Analysis of the Spatial Pattern and Influencing Factors of Tourist Attractions in the Yellow River Tourism Belt

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Abstract: In light of the development of China's economy, the tourism industry has flourished throughout the nation, emerging as a pivotal catalyst for economic growth. The tourism sector has firmly established itself as one of the nation's most robust and substantial industries, playing an increasingly vital role in the socioeconomic landscape. This is particularly evident in the case of the Yellow River tourism belt, which boasts a plethora of diverse tourism resources, a wealth of cultural heritage, and a profound cultural legacy. Leveraging a dataset of 1,226 5A and 4A tourist attractions from the Yellow River Tourism Belt, this study utilizes various methodologies, including the average nearest neighbor, geographic concentration index, and kernel density, to explore spatial patterns and underlying factors. The findings of this research reveal a concentrated distribution of tourist attractions within the Yellow River Tourism Belt, with a pronounced concentration observed in the southern areas of the Yellow River. The spatial distribution of scenic spots in the Yellow River tourism belt is related to elevation, traffic and economic factors.

Keywords: tourism resources, Geographic Information System (GIS), spatial analysis, Influencing factor

1 Introduction

China, known for its vast territory and abundant and unique tourism resources, stands as one of the world's most resource-rich nations for tourism. The Chinese tourism industry is experiencing rapid growth, not only fostering job opportunities and stimulating consumer expenditure but also propelling economic advancement. Research avenues in this field differ between domestic and international scholars. International research predominantly revolves around visitor numbers at attractions[1] and the intelligent evolution of tourist sites[2]. In contrast, domestic research places greater emphasis on the spatial distribution of attractions and their temporal dynamics. Nevertheless, there has been relatively limited exploration into the spatial patterns[3-5] and influencing factors of tourist attractions along the Yellow River Tourism Belt. This study is of great significance for optimizing the layout of tourism industry along the Yellow River, improving the allocation of factors, and promoting the ecological protection and high-quality development of the Yellow River Basin. This paper mainly studies the 4A and 5A scenic spots along the Yellow River tourism belt, and explores the distribution

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pattern of scenic spots along the Yellow River tourism belt by means of GIS methods such as mean neighbor, geographical concentration index and nuclear density. Natural factors and human factors are used to analyze the influencing factors.

The Yellow River, China's second-largest river, meanders across four distinctive geographical zones from west to east: the Qinghai-Tibet Plateau, Inner Mongolia Plateau, Loess Plateau, and North China Plain. En route, it traverses nine provinces: Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shanxi, Shaanxi, Henan, and Shandong, eventually reaching the Bohai Sea in Kenli County, Shandong. The Yellow River Tourism Belt experiences a continental monsoon climate, featuring an average annual temperature of 6.4°C and irregular precipitation distribution both seasonally and annually.

2 Research methods and Data Source

2.1 Research Methods

2.1.1 Average Nearest Neighbor

In ArcGIS, tourist attractions are typically represented as points, and their spatial distribution can be categorized into three types: random, uniform, and clustered. The Nearest Neighbor Index (R) is commonly used to distinguish these distributions[6]. When R=1, the distribution tends towards randomness; when R>1, it leans towards uniformity, and when R<1, it becomes clustered. The formula for computing this index is as follows:

$$R = \overline{r_1}/r_E \quad (1)$$

$$r_E = \frac{1}{2\sqrt{m/A}} = \frac{1}{2\sqrt{D}} \quad (2)$$

Where: $\overline{r_1}$ represents the average distance between the scenic spot and its nearest scenic spot; r_E is the theoretical nearest distance when the scenic spots are randomly distributed. m stands for the number of scenic spots; A represents the area of the Yellow River tourism belt; D represents the number of scenic spots per unit area.

