatial distribution characteristics as a whole.

4.2.2 Spatial distribution characteristics of tourism demand & supply in the GBA
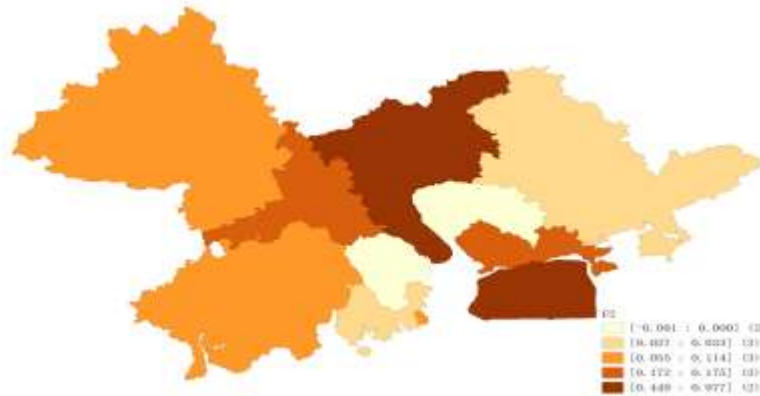

Fig 2: Spatial distribution of tourism demand & supply (F2) in the Area

The analysis by using GeoDa software shows that the scores of tourism demand & supply level in the GBA specifically present five grades with distinct levels. Hong Kong and Guangzhou have the spatial distribution characteristics of tourism demand & supply level (F1) in the first grade (higher), Foshan and Shenzhen in the second grade (high), Jiangmen, Macao and Zhaoqing in the third grade (middle), Zhuhai and Huizhou in the fourth grade (low), Dongguan and Zhongshan in the fifth grade (lower) (Fig. 2). The overall score of tourism demand & supply in the Area show scattered spatial distribution characteristics among various cities as a whole (Fig. 2).

4.2.3 Spatial distribution characteristics of tourism openness in the GBA
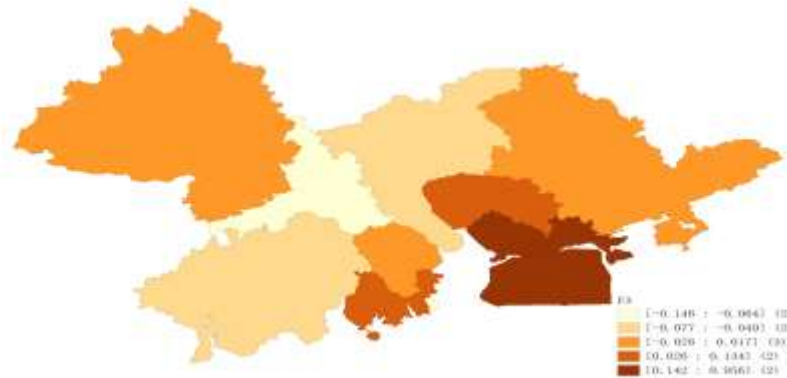
Fig 3: Spatial distribution of tourism openness (F3) in the Area

The analysis by using GeoDa software shows that the scores of tourism openness level in the GBA specifically present five grades with distinct levels. Hong Kong and Shenzhen have the spatial distribution characteristics of tourism openness level (F1) in the first grade (higher), Dongguan and Zhuhai in the second grade (high), Huizhou, Zhongshan and Zhaoqing in the third grade (middle), Jiangmen and Guangzhou in the fourth grade (low), Foshan and Macao in the fifth grade (lower) (Fig. 3). The scores of tourism openness level in the Area decreased from the southeast cities to the northwest cities as a whole (Fig. 3).

4.2.4 The spatial distribution characteristics of comprehensive scores for tourism support level, tourism demand and supply level, and tourism openness level in the GBA

The analysis by using GeoDa software shows that the comprehensive scores of tourism support, tourism supply& demand, and openness level in the GBA specifically present five grades with distinct levels. Guangzhou and Hong Kong have the comprehensive score in three dimensions in the first grade (higher), Shenzhen and Foshan in the second grade (high), Huizhou, Jiangmen and Zhongshan in the third grade (middle), Zhaoqing and Zhuhai in the fourth grade (low), Dongguan and Macao in the fifth grade (lower) (Fig. 3). Overall, the comprehensive scores of the three dimensions of the GBA show the spatial characteristics of decreasing from Shenzhen-Hong Kong-Guangzhou-Foshan to the surrounding cities (Fig. 4).
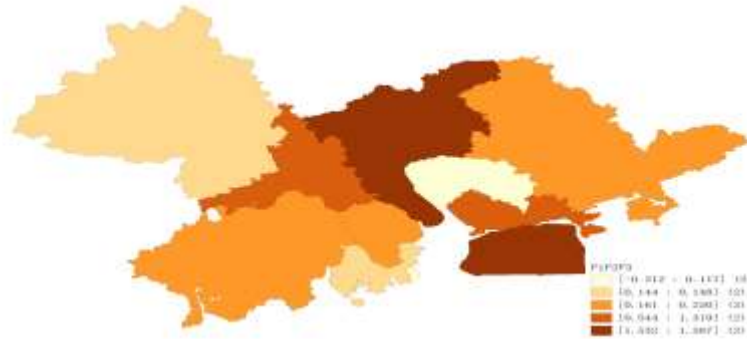
Fig 4: Spatial distribution of tourism support level (F1), tourism demand & supply level (F2) and tourism openness level (F3) in the GBA

