



A GIS-Based Study on the Spatial Distribution of Rural Tourism Resources and the Correlation Mechanism of Transportation Accessibility in Northern Anhui Province, China

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SUMMARY: *This study provides quantitative evidence on the spatial distribution of rural tourism resources and their relationship with transportation accessibility in Northern Anhui Province, China. Using spatial analysis of tourism development patterns across five core counties, the results reveal a strong association between transportation infrastructure density and the concentration of tourism resources. Counties with higher densities of roads, expressways, and railway stations exhibit significantly greater clustering of tourism attractions. In contrast, larger administrative units such as Fuyang and Suzhou, despite possessing notable scenic resources, demonstrate weaker tourism development trends, largely due to insufficient transportation accessibility and dispersed resource distribution. The findings indicate that administrative scale and urban–rural land allocation structures play a decisive role in shaping tourism spatial patterns, with smaller counties enjoying a natural advantage in achieving resource concentration. Conversely, tourism resources in larger counties tend to be spatially fragmented, which constrains tourism growth and related economic activities. Furthermore, ordinary least squares (OLS) regression analysis confirms that transportation accessibility is the most influential factor affecting the spatial agglomeration of rural tourism resources, explaining approximately 69% of the observed variation. Better accessibility not only enhances connectivity and reduces travel time but also promotes investment in tourism infrastructure and services. These findings offer important policy implications for optimising transportation planning and promoting balanced rural tourism development in Northern Anhui Province.*

KEYWORDS: *Rural tourism; spatial distribution; transportation accessibility in Northern Anhui Province; Tourism resource clustering; GIS spatial analysis*

1 Introduction

As the Chinese government has been pursuing strategic initiatives that aim at cultural preservation, promoting economic diversification, and ensuring sustainable development, rural tourism is considered the cornerstone and a key to realising its strategic objectives [1]. Taking into consideration the significance of rural tourism, rural revitalisation has emerged as the core priority of the Chinese central government [2]. Recent policies that the Chinese government has been pursuing for the sake of rural revitalisation have thus stressed not only rural tourism development, but also rural tourism has been playing a key role in enhancing the livelihoods of the local population, promoting ecological conservation and drastically cutting down the disparities witnessed between the Chinese urban and rural areas [3].

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Increasingly, transportation infrastructure is considered a critical factor that shaped tourism accessibility [4]. In particular, visitor flows, regional competitiveness and the sustainable development of tourism largely depend on transportation networks in a given region [5]. Regions that have greater accessibility usually outsource other regions as tourism resources in such regions could be better reached. [6] have pointed out that transportation networks determined tourism hotspots and a significant portion of the conversion of tourism resources into sustained visitation. Particularly, [7] have asserted that efficient road networks, expressways and rail infrastructure could not only significantly cut down travel time, but also such resources are the means through which better catchment of rural tour attraction points could be ensured. [8] have also asserted that transportation networks dictate the economic viability of rural tourism, whereas the lack of such networks could not only affect the accessibility of rural tourism but also significant disparities and lopsided spatial patterns, and underutilisation of tourism resources could be witnessed in such regions.

Northern Anhui Province is predominantly characterised by rural areas, whereas cultural heritage and scenic landscape distinguish the province from other parts of the world [9]. In particular, an overwhelming number of the inhabitants living in the province earned their livelihood through agriculture and cultural heritage-related industries [10]. Although there are different provinces across China that could be analysed for the sake of spatial distribution of rural tourism resources, Northern Anhui province emerged as an ideal case that could be analysed for examining the spatial distribution of rural tourism resources and the key place that transportation accessibility has been playing in shaping tourism development in the province [11].

The analysis of existing literature could reveal that there are different studies conducted that analysed spatial patterns of tourism resources and tourism development; however, there is limited literature that elaborates on the interrelation between spatial patterns of tourism resources and accessibility and resource distribution [12]. Particularly, in the Chinese context such studies are lacking. This research has been organised with the aim to bridge the literature gap, as the study presents quantitative evidence regarding spatial patterns of tourism resources and its relations between accessibility and resource distribution. The study presents Ground Information System (GIS)-based spatial analysis and quantitative modelling that helped in analysing the role of transportation infrastructure in shaping the spatial clustering of rural tourism resources in Northern Anhui Province.

