

Research on Spatial Pattern and Accessibility of Traditional Villages-Taking Henan Province as an Example

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Abstract

Chinese culture has a long history. Traditional villages carry the breath of history. The great cultural attraction of traditional villages to people and the implementation of rural revitalization policies, it makes the attention to traditional villages gathered. Henan Province has a deep cultural heritage, he has many traditional villages, widely distributed. Therefore, it is particularly important to study the spatial pattern and accessibility of national-level traditional villages in Henan Province. This study takes 275 national-level traditional villages in Henan Province as research objects, using GIS analysis with accessibility to study the spatial pattern of traditional villages in Henan Province and to demonstrate the accessibility of traditional villages in prefectural-level cities in Henan Province at the municipal scale. Studies have shown that the spatial pattern and accessibility of the distribution of traditional villages in Henan Province are closely related to many factors (transportation road network, distance from the central city, etc.). The accessibility values of traditional villages in each prefecture-level city vary greatly, indicating that there are obvious differences in the accessibility of traditional villages in Henan Province. It intuitively reflects the spatial distribution and accessibility of traditional villages in Henan Province, with a view to providing a reference for the tourism development of traditional villages. Providing an analytical basis for promoting the optimal allocation of traditional village resources.

1. Introduction

Chinese culture has a long history. Traditional villages carry the historical atmosphere (Rahman,2018). Through the study of traditional villages, it can better have understood the value of Chinese culture, help people better protect (Fan,2019), better protect and develop tourism in traditional villages (Chun,2019).

Accessibility is how easy it is to get from one vertex to another. At present, in foreign studies on accessibility, Hansen proposed as early as 1959 that accessibility was defined as the potential of interaction opportunities, he took employment, shopping opportunities and resident activities as the basic objectives of accessibility measurement (Walter G. Hansen,1959). Brian Linneker et al studied the road accessibility of British transport vehicles by measuring the time spent, distance spent impedance function of transport vehicles (Brian Linneker,1996). Gutierrez et al. used the weighted average distance method to study the accessibility characteristics between European highways and surrounding cities (Javier Gutiérrez,1996). There are also many achievements in the research on accessibility in China. From the perspective of spatial accessibility, Chen Wei analysed the scope of urban areas, urban circles, metropolitan areas and metropolitan areas at different scales in China (Chen,2020). Liu Qing fang et al. used the cost-distance model to analyse highway accessibility in two seasons of rain in the Qinghai-Tibet Plateau (Liu,2023).

In addition, the following studies are conducted on the accessibility of traditional villages: Chen Zhen hua took San he Ancient Town as his research object, combined with space syntax theory, accessibility study of traditional villages in Anhui Province based on depth map (Chen,2021). Dou Yin di et al. took the state-level traditional villages in Hunan Province as the research object, he used buffer analysis and grid cost distance model to further study the state-level traditional villages in Hunan Province, explore their spatial distribution

characteristics (Dou,2015). Wang Yu ping et al. have studied the accessibility of traditional villages in Wei xi County on the basis of field surveys using GIS technology (Wang,2018). Taking Beijing as the research object, Wang Guo hua et al. analysed the correlation between urban subway network accessibility, social economy by using space syntax (Wang,2021). Zuo Jin you et al. used various analysis tools of GIS, linear regression method, GWR model to study the accessibility of spatial of traditional villages in Wu ling Mountain region (Zuo,2023).

The above studies have been conducted on the distribution of spatial patterns and accessibility of some geographic things (traditional villages, cities), but there are relatively few studies on the traditional villages in Henan Province. Therefore, it is necessary for us to choose to study the spatial pattern and accessibility of national-level traditional villages in Henan Province. In this paper, take 275 national-level traditional villages in Henan Province as the research object, combine a variety of data, use the GIS analysis method of spatial agglomeration to distribute the spatial distribution of traditional villages. Calculate the average accessibility time of traditional villages, consider their many influencing factors, study the accessibility of traditional villages in each prefecture-level city in Henan Province on the city scale. Visualizing the spatial distribution and accessibility of traditional villages in Henan Province. In order to improve the practical significance of the traditional village accessibility calculation, it provides an analytical basis for promoting the optimal allocation of traditional village resources, enhances the cultural soft power. Better promotion of traditional Chinese culture, further protection of traditional villages.