As a whole (Table II), the average proportion of tourism support level to the comprehensive level of tourism support, tourism demand & supply, and tourism openness in the GBA is the highest (65.2%), that of openness (37.0%) is in the middle, and that of demand and supply level (28.5%) is the lowest. Comparatively speaking, the average absolute deviation (AAD) and dispersion coefficient (COD) of the proportion of tourism openness to the tourism support, tourism demand & supply, tourism openness comprehensive level are higher than those of the proportion of tourism support to the tourism support, tourism demand & supply, tourism openness comprehensive level in the GBA, that is, the dispersion degree is high, which can also be proved by the coefficient of variation (COV), indicating that the difference in the tourism support level of the GBA is the smallest among the 11 cities in the Area, while the difference in the development level of tourism demand &supply, tourism openness in the Area is larger Therefore, it is concluded that the average proportion of tourism support level to the comprehensive level of tourism support, tourism demand & supply, and tourism openness in the GBA is the highest (65.2%), but with a small difference. While the average proportion (37.0%) of tourism demand & supply level to the comprehensive level of tourism support, tourism demand & supply and tourism openness is in the middle, but with the largest difference. The average proportion (28.5%) of tourism demand & supply level to the comprehensive level of tourism support, tourism demand & supply and tourism openness in the GBA is the smallest, but with a relatively large difference.

TABLE II. Ratio analysis results of F1 level, F2 level and F3 level /F1F2F3 comprehensive level in the GBA

Ratio statistics of F1 level, F2 level, F3 level /F1F2F3 comprehensive level	
	COV

Groups	Average	AAD	COD	COV (median)	(median)
F1 level /F1F2F3 comprehensive level	0.652	0.178	0.241	38.4%	36.1%
F2 level /F1F2F3 comprehensive level	0.285	0.148	0.503	68.0%	66.1%
F3 level /F1F2F3 comprehensive level	0.370	0.282	1.947	117.7%	345.2.%

Note: F1 is tourism support, F2 is tourism demand &supply, F3 is tourism openness.

4.3 Distribution Characteristics of Tourism Industry Development Level in the GBA Based on Spatial Dependence Analysis

4.3.1 Global spatial correlation analysis

According to Moran index, GeoDa software was used to select the adjacency matrix as the spatial weight matrix to test the overall spatial correlation of 11 cities in the GBA, and to calculate the global spatial correlation of the tourism support, tourism demand supply and openness scores of the tourism industry in the Area in 2018 and the comprehensive scores of the three dimensions respectively. The calculation results showed that (Table III): Moran index of global spatial autocorrelation of the score of tourism support development level was -0.178 and negative, Z value was -0.308, and significance level P value was 0.391 greater than 0.05, indicating that there was a low degree of spatial autocorrelation and negative spatial autocorrelation of tourism support development level in the GBA in 2018, and a low degree of spatial cluster of tourism support development level in the Area in 2018. Cities with high level of tourism support development and cities with low level of tourism support development showed a low degree of cluster in space, that is, cities with high level of tourism support development tended to be adjacent to cities with low level of tourism support development, and cities with low level of tourism support development tended to be adjacent to cities with high level of tourism support development. The global spatial autocorrelation Moran index of the development level score of tourism demand & supply was -0.155 and negative, the Z value was -0.291, the significance level P was 0.392 and the value was greater than 0.05, indicating that the development level of tourism demand & supply in tourism industry in the GBA in 2018 had a low degree of spatial cluster and negative spatial autocorrelation. Cities with high development level of tourism demand & supply and cities with low development level of

tourism demand &supply showed a low degree of cluster in space, that is, cities with high level of tourism demand & supply development tended to be adjacent to cities with low level of tourism demand & supply development in space, and cities with low level of tourism demand &supply development tended to be adjacent to cities with high level of tourism demand & supply development in space. The global spatial autocorrelation Moran index of the development level score of the tourist destination's openness degree was 0.179 as a positive value, the Z value was 1.897, and the significance level P value was 0.018 less than 0.05. The test under the 5% significance level showed that the development level of tourism industry's openness in the GBA in 2018 had a higher degree of spatial autocorrelation, and a significant positive spatial autocorrelation. The cities with high development level of tourism openness and the cities with low development level of tourism openness showed a certain degree of cluster characteristics in space, that is, the cities with low development level of tourism openness tended to be adjacent in space and the cities with high development level of tourism openness tended to be adjacent in space. The global spatial autocorrelation Moran index of the comprehensive development level of tourism support, tourism demand supply and tourism openness was 0.226 positive, Z value was 1.085, and significance level P value was 0.156 greater than 0.05, indicating that there was a high degree of spatial autocorrelation and positive spatial autocorrelation in the comprehensive development level of tourism support, tourism demand supply and tourism openness in tourism industry in the GBA in 2018. Cities with high comprehensive development level of tourism support, tourism demand supply, tourism openness and tourism support, tourism demand & supply and cities with low comprehensive development level of tourism openness showed a certain degree of cluster characteristics in space, that is, cities with low comprehensive development level of tourism support, tourism demand & supply and tourism openness tended to be adjacent in space, and cities with high comprehensive development level of tourism support, tourism demand & supply and tourism openness tended to be adjacent in space. The results of global spatial autocorrelation analysis showed that there was a certain degree of spatial correlation in the development level of tourism industry in the GBA, a negative correlation between tourism support and tourism demand & supply, a positive correlation between the tourism openness and a positive correlation between the comprehensive development level of the three indicators. Accordingly, in this paper, the local spatial correlation analysis can be carried out to explore the local spatial relationship of tourism industry development in the Area.

