# Spatial Analysis of Tourism Economy in Cities along the Jiangnan Canal Based on PCA and Modified Gravity Model

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**Abstract**— The Beijing-Hangzhou Canal is a cultural link and an economic artery that connects the northern and the southern parts of China, and the Jiangnan Canal is the core of two national strategies: the "Canal Cultural Belt" and the "Yangtze River Economic Belt". In 2018, China issued a series of strategies and policies to promote the development of cultural tourism in the Grand Canal of Beijing and Hangzhou. This development vision requires further analysis of the status of tourism economic development in cities along the Canal. This paper selects 14 cities in the Jiangnan Canal section to analyze the spatial distribution of tourism factors and the spatial structure of tourism economy by means of principal component analysis (PCA) and modified gravity model, identifying the development characteristics of tourism economy in the Jiangnan Canal section, including the disparity in the development of tourism economy and the weak radiation-driven role of the core area, and from the perspective of cultural economics. The phenomenon of uneven development of tourism economy in Jiangnan canal section cities needs to build a coordinate planning mechanism to regulate the level of economic development factors in the region, and cooperate to achieve the coordination of cultural resources protection and economic development goals.

**Keywords-** Tourism Economy; Spatial Structure; Gravitational model ； Beijing-hangzhou Canal; Coordinated Development

## 1    INTRODUCTION

The Beijing-Hangzhou Beijing-Hangzhou Canal has a history of over 2,500 years and is the longest surviving canal in the world, and one of the oldest. The canal is not only a cultural link between north and south, ancient and modern, but also an economic artery for the eastern part of China. The cities along the canal have developed and built up over a long period of time to present a distinctive appearance, making it a region rich in tourism resources in China. Since the inscription of the Beijing-Hangzhou Canal on the World Cultural Heritage List in 2014, the protection, inheritance and utilization of canal culture have received widespread attention from the state and society as a whole [1]. In the Tourism Development Plan for the 13th Five-Year Plan released by the State Council in 2016, the Beijing-Hangzhou Canal Cultural Tourism Belt became one of the ten "national boutique tourism belts". However, due to the high reliance on

government investment to maintain the cultural heritage protection of cities along the canal in the early days, some cities along the canal cultural belt are currently facing problems [2]. Studies have already shown that tourism development has a significant driving effect on the economic growth of urban agglomerations [3,4], and that the flow of tourism flows in the cities along the Beijing-Hangzhou Canal belt and within its radiation zone will influence the tourism economic links between cities and the overall construction of tourism economic networks. The spatial structure of the tourism economy is a network formed by the flow of tourism elements between cities. Previous research has focused on the spatial evolution of tourism flows, the relationship between tourism and geographic space and the classification of tourism destinations [5]. In recent years, studies of tourism spatial structure have mainly used gravity models [6], social network analysis [7], core-periphery theory [8], while lacking of combining the research of the factors influencing the tourism economy and the spatial structure. Therefore, this paper selects 14 cities in the Jiangnan Canal section as research objects, analyses the spatial structure of tourism economy in the region through principal component analysis and gravity model, which leads to the concept of coordinated planning mechanism.

## 2 RESEARCH METHODOLOGY

The Jiangnan Canal section of the Canal Cultural Belt is located in the southern part of the Beijing-Hangzhou Canal and is the intersection of two national strategies: the Canal Cultural Belt and the Yangtze River Economic Belt, including a total of 14 cities. In 2018, there are 104 scenic spots above 4A level and 1,559 cultural relics protection units at provincial level or above in this region. The indicator data for the 14 cities in the region were obtained from the 2018 Statistical Yearbook of Jiangsu, Zhejiang and Anhui Provinces, and the 2018 Statistical Yearbook of each city. It should be noted that some of the cities within the study area (e.g., Chizhou to Jiaxing) do not have railways or direct flights, so the temporal and spatial data used for the measurement of inter-city distances used in the study are all data from high-way traffic, as measured by Baidu Maps. The least time-consuming path between the two cities was chosen as the temporal distance and the shortest road distance as the spatial distance when using Baidu Maps measurements to avoid the influence of factors such as peak traffic periods.

### 2.1 Evaluation model for comprehensive level of tourism resources

The overall level of tourism resources reflects the number and abundance of tourism resources in the region as well as its reception capacity. The number of well-known scenic spots in the indicator is counted as the number of scenic spots of grade 4A or above. Meanwhile, the attractiveness of different levels of scenic spots and intangible cultural heritage to tourists varies. In order to quantify the scientific nature of the measurement indicators, the concept of richness is introduced into the resource level indicator system based on previous experience. Different weights were introduced in the calculation of richness (the results are shown in Table 1), and the calculation formulae were: richness of tourist attractions = $N_5 \times 9 + N_4 \times 7 + N_3 \times 5 + N_2 \times 3 + N_1 \times 1$ (N indicates the number of attractions, and the subscripts indicate the level of attractions), and richness of intangible cultural heritage = $N_h \times 5 + N_c \times 3 + N_p \times 1$ (N indicates the number of intangible cultural heritage items, and the subscripts h, c , p denote cultural heritage of humanity, national and provincial level respectively).