2. Material and Methods

2.1 Study area

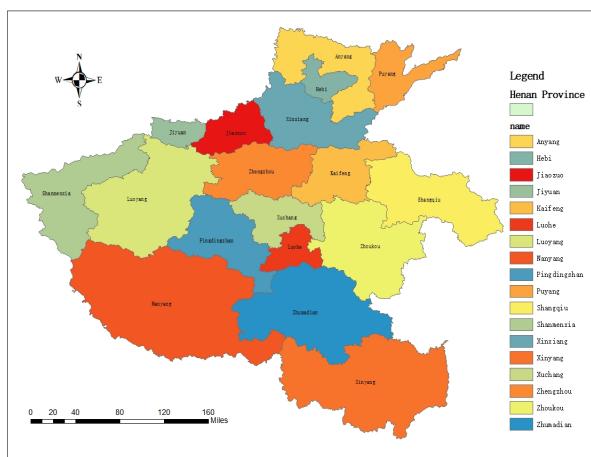


Figure 1. Administrative divisions of Henan

The research area of this paper is Henan Province, with a total area of 167,000 square kilometres, 18 prefectural-level cities, which is located in the central-eastern part of China, in the middle reaches of the Yellow River. As shown in Figure 1.

2.2 Basic data are obtained

The experimental object is 275 national-level traditional villages in Henan Province, the data is obtained from the traditional villages in Henan Province directory to obtain their geographic coordinates, in addition, this paper needs to study the spatial pattern of the traditional villages in Henan Province, so the required data are also the data of the municipal administrative centre in Henan Province, the data of the road traffic in Henan Province, the data of the county-level administrative villages in Henan Province, and so on.

2.3 Experimental Procedures and Methods

2.3.1 Experimental Procedures

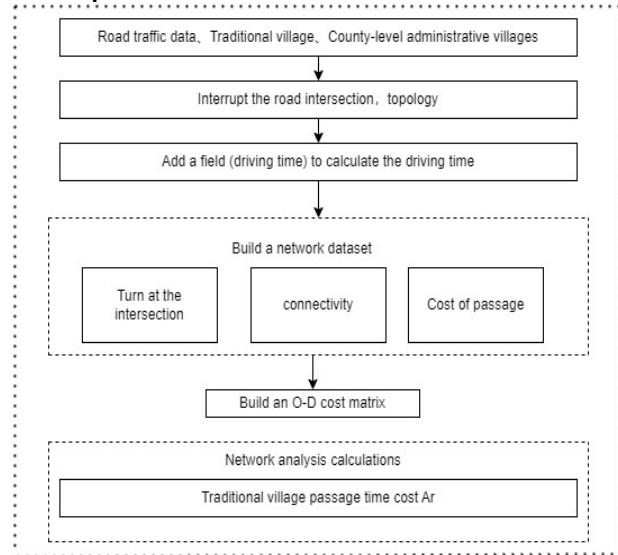


Figure 2. Workflow of the proposed approach

The experimental process is shown in Figure 2 above, from the starting point, i.e. 275 national-level traditional villages, to each county-level administrative village (a total of 85 county-level administrative villages). Network analysis was carried out to obtain 23,375 recorded data, which were collated to finally obtain the traditional village accessibility data in Henan Province. The results obtained were calculated and summarised to derive the travel time cost, i.e. the value of accessibility, for each traditional village in Henan Province.

2.3.2 Traditional village accessibility calculation method

Through the real-time monitoring of Baidu map, with the traditional village as the starting point, the shortest driving time to any county administrative centres, as a cost of access time, to get the traditional village to all the county administrative centres of the cost of access time, add up the total sum divided by the total number of county administrative centres, to get the average cost of access time of this traditional village as the value of accessibility to this traditional village, The shorter the average passage time, the smaller the accessibility value and the better the traditional village accessibility. The accessibility calculation model is shown in equation (1).

$$A_r = \frac{\sum_{i=1}^n E_{ri}}{n} \quad (1)$$

A_r is the value of accessibility of traditional villages, i is the county administrative centres; n is the total number of county administrative centres, E_{ri} is the cost of access time from traditional villages to county administrative centres.