2.1.2 The Imbalance Index

The Imbalance Index (S) [7, 8]serves as an indicator of the degree of balance in the distribution of tourist attractions within the Yellow River Tourism Belt. Its calculation formula is as follows:

$$S = \frac{\sum_{i=1}^{n} Yi - 50(n+1)}{100n - 50(n+1)} \quad (3)$$

Where: n represents the number of provinces along the Yellow River tourism belt, and Yi represents the cumulative percentage of the i-th place of the proportion of scenic spots in each province to the total number of scenic spots in the region, sorted from largest to smallest. The value range of S is 0-1: when S=0, the scenic spots are evenly distributed in each province; when S=1, the scenic spots are concentrated in one province.

2.1.3 Geographic Concentration Index

The concentration level of tourist attractions is typically presented using the Geographic Concentration Index[9], which is primarily used to reflect the concentration of tourist attractions. The Geographic Concentration Index values range from 0 to 100, where a higher G value indicates a more concentrated distribution of attractions within the region, while a lower value suggests a more dispersed distribution. Its representation is in the form of the following formula:

$$G = 100 * \sqrt{\sum_{i-1}^{n} \left(\frac{Xi}{T}\right)^2} \quad (4)$$

Where: G is the geographical concentration index of the scenic spot; Xi is the total number of scenic spots in a province; T is the total number of scenic spots in the whole research area; n is the total number of provinces.

2.1.4Kernel Density

Kernel density analysis can calculate the point elements within a certain range of each grid, and thus calculate its density value[6, 10]. It can reflect the degree of concentration and dispersion of the distribution of the scenic spot, and the formula is as follows:

$$f(x) = \frac{1}{\mathrm{nh}} \sum_{i=1}^{n} k\left(\frac{\text{x-x}i}{h}\right) \quad (5)$$

Where: $k\left(\frac{\text{x-x}i}{h}\right)$ is a function of kernel density; h represents the bandwidth; n is the number of points in the threshold range; (x-xi) is the distance from the estimated point x to the event xi.

2.2 Data Source

The data employed in this study predominantly consist of information regarding premium tourist attractions in the nine provinces spanning the Yellow River Tourism Belt. This comprehensive dataset encompasses details regarding both 5A and 4A tourist attractions, as well as pertinent data concerning roads, rivers, and other relevant factors. Specifically, our data collection process was as follows:

Data pertaining to tourist attractions were meticulously gathered from the official directories made available on the websites of the culture and tourism departments of each respective province.

Information concerning rivers and roads was sourced from the esteemed Chinese Academy of Sciences Data Center.

For our topographical analysis, we accessed DEM (Digital Elevation Model) data via the Geographic Spatial Data Cloud Platform.

Socio-economic data were diligently extracted from the statistical yearbooks of each province, ensuring comprehensive coverage.

To compile a comprehensive list of A-grade tourist attractions along the Yellow River Tourism Belt, this study extensively leveraged the available tourist attraction directories. Geographical coordinates were meticulously procured using the Baidu Maps coordinate retrieval system. Further spatial data refinement was accomplished through the use of ArcGIS 10.8 software, resulting in the creation of spatial vector point data representing A-grade tourist attractions within the Yellow River Tourism Belt, as shown in the 0.

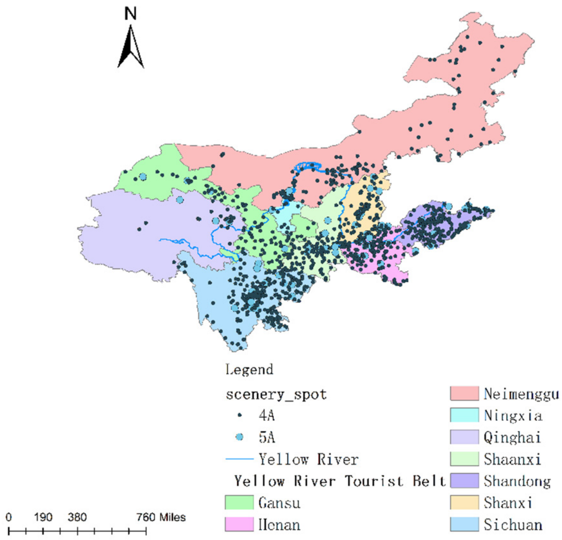

Figure1 Tourism resource survey map

3 The Spatial Distribution Characteristics of Tourist Attractions along the Yellow River Tourism Belt

Tourist attractions in the nine provinces are represented as point features, categorized into three distribution types: uniform, clustered, and random. Through ArcGIS software analysis, an R value of 0.529 was obtained, indicating a clustered spatial distribution type since R<1. The degree of spatial distribution imbalance was assessed using the Imbalance Index. Calculation using Formula (3) yielded an Imbalance Index value of S=0.381, signifying an uneven distribution of tourist attractions across the Yellow River Tourism Belt.