**Table 1** Tourism Resources Comprehensive Level Evaluation Index System

| Primary indicators | Secondary indicators |
|---|---|
| Level of Resource Abundance (B₁) | Number of renowned scenic spots (C₁), Number of national and provincial cultural heritage protection units (C₂), Tourist Attractions Richness (C₃), Intangible Cultural Heritage Richness (C₄) |
| Level of Support Facilities (B₂) | Number of star-rated hotels(C₅), Number of travel agents(C₆), Total passenger traffic (C₇) |

## 2.2 Tourism Economic Analysis

### 2.2.1 Measuring the intensity of tourism economic linkages

The intensity of tourism economic linkages can reflect the radiation effect of the node cities on the surrounding cities. Therefore, this paper refers to the economic linkage calculation method of Wu et al [9] and adopts the gravitational force model to measure the strength of city tourism economic linkages and make corrections in order to construct a city tourism economic linkage network. The optimized model adopted by Wu et al. [9] uses the shortest road distance between two cities, i.e., the spatial distance. Considering that in reality, given a limited duration of a holiday, traffic time can also be an important factor influencing travelers' decision to travel, and travelers prefer to choose destinations that take less time for round trips, this paper uses Equation 3 as a correction to the distance measurement. The model for calculating the strength of economic ties between the two cities as follows:

$$F_{ij} = k \frac{\sqrt{Q_i T_i}\sqrt{Q_j T_j}}{D_{ij}^2} \tag{1}$$

$$k_{ij} = \frac{T_i}{T_i + T_j} \tag{2}$$

$$D_{ij} = \sqrt{t_{ij}}\sqrt{d_{ij}} \tag{3}$$

$F_{ij}$ denotes the tourism attractiveness between City $i$ and City $j$ in 2018. $k_{ij}$ is a moderating parameter reflecting the strength of economic ties weighted by City $i$ to City $j$. $D_{ij}$ denotes the modified distance between Cities $i$ and $j$, where $t_{ij}$ denotes the traffic between the two cities (i.e., the minimum traffic time between the two cities measured by high-way transportation), and $d_{ij}$ denotes the spatial distance between the two cities (i.e., the shortest highway distance).

### 2.2.2 Gross tourism economic linkages

The total external tourism economic linkage of City $i$ is the sum of the degree of tourism economic linkage of City $i$ with the rest of the cities. $C_{ij}$ indicates the total external tourism economic linkages for City $i$ in 2018.

$$C_{ij} = \sum_{i=1}^{n} F_{ij} \tag{4}$$

## 2.3 Tourism Economic Contribution

The contribution of tourism to a city's economic development is multifaceted and, by economic measure, urban tourism development makes an extremely important contribution to total local economic growth, job creation and increased fiscal revenues. Measuring the contribution of the tourism economy to a city's overall economy can also reflect the extent to which a city's economic development is dependent on tourism development, and thus assess the importance of a city's tourism economic development.

Drawing on previous research literature, this study measures the contribution of the tourism economy using the total tourism revenue of a city and its value added and the total GDP of the city for the year and its value added, with the formula.

$$\boldsymbol{R}_{\text{ti}} = \frac{L_{\text{ti}}}{D_i} \frac{\text{LR}_{\text{ti}}}{\text{DR}_i} \times 100\% \tag{5}$$

$R_{ti}$ denotes the economic contribution of tourism in City $i$ in 2018, $L_{ti}$ denotes the total tourism revenue of City $i$ in that year, $D_i$ denotes the GDP of City $i$ in that year, $LR_{ti}$ denotes the growth rate of tourism revenue of City $i$ in that year, and $DR_i$ denotes the growth rate of GDP of City $i$ in that year.

# 3 ANALYSIS OF THE JIANGNAN CANAL SECTION OF THE CANAL CULTURAL BELT

This section analyses the spatial structure of the economic development of tourism in the canal section of Jiangnan and uses it as an economic basis for the coordinated planning mechanism. Some of the results are visualized through the ArcGIS 10.2 to better illustrate the spatial characters and economic relations between cities.

