

The spatial distribution characteristics, influencing factors and development models of rural tourism in China

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Abstract. As an essential support for rural revitalization and global tourism strategies, rural tourism has a lot to do in the dual-cycle development pattern. Based on the first and second batch of crucial rural tourism villages in the country, the nearest neighbor index, geographic concentration index, Gini coefficient, standard deviation ellipse, nuclear density and other methods are used to analyze their spatial distribution types, spatial balance, spatial pattern and evolution. Then, the factors influencing the distribution differences are analyzed by using the tools of geographic connection rate and buffer zone. From a configuration perspective, QCA is used to explore the development model of crucial rural tourism villages. The results show that: ①China's rural tourism crucial villages along the Hu Huanyong line show a condensed distribution characteristic of "sparsely located in the southeast and sparsely northwest". The distribution within the provinces is weakly concentrated and the spatial imbalance is prominent. Moreover, the spatial pattern is evident from the Northeast to the Southwest and shows the insense evolution trend. ②The crucial rural tourism villages are spatially formed with the dual-core radiation and multi-regional structural features centered on the Beijing-Tianjin-Hebei, Yangtze River Delta, and supplemented by several sub-high-density areas such as Guanzhong, Sichuan, Chongqing, Guizhou, and Pearl River Delta, and finally formed the radiation pattern of urban agglomerations-central cities-crucial rural tourism villages. ③Natural geography, source market, transportation environment, economic level, and endowment of tourism resources are important factors that affect the spatial distribution of crucial rural tourism villages. ④There are three main development models of crucial rural tourism villages in China: source market-driven, traffic-oriented and scenic-radiant.

1 Introduction

In recent years, with the promotion of rural revitalization strategies and supply-side structural reforms, the process of high-quality agricultural and rural development in China has been accelerating. As an essential engine for the transformation and upgrading of the rural economy, rural tourism plays a key role in solving the problems of agriculture, rural areas and farmers and winning the battle against poverty. Under the new situation, the rural tourism's consumer demand is developing in the direction of scale and diversification. This change in quantity and quality provides a huge release space for our domestic demand potential. Rural consumer demand has become a significant basis for the construction of "dual-circulation" pattern. Accelerating rural tourism development and tapping the potential of urban and rural consumer demand are both realistic and due. Since 2019, the Ministry of Culture and Tourism has successively announced the first and second batch of crucial rural tourism villages in the country, clarifying the demonstration standards for rural tourism at the national

level. In this context, objectively analyzing the spatial laws and distribution characteristics of rural tourism and exploring the configuration paths of influencing factors are of great significance to the high-quality and sustainable development of rural tourism in China.

The current research on rural tourism mainly focuses on the following four aspects: First, the research on the development model and rural tourism path. Based on the perspectives of consumer demand^[1-2], industrial integration^[3-5], ecological civilization^[6-8], and spatial structure^[9], scholars in various fields have summarized different development models such as government-driven, enterprise development, resident participation, and mixed development^[10]. Some studies compare the development models of rural tourism at home and abroad^[11-12] to provide references for the sustainable development of rural tourism in China. The second is the evaluation of sustainable development of rural tourism. With the official rise of global tourism as a national strategy, rural tourism has ushered in a "blowout" development. How to objectively evaluate the development level of rural tourism in China and create a

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high-quality leisure tourism business has increasingly become a focused topic. Scholars use the analytic hierarchy process, entropy method, TOPSIS method, IPA and other methods to establish a comprehensive evaluation index system, focusing on rural tourism vulnerability evaluation^[13], resource development evaluation^[14], tourism development level evaluation^[15], and tourist perception evaluation^[16] at different scales. The real dilemma of tourism is looking for a solution. The third is the research on the driving mechanism of rural tourism. Previous studies mainly proceeded from the perspective of system theory, and believed that rural tourism is a complex system composed of tourism subjects, tourism objects, tourism media, and tourism supporters^[17]. From tourism attractions, tourism location, tourism support factors, tourism needs, destinations to construct a structural relationship model in management, tourism supply, tourism innovation to explore the driving factors and mechanism of rural tourism^[18]. The fourth is the research on the temporal and spatial characteristics of rural tourism. Simultaneously rural tourism is booming, the organization that pays attention to its geographical space is also imminent. Existing research mainly focuses on rural tourism demonstration villages^[19], characteristic towns^[20], and rural tourist attractions^[21] at the regional scale, using gravitational models^[22], nearest neighbor index^[23], Gini coefficient^[24], standard deviation ellipse and other spatial measurement methods to explore rural areas Tourism's spatial distribution pattern^[25], spatial structure evolution^[26], temporal and spatial coupling characteristics^[27], etc.

Synthesize existing literature, the research on rural tourism in China shows a diversified development, but few results exist about its spatial distribution characteristics. The research can be further deepened from the following three perspectives: First, in terms of research objects, the previous selection of spatial samples lacks typical representativeness, and cannot represent the distribution of rural tourism at the national level. Second, in terms of research scale, most of them focus on small and medium-sized scales, and there are few spatial discussions about rural tourism at the national level, lacking a summary of general laws, and there are still limitations in research. The third aspect is the influencing factors of rural tourism. Existing studies mainly use traditional quantitative methods to explore the degree of influence of a single factor. Rural tourism is a complex system, and its development results from multiple and complex factors, which needs to be analyzed from the perspective of configuration. This article intends to proceed from the above aspects to conduct an empirical analysis of the spatial differentiation law of rural tourism in China, explore the configuration path of influencing factors, and then summarize its development model.

2 Materials and methods

2.1. Data Source and Processing

The list of China's crucial rural tourism villages in this article comes from the official website of the Ministry of Culture and Tourism of the People's Republic of China (<https://www.mct.gov.cn/>). In order to implement the rural revitalization strategy and the "Thirteenth Five-Year" Tourism Development Formulate, and improve the ability of China's rural production to meet the people's growing needs for a better life, the Ministry of Culture and Tourism announced the first batch in 2019 and 2020 respectively. 320, the second batch of 680 crucial rural tourism villages nationwide, a total of 1,000. The selected crucial rural tourism villages have rich cultural and tourism resources, better protection of natural ecology and traditional culture, better development of rural residential accommodation, mature tourism product system, perfect infrastructure and public services, and obvious benefits of employment and prosperity, which have typical demonstration and leading role, representing the high-quality rural tourism service level in the new era. The detailed coordinate data of each village and town is obtained based on the Google map, and the point-like elements are projected and transformed on the standard map through ArcGIS10.5 (Figure 1).