TABLE III. Global spatial autocorrelation coefficient

Tourism development level	Mroan's Index	Z-value	P-value

Tourism support, tourism demand & supply, and tourism openness synthesis	0.226	1.085	0.156
Tourist destination support	-0.178	-0.308	0.391
Tourism destination demand & supply	-0.155	-0.291	0.392
Tourism destination openness	0.179	1.897	0.018

4.3.2 Local spatial correlation analysis

A comparative analysis on the three development level indicators of the tourism industry in the GAB by using the local spatial correlation tool (LISA cluster map) of GeoDa software and Moran scatter plot (Figs. 6-8) shows that there are local spatial correlation tourism industries in terms of tourism destination support, tourism destination demand and supply, and tourism destination openness on the whole; the scores of three development levels of tourism industry in the Area, such as tourism destination support, tourism destination demand and supply, and tourism destination opening degree, show different characteristics in spatial distribution. In this paper, referring to different types of local spatial autocorrelation, the spatial differences of three development level indicators and their comprehensive indicators on the development level of tourism industry in the Area were analyzed.

According to the results of local spatial correlation of tourism support scores in the GBA in 2018 (Figs. 5 and 6) and Moran scatter diagram of tourism support, there are seven cities in the Area which mostly fell in the second quadrant and the fourth quadrant, indicating that the development level of tourism support in the Area was characterized by obvious cluster in space, that is, areas with higher (lower) tourism support development level were connected with lower (higher) surrounding areas in space. The proportion of cities in the second quadrant and the fourth quadrant in 2018 was 45.45% and 18.18% respectively, indicating that the cluster degree of the cities with low level of tourism support in the Area was higher than that in the higher regions. LISA cluster map of local spatial correlation of tourism support shows that there are two cities with low-high (L-H) aggregation and diffusion effect, namely Dongguan and Hong Kong, which indicates that the tourism support of Hong Kong and Dongguan can absorb the radiation of the surrounding high-level tourism support cities, and there are no cities with high-low (H-L) aggregation and low-low (L-L) aggregation, which further indicates that the spatial dependence of tourism support development level of other cities is not significant. As a whole, the cities with low-high (L-H) cluster are mainly distributed in the southeast of the Area.
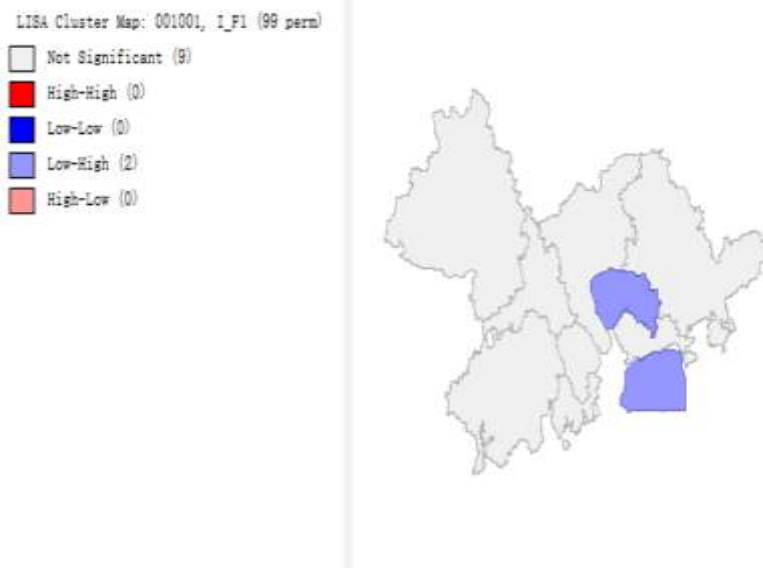
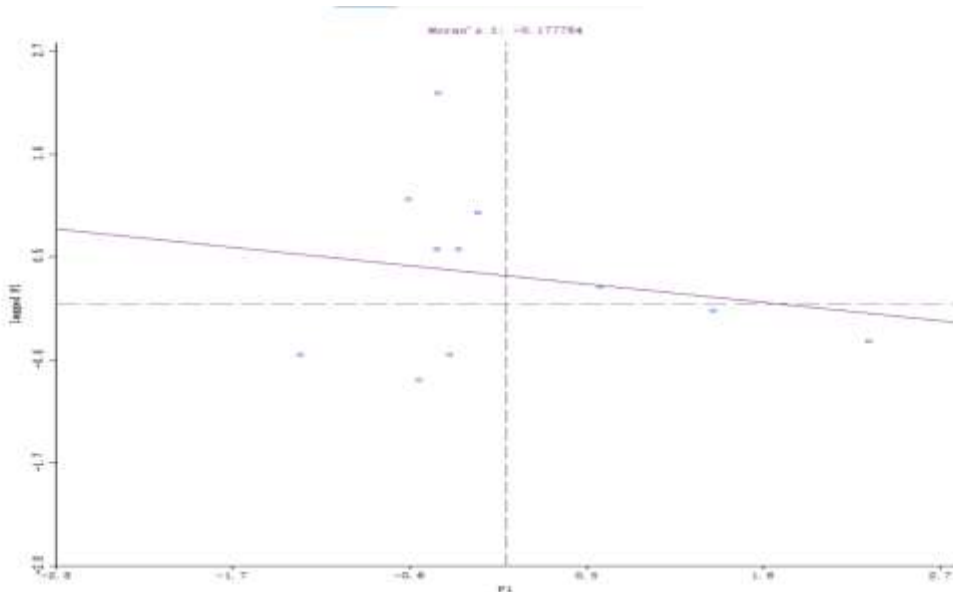Fig 5: LISA cluster map of local spatial correlation of tourism support (F1)