## 3.1 Spatial distribution of the comprehensive level of tourism resources

Using SPSS23 statistical analysis software, the two principal component factors were derived after the original variable test and factor loadings rotation lamp steps, with a cumulative variance contribution of 81.799%, a Bartlett's spherical test value of 0.00 and an overall KMO test score of 0.7, indicating that the data were appropriately subjected to factor analysis results. Weighting the variance of the metric factors for the Jiangnan Canal Section city cluster gives the scores of each city on the resource level and support level, Y1 and Y2 respectively (see Table 2). The final scores for the combined level of tourism resources can then be weighted using the respective variance contribution of the two categories

as weights (see Table 3).

**Table 2** Tourism Resources Comprehensive Level Evaluation Index System

| Common Factor | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
|---|---|---|---|---|---|---|---|
| Factor I | 0.080 | 0.092 | 0.398 | 0.278 | 0.364 | 0.330 | 0.425 |
| Factor II | 0.877 | 0.839 | 0.839 | 0.386 | 0.386 | 0.482 | 0.270 |

**Table 3** Jiangnan Canal Section 2018 City Tourism Resources Overall Score and Ranking

| City | Y1 | Y2 | Y | Ranking |
|---|---|---|---|---|
| Hangzhou | 2.955 | 6.611 | 3.825 | 1 |
| Suzhou | 3.335 | 3.134 | 2.651 | 2 |
| Jiaxing | 0.357 | 3.033 | 1.322 | 3 |
| Nanjing | 1.595 | 0.76 | 0.983 | 4 |
| Huzhou | -0.158 | 2.058 | 0.724 | 5 |
| Wuxi | 0.247 | 0.46 | 0.284 | 6 |
| Huangshan | -0.29 | -1.235 | -0.601 | 7 |
| Changzhou | -0.596 | -1.243 | -0.737 | 8 |
| Xuancheng | -0.919 | -1.057 | -0.805 | 9 |
| Zhenjiang | -0.917 | -1.48 | -0.967 | 10 |
| Wuhu | -0.371 | -2.461 | -1.108 | 11 |
| Chizhou | -1.469 | -2.187 | -1.478 | 12 |
| Ma'anshan | -1.692 | -2.793 | -1.808 | 13 |
| Tongling | -2.076 | -3.601 | -2.286 | 14 |

## 3.2 Tourism Economic Development Analysis

This section will illustrate the economic relationship and closeness of tourism between cities in the Jiangnan Canal section through the strength of tourism economic linkages and the economic contribution of tourism. It can be seen that cities located in Jiangsu and Zhejiang provinces have close tourism economic linkages with each other, while cities in Anhui province have weaker tourism economic linkages.

*1) Intensity of tourism economic linkages:* The top five cities in terms of total economic linkages are Suzhou, Wuxi, Huzhou, Nanjing and Hangzhou. There are two groups of cities with the highest linkages within the region, namely Wuxi-Suzhou and Huzhou-Hangzhou, both located in the Jiangnan Canal section (see Figure 1). The tourism economic linkages are unevenly distributed, with the cities along the canal in the east being more closely connected, and the cities within Anhui Province in the west being less connected as a whole, with Tongling and Chizhou in Anhui Province being further away from the core cities and having a weak level of integrated tourism resources, thus presenting a clear isolated state.
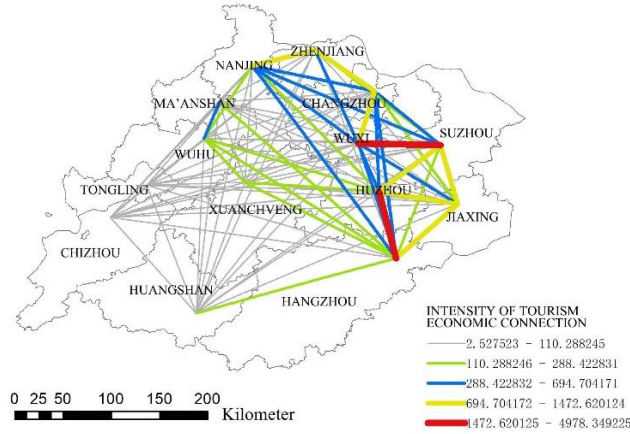
**Figure 1** Tourism Economic Linkage Intensity in Jiangnan Canal Section in 2018 (by Author)

*2) Tourism economic contribution:* The results of the tourism contribution model are shown in Table 4, which shows that Huangshan, Huzhou and Zhenjiang are the three cities in the region that have a very high tourism contribution rate, with their tourism economies growing faster than the local economy as a whole, and therefore have a very high reliance on the tourism economy. After excluding the influence of the three cities with extremely high values, the average tourism contribution rate of the other 11 cities is 0.448. Hangzhou, Tongling, Jiaxing and Xuancheng are all above the average tourism economic contribution rate, indicating that the development of tourism has a significant influence on the local economic development and are tourism economic dependent cities in the region; Wuhu, Chizhou and Ma'anshan are closer to the average, indicating that tourism plays a more important role in the local economic development. Nanjing and Suzhou-Xizang have a low tourism contribution rate, and the contribution effect of tourism economy is not obvious.