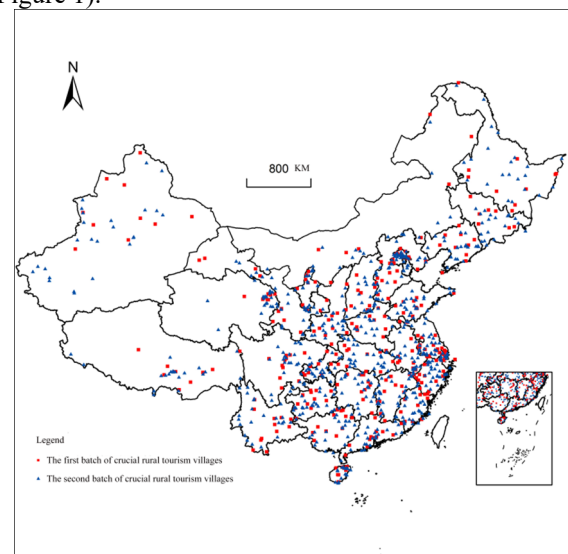


Fig. 1. The spatial distribution of crucial rural tourism villages in China.

2.2. Research Methods

2.2.1 Nearest Neighbor Index

The nearest neighbor index analyzes the degree of mutual proximity by comparing the nearest neighbor distance and theoretical nearest neighbor distance of spatial elements, and judges the spatial distribution type of crucial rural tourism villages. The formula is:

$$R = \frac{r_l}{r_E} \quad (1)$$

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

Among them, R is the nearest neighbor index; r_l is the actual nearest neighbor distance; r_E is the theoretical nearest neighbor distance; N is the number of crucial rural tourism villages; A is the area of the study area. $R=1$, the crucial villages of rural tourism are distributed randomly in space; $R<1$, which is a cohesive distribution; $R>1$, which is a uniform distribution.

2.2.2 Geographic Concentration Index

The geographic concentration index can be used to measure the regional concentration of crucial rural tourism villages. The formula is:

$$G = \sqrt{\sum_{i=1}^n \left(\frac{X_i}{T} \right)^2} \times 100 \quad (3)$$

Among them, G is the geographic concentration index; X_i is the number of crucial rural tourism villages in the i-th region; T is the total number of crucial rural tourism villages in the country; the larger the G, the stronger the degree of spatial agglomeration.

2.2.3 Geographic Concentration Index

The Gini coefficient is an essential method for comparing the spatial differentiation of regional geographic elements. It can be used to analyze the specific balance of crucial rural tourism villages in each region and reveal differences in different regions. The formula is:

$$Gini = \frac{-\sum_{i=1}^n P_i \ln P_i}{\ln n} \quad (4)$$

Among them, Gini is the Gini coefficient of crucial rural tourism villages; P_i represents the proportion of crucial rural tourism villages in region i; n represents the number of regions; the larger the Gini, the more concentrated the spatial elements in the region and the more uneven the distribution.

2.2.4 Nuclear Density Analysis

Kernel density estimation is a method for estimating the probability of occurrence of geographic events in geographic locations. The density of reference points is related to the probability of occurrence of events. The greater the density of points, the higher the probability of occurrence of events, and vice versa. The calculation formula is:

$$f_h(x) = \frac{1}{nh} \sum_{i=1}^n \left(\frac{x - x_i}{h} \right) \quad (5)$$

Among them, $f_h(x)$ is the kernel density estimation function; h represents the width; $(x-x_i)$ represents the distance from x to x_i .

2.2.5 Geographical Connection Rate

The geographic connection rate is used to analyze the degree of geographical connection between each factor and crucial rural tourism villages, and reveal the distribution factors that affect crucial rural tourism villages from a spatial perspective. The calculation formula is:

$$L = 100 - \frac{1}{2} \sum_{i=1}^n |S_i - P_i| \quad (6)$$

Among them, L is the geographic connection rate; S_i is the proportion of crucial rural tourism villages in each region in the total; P_i is the proportion of each influencing factor.

3 Spatial distribution characteristics of rural tourism

3.1. The overall distribution characteristics of crucial rural tourism villages

From a macro perspective, China's crucial rural tourism villages show noticeable geographic distribution differences along the Heihe-Tengchong line, which is consistent with the pattern of population density high in the southeast and low in the northwest. From the perspective of the three major economic zones, crucial rural tourism villages in the eastern, central, and western regions accounted for 37.1%, 28.2%, and 34.7%, respectively, showing obvious east-west-middle gradient characteristics; from the perspective of the eight comprehensive economic zones, the northeast Regions, northern coastal regions, eastern coastal regions, southern coastal regions, middle Yellow River regions, middle Yangtze River regions, Southwest regions, and Northwest regions accounted for 8.8%, 11.9%, 9.6%, 9.3%, 11.5%, 14.3%, and 17.1, respectively % And 17.5%, the Northwest Region has the highest distribution ratio. The unique local culture and rich historical precipitation provide an excellent foundation for rural tourism. In contrast, the Northeast Region has the lowest distribution ratio due to geographical and climate constraints; From the three significant steps, the crucial rural tourism villages in China are concentrated in the second and third steps, which also shows that the distribution of crucial rural tourism villages is closely related to physical and geographic factors.