Utilizing Formula (4), a Geographic Concentration Index of G=39.12 was computed. In an equitable distribution scenario, each of the nine provinces would house approximately 136.2 attractions, resulting in a theoretical Geographic Concentration Index of G0=33.33. As G>G0, we deduce that tourist attractions are relatively concentrated within the Yellow River Tourism Belt.

In essence, tourist attractions exhibit a concentrated distribution with sporadic occurrences. The primary concentration is observed in the southern regions along the Yellow River, while certain areas in Qinghai and the Inner Mongolia Autonomous Region lack tourist attractions. The clustering of scenic spots is obtained through kernel density analysis, as shown in 0. It is mainly distributed in Sichuan, Shaanxi, Henan, Shanxi and Shandong areas. These areas often have better economic development, better climatic conditions, good geographical conditions and flat terrain.

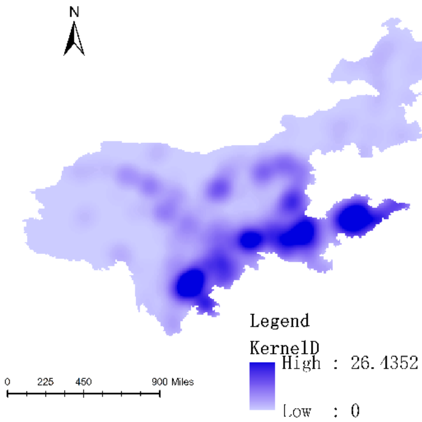

Figure 2 Density Map of Scenic Spots in the Yellow River Basin

4 Analysis of Distribution Influencing Factors

4.1 Transportation Factors

Taking into account the impact of transportation networks on the spatial distribution of tourist resources, we established buffer zones with radii of 2, 5, and 10 kilometers. As shown in 0. Within the 10-kilometer buffer zone, there are a total of 423 tourist attractions strategically positioned along the main roadways. This comprises roughly 34% of the overall tourist attractions within the Yellow River Basin. The well-connected transportation arteries within the Yellow River Basin make these attractions easily accessible, significantly contributing to the rapid growth of the tourism industry in the region.

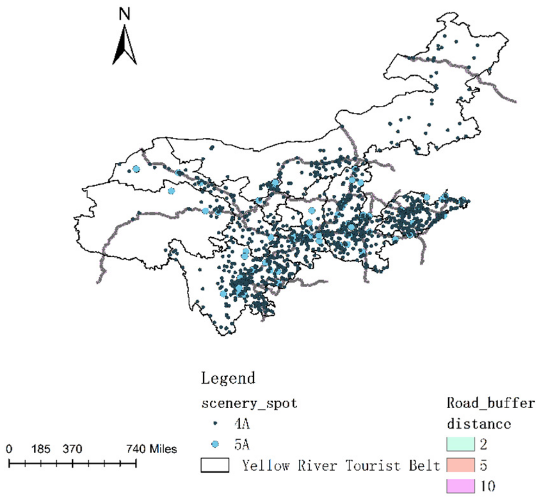

Figure 3 buffer zone along major roads

4.2 Topographical Factors

Elevation emerges as a pivotal factor influencing the distribution of tourist attractions. By categorizing these attractions based on various elevation ranges, we gain insights into how elevation shapes their spatial distribution. 0 is the DEM of the Yellow River tourism belt. Statistical analysis unveils that in the low-altitude range of 0-1000 meters, a substantial 781 tourist attractions are located, constituting approximately 63.7% of the total. As depicted in the graph, the majority of attractions are situated in low to mid-altitude regions, with only 20 attractions found in high and extremely high-altitude areas, representing a mere 1.63%. Lower altitude areas tend to be more densely populated and witness swifter development of tourism resources, resulting in a higher concentration of attractions.