**Table 4** Comparison of urban tourism economic contribution rate (TECR) of Jiangnan Canal Section in 2018

| City | TECR | City | TECR |
|------|------|------|------|
| Huangshan | 1.448 | Wuhu | 0.443 |
| Huzhou | 1.144 | Chizhou | 0.418 |
| Zhenjiang | 1.012 | Ma'anshan | 0.352 |
| Hangzhou | 0.714 | Nanjing | 0.321 |
| Tongling | 0.710 | Changzhou | 0.313 |
| Jiaxing | 0.584 | Wuxi | 0.274 |
| Xuancheng | 0.561 | Suzhou | 0.240 |

# 4    COORDINATED PLANNING STUDY OF THE JIANGNAN CANAL SECTION CITY CLUSTER

The comprehensive level of tourism resources in the Jiangnan Canal Basin is high in the east and low in the west, but the overall difference is small and the distribution is relatively balanced, indicating that the tourism resources of the Jiangnan Canal are in good condition and have strong development potential. From the perspective of tourism resources development and tourism economic linkage, the core of the tourism economy is currently in the northern and eastern areas. To improve the development in the southern part, it is more important to adopt coordinate planning mechanism to gain more development opportunities for the cities in south.

## 4.1    Incentive and benefit sharing mechanism

The participation of localities within the region in coordinated planning is conducive to the in-depth synergy and sustainable development of the tourism economy and the conservation of cultural resources, and therefore requires the mobilisation of the participation of themes at all levels and the establishment of incentive mechanisms from several perspectives. Municipalities can play to their relative strengths and co-ordinate the distinctive highlights of their tourism products. Coordinate mechanism can provide a solid platform for the development of tourism projects and the corporate protection of cultural resources. In addition, the establishment of a benefit-sharing mechanism allows multiple parties to share the overall benefits of coordinated development, and is an important guarantee for the effective operation of coordinated planning and development.

## 4.2    The cultural heritage protection mechanism

The protection of cultural heritage has long been limited to the preservation of the material structure of the heritage and relies solely on government investment to maintain it. This unsustainable development model is facing more challenges especially for the Beijing-Hangzhou Canal as there are many cities involved in this heritage protection system. The establishment of a coordinated planning mechanism for the conservation of cultural resources and tourism development is conducive to the expansion of communication channels and promotion platforms to further improve the influence and attractiveness of the Beijing-hangzhou Canal as a world cultural heritage [10-12]; meanwhile, it is also conducive to the integration of tourism resources within the region and provide dynamic support for heritage conservation.

## 4.3    Supporting facilities and enterprise cooperation

The improvement of supporting facilities is an important element and a driving force behind the coordinated planning mechanism. From the perspective of the overall development of the region, it can promote the rapid flow of tourists and capital flow between regions, forming a regional tourism chain and driving the development of the overall regional economy. from the perspective of the market, it can better accommodate tourists to be more comfortable and pleasant when visiting and better serve their various needs. At present, the canal basin in Jiangnan is characterised by a wide range of companies of different sizes and a lack of collaboration between them. It is therefore important to promote in-depth exchanges between

local enterprises in order to facilitate the development of culture and tourism in the region as a whole. Meanwhile, the involvement of enterprises in coordinated planning mechanisms can help alleviate the financial dependence of local governments in some areas on cultural heritage conservation and enhance sustainability.

## 5    CONCLUSION

This paper tries to analyze the spatial structure of tourism economy of cities along the Jiangnan Canal section, and provides basis for the establishment of coordinated planning mechanism of cities along the Beijing-Hangzhou Canal. This study found that the tourism resources and development of cities along the Beijing-Hangzhou Canal are not balanced, which is reflected in the excessive concentration of resources in some key cities. At the same time, the level of economic development and traffic are also important factors affecting the development of local tourism. Therefore, considering that the Beijing-Hangzhou Canal as a whole heritage system needs to be completely protected, and it is hoped that the cities along the canal can make good use of this advantage to develop the local tourism economy, this paper proposes a cooperative planning mechanism. Meanwhile, the canal basin in Jiangnan is characterized by a wide range of companies of different sizes and a lack of synergy between them. It is therefore important to strengthen the government's role to promote in-depth exchanges between local enterprises in order to facilitate the development of culture and tourism in the region as a whole. There are still some shortcomings in the research. Although the system construction index construction of the comprehensive level measurement of tourism factors has reached a statistically reasonable effect, more index factors can be included from the realistic level. Meanwhile, the gravity correction model can only use the time and distance of highways to calculate the temporal and spatial distance between cities, ignoring faster transportation systems such as aviation and railway.

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