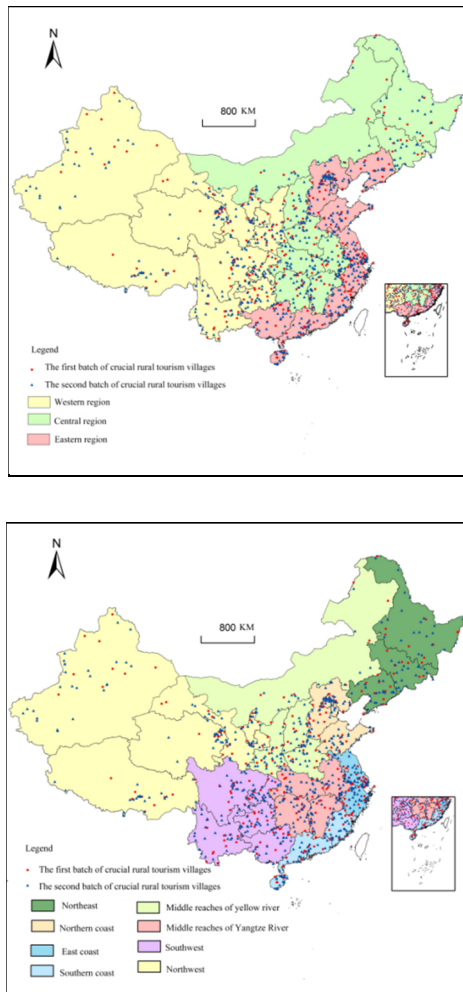


Fig. 2. Spatial distribution of three zones and eight regions of Crucial Rural Tourism Villages in China.

3.2. Spatial distribution types of crucial rural tourism villages

Use ArcGIS10.5 to calculate each batch's nearest neighbor index of rural tourism crucial villages, and analyze their spatial distribution types. The results are shown in Table 1. The first batch's actual nearest neighbor distances, second batch and all batches of rural tourism crucial villages are all less than the expected nearest neighbor distance. The nearest neighbor index is 0.67, 0.55, and 0.54, which are all less than 1. Furthermore, the significance level is far less than 0, indicating that the crucial rural tourism villages in China are spatially cohesively distributed. Simultaneously the nearest neighbor index and Z value of the second batch of crucial tourism villages are lower than those of the first batch, reflecting that the spatial agglomeration of rural tourism in China has decreased and a weakening trend has emerged.

Table 1. Nearest neighbor index of Crucial Rural Villages.

Index	The first batch	The second batch	The first two batches
Actual nearest distance	73.24	44.44	35.68
Expected nearest distance	108.6	80.36	66.41
R	0.67	0.55	0.54
Z	-11.14	-22.3	-28
P	0	0	0

3.3. Balance of the spatial distribution of crucial rural tourism villages

3.3.1 The degree of spatial distribution and concentration

The geographic concentration index analyzes the regional concentration of crucial rural tourism villages in China. See Table 2 for the crucial rural tourism villages, their proportions and cumulative proportions in each region of China. The total number of rural villages $T=1000$, and the number of regions $n=31$. Calculate the geographic concentration index of crucial rural tourism villages by formula (3), and obtain $G=18.4$. Assuming that 1,000 crucial rural tourism villages are evenly distributed in each region, the ideal geographic concentration index is $G = 17.7$, and G is slightly larger than G , indicating that China's crucial rural tourism villages show a weak degree of concentration at the inter-provincial regional scale.

Table 2. Number and proportion of Crucial Rural Tourism Villages in China.

Region	Proportion	Cumulative proportion	Region	Proportion	Cumulative proportion
xinjiang	5.6	5.6	guangdong	3.2	62.4
zhejiang	4	9.6	gansu	3.2	65.6
jiangsu	3.9	13.5	heilongjiang	3.1	68.7
hubei	3.8	17.3	henan	3.1	71.8
guizhou	3.8	21.1	liaoning	3	74.8
fujian	3.7	24.8	xizang	3	77.8
jiangxi	3.7	28.5	chongqing	2.9	80.7
yunnan	3.6	32.1	ningxia	2.9	83.6
hebei	3.5	35.6	qinghai	2.8	86.4
sichuan	3.5	39.1	jilin	2.7	89.1
anhui	3.4	42.5	shanxi	2.6	91.7
shandong	3.4	45.9	neimenggu	2.4	94.1
hunan	3.4	49.3	hainan	2.4	96.5
shannxi	3.4	52.7	tianjin	1.8	98.3
guangxi	3.3	56	shanghai	1.7	100
beijing	3.2	59.2	total	100	100

3.3.2 The degree of spatial distribution balance

The Gini coefficient and the Lorenz curve are used to reflect the balance of crucial rural tourism villages in the inter-provincial region. The number and proportion of crucial rural tourism villages in each region are shown in Table 3. Equation (4) calculates the Gini coefficient of crucial rural tourism villages in China, $Gini=0.993$, which shows that crucial rural tourism villages are extremely spatially distributed across provinces at the national scale. Unbalanced, the pattern of differences is obvious. From the perspective of the seven administrative geographical divisions, the Gini coefficient of North China, Central China, Southwest China, and Northwest China is in the range of 0.3-0.4, which is a relatively reasonable distribution; the Gini coefficient of Northeast and South China is in the range of 0.2-0.3, indicating that their rural tourism is developing in a balanced manner. The situation; and the Gini coefficient in East China exceeds 0.4, indicating that the distribution of crucial rural tourism villages in East China is highly concentrated and the spatial imbalance is prominent.

Table 3. Gini coefficient of Crucial Rural Tourism Villages

Index	The first batch	The second batch	The first two batches
Actual nearest distance	73.24	44.44	35.68
Expected nearest distance	108.6	80.36	66.41
R	0.67	0.55	0.54
Z	-11.14	-22.3	-28
P	0	0	0

Besides, the spatial Lorenz curve (Figure 3) in each region is obviously convex, which once again confirms the spatial imbalance of China's crucial rural tourism villages.