3. Results and Discussion

3.1 Experimental data

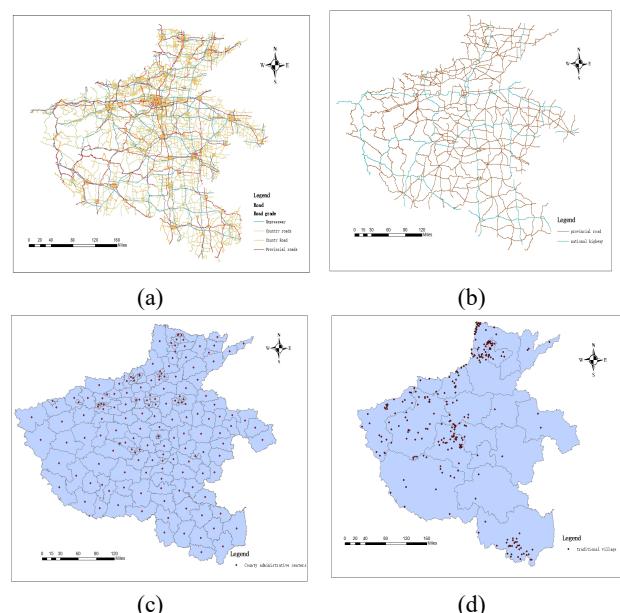


Figure 3. (a)Road network, (b)National and provincial highways, (c)County administrative centres, (d)National Traditional Villages

The above figure 3(a) shows the data of highway network in Henan Province, figure3 (b) shows the data of national and provincial highways in Henan Province, figure3 (c) shows the data of county administrative centres in Henan Province,

figure3 (d) shows the data of traditional villages in Henan Province.

3.2 Spatial distribution patterns

3.2.1 Kernel density analysis

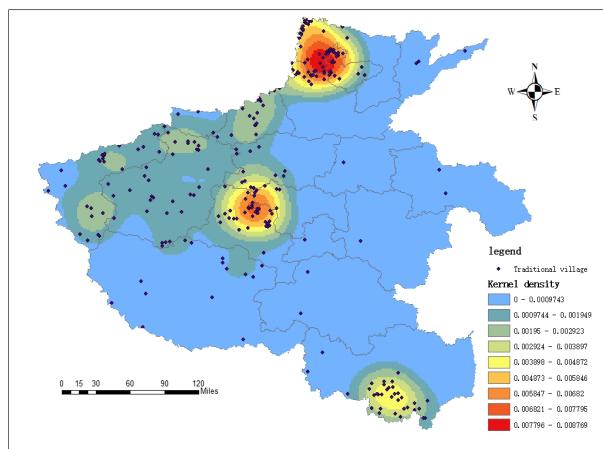


Figure 4. Kernel density analysis of traditional villages in Henan Province

It can have an obvious visualization of the spatial pattern of traditional villages in Henan Province. In the figure 4, can see that there are three main areas where the density is too concentrated:(1)one of which is mainly concentrated at the border of Anyang, Hebi, with a total of 76 traditional villages, accounting for about 27.6% of the traditional villages in Henan Province.(2)the second is mainly concentrated at the border of Pingdingshan City and Zhengzhou City, with a total of 49 traditional villages, accounting for about 17.8% of the traditional villages in Henan Province.(3) the three areas of Xinyang City, with a total of 34 traditional villages in Xinyang City, accounting for about 17.8% of the traditional villages in Henan Province. Xinyang City has a total of 34 traditional villages, accounting for about 12.4% of the traditional villages in Henan Province.

