 DOI: 10.19601/j.cnki.issn1943 - 9903.2023.09.010

Using ArcGIS to Study Transportation Accessibility of Cultural Tourism Resources with Wan'an County in Jiangxi Province as an Example

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Abstract This paper reviews cultural tourist attractions and transportation conditions of Wan'an County in Jiangxi Province, and calculates the accessibility and kernel density of transportation network by using ArcGIS. Through the analysis, it obtains the spatial relationship between the accessibility of Wan'an County and the spatial structural characteristics of "one center, two clusters, two verticals and one horizontal" presented by the cultural tourism resources. Based on this, the paper puts forward the transportation development suggestions for the development of cultural tourism for Wan'an County.

Key words Cultural tourism resources, GIS, Spatial distribution, Transportation accessibility, Wan'an County

1 Introduction

In 2018, Jiangxi Province issued the *Opinions on Promoting All-for-one Tourism Development in an All-round Way*, which put forward specific requirements for promoting all-for-one tourism products, actively creating global image brands, and realizing all-for-one tourism and universal sharing of tourism development achievements, hoping to build Jiangxi Province into an important national and even internationally renowned tourist destination. Wan'an County actively responded to the strategies of "Panoramic Ji'an, All-for-one tourism" and "Prospering County through Cultural Tourism" and "Thriving County through Ecology" in Ji'an City, innovated tourism development ideas, aimed at new forms of rural tourism development, transformed ecological potential into development advantages, and vigorously implemented the strategy in the county, so as to actively promote the development of all-for-one tourism. By the end of 2021, the tourism industry in Wan'an County has received more than 5 million tourists in the whole year, with a total tourism income of 4 billion yuan. From the main data of tourism development alone, it far exceeds the overall target of the planning forecast that "by 2025, the number of tourist receivers will reach 1.6 million, and the tourism revenue will reach 6.7 billion yuan".

Transportation is of great significance to the development of tourism. Transportation is the prerequisite for the existence and development of tourism, the spatial material premise and development foundation of tourism development, and the artery of long-term development of tourism. Besides, transportation also promotes the continuous improvement of tourism income and foreign exchange earnings. In the total tourism consumption, transportation expenditure accounts for 30% on average. The development of cultural tourism in Wan'an County should not be separated from the development and improvement of transportation network.

Received: July 12, 2023 Accepted: September 1, 2023

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2 Overview of research area and research methods

2.1 Overview of research area Wan'an County is located in the south-central part of Jiangxi Province, the southern edge of Ji'an City, and belongs to the subtropical climate area. It is adjacent to Xingguo County in the east, Ganxian County and Nankang District of Ganzhou in the south, Taihe County in the north, and Suichuan County in the west, with an area of 2038.44 km^2 (data from the third national land resource survey). Wan'an County is surrounded by mountains in the east, west and south, and the northern part is low and flat, forming a valley plain, which is a typical hilly terrain as a whole. Wan'an County is rich in forest land resources, with a forest coverage rate of 69.5%. In addition, Ganjiang River runs through the territory of Wan'an County. The main rivers in Wan'an County include Kuobu River, Tongjin River, Tanqian River, Zaokou River, Mianjin River and Suichuan River. Wan'an County has profound historical and cultural connotations and rich cultural tourism resources, such as the historical and cultural blocks of the ancient city wall of Wan'an, the historical and cultural blocks of Zhujiaxiang, and the seven pagodas of Wan'an.

2.2 Data sources and research methods

2.2.1 Data sources. The data involved in the article come from the *Outline of the Fourteenth National Economic and Social Development Plan of the Wan'an County*, the *List of National A-level Tourist Scenic Spots of Ji'an City* (2023.01), the *List of A-level Rural Tourist Spots of Ji'an City* (2022.11). Data on tourism resources published in the *Statistical Yearbook of the Wan'an County* (2016 - 2021) and other materials. Through the field survey on the basis of the vector data provided by the relevant departments, the coordinate data of the tourism resources in the whole study area

were checked, and 196 effective items of tourism resources in Wan'an County were finally selected, of which 164 were individual resources of cultural tourism resources. Then using ArcGIS 10.2, we set up a Wan'an County cultural tourism resources database, and store the data in the geographic database according to different types and characteristics of attributes.