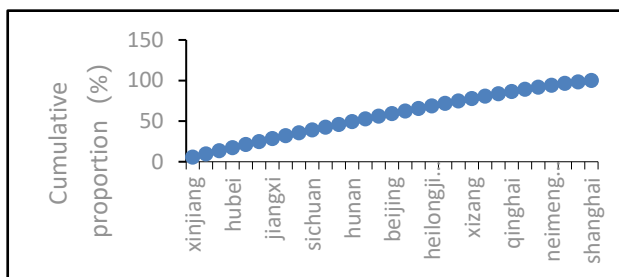


Fig. 3. Lorenz curve of Crucial Rural Tourism Villages in China

3.4. The spatial evolution of crucial rural tourism villages

The standard deviation ellipse is used to analyze the spatial distribution direction and evolution trend of China's rural tourism crucial villages. As shown in Figure 4, the ellipse covers most areas of China and can fully reflect the spatial development trend of rural

tourism. Overall, the spatial evolution trend of crucial rural tourism villages in China is apparent, showing the characteristics of south-west movement, with a northeast-southwest distribution pattern in space. Specifically, from the center of the standard deviation ellipse, the distribution center of rural tourism in China is always located in Henan Province, between $32.86^{\circ}\text{N} \sim 32.94^{\circ}\text{N}$ and $111.63^{\circ}\text{E} \sim 112.01^{\circ}\text{E}$. From 2019 to 2020, the distribution center of rural tourism in China will move to the northwest, and the east-west movement is greater than the north-south, indicating that the development of leisure tourism in Northwest China is fast, and the force of rural tourism is no longer limited to the eastern region. The degree of influence in the central and western regions continues to deepen. Judging from the shape of the standard deviation ellipse, the ellipse area continues to expand, indicating that the distribution range of rural tourism in China is expanding and the spatial spillover effect is good.

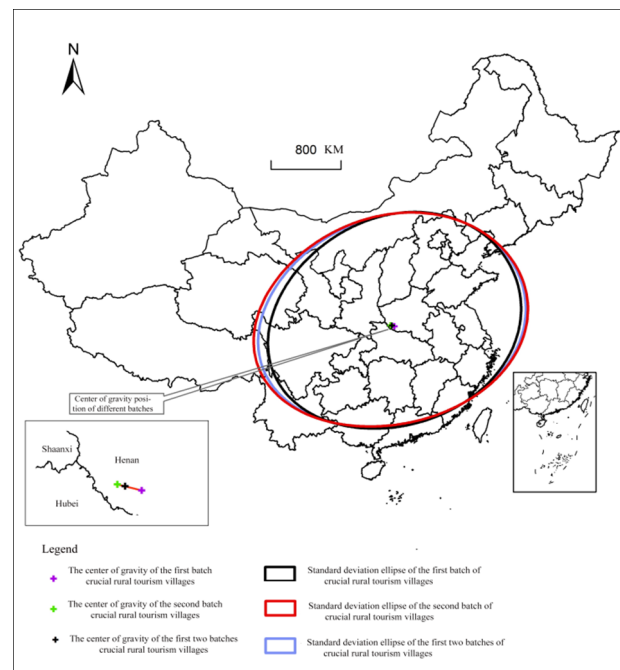


Fig. 4. Standard deviation ellipse of Crucial Rural Tourism Villages in China.

It can be seen from Table 4 that the length of the central axis of the standard deviation ellipse increases while the length of the minor axis decreases, indicating that China's rural tourism has an east-west spatial expansion trend and a north-south spatial contraction trend. Simultaneously, the expansion rate in the east-west direction is significantly higher than the contraction rate in the north-south direction, indicating that the development vitality of China's east-west rural tourism is stronger than the north-south direction. From the angle of the standard deviation ellipse, the spatial distribution pattern of China's rural tourism shows an obvious northeast-southwest direction, and the direction angle increases from 76.29° to 79.86° , indicating that the sustainable development of rural tourism in the southwest is better, and the distribution pattern of rural

tourism in the Northeast-Southwest has been strengthened.

Table 4. Coefficients of standard deviation ellipse of rural tourism in China.

Batch	Central point		Length of major axis	Length of minor axis	Direction angle
The first batch	32.86°N	112.01°E	13.18	9.32	76.29
The second batch	32.94°N	111.63°E	14.2	9.26	79.86
The first two batches	32.92°N	111.75°E	13.88	9.28	78.94

3.5. Spatial distribution of nuclear density characteristics

Use ArcGIS10.5 to analyze the nuclear density of crucial rural tourism villages in China, as shown in Figure 5. The results show that: ①There are apparent differences in the geographic distribution along the Heihe-Tengchong line in the crucial rural tourism villages in China, showing a pattern of dense in the east and sparsely in the west and more coastal areas in the east than inland in the west. It shows that rural tourism and the source market are close in scale. Related. ②Rural tourism presents the spatial characteristics of dual-nuclear radiation and multi-regional surroundings, with dots, generations, and planes coexisting, and the trend of clustering into regions is evident. The dual-core is a high-gathering area of Beijing-Tianjin-Hebei with Beijing as the center, including Beijing, Tianjin, Hebei and other places; the high-gathering area of the Yangtze River Delta with Shanghai and Zhejiang as the center, including Jiangsu, Anhui, Zhejiang, Shanghai and other places. "Dual-core" areas have a high level of economic development, complete infrastructure, strong rural informatization service capabilities, and various elements and guarantee mechanisms for the development of leisure agriculture are relatively sound. As a result, a group of crucial rural tourism villages with traditional culture, folk scenery and cultural tourism resources have been formed. Multi-zone refers to the ten sub-high-density areas with the provincial capital or municipality as a single core, namely the northwest sub-high-density area with Xining and Lanzhou as the center, the Guanzhong sub-high-density area with Xi'an as the center, and the Central Plains with Zhengzhou as the center Sub-high-density area, Sichuan-Chongqing Gui sub-high-density area centered on Chongqing, Xiangdong Jiangxi sub-high-density area centered on Changsha, Pearl River Delta sub-high-density area centered on Guangzhou, southern Shandong, eastern Hubei, There are several small agglomeration areas in North Guangxi and Qiongbai. ③The crucial rural tourism villages are mainly distributed around the central city, relying on the economy, resources, transportation, and market of the central city to expand the distribution range, forming a radiation pattern of urban agglomerations-central cities-crucial rural tourism villages.