2 Materials and Methods

2.1 Research Strategy

The research strategy that has been adopted in this study that analyses the spatial patterns of tourism resources and its relations between accessibility and resource distribution could be categorised as a case study research strategy. The case study means that the findings of the study are based on real-life instances. For the present study, the analysis is based on Northern Anhui Province, which is one of the core tourist attractions in China. The province has been selected for this study because it not only comprises predominantly rural areas, but also the province has significant disparities in terms of development, as some of the counties within the province having more tourist attractions are more developed than other parts of the province. Additionally, the case study has been selected because of the diverse transportation network structure in different parts of the province, diverse cultural heritage and historical village concentration. The Chinese central government as well as the provincial government has been making extreme efforts in terms of rural revitalisation, which also makes Northern Anhui Province a perfect case

study for analysing spatial patterns of tourism resources and its relations between accessibility and resource distribution.

2.2 Data Sources

The data sources that have been utilised for investigating spatial patterns of tourism resources and their relations between accessibility and resource distribution could be categorised as secondary data. A range of credible and authentic data sources have been used in this study, which include officially published data for the Chinese central government and provincial authorities. Due to the high degree of credibility of the selected data, the present research enjoys a high degree of accuracy and reproducibility, which contributes to better validity and reliability of the study. In this regard, some of the key data sources that have been leveraged include socio-economic and tourism data published by the Anhui Statistical Yearbook, transportation data published by the China Transport Statistical Yearbook, and GID shapefiles, which elaborate on the transportation and railway network in Northern Anhui Province extracted from the provincial official GIS repositories.

2.3 Data Analysis

As this study is primarily quantitative in nature, there are a range of variables analysed in this study, which include dependent and independent variables. The major dependent variable of the study is Tourism Resource Density (TRD), which has been measured in terms of 1000 km². The ratio exhibits standardised resources relative to the size of each prefecture. The following formula has been adopted in the study for measuring TRD:

$$TRD_i = \frac{\text{Number of A-level Scenic Spots}_i}{\text{Administrative Area}_i} \times 1000$$

In addition to the measurement of dependent variables, there are three key independent variables that affect the major dependent variable analysed in this study. This includes road density, expressway density, and railway station density. The road density (RD) has been measured through the following formula:

$$RD_i = \frac{\text{Total highway length}_i}{\text{Area}_i} \text{ (km/km}^2\text{)}$$

The second independent variable in this study is expressway density, which has been measured through the following formula:

$$ED_i = \frac{\text{Expressway length}_i}{\text{Area}_i} \text{ (km/km}^2\text{)}$$

The third core independent variable in this study is railway station density, which has been analysed using the following formula:

$$RSD_i = \frac{\text{Number of railway stations}_i}{\text{Area}_i} \text{ (No./1000 km}^2\text{)}$$

As the accessibility index has been caused by these three different independent variables, for the sake of this study, a composite accessibility index has been constituted, whereas a weighted sum has been adopted, for which a weight of 0.4 has been assigned to the road network, 0.3 has been assigned to expressway density, and a weight of 0.3 has also been assigned to railway station density. The following is the formula that has been used to calculate the accessibility index in the present study:

$$AI_i = 0.4 \times RD_{std} + 0.3 \times ED_{std} + 0.3 \times RSD_{std}$$

Furthermore, the study also utilised regression analysis with the aim of quantifying the relation between tourism resource density and transportation accessibility. In this regard, ordinary least squares regression analysis has been utilised, for which the following formula has been used in this study:

$$TRD_i = \beta_0 + \beta_1 AI_i + \epsilon_i$$

3 Results

3.1 Northern Anhui Province Socio-Economic and Tourism Characteristics

The socio-economic characteristics of Northern Anhui Province have been summarised and presented in Table 1, whereas the results have been classified into different counties.