2.2.2 Research methods. Using ArcGIS 10.2 software, we sorted out the data of the cultural tourism resources and analyzed the nearest neighbor of the cultural tourist attractions to determine whether there is aggregation. We made a kernel density analysis of the scenic spots to determine their spatial agglomeration characteristics, and made a multi-distance buffer analysis of the roads to calculate the proportion of the number of scenic spots covered by the main road buffer. Taking the whole county as a base, we constructed the transportation network, and analyzed transportation accessibility of the whole county by using the time and distance costs of OD matrix. Then, we compared and analyzed the spatial distribution characteristics of cultural tourist attractions and the spatial characteristics of road accessibility, and finally obtained the problems of transportation network pattern of Wan'an County. According to the spatial distribution structure of cultural tourist attractions, we put forward some reasonable suggestions. The specific methods are as follows:

(i) Kernel density estimation method: Kernel density estimation is a process of interpolating the existing tourism resource point data. The whole county is used as the search area, and the value points in the area are given different weights according to the distance from the county center. The closer to the center, the larger the value is, and *vice versa*.

(ii) GIS road buffer analysis method: Through ArcGIS 10.2 software, the Wan'an County road traffic is taken as the main object of analysis, the cultural tourism resources is taken as the objective object of analysis, and the buffer zone is established around it, to analyze the relationship between cultural tourism resources and road space quantity.

(iii) OD matrix refers to the matrix in which all traffic zones are sorted by row (starting point) and column (ending point), and the tourist attractions (OD quantity) between any two zones are taken as the elements. In this study, we used the time cost matrix to analyze.

(iv) Average Nearest Neighbor Index method: Taking the traffic line of Wan'an County as the main analysis object, and the cultural tourism resources as the object affected by the main body, we analyzed it through the linear analysis model[2]. The nearest neighbor index is the ratio of the actual distance to the theoretical distance, *i.e.*, $R = r/R$. When $R = 1$, the spatial distribution is random; when $R > 1$, it is uniform; when $R < 1$, it is aggregated.

3 Overview of cultural tourism resources in Wan'an County

3.1 Status of cultural tourism resources According to the *Classification, Investigation and Evaluation of Tourism Resources*, combined with the existing characteristics of local resources, we classified the types of tourism characteristic cultural resources in Wan'an County. The cultural resources of Wan'an tourism characteristics cover 4 categories, 15 subcategories and 34 basic types, with a total of 196 resource units. Among them, the largest proportion is 126 building and facility resource units, accounting for 64.29% of the total number of resource points; 18 tourism commodity resource units, accounting for 9.17% of the total number of resource points; 26 cultural activity resource unit, accounting for 13.27% of total resource points; there are 26 pastoral landscape resource units, accounting for 13.27% of the total number of resource points. Among the 15 subcategories, there are a large number of residential areas and communities (69), comprehensive cultural tourism (25), architectural landscape and ancillary buildings (21), local tourism commodities (18), agricultural production landscape (14), folk customs (12), forest landscape (10) and person and event records (9). Among them, the famous cultural tourist attractions include the former site of Wan'an Riot Action Committee, Kang Keqing's former residence and Kang Keqing Memorial Hall; county-level ancient city walls of the Song Dynasty and rare stupas (Buddhist shrine) of the Tang Dynasty in the south of the Yangtze River; as well as the key tourist areas such as Tianbei Peasant Painting Village, Traditional Chinese Folk Game Village and Wonderful World, which have been successfully built in recent years with peasant life painting culture as the main part, as well as historical and cultural blocks represented by Erlang Culture Exhibition Hall and Fish Culture Exhibition Hall.

3.2 Spatial distribution characteristics of cultural tourism resources

3.2.1 Average nearest neighbor index. Using the spatial statistical analysis program of ArcGIS 10.2, we calculated the average nearest neighbor distance of the main cultural tourist attractions of the Wan'an County. We obtaind the average nearest distance (actual average distance) $R = 1\ 365$ and the expected average nearest distance (theoretical average distance) $R = 2\ 075$, and the average nearest distance index $R = r/R = 0.657\ 827 < 1$, indicating that the main cultural tourism resources of Wan'an County is low partial aggregation distribution.