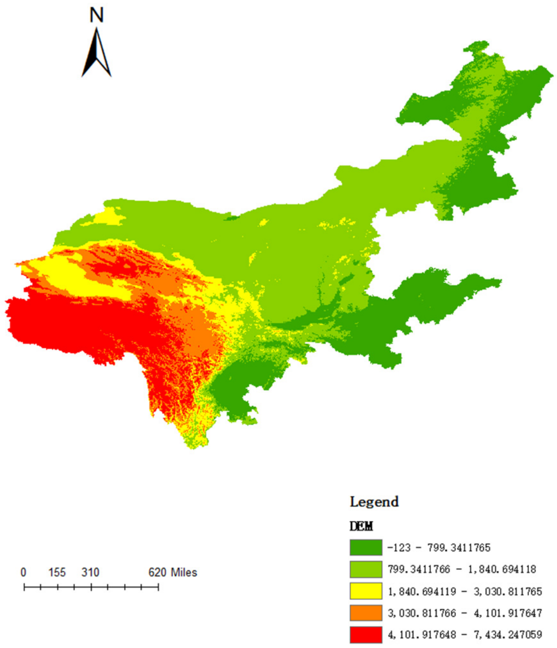

Figure 4 DEM of Yellow River tourism belt

4.3 Economic Factors

Economic conditions and development structures exert a profound influence on the distribution of tourist attractions. By referencing statistical yearbooks, we can gauge the economic landscape in various provinces along the Yellow River Tourism Belt. The data indicates that provinces with higher GDP figures, such as Sichuan, Henan, and Shandong, boast a greater number of tourist attractions, collectively constituting approximately 57% of the total. Regions with robust economic development tend to possess well-established tourism sectors, encompassing more comprehensive infrastructure. This not only draws a larger number of visitors but also augments fiscal revenue, further fueling the growth of tourism and fostering a positive feedback loop.

Table1 Economic data and number of scenic spots

Index	Province								
	Qinghai	Sichuan	Gansu	Ningxia	Inner Mongolia	Shaanxi	Shanxi	Henan	Shandong
GDP/100millionyuan	3006	48599	9017	3921	17360	26182	17652	54997	73129
GDP per capita /yuan	50819	58126	35995	54528	72062	66292	50528	55435	72151
Number of scenic spots	28	287	104	27	125	126	107	177	235

5 Conclusions

This study mainly analyzes the spatial distribution of scenic spots along the Yellow River tourism belt and its influencing factors. By calculating the R value of 0.529, it is found that the scenic spots along the Yellow River tourism belt mainly present a condensed distribution. Through the calculation of the imbalance index, it is found that the distribution of scenic spots in the Yellow River tourism belt is not uniform. Through the nuclear density analysis, it is found that the scenic spots are mainly distributed in Sichuan, Shaanxi, Henan, Shanxi and Shandong regions in the southern region of the Yellow River line.

Several factors impact the distribution of these attractions, with regions enjoying convenient transportation networks hosting a higher concentration of attractions. Notably, within a 10-kilometer buffer zone, a total of 432 attractions were identified, underscoring the positive influence of accessible transportation on the collaborative development of these attractions.

Furthermore, the majority of these attractions are situated at elevations below 1000 meters, comprising 63.7% of all attractions within the Yellow River Tourism Belt. This distribution pattern underscores the significance of lower-altitude regions, where population density is higher and tourism resource development is more robust, resulting in a greater concentration of attractions.

Lastly, the spatial allocation of attractions exhibits a close correlation with economic conditions and industrial structures. Economically developed regions, such as Sichuan, Henan, and Shandong, host a higher number of attractions, often accompanied by more comprehensive supporting facilities. This symbiotic relationship further enhances the attractiveness of these areas to tourists, contributing to the continuous growth of the tourism industry.

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