Table 1: Northern Anhui Province Socio-Economic and Tourism Characteristics [13] [14]

City	Administrative Area	GDP 2024	Rural Population (10 ⁴ persons)	Number of A-Level Scenic Spots
Fuyang	10,118 km ²	326.1 Billion CNY	595.2	42
Bozhou	8,522 km ²	221.4 Billion CNY	461.8	36
Suzhou	9,787 km ²	243.8 Billion CNY	486.5	39
Bengbu	5,951 km ²	321.5 Billion CNY	312.4	44
Huaibei	2,725 km ²	130.2 Billion CNY	168.3	28

From the analysis of Table 1, it is clear that Fuyang emerged as the biggest administrative division of Northern Anhui Province, not only in terms of administrative area but also in terms of GDP, total population and the number of A-class scenic attractions for tourists. As compared to this, Huaibei emerged as the smallest county, as it has the lowest administrative area, total population, GDP growth, and number of A-class scenic spots that tourists visit. Although Hubei has the least number of A-level scenic spots, since the county has the smallest area amongst the five counties analysed in Table 1, this in turn has been accounting for a higher tourism resource density. Thus, significant concentrated tourism could be witnessed in Huaibei as compared to the other four counties analysed in Table 1. On the other hand, Bengbu has the largest number of A-level scenic spots; however, as the county has a large administrative area comprising 5,951 km², this in turn makes the tourists' attractions more dispersed than in Huaibei.

3.2 Transportation Infrastructure of Northern Anhui Province

The transportation infrastructure of Northern Anhui Province has been summarised in Table 2, which largely shows significant disparities in terms of transportation infrastructure in different

parts of the province.

Table 2: Transportation Infrastructure of Northern Anhui Province [15]

City	Highway Mileage	Expressway Mileage	Number of Railway Stations
Fuyang	22,480 KM	612 KM	11
Bozhou	18,340 KM	528 KM	9
Suzhou	19,210 KM	566 KM	10
Bengbu	16,850 KM	604 KM	12
Huaibei	9,460 KM	332 KM	7

From the analysis of Table 2, it is very clear that Fuyang County has the lengthiest highway, which totals 22,480 kilometres, and expressway, which totals 612 km. On the other hand, Huaibei has the shortest highway mileage and expressway mileage; however, since the county has a small administrative area, this in turn has been resulting in relatively higher highway and expressway mileage coverage per unit area. Resultantly, one could see that Huaibei's greater concentration has been resulting in better connectivity as compared to the other four counties analysed in Table 2. Furthermore, from the analysis of Table 2, one could note that although significant variation in terms of transportation infrastructure could be found in different parts of Northern Anhui Province, nevertheless the counties with higher expressway and railway station density have been showing greater concentration of tourism development.

3.3 Transportation Accessibility

Transportation accessibility could be analysed through computation of road, expressway, and railway station density. The following Table 3 provides relevant computation in this regard.

Table 3: Transportation Accessibility

City	Road Density	Expressway Density (km/km ²)	Railway Station Density
Fuyang	2.22 (km/km ²)	0.061 (km/km ²)	1.09 per 1000 km ²
Bozhou	2.15(km/km ²)	0.062 (km/km ²)	1.06 per 1000 km ²
Suzhou	1.96(km/km ²)	0.058(km/km ²)	1.02 per 1000 km ²
Bengbu	2.83 (km/km ²)	0.101(km/km ²)	2.02 per 1000 km ²
Huaibei	3.47 (km/km ²)	0.122 (km/km ²)	2.57 per 1000 km ²

From the analysis of Table 3, it is clear that Suzhou has the lowest transportation accessibility amongst the five counties of Northern Anhui Province analysed in this study, followed by Bozhou and Fuyang. On the other hand, Huaibei has been showing significant concentration and the highest density for all three major transportation indexes analysed in this study. One could see that Huaibei not only has 3.47 km/km² road density, but also the express density of the county is 0.122 km/km², and the number of railway stations per 1000 km² is also the highest, standing at 2.57. The better transportation accessibility in turn shows better connectivity, which in turn could have also been contributing to better tourism accessibility in the city. Unlike Huaibei City, other core counties like Suzhou have greater transportation infrastructure; however, since the county has the largest administrative area, in terms of density, it has shown inefficient distribution.

3.4 Composite Transportation Accessibility Index

The composite transportation index encompassed integrated road, expressway and railway

station density computation, for which weights have been applied, considering the relative importance of the three different forms of transportation. For this purpose, min-max standardisation has been used in the computation. The following Table 4 presents the composite transportation accessibility index for the five major counties of Northern Anhui Province.