3.2.2 Kernel density assessment. According to the calculation results of the nearest neighbor index, the Wan'an County cultural tourist attractions are concentrated in the county scale. The data analysis range of average distance and ideal distance setting and density in the nearest neighbor index analysis was 1 900, 5 000, 7 000 and 10 000 m, respectively. By analyzing the kernel density of the Wan'an County cultural tourism resources with different expected distances, it can be found that the cultural tourism resources increase with the expected distance. Its overall characteristics are becoming more and more obvious, showing the characteristics of different distribution between the north and the south, more in the north and less in the south, more in the west and less in the east. Among them, Chengguan Town, Furong Town and Wufeng Town in Wan'an County are the main gathering points.

4 Overview of transportation in Wan'an County

4.1 Status of road transportation From the perspective of the spatial layout of the transportation network, the Wan'an County

transportation network has formed a distinctive "three vertical" structure. The "three vertical" structure refers to the "three vertical" shape of Nanchang-Ganzhou High-speed Railway Passenger Dedicated Line, Daguang Expressway and National Highway 105 running through the Wan'an County.

Nanchang – Ganzhou High-speed Railway Passenger Dedicated Line is the only passenger railway line in Wan'an County and an important part of Beijing – Kowloon Passenger Dedicated Line. It passes through many cities in Jiangxi Province, such as Fengcheng and Zhangshu in Yichun; Xingan, Xiajiang, Taihe and Wan'an in Ji'an; Xingguo and Ganxian in Ganzhou; Daguang Expressway runs through the county from north to south, with Shaokou and Wan'an high-speed entrances and exits; National Highway 105 passes through Lutian Town, Gaopi Town and Xiazao Town in the Wan'an County.

4.2 Problems of transportation The development of transportation infrastructure in Wan'an County is still in a period of rapid development, and the urgent problem of improving transportation services, quality and efficiency has become increasingly prominent. While summarizing the development history of Wan'an County transportation facilities, we also see the problems we are facing. These problems are mainly reflected in the following aspects: the transportation network between regions needs to be further improved and optimized; the ability to provide road passenger transport information is insufficient; the degree of connection between rural transportation networks is insufficient; bus station construction and rural passenger station site construction facilities are lagging behind.

4.3 Road buffer analysis Based on the analysis of the maximum pedestrian buffer zone of 2 000 m and the interval of 500 m, it is concluded that there are 90 cultural tourist attractions within the buffer zone of 0 – 500 m, 29 cultural tourist attractions within the buffer zone of 500 – 1 000 m, and 29 cultural tourist attractions between the buffer zones of 0 – 500 m and 500 – 1 000 m; 15 within 1 000 – 1 500 m and 10 cultural tourism resources within 1 500 – 2 000 m. A total of 140 cultural tourism resources are covered within the buffer distance, accounting for 87.8% of the total number of cultural tourism resources in Wan'an County.

From the perspective of road traffic distribution, the buffer zones of National Highway G105, Provincial Highway S221 and Provincial Highway S225 are relatively dense, with obvious "belt" distribution characteristics in spatial form. As far as the overall spatial layout of the county is concerned, the surrounding areas of the city are densely distributed, followed by Gaopi Town, Shaokou Township, Jiantou Town and other townships; from the perspective of spatial distribution, Wuyun Avenue, as the center of the county town and the main traffic connection point, is the most intensive resource gathering area, followed by Gaopi Town, Shaokou Township and Jiantou Town.

4.3 Transportation accessibility analysis The accessibility analysis in this paper was based on the time and distance of the transportation network. The transportation accessibility refers to the degree of convenience of starting from any point to reach other points in the range[4]. A typical sectional road network structure is for by carrying out intersection interruption process on Wan'an County roads including expressways, national road, provincial roads, county roads, urban roads and roads below that county level. The transportation network model was initially constructed to match the road grade and select the appropriate speed to calculate the travel time. By using OD matrix, the accessibility analysis was carried out by taking each point as the origin and destination, and the visualization processing was carried out by ArcGIS 10.2. The analysis shows that the transportation accessibility in Wan'an County is gradually decreasing from the central city to the surrounding areas, and the accessibility in the south is worse than that in the north. The road accessibility on the west side of Ganjiang River in the northern area decreases obviously, the accessibility on the east side is better, and the southern area shows a decreasing trend from the center to both sides.