3.2.2. Analysis of topographic elements

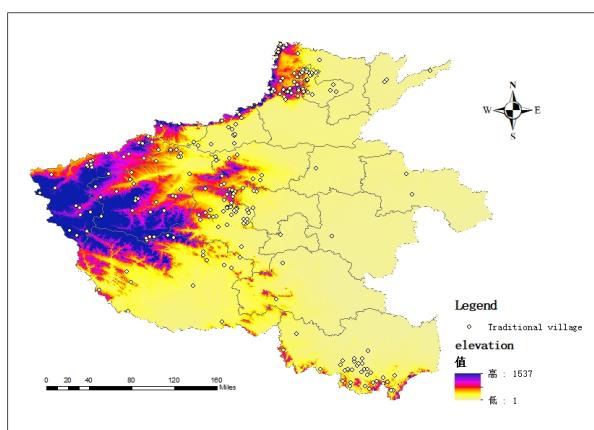


Figure 5. Topographic map of the distribution of traditional villages in Henan Province

As shown in figure 5, A clear distinction of the distribution of traditional villages shows that traditional villages in Henan Province are mainly concentrated in some areas where the ground elevation is too high, mainly in Pingdingshan City,

Anyang, Hebi, Xinyang and along the border of Henan. Prove that there is a positive correlation between topographic elevation and the concentration of traditional villages, and that the higher the topographic elevation, the more concentrated the distribution.

3.2.3 Transportation element analysis

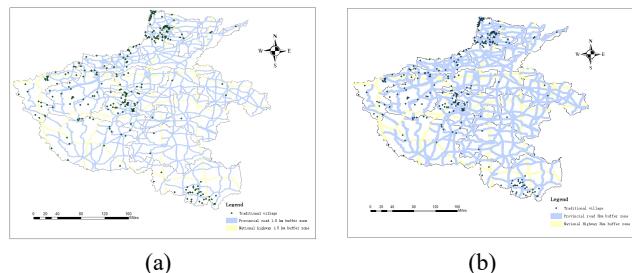


Figure 6. Traditional Village and Road Buffer Analysis Map : (a)Road 1.5km buffer, (b) Road 3km buffer

From the buffer zone map of national and provincial roads in Henan Province, it can be seen that traditional villages in Henan Province are mainly distributed in areas with sparse roads, and the farther away from the main roads in Henan Province, the more traditional villages are distributed in Henan Province, and it can be seen that very few traditional villages are distributed in the 1.5km buffer zone, while in the 3km buffer zone map, almost the whole province of Henan is covered, but some traditional villages are not distributed in it. This proves that there is a positive correlation between the distance from the main road and the concentration of traditional villages in Henan Province, and the further away from the main road, the more traditional villages are distributed.

3.2.4. Downtown Element Analysis

In order to verify whether the distance from the city centres is related to the spatial pattern of the distribution of traditional villages, based on the point data of traditional villages in Henan Province and the centres point data of administrative villages, a buffer analysis of 20km and 50km is done in the centres of each city, respectively, and a buffer analysis map based on the centres of prefecture-level cities is obtained.

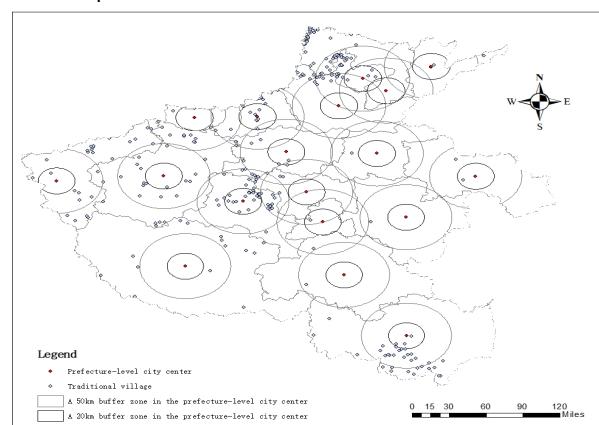


Figure 7. City centres 20km, 50km buffer zone

As shown in figure 7 above, there are almost no traditional villages in the 20km buffer zone, with only 33 traditional villages, accounting for 12% of the total; and the 50km buffer zone does not completely cover all traditional villages. It can be concluded that the distribution of traditional villages has a

tendency to be far away from the city centres, and the farther away from the central city, the more traditional villages there are, this proves that the proximity to the central city is positively correlated with the concentration of the distribution of traditional villages.