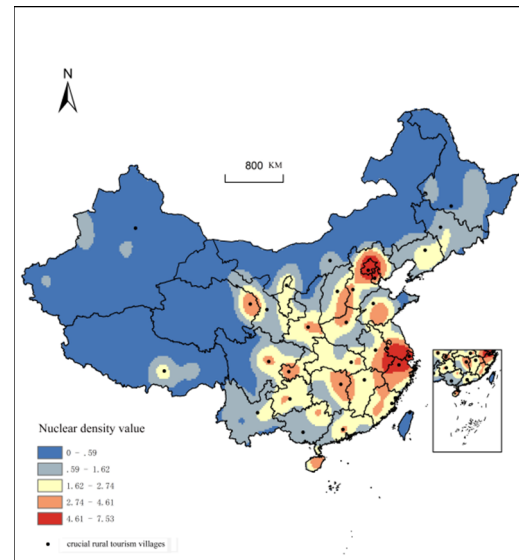


Fig. 5. Core density of Crucial Rural Tourism Villages in China.

4 Influence factors

4.1 Physical geographical factors

Rural tourism is an economical form based on agricultural production and life, and it is more sensitive to natural geographic factors^[28]. The natural environment includes landscape patterns such as topography, altitude, and rivers, which are decisive factors affecting the economic structure and spatial distribution of crucial rural tourism villages. Elevation reflects the village's topography, and the difference in water and heat conditions leads to changes in agricultural production methods in different regions, which in turn affects the traditional folk customs and culture of the village. The characteristics of tourists and ecotourism behaviors vary depending on the tourist destinations located at different altitudes. Using ArcGIS to overlay the distribution of crucial rural tourism villages with China's topography and geomorphology map (Figure 6), it is found that the number of crucial tourism villages is positively correlated with altitude, and they are concentrated in the low-altitude, gentle plains and terrains of the second and third steps. Hilly area. These areas have convenient transportation, good communication conditions and accessibility. Various socio-economic factors have fully explored the natural potential of the countryside, creating a complete infrastructure and good accommodation, catering and other leisure environment, which are closely connected with most tourists' actual needs. Therefore, the number distribution is denser. In contrast, remote areas such as mountains and plateaus with higher elevations and steep terrain, although they retain unique landscapes and regional culture, also increase the economic distance between tourists and villages, and low accessibility greatly limits rural tourism development.

Meanwhile, hydrology is also an indispensable condition for the generation of settlements, and it also influences the spatial distribution of crucial rural tourism

villages. On one hand, the river provides a unique hydrological landscape system and development resources for rural tourism. The unique water transportation function allows tourists to directly feel the water system's scenery, which greatly enhances the tourist appreciation. On the other hand, the river also provides residential areas. A large amount of water for domestic, drinking, industrial, and agricultural use greatly facilitates coastal villages's lives. Through the establishment of a 10km buffer area for major rivers above the third level in the country (Figure 7), it can be found that the Huaihe River system and the Yangtze River system have become important factors in promoting the Beijing-Tianjin-Hebei and Yangtze River Delta urban agglomerations to become the "dual-core" pattern of crucial rural tourism villages. Besides, the distribution of crucial rural tourism villages in areas with rich water systems such as the Yellow River Basin, the Pearl River Basin, the Songliao River Basin, and the Haihe River Basin has become denser, further proving the importance of hydrological factors to rural tourism.

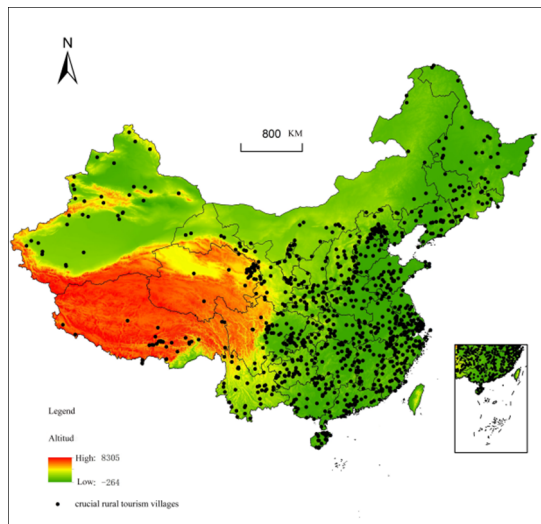


Fig. 6. Superimposed map of China's topography and Crucial Rural Tourism Villages.



Fig. 7. 10km buffer zone of rivers above grade 3.

4.2 Traffic factors

Transportation infrastructure is a crucial element of communication between tourists and destinations. Transportation networks play an important role in the creation of new attractions and the healthy development of existing attractions. Traffic conditions determine the accessibility of crucial rural tourism villages to the information flow, capital flow, people flow, logistics, and enterprise flow. As an important infrastructure for urban-rural connections, major roads directly affect the accessibility and re-accessibility of crucial rural tourism villages. Visit rate. On the one hand, the improvement of transportation infrastructure will increase road capacity, reduce commuting costs, increase tourists experience, and enhance the attractiveness of tourist attractions. On the other hand, the arrival of a large number of tourists will promote the development of rural tourism, create a large number of employment opportunities, strengthen the construction of various business activities, such as hotels, restaurants and other related service industries, and further improve the satisfaction of tourists and the service capacity of rural scenic spots. In recent years, with the continuous improvement of residents' living conditions, relying on self-driving travel has become the main rural tourism mode. To further verify the spatial impact of traffic factors on crucial rural tourism villages, a 20km buffer zone of major national highways has been established with the help of ArcGIS10.5. The results are shown in Figure 8. About 82.7% of the crucial rural tourism villages are distributed within the buffer zone. A good road network improves the accessibility of rural tourism, and spatially promotes the clustering of crucial rural tourism villages along the main traffic line.