Fig 6: Moran scatter plot of tourism support (F1)

According to the local spatial correlation results (Figs. 7 and 8) and Moran scatter plot of tourism demand & supply in the GBA, most of the urban units in the Area are located in the first quadrant and the third quadrant, indicating that the development level of tourism demand & supply in the Area was characterized by obvious cluster in space, that is, the areas with higher (lower) development level of tourism supply & demand were connected with the

surrounding areas with higher (lower) level in space. The absence of four different local spatial autocorrelation types in all cities further indicates that the spatial dependence of tourism supply & demand development levels in the 11 cities of the Area is not significant.
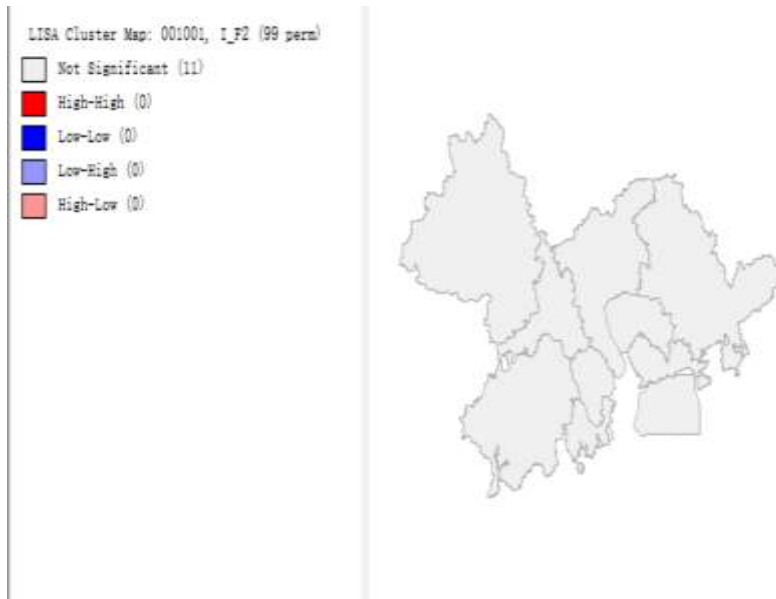

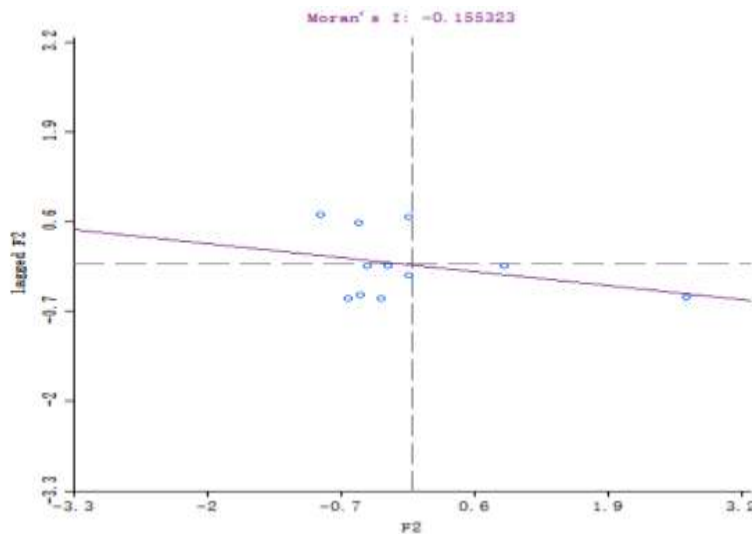Fig 7: LISA cluster map of local spatial correlation of tourism supply & demand (F2)