3.3 Reachability analysis

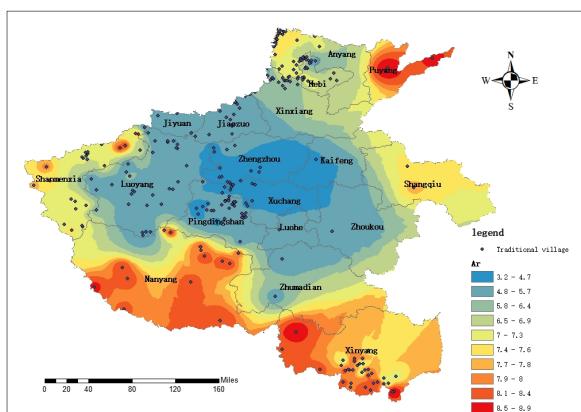
3.3.1 Accessibility evaluation and analysis

The calculated results of OD cost matrix were processed, and the data were exported into a table form. Based on the accessibility calculation formula, the average travel time of all national-level traditional villages in Henan Province was obtained, that is, the accessibility data of traditional villages in Henan Province was finally obtained, and then the accessibility data of traditional villages in Henan Province was studied.

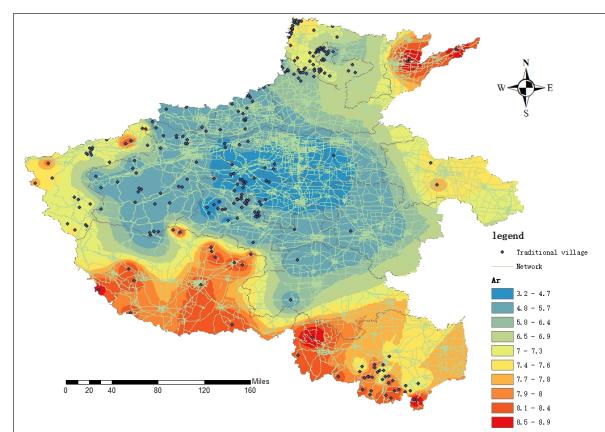
Since there are too many national-level traditional villages in Henan Province, in order to better and more intuitively reflect the accessibility of traditional villages, the value of accessibility is graded to further reflect the accessibility of traditional villages in Henan Province in a direct and clear way. The principles of classification are as follows: good reachability (3.23h–5h), average reachability (5h–7h), poor reachability (7h–8.94h). The numbers in Table 1 represent the number of traditional villages. See appendix for tables.

Based on the above classification, can see that there are 74 villages with good accessibility, accounting for 26.9%. There were 94 villages with general accessibility, accounting for 34.2%. There were 107 villages with poor accessibility, accounting for 38.9%. By comparison, it can be seen that the accessibility of traditional villages in Henan Province is quite different, there are two levels of characteristics. Generally speaking, the proportion of villages with poor accessibility is relatively large, the proportion of villages with general accessibility is second, the proportion of villages with good accessibility is the smallest. Therefore, the overall accessibility level distribution of traditional villages in Henan Province is unbalanced.

3.3.2 spatial interpolation



(a)



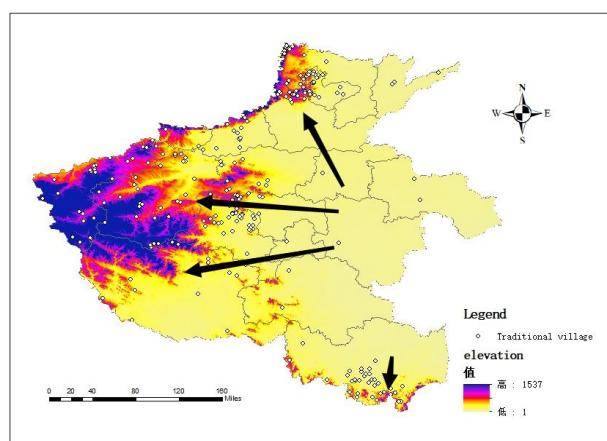
(b)

Figure 8. (a) Illustration of traditional village accessibility space, (b) Spatial interpolation of traditional village accessibility and road network analysis