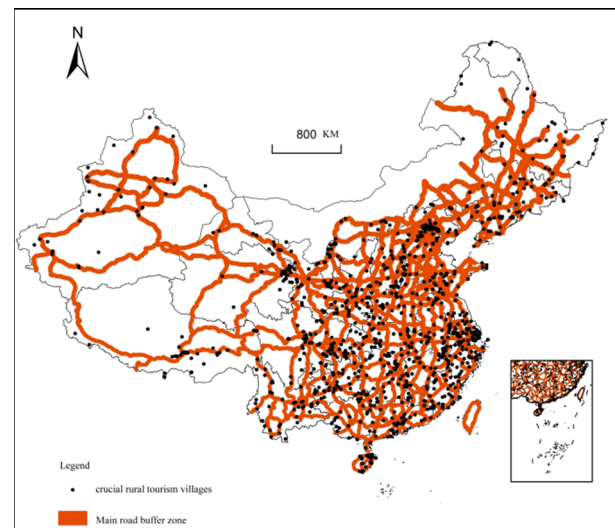


Fig. 8. 20 km buffer zone of main highways in China.

4.3 The source market

Rural tourism is closely related to urban consumption, and urban populations have become the direct market for crucial rural tourism villages. The acceleration of urbanization and the increase in residents' income have greatly stimulated urban and rural residents' tourism

needs. Traditional consumer tourism models have been unable to meet the increasing material and cultural needs of people. New forms of tourism in the rural environment are gradually attracting more and more people. Tourists. Unlike providing a single and homogeneous viewing service, rural tourism is a complex experience of various consumer services. Residents pay more attention to high-quality tourism satisfaction and shorter and more frequent trips. Simultaneously, the diversified activities and folklore experiences provided by rural tourism enhance tourists' sense of local cultural identity and adapt to the nature of the urban population in the fast-paced era. Using ArcGIS to make the buffer zone of major cities across the country (Figure 9), it can be found that crucial rural tourism villages are clustered and distributed around China's municipalities, provincial capitals, and prefecture-level cities, and are arranged in the suburbs, indicating that the source market for rural tourism in China is mainly from urban residents. And the higher the population density, the denser the distribution of the number, showing that the crucial rural tourism villages are mostly distributed in the suburbs of cities with strong demand and dense population.

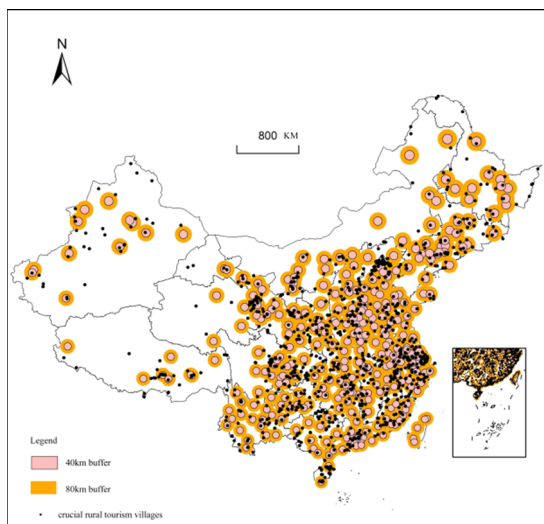


Fig. 9. 40 km and 80 km buffer zones in municipalities, provincial capitals and prefecture level cities.

4.4 Economic development level

Rural tourism is inseparable from financial support, and the economic environment is an essential guarantee for the survival and development of crucial rural tourism villages. Areas with higher economic development levels have sound market elements, complete rural infrastructure, and high population density. crucial rural tourism villages have various social capital participation, fund subsidies, tax relief and other policy support during the construction process. In addition, the income level of residents in areas with high economic development levels is higher, and there is a larger demand market for rural tourism. From the analysis of nuclear density, it can be found that rural tourism mainly revolves around major urban agglomerations, which also shows that rural

tourism is closely related to the level of the regional economy. To further explore the degree of connection between the economic environment and rural tourism, the per capita GDP and the per capita disposable income of residents in each region are selected as measurement indicators to calculate the geographic connection rate between crucial rural tourism villages and the economic development environment. The results show that the geographic connection rates of per capita GDP, per capita disposable income and crucial rural tourism villages are 80.53 and 83.41 respectively, which further proves that the economic environment is closely related to rural tourism.

4.5 Endowment of tourism resources

The richness and level of tourism resources directly determine the development model of the regional tourism industry. As an obvious resource-oriented industry, tourism benefits from landscape value, and the development of landscape value is based on the functional diversity of tourism resources. Rural tourism has gradually become the attraction of the surrounding traffic in the region. Relying on the radiation of traditional tourism, it provides a complex and comprehensive combination of leisure services to meet the needs of tourists. In other words, the success of rural tourism depends on the endowment of its regional tourism resources. While competing with traditional tourism forms, rural tourism continues to integrate and optimize its tourism resources to obtain competitive advantages to meet changing market demands. Similarly, select China's 5A-level scenic spots as a regional tourism resource endowment, measure and discuss the degree of connection between crucial rural tourism villages and resources. The calculated geographic concentration index is 84.76, and the two are closely related. The crucial rural tourism villages and 5A-level scenic spots give full play to the complementary role of resources, and regional tourism achieves sustainable and circular development.

5 The development mode of crucial villages in rural tourism

5.1 Qualitative comparative analysis method (QCA)

The qualitative comparative analysis method (QCA) is based on set theory and fuzzy mathematics. Its core is "Boolean algebra" calculation logic and "Boolean minimization principle". It focuses on the study of meso and macro issues. The American sociologist Charles La King (Charles C. Ragin)'s monograph "QCA Design Principles and Applications: New Methods Beyond Qualitative and Quantitative Research" has been systematically explained. Ragin believes that the reason why social phenomena are complicated and difficult to explain is not that there are too many variables that affect the occurrence of social phenomena, but because

different conditions related to the cause are combined to produce a specific result in some way^[29]. Unlike previous quantitative analysis methods that explore the impact of a single factor on the results, QCA pays more attention to the multiple concurrent causalities of cases. Based on the configuration perspective, the following five independent conditional factors, including physical geography, transportation environment, source market, economic level, and tourism resource endowment will be included in the same framework. The number of crucial rural tourism villages in 31 provinces, cities, and autonomous regions is taken as Outcome Variables, discuss the multiple influence mechanisms on the spatial distribution of crucial rural tourism villages in China.