Fig 8: Moran scatter plot of tourism supply & demand (F2)

The results of local spatial correlation of tourism openness scores in the GBA (Figs. 9 and

10) and Moran scatter plot of tourism openness indicate that the urban units of the Area are mostly located in the first quadrant and the third quadrant, with a total of 10 cities, indicating that the development level of tourism openness in the Area presents a more obvious cluster feature in space, i.e. the regions with higher (lower) tourism openness tend to be connected with the surrounding regions with higher (lower) tourism openness in space. In 2018, the proportion of cities distributed in the first quadrant and the third quadrant was 18.18% and 90.91% respectively, which indicated that the cluster degree of cities with lower level of tourism openness in the Area was higher than that of regions with higher level. The LISA cluster map of tourism openness shows that Shenzhen is the only city with high-high (H-H) cluster and diffusion effect, where the tourism industry can have diffusion effect on the surrounding tourism industry in the corresponding development process, Foshan is the only city with low-low (L-L) cluster, where can be surrounded by the surrounding cities with low tourism industry development level in the corresponding development process. There are no high-low (H-L) cluster and low-high (L-H) cluster cities, which further indicates that the spatial dependence of the development level of tourism openness in other 10 cities is not significant. On the whole, the cities with high level of tourism openness (H-H) are clustered in the southeast of the GBA, while the cities with low level of tourism openness (L-L) are clustered in the central part of the Area.
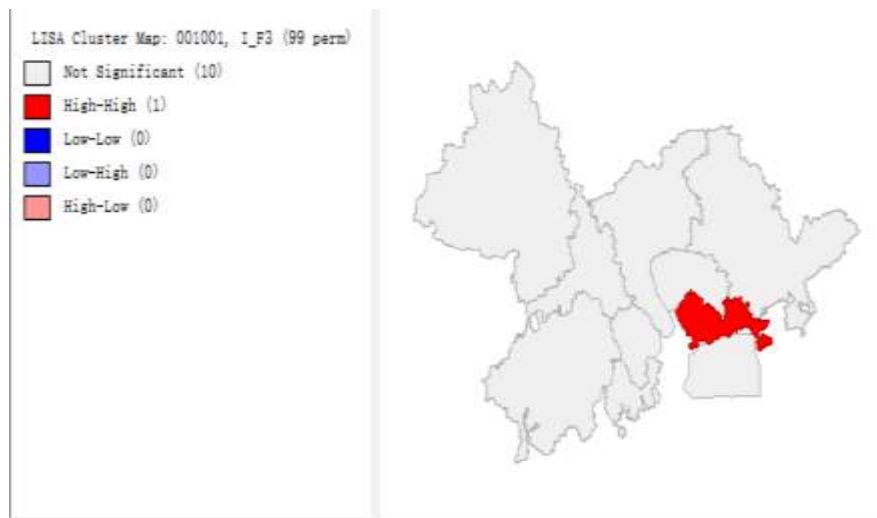

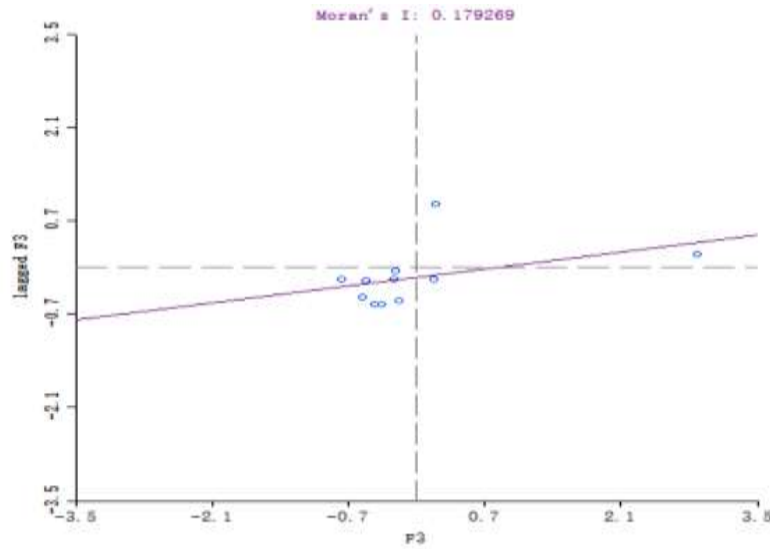Fig 9: Local spatial correlation LISA cluster map of tourism openness development level