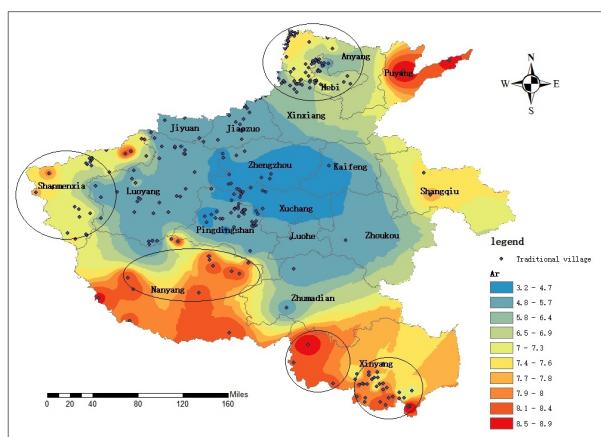
From the correlation analysis of road transportation network and accessibility in Henan Province, the accessibility of traditional villages in Henan Province has a certain relationship with road density. Areas with higher levels of accessibility of traditional villages in Henan Province, such as Zhengzhou and Kaifeng generally have higher road densities, while areas with poorer levels of accessibility of traditional villages in Henan Province, such as the border areas of Xinyang City and Nanyang City, generally have relatively lower road densities. It can be seen that the level of accessibility of traditional villages in Henan Province is positively correlated with the degree of road density in Henan Province. The higher the road density, the higher the accessibility level of traditional villages.

3.4 Analysis of factors affecting accessibility

3.4.1 Analysis of topographic elements



(a)



(b)

Figure 9. (a) Trends in topographic elevation in Henan Province, (b) Analysis of traditional village distribution and topographic elements

The accessibility of the traditional villages is similarly affected by the topographic elements of Henan Province, some traditional villages with poor accessibility are circled in the figure. Most of the areas with poor accessibility are also mainly distributed in the border areas of Henan Province, mainly in the areas with higher ground elevation, as shown in the figure above, which shows that the accessibility is negatively correlated with the level of topographic elements, the higher the ground elevation, the poorer the accessibility. The lower the ground elevation, the better the accessibility.

3.4.2 Analysis of transport elements

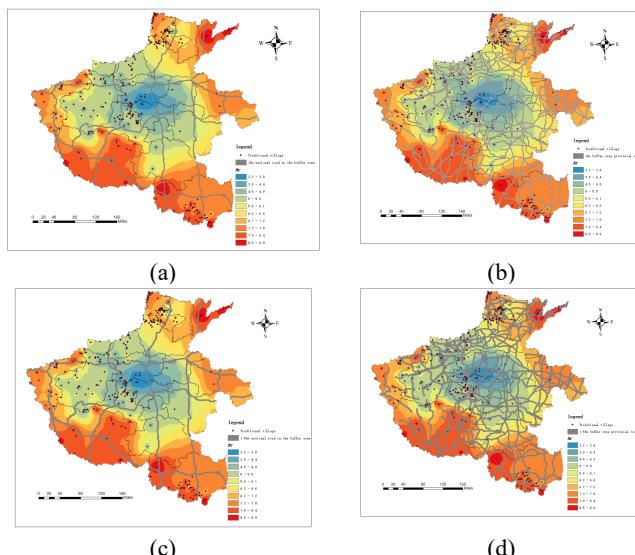


Figure 10. Impact of road elements on accessibility: (a) 1km national road buffer zone, (b) 1km provincial road buffer zone, (c) 1.5km national road buffer zone, (d) 1.5km provincial road buffer zone

Within the 1km buffer zone of national and provincial highways, traditional villages with better accessibility and those with poorer accessibility are not in the buffer zone. The 1.5km buffer zone is similar to it. It can be seen that the convenience of transport elements and the closeness of transport elements are positively related to the accessibility, the more convenient the

transport, the better the accessibility. The more closed the transport, the worse the accessibility.