5.2 Variable assignment and calibration

Qualitative comparative analysis needs to assign and calibrate each condition variable. When fsQCA is

specifically used, the data needs to be calibrated so that each variable is divided into membership degrees between [0-1]. Among them, the calibration anchor points are divided into complete affiliation, crossover point, and completely non-affiliation. For example, the "5 points" Likert scale is used for measurement, that is, "5" means "strongly agree", "4" means "agree", "3" means "neutral", "2" means "disagree", and "1" means "strongly disagree". These values are calibrated into the fuzzy set and converted into the value "1" of "strongly agree" (completely agree). Affiliation), "Agree" with a value of "0.75", "Neutral" with a value of "0.50" (intersection), "Disagree" with a value of "0.25", and "Strongly disagree" with a value of "Not affiliated at all". This article refers to existing research and selects the 95% and 5% quantiles of the sample data as anchor points^[30]. The assignment description and calibration of each variable are shown in Table 5.

Table 5. Description and calibration of variable assignment

	Variable	Assignment basis	Full member	Cross-over	Non-member
Outcome	Development level of rural tourism	Number of crucial villages in rural tourism	39.5	32	21
Condition	Geography	Topographic relief	3.92775	0.6519	0.01895
		Per capita water resources	9793.95	1765.47	132.03
	Traffic	Highway transportation mileage	28.465	16.87	1.925
	Tourist market	Population density	1313	280	12
	Economic	Per capita GDP	85349.525	24757.5	3357.215
	Resource endowment	Number of 5A scenic spots	16	8	3

5.3 Single factor necessity analysis

First, analyze whether a single variable constitutes a necessary condition for the dense distribution of crucial rural tourism villages. In the qualitative comparative analysis method, Consistency greater than 0.9 can be considered as a necessary condition for the variable to

constitute the result. The calculation formula is as follows. The results show (Table 6) that the consistency of each condition variable is below 0.9, indicating that a single variable cannot explain the spatial distribution of crucial rural tourism villages, which also reflects the complexity of the rural tourism environment.

Table 6. Single factor necessity analysis

Conditional variable	High density distribution		Low density distribution	
	Consistency	Coverage	Consistency	Coverage
Economic	0.710714	0.822314	0.509859	0.498623
~Economic	0.566667	0.57767	0.81831	0.705097
Topographic relief	0.633333	0.737864	0.6	0.590846
~Topographic relief	0.64881	0.657418	0.733803	0.628468
Tourist market	0.585714	0.716157	0.609859	0.630277
~Tourist market	0.697619	0.679027	0.725352	0.596755
Traffic	0.753571	0.815197	0.523944	0.479073
~Traffic	0.518452	0.563025	0.79a7887	0.732385
hydrology	0.558929	0.750599	0.514085	0.583533
~hydrology	0.689881	0.626825	0.780282	0.599243
Resource endowment	0.800595	0.853427	0.498592	0.449239
~Resource endowment	0.483333	0.532808	0.837324	0.780184

5.4 Figures an configuration path of influencing factors

In view of the fact that a single variable cannot explain the result variable, this study adopts the configuration idea to analyze the combination of each condition variable. The analysis of the fuzzy set qualitative comparison method's results will produce three kinds of solutions, namely, the complex solution, the intermediate solution and the simple solution. The complex solution does not consider the logical remainder, the intermediate solution only considers the simple counterfactual hypothesis, and the simple solution considers both the simple counterfactual hypothesis and the complex counterfactual hypothesis. Generally, intermediate solutions are taken in the research. This article refers to the existing literature. After the data is calibrated for the degree of membership, the threshold value of PRI greater than 0.7 is selected, and the following five configuration paths are finally generated. Table7 shows the five configuration paths of high-density distribution of crucial rural tourism villages. The overall solution coverage is about 0.91, which is greater than the 0.8 threshold, that is, the reliability of the solution is about 91%. The coverage of the overall solution is about 0.72, which means that these five paths can explain about 72% of the cases.

Table 7. Configuration path of influencing factors of Crucial Rural Tourism Villages¹

Code	Conditional combination	Coverage	Consistency
M1	Economic*~Topographic relief*Tourist market*Resource endowment	0.526786	0.9238
M2	~Economic*~Topographic relief*~Tourist market*Traffic*hydrology	0.34881	0.914197
M3	Economic*Topographic relief*Traffic*~hydrology*Resource endowment	0.358929	0.937792
M4	Economic*Topographic relief*~Tourist market*Traffic*Resource endowment	0.385119	0.94868
M5	Economic*Tourist market*~Traffic*hydrology*Resource endowment	0.24881	0.965358
	Solution coverage	0.716667	
	Solution consistency	0.904583	

5.5 The development model of crucial rural tourism villages

Further, visually analyze various configuration paths, and summarize the three patterns of distribution of crucial villages of rural tourism resources in China, as shown in Table 8.

Model 1: Tourist source market-driven. This rural tourism crucial village has a relatively high economic level, gentle terrain fluctuations, a prominent tourist source market, and a good endowment of tourism

resources. Its advantages mainly come from a large consumer group. The crucial rural tourism villages of this type provide different services and rely on flat terrain to develop diversified tourist attractions, including sightseeing farms, educational farms, family farms, and leisure farms. Provide simple accommodation and develop to more professional leisure services, such as fishing, fruit picking, tasting local dishes, folk education and agricultural products sales, etc., providing urban residents with a city form that slows down the pace of life and satisfies the differentiation of tourists Demand, the market potential is huge.