Table 4: Composite Transportation Accessibility Index

City	Standardised Road	Standardised Expressway	Standardised Rail	Accessibility Index
Fuyang	0.43	0.41	0.39	0.41
Bozhou	0.40	0.43	0.36	0.40
Suzhou	0.31	0.38	0.33	0.34
Bengbu	0.71	0.73	0.78	0.74
Huaibei	1.00	1.00	1.00	1.00

From the analysis of Table 4, one could establish a clear viewpoint regarding the impact of transportation infrastructure and the utilisation of the same for tourism development in the Chinese rural areas. Unlike other cities, Huabei and Bengbu ranked as the two best counties in Northern Anhui Province in terms of the composite transportation accessibility index. The two counties have the best road, expressway and railway station network, which in turn has been contributing to higher tourism density in the two cities. The potential clustering of resources could be thus witnessed in Huabei and Bengbu cities, which have the core reason behind the rural revitalisation witnessed in the two regions. A clearer viewpoint regarding this could be developed on the basis of Figure 1 that graphically exhibits the GIS-based viewpoint of the composite transportation network in the Northern Anhui Province.

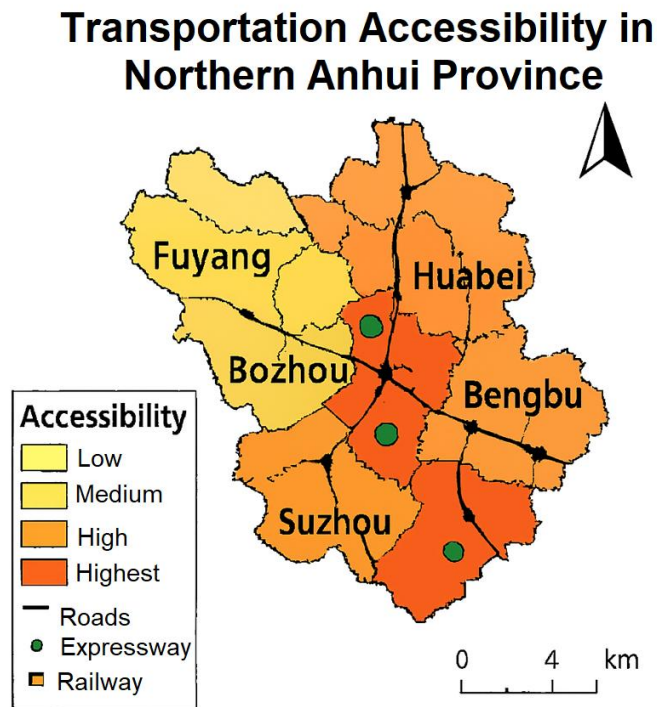


Figure 1: Transportation Accessibility in Northern Anhui Province [16]

3.5 Regression Analysis

In order to establish a clear viewpoint regarding the impact of accessibility on tourism resource density, regression analysis has been conducted. The following Table 5 exhibits the results of the OLS regression analysis.

Table 5: OLS Regression Analysis

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Constant	2.01	0.58	3.47	0.018
Accessibility Index	6.42	1.91	3.36	0.020
R ²	0.69			

From the results compiled and summarised in the above Table 5, one could see that accessibility is positively correlated with the tourism resources density, as the coefficient of the accessibility index has been computed (6.42, $p < 0.05$). This in turn means that in situations where better transportation accessibility is found, this could result in higher rural tourism resource density. Furthermore, from the analysis of Table 5, the R² value of 0.69 indicates transportation accessibility has been accounting for approximately 69% of the changes witnessed in tourism density in different parts of Northern Anhui Province. From the OLS regression results, it could be thus confirmed that transportation infrastructure concentration could significantly enhance tourism clustering.