3.4.3. Analysis of city Centre elements

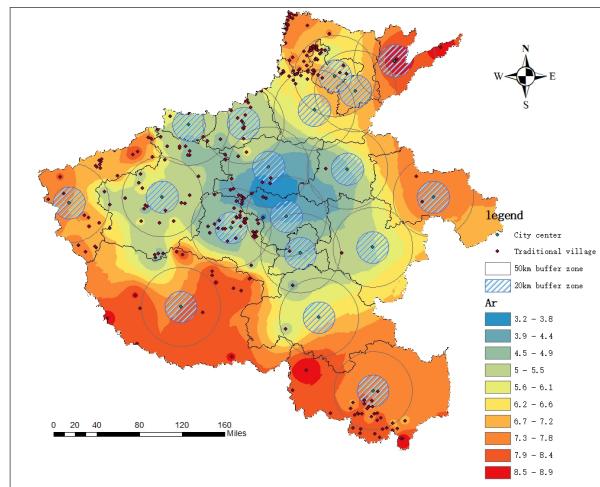


Figure 11. Map of the impact of distance from the city centre on accessibility

From the above figure (10), it can be seen that the traditional villages within the 20km and 50km buffer zones from the city centre have better accessibility. In the central area of the above figure, the traditional villages are completely distributed in the 50km buffer zone of the city centre, while many traditional villages in the border areas of Henan Province are not distributed in the 50km buffer zone of the city centre, most of them have poor accessibility. It can be seen that the proximity of urban elements is negatively correlated with accessibility. The further away from the urban centre, the worse the accessibility. The closer to the city centre, the better the accessibility.

4. Conclusions

(1) The spatial pattern and accessibility of the distribution of traditional villages in Henan Province are affected by various Factors. Such as topography, transportation, and distance from urban centres.

- Among them, the higher the ground elevation is, the more concentrated the distribution of traditional villages is, the larger the value of accessibility is.
- The more closed the road traffic is, the more concentrated the distribution of traditional villages is, the larger the value of accessibility is.
- The further away from the city centres is, the more concentrated the distribution of traditional villages is, the larger the value of accessibility is.

(2) Analysing the accessibility of traditional villages in Henan Province.

- The areas with better accessibility are mainly concentrated in the core area of central Henan Province, including Zhengzhou, Kaifeng, Xuchang and most other areas, the average visit time of traditional villages in this region is about 4.06 hours.
- The accessibility of Luoyang, Jiaozuo, Pingdingshan, Luohe and other peripheral areas is average, the average travel time of traditional villages is mostly around 4.96 hours.
- The accessibility of Henan's border areas of Xinyang City, Nanyang City, and Puyang City is poorer, the average travel time of traditional villages is about 8.29 hours.

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Appendix

Table1. Number, proportion, and average value of accessible traditional villages by prefecture-level city

| Cities | Good accessibility (pcs) | Accessibility average (pcs) | Poor accessibility (pcs) | total | Mean reachability |
|--------------|--------------------------|-----------------------------|--------------------------|-------|-------------------|
| Zhengzhou | 11 | 1 | 0 | 12 | 4.25 |
| Kaifeng | 1 | 0 | 0 | 1 | 4.65 |
| Luoyang | 18 | 16 | 0 | 34 | 5.05 |
| Pingdingshan | 24 | 13 | 0 | 37 | 4.87 |
| Shanmenxia | 0 | 6 | 24 | 30 | 7.34 |
| JizoZuo | 6 | 12 | 0 | 18 | 5.18 |
| XinYang | 0 | 7 | 27 | 34 | 7.87 |
| Zhoukou | 0 | 1 | 0 | 1 | 5.38 |
| Hebi | 4 | 17 | 8 | 29 | 6.57 |
| Anyang | 0 | 2 | 31 | 33 | 7.46 |
| Nanyang | 0 | 0 | 14 | 14 | 8.26 |
| Puyang | 0 | 0 | 3 | 3 | 8.73 |
| Xinxiang | 2 | 14 | 0 | 16 | 5.82 |
| Luohe | 1 | 0 | 0 | 1 | 4.74 |
| Zhumadian | 1 | 1 | 0 | 2 | 5.05 |
| Xuchang | 6 | 0 | 0 | 6 | 3.30 |
| Shangqiu | 0 | 2 | 0 | 2 | 7.52 |
| Jiyuan | 0 | 2 | 0 | 2 | 5.48 |
| total | 74 | 94 | 107 | 275 | 5.97 |
| Percentage | 26.9% | 34.2% | 38.9% | 100% | / |