Exploration of the Spatial Distribution Characteristics and Influencing Factors of Traditional Villages: A Case of Shaanxi Province

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ABSTRACT

Rural revitalization is an important strategy in the opening year of the 14th Five-Year Plan in China. There exists a special category of villages - traditional villages, which are carriers of regional culture and customs; and have strong historical and cultural values. This study uses ArcGIS 10 to conduct an exploration of the spatial distribution characteristics and related influencing factors, to provide reference values for the development of rural revitalization in Shaanxi Province. The results of the study show that the distribution of traditional villages in Shaanxi Province is greatly influenced by natural environmental factors and socio-economic factors, showing two major high-density clusters, one located along the Wuding River of the Loess Plateau in the eastern Shanbei zone and the other along the Wei River in Northeastern Guanzhong zone. The villages are mainly located in urban areas with a better economic situation and show a positive correlation with economic development.

Keywords: *Traditional villages, Spatial distribution, Influencing factors.*

1. INTRODUCTION

In order to highlight the historical and cultural value of traditional villages; and to emphasize that they are an important heritage of agricultural civilization and a non-renewable "living heritage", the Expert Committee on the Protection and Development of Traditional Villages changed the customary term "ancient villages" to "traditional villages"[1,2]. In 2012, for promoting the protection and development of traditional villages, China organized the first national mapping survey of traditional villages and published the first list of traditional villages, and by 2019, China had published five batches of traditional villages, totaling 6,819 traditional villages. Among them, Shaanxi Province has a total of 113 traditional villages, ranking top among the northwestern provinces[3]. In the present time of rural revitalization, it is of great theoretical and practical significance to research on traditional villages. By analyzing the distribution characteristics and influencing factors of traditional villages in Shaanxi Province, this paper aims to provide reference and reference for the protection and revitalization of traditional villages in the province.

2. METHODS

2.1. Research Subjects

The research object of this paper is the traditional villages in Shaanxi province. Shaanxi Province has a long history, is one of the birthplaces of the Yellow River civilization, has been a political, economic, and cultural center many times in China's history, and has a rich cultural industry base. It is a very important topic to explore the spatial distribution characteristics of traditional villages in Shaanxi Province, analyze the influencing factors, and discuss how to protect these cultures and heritage for the development of rural revitalization in Shaanxi Province.

2.2. Research Methods

In terms of methods for the study of traditional village distribution, geographic concentration index analysis and imbalance index analysis in econometric geography, and kernel density and average nearest neighbor analysis methods on GIS platforms are the most