Mode 2: Traffic-oriented mode is a mode that relies on the main traffic lines along the route to carry out tourism promotion and improve the vitality of tourism. This type of rural tourism crucial village has a large degree of undulations, but the transportation infrastructure is complete, the transportation network is fully covered in the area, and the transportation conditions completely compensate for the terrain obstacles. Its advantage is mainly high accessibility. The powerful tourism transportation system makes it possible for tourists to travel anywhere. Consumers are no longer limited to tourist destinations mainly in the suburbs of cities, and then look for novel and exciting outdoor experiences such as mountains and rock climbing, providing tourists with more opportunities for excursions. Besides, the traffic environment can also be derived as a separate tourist attraction element, such as rafting, express trains, boating, etc. The distance, travel cost and traffic accessibility of the key villages of rural tourism will affect the tourists' choice of tourism, so the tourism villages around the main roads have great advantages.

Model 3: Scenic area radiation type, which refers to a development model that is distributed near scenic spots and relies on the popularity of high-level scenic spots and a stable source market to integrate unique rural production, life, customs and culture and other characteristic tourism resources into it. Such crucial rural tourism villages are adjacent to economically developed and densely populated areas. The radiation of traditional tourist attractions activates the development potential of rural tourism, transforms untapped rural resources into tourism products and leisure services, and creates a series of "tourism IP". At the same time, due to the spatial spillover effects of traditional tourist attractions, crucial rural tourism villages are developed adjacent to each other geographically, and the spatial connection has been transformed from the traditional separate and independent structure into an interconnected and interactive pattern, thus integrating the mountains, water, city, village, people and landscape.

¹ In qualitative comparative analysis, ~ means the lack of the conditional variable, * means and, that is, the conditional variable occurs simultaneously.

Table 8. Development mode of key Rural Tourism Villages²

	Customer market driven	Traffic-oriented			Scenic area radiation
	M1	M2	M3	M4	M5
Economic	●	⊗	●	●	●
Topographic relief	⊗	•	•	•	
Tourist market	•	⊗		⊗	•
Traffic		●	●	●	⊗
hydrology		●	⊗		●
Resource endowment	●		●	●	●
coverage	0.526786	0.34881	0.358929	0.385119	0.24881
consistency	0.9238	0.91419 7	0.937792	0.94868	0.965358
Overall Solution coverage	0.716667				
Overall Solution consistency	0.904583				

6 Conclusion

This paper uses the nearest neighbor index, geographic concentration index, Gini coefficient, standard deviation ellipse, nuclear density analysis and other spatial measurement tools to analyze the spatial distribution type, spatial balance, spatial pattern, and spatial pattern of the first and second batch of rural tourism crucial villages across the country. Evolution analysis. On this basis, using tools such as geographic connection rate and buffer zone to analyze the factors affecting the distribution of crucial rural tourism villages, and then summarize the development model of rural areas from the perspective of configuration. The main conclusions are as follows:

①On the macro scale, the crucial rural tourism villages in China show obvious differences in the geographic distribution along the Hu Huanyong Line; on the three major economic belts, the eastern zone has the largest number, and the central zone has the least, and the spatial distribution is east→west→central and coastal→inland. Among the eight comprehensive economic zones, the Northwest has the highest distribution ratio due to factors such as rich historical precipitation and primitive geographic landscapes, while the Northeast has the lowest distribution ratio due to restrictions on location and climate; on the three major steps, rural tourism focuses on Villages are concentrated in the second and third steps, tending to gather in areas with gentle terrain.

②The nearest neighbor index of crucial rural tourism villages is $R=0.54$, indicating that China's crucial rural tourism villages are spatially cohesively distributed, and

the degree of agglomeration is decreasing, showing a weakening trend. The geographical concentration index $G=18.4$ and the Gini coefficient $Gini=0.993$, indicating that the spatial distribution of crucial rural tourism villages in China is highly uneven within the province, showing a weak degree of concentration. From the perspective of the seven administrative geographical divisions, the distribution of crucial rural tourism villages in East China is highly concentrated, and the spatial imbalance is prominent. Also, the spatially convex Lorenz curve in each region further proves the spatial imbalance of crucial rural tourism villages in China.

③The spatial evolution trend of rural tourism in China is significant, and the distribution center of gravity shows the characteristics of the southwest movement, showing a northeast-southwest distribution pattern in space. The distribution range of crucial rural tourism villages across the country shows an expanding trend, with sound spatial spillover effects. It has a clear east-west spatial expansion trend and a north-south spatial contraction trend, and the expansion rate in the east-west direction is significantly higher than the contraction rate in the north-south direction, indicating that China's east-west direction The development vitality of rural tourism is stronger than that of north-south.

④The distribution of rural tourism presents the spatial characteristics of dual-core radiation and multi-regional surroundings, and the radiation pattern of urban agglomerations-central cities-crucial rural tourism villages is obvious. Two high-density areas, namely the Beijing-Tianjin-Hebei area with Beijing as the center, the Yangtze River Delta with Shanghai and Zhejiang as the center, the second-high-density area in the northwest with Xining and Lanzhou as the center, the second-high-density area in Guanzhong with Xi'an as the center, and the Yangtze River Delta with Shanghai and Zhejiang as the center, are formed. The Central Plains sub-high-density area with Zhengzhou as the center, the Sichuan-Chongqing high-density area with Chongqing as the center, the Xiangdong and Jiangxi sub-high-density area with Changsha as the center, the Pearl River Delta sub-high-density area with Guangzhou as the center, and Shandong There are several small agglomeration areas in the south, eastern Hubei, northern Guangxi, and Qiongbai.

⑤The influence mechanism of rural tourism is formed by the regional supply-side attractiveness and demand-side driving force. The degree of topographical fluctuations, hydrological conditions, source market scale, economic level, transportation environment, and tourism resource endowments affect the spatial distribution of crucial rural tourism villages. Factors influencing differences.

⑥Rural tourism faces a complex and diverse environment. A single factor cannot determine the spatial distribution of crucial rural tourism villages. Rural tourism is a system of multiple factors. There are mainly three driving modes in China's crucial rural tourism villages, namely, source market-driven, traffic-oriented, and scenic-radiation.

² The expression of the results refer to the way proposed by Ragin. ●Indicates the core condition, Conditional variables appear in both simple and intermediate solutions; •represents the edge condition, conditional variable appears only in the intermediate solution; ⊗Indicates that the condition variable does not appear; Blank indicates that the condition can appear or not.

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