4 Discussions

4.1 Spatial Distribution of Rural Tourism Resources

As per the core findings of the current research, based on the analysis of rural tourism trends witnessed in the five core counties of Northern Anhui Province, the areas where greater concentrations of transportation resource density have been witnessed have shown significantly greater tourism attractions. Larger counties that have more scenic tourist attractions, including Fuyang and Suzhou, have been lacking the desired tourism trends, which could be primarily attributed to the lack of transportation resource density in such counties. From the findings of the current study, heterogenous distribution across prefecture level is thus evident, as smaller counties are showing more positive trends in terms of tourism resources and tourism attractions. From the findings of the study, one could hold that administrative size and urban-rural land allocations predominantly affect the spatial concentration of tourism resources; thus, counties with smaller total size get a natural advantage over larger administrative areas.

On the other hand, the tourism attractions and resources in the larger counties in the Northern Anhui Province are dispersed and lack the desired concentration, which in turn affects tourism and related activities in such counties. The findings of the current study that place smaller administrative units as more attractive than the larger administrative units are in line with the findings of [17] and [18], who have also pointed out that higher tourism resource concentrations play a dominant role in the tourists' attraction.

4.2 Transportation Accessibility

From the analysis of composite transportation accessibility presented in the current study, it is quite evident that administrative areas that have greater concentrations of roads, expressways and railway stations are exhibiting higher tourism resource density. As a result, one could see that counties like Huaibei and Bengbu have denser roads, expressways and railway stations,

and as a result, these facilities have been playing a pivotal role in the tourism clustering in these areas. The transportation accessibility has been not only resulting in better connectivity, which decreases travel time, but the better accessibility has also been playing a key role in terms of investment in tourism facilities and services.

Additionally, the OLS regression conducted in the study also confirmed that accessibility has been playing a key role in tourism resource density, accounting for about 69% of the changes. The causal influence of transportation facilities found in the current study is in line with the findings of [19] and [20], who have also found the positive impact of transportation accessibility on rural tourism development.

4.3 Implications of the Study for Rural Tourism Development in Northern Anhui Province

As per the clear empirical evidence found in the current study, there are a range of implications that could be presented to the provincial authorities and policymakers. In this regard, transportation infrastructure development should be one of the core priorities of the provincial government, as without solid tourism resource accessibility, the desired level of tourism benchmarks could not be realised. Additionally, the key implication of the research is that the counties like Huaibei and Bengbu that have already realised the desired tourism density need to attract more targeted tourism investments. These regions need sustainable investment with the aim to upgrade the facilities and realise the next level of development in terms of tourism development. Furthermore, another key implication of the study is that the provincial authorities should leverage the spatially informed policies, for which it could integrate GIS-based accessibility and clustering analysis. The transformation of the existing planning efforts in this way could help in leveraging evidence-based allocation of resources, which are essential for more balanced development, particularly for avoiding oversaturation of tourism resources in some parts of the province.

5 Conclusion

This research examined quantitative evidence regarding spatial patterns of tourism resources and its relations between accessibility and resource distribution in Northern Anhui Province. As per the core findings of the current research, based on the analysis of rural tourism trends witnessed in the five core counties of Northern Anhui Province, the areas where greater concentrations of transportation resource density have been witnessed have shown significantly greater tourism attractions. Larger counties that have more scenic tourist attractions, including Fuyang and Suzhou, have been lacking the desired tourism trends, which could be primarily attributed to the lack of transportation resource density in such counties. From the findings of the study, one could hold that administrative size and urban-rural land allocations predominantly affect the spatial concentration of tourism resources; thus, counties with smaller total size get a natural advantage over larger administrative areas. On the other hand, the tourism attractions and resources in the larger counties in the Northern Anhui Province are dispersed and lack the desired concentration, which in turn affects tourism and related activities in such counties. Additionally, the study stressed that administrative areas that have greater concentrations of roads, expressways and railway stations are exhibiting higher tourism resource density. As a result, one could see that counties like Huaibei and Bengbu have denser roads, expressways and railway stations, and as a result, these facilities have been playing a pivotal role in the tourism clustering in these areas. The transportation accessibility has been not only resulting in better connectivity, which decreases travel time, but the better accessibility

has also been playing a key role in terms of investment in tourism facilities and services. Additionally, the OLS regression conducted in the study also confirmed that accessibility has been playing the most pivotal role in shaping the spatial clustering of rural tourism resources in Northern Anhui Province, accounting for about 69% of the changes.

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