Fig 10: Moran scatter plot of tourism openness development level

The local spatial correlation results of and Moran scatter plot comprehensive scores of tourism support (F1), tourism demand & supply (F2) and tourism openness (F3) in the GBA (Figs. 11 and 12) show that the urban units in the Area are mostly in the first quadrant and the third quadrant, with a total of seven cities, indicating that the comprehensive development level of tourism support, tourism demand & supply, and tourism openness in the Area presents obvious cluster characteristics in space, that is, the areas with higher (lower) comprehensive scores of tourism support, tourism demand and tourism openness are connected with the surrounding areas with higher (lower) comprehensive scores in space. In 2018, the proportion of cities distributed in the first quadrant and the third quadrant was 27.27% and 27.27% respectively, which indicated that the cluster degree of areas with low comprehensive development level of tourism support, tourism demand supply and tourism openness in the Area was lower than that of areas with higher level. The LISA cluster map of the comprehensive development level scores of tourism support, tourism demand & supply and tourism openness in the Area shows that there are no four different types of local spatial cluster in all cities, which further indicates that the spatial dependence characteristics of the comprehensive development level scores of 11 cities in the Area are not significant.
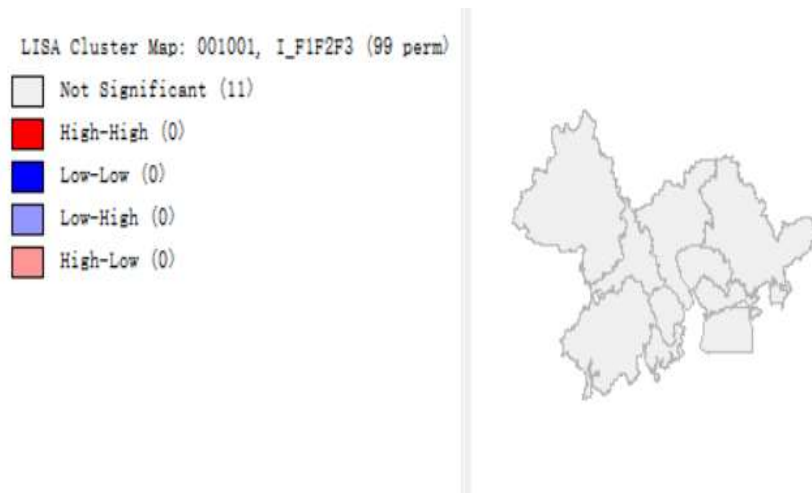
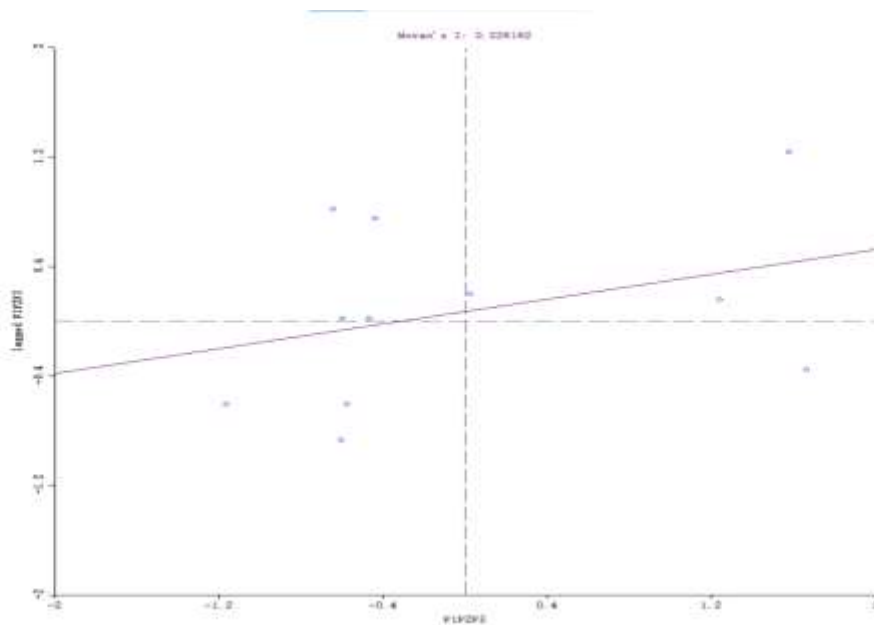Fig 11: Local spatial correlation LISA cluster map of comprehensive development level of F1, F2 and F3

Fig 12: Moran scatter plot of comprehensive development level of F1, F2 and F3

V. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

Overall, in this paper, 11 cities in the GBA were selected as the research object to establish

an evaluation indicator system. Principal component analysis was used to determine the scores of tourism support level, tourism demand & supply level, and tourism openness and calculate the comprehensive scores. Based on the spatial dependence analysis, the evaluation indicator system can comprehensively, objectively and scientifically reflect the development level of tourism industry in the Area in 2018. The main conclusions drawn are as follows:

(1) The quintile classification of spatial distribution characteristics of tourism support level, tourism demand & supply level and tourism openness in the GBA shows that the development level of tourism industry in the Area has significant spatial differentiation characteristics. The overall level of tourism development is at a low level, and the comprehensive scores of the three dimensions of the GBA show the spatial characteristics of decreasing from "Shenzhen-Hong Kong-Guangzhou-Foshan" to the periphery. The comprehensive level of tourism industry development in the Area is mainly influenced by tourism support with little difference, but slightly influenced by tourism demand & supply and tourism openness with large difference.