4.4 Comparative analysis of accessibility and scenic spot distribution By processing that kernel density analysis with the 10 000 m as the expected distance and superimposing the road network, and comparing the results of kernel density and accessibility analysis, it is found that in areas with dense distribution of cultural tourist attractions, the accessibility is generally relatively good, and the trend of the two is also highly similar. However, there are places with insufficient transportation accessibility and relatively abundant tourism resources in some areas, such as Jiantian Township. Jiantian Township is located in the southeast of Wan'an County, and cultural tourist attractions are mainly based on red cultural types, including county-level cultural protection units such as the former site of the Red Army Hospital and the former site of the Political Security Bureau. Its transportation location is relatively poor in Wan'an County, with weak transportation links to the central urban area of Wan'an County, and lack of direct roads to the western townships.

5 Recommendations for transportation development

5.1 Improving the external traffic road network Relying on the existence of Ganzhou Huangjin Airport, Jinggangshan Airport and the surrounding airports, it can connect the national key passenger groups such as the Pearl River Delta and the Yangtze River Delta. The connection of Chang – Gan High-speed Railway and Gan – Shen High-speed Railway further broadens the coverage area of Wan'an County tourism development and enhances the accessibility of Wan'an County as tourist destinations; G356 and G105, S225 and S221 provincial highways run through the Wan'an County from north to south, and build the main framework of the Wan'an County's external traffic.

5.2 Improving the internal traffic road network Relying on the external linkage of Wan'an County tourism, it is recommended to optimize the internal highway network pattern of the county, improve the public transport service facilities in scenic spots, optimize the travel conditions, and form a "fast travel and slow travel" transportation system of "high-speed + national highway + direct scenic road + tourist scenic road". According to the distribution of tourism resources in Wan'an County and the traffic routes in Wan'an County, it is recommended to plan the rural tourism routes

and the tourism transportation network with G356, G105 and S221 as the backbone to form the main road traffic pattern of "three verticals and three horizontals". Three horizontals refers to the bridge to be built across Ganjiang River in the south, the east-west section of G356 in the middle, and the transverse line of provincial highway S225 and X065 in the north; Three verticals refers to national highway G105, national highway G356 and provincial highway S225. Through the construction of county-wide tourism highway network, it is able to enhance the ability of county-wide interconnection, create a traffic pattern of East – West – North – South interconnection, and enhance the complementarity of tourism development among major tourism development areas. Tourist bus, taxi and self-driving car rental are the main body in the tourism development area, and an integrated tourism transportation service network with clear hierarchy, clear structure and clear functions is constructed. Scenic spots mainly construct green corridors for leisure tourism, promote self-driving, bicycle, hiking and other modes of transportation, construct a perfect leisure greenway system, form a linear landscape service system connecting the nodes of scenic spots in series, and realize the transportation network of "point-line-plane" linkage of scenic spot-tourist line-tourist area.

6 Conclusions

There are abundant cultural tourism resources in Wan'an County, but it is necessary to rely on the characteristics and endowments of county tourism resources to reveal the spatial distribution characteristics of cultural tourism resources. The spatial relationship between the spatial distribution of tourism resources and the county transportation accessibility is analyzed to provide better reference suggestions for tourism transportation. Taking Wan'an County as an example, we made an overall analysis from the aspects of cultural tourism resources attribute structure and spatial structure, and reached the main conclusions. The cultural tourism resources of Wan'an County shows the characteristics of agglomeration distribution, and is greatly affected by the development of road construction, mainly taking national highways G356 and G105 and provincial highways S221 and S225 as the main distribution routes. The spatial pattern is characterized by "one center, two clusters, two verticals and one horizontal". The cultural tourist attractions transportation accessibility in Wan'an County shows a decreasing trend from the central city to the surrounding areas, and the accessibility of the south is worse than that of the north. The road accessibility on the west side of Ganjiang River in the northern area decreases obviously, the accessibility on the east side is better, and the southern area shows a decreasing trend from the center to both sides. The development of cultural tourism resources in Wan'an County should take the concept of "all-for-one tourism" " as the core. Combining with the spatial distribution pattern characteristics of "one center, two clusters, two verticals and one horizontal", the link function of highway traffic is strengthened, so that the network distribution of highway traffic breaks the division between administrative towns and deepens the link between towns. It is recommended to strengthen the exchange of cultural activities and form an all-for-one tourism traffic with a "point-line-plane" structure. Specifically, to solve the east-west connection of the southern area, the east-west side of the southern area can be divided into two parts by the Ganjiang River, but the necessary traffic connection should be established.

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