(2) The results of global spatial autocorrelation analysis show that there is a certain degree of spatial correlation in the development level of tourism industry in the GBA as a whole, and there is a negative correlation between tourism support and tourism demand & supply, a positive correlation between tourism openness and a positive correlation between the comprehensive development level of the three indicators.

(3) The results of local spatial correlation analysis show that the development level of tourism support in the GBA shows obvious cluster characteristics in space, that is, the areas with higher (lower) development level of tourism support are connected with the surrounding areas with lower (higher) development level of tourism support, the tourism support in Hong Kong and Dongguan can absorb the radiation of the surrounding high-level tourism support cities, and the spatial dependence characteristics of the development level of tourism support in other cities are not significant. On the whole, low-high (L-H) cities are clustered in the southeast of the Area. The development level of tourism demand & supply in the Area presents obvious cluster characteristics in space, that is, the regions with higher (lower) development level of tourism demand & supply are connected with the surrounding regions with higher (lower) development level of tourism demand & supply, while the spatial dependence characteristics of the development level of tourism demand & supply in 11 cities in the Area are not significant. The cluster degree of the cities with low level of tourism openness in the GBA is higher than that of the regions with high degree of tourism openness. The LISA cluster map of local spatial correlation of tourism openness shows that Shenzhen is the only city with high-high (H-H) cluster and diffusion effect, where tourism industry can have diffusion effect

on the surrounding tourism industry in the corresponding development process, while Foshan is the only city with low-low (L-L) cluster that can be surrounded by the cities with low level of tourism industry development in the periphery in the corresponding development process. The spatial dependence characteristics of the development level of tourism openness in other 10 cities are not significant. Cities with high-high development level (H-H) of tourism openness are clustered in the southeast of the Area, while cities with low-low development level (L-L) of tourism openness are clustered in central GBA. The cluster degree of the regions with low comprehensive development level of tourism support, tourism demand & supply and tourism openness in the GBA is lower than that of the regions with high comprehensive development level. The spatial dependence characteristics of comprehensive development level of tourism in 11 cities in the Area are not significant.

5.2 Suggestions

In order to improve the overall development level of the tourism industry in the GBA, focus must be put on the actual development of 11 cities in the Area and a tourism industry promotion strategy that suits local conditions must be adopted. The specific recommendations are as follows:

(1) The 11 cities in the GBA should accurately position their respective advantages and disadvantages in the development of the tourism industry based on the new development pattern and develop key tourism resources with distinctive features in a staggered way. The central cities with "Shenzhen–Hong Kong–Guangzhou–Foshan" as the central axis should continue to maintain the current development trend of the tourism industry, increase the number of tourism industry employees based on the new development concept, improve the service awareness and quality of tourism industry employees, vigorously develop smart tourism, and urge the tourism industry to form a new pattern of digital, networked and intelligent development to continuously consolidate the central axis of the tourism industry in the Area. In the future, the development of the tourism industry in Shenzhen should be coordinated with the surrounding areas and developed in a staggered way so as to give full play to its diffusion effect on the tourism industry in the surrounding cities.

(2) Cities located in the west of the central axis of "Shenzhen-Hong Kong-Guangzhou-Foshan", such as Macao, Jiangmen, Zhongshan, Zhuhai and Zhaoqing, should open wider to the outside world, speed up the development of tourism markets in all aspects, take strengthening the support of regional economy and society for the tourism industry as the starting point, increase the investment in infrastructure, improve the network communication service capacity, relax the population settlement system, increase the

investment in higher education and enhance the application level of science and technology. Zhongshan and Zhuhai should, in particular, give priority to raising the level of demand and supply for tourism, intensify the development according to the characteristics of their respective urban tourism resources, expand the number of urban tourism resources, increase the number of star-rated hotels and enhance the quality of services, and create high-quality and diversified tourism products with urban characteristics, such as vigorous development of health care tourism projects in Zhuhai.

(3) Cities located in the east of the central axis of "Shenzhen-Hong Kong-Guangzhou-Foshan", such as Huizhou and Dongguan, should fully absorb the radiation-driven role of its neighboring central axis cities of "Shenzhen-Hong Kong-Guangzhou-Foshan", consider the regional industrial chain construction, exert all-round efforts from the level of tourism support, the level of tourism demand supply and the level of tourism opening to the outside world, and increase investment in science and technology and education based on the concept of global tourism development, expand the tourism market, increase the proportion of investment in infrastructure such as public transportation, create key tourism resources with distinctive urban characteristics, and promote the green development of regional tourism economy and society.

(4) Eleven cities in the GBA should continue to expand the level of openness, especially those located in the east and west of the central axis of "Shenzhen-Hong Kong-Guangzhou-Foshan" shall pay more attention to and invest in the tourism industry, give priority to the development of tourism as a strategic industry, implement the strategy of regional tourism integration, and give full play to its strong driving force, compatibility and openness, especially its comprehensive driving force and good environmental benefits, coordinate the tourism division and cooperation among cities, set up comprehensive tourism management institutions, and promote the green development of regional economy and society based on the rapid development of tourism industry, so as to accelerate the realization of strategic objectives in the GBA.

ACKNOWLEDGEMENTS

REFERENCES

[1] Wu KJ, Feng ZX (2021) Study on the spatial pattern and evolution of coordinated development of tourism economy in Guangdong Hong Kong Macao Greater Bay Area. Areal Research and Development 40 (01): 109-114

[2] Thunen, JH Von (1997) Relations between isolated countries and agriculture and national economy. Translated by Wu Hengkang, Beijing: Commercial Press

[3] Weber A (1997) Industrial Location Theory. Beijing: Commercial Press

[4] Zhang MY, Zhou M, Zhang X (2019) Evaluation of the level of tourism development in 11 provinces and cities of the Yangtze River economic zone. Journal of Central China Normal University (Natural Science Edition) 53 (05): 792-803+814

[5] Huang H, Wang J, Ming QZ, Wang F (2012) Restructuring the spatial system of tourist destinations driven by local tourism demand. Tourism Tribune 27(09): 40-45

[6] Mao XG, Song JP, Yu W (2011) Spatial structure and evolution of A-class scenic spots in Beijing. Economic Geography 31(08): 1381-1386

[7] Lin L, Yang LL, Dai XJ, Tang DH (2011) Spatial structure coupling and optimization of tourism destination system based on a case study of Fujian Province. Human Geography 26(04): 140-146+98

[8] Li Y, Ding YJ, Wang D (2016) The design method of scenic tourist routes with time constraints and spatial behavior characteristics of tourists. Tourism Tribune 31(09): 50-60

[9] Bao JG, Zheng HY, Dai GQ (2002) Spatial structure evolution of domestic customer source market in Guilin [J]. Acta Geographica Sinica (01): 96-106

[10] Lu L (1996) Study on tourists' spatial behavior in mountain scenic spots--A comparison between Huangshan and Yellowstone Park in the United States. Acta Geographica Sinica (04): 315-321

[11] Wu YM (2010) Estimation of elasticity of China's provincial tourism industry considering spatial effects. Tourism Tribune 25(08): 18-25

[12] Ge DM, Jiang L (2013) Spatial difference analysis of influencing factors of provincial tourism based on GWR model. Eco-economy (07): 93-97+132

[13] Wang XJ, He W, Li YP (2021) Study on spatial dislocation of tourism resources and economic development in Guangdong-Hong Kong-Macao Greater Bay Area. Journal of Geomatics (1-6): 2019550

[14] Wu KJ, Chen XY (2020) Spatial spillover effect and spatial characteristics of tourism development in Guangdong-Hong Kong-Macao Greater Bay Area. Jingchu Journal 21(04): 40-49

[15] Wang ZJ, Wu SD (2021) The Spatial and temporal evolution and spatial structure optimization of tourism development in Shanxi Province. Journal of Shanxi Normal University (Natural Science Edition) 35 (01): 122-128

[16] Zhang GH, Yan WJ (2020) Spatial and temporal evolution of comparative advantage in China's tourism industry and analysis of influencing factors. Resource Development & Market 36(04): 427-433

[17] Shen DF, Li MX, Zhong RF (2021) The change of Fujian tourism policy and the spatial-temporal response of its regional tourism industry. Journal of Xinxiang University 38(02): 13-19

[18] Yan YB, Hu HH (2021) Measurement and analysis of high-quality development level of tourism

industry in China. Journal of Hunan Institute of Finance and Economics 37(01): 5-18

[19] Tao H, Wen JM, Zhu H, Zhang Q (2018) Spatial dislocation analysis of tourism development in Guangdong Province (English). Journal of Resources and Ecology 9 (02): 181-190

[20] Dai FC (2018) Spatial dislocation of tourism development in Hunan Province. Yunnan Geographic Environment Research 30(01): 28-34

[21] Fan BB, Su JJ (2021) The Spatial-temporal differences and influencing factors of the development level of cultural and tourism industry in Shaanxi. Special Zone Economy (02): 111-115

[22] Xiang YQ, Zhou WX (2019) Hubei Province: The Impact of Tourism on Economic Growth and Its Spatial Difference Effect. Regional Governance (42): 23-27

[23] Shi DH, Wang DX, Wu YZ, Chen QH (2019) Development evaluation and spatial pattern study of small towns in Zhejiang Province: analysis based on spatial correlation. Modern Urban Research (06): 86-94

[24] Cliff AD, Ord JK (1981) Spatial processes, models and applications. Journal of the Royal Statistical Society 147(3):238

[25] Anselin L (1995) Local indicators of spatialassociation-LISAC. Geographical Analysis 27(2): 93-115

[26] Bao FH, Chen Y (2019) Spatial-temporal coupling evolution characteristics and driving mechanism of the focus of China's inbound tourism and import and export trade. Tourism Tribune 34(11): 66-81

[27] Zhang WT, Dong W (2012) Advanced Course of SPSS Statistics, Beijing: Higher Education Press

[28] Cliff AD, Ord JK (1973) Spatial Autocorrelation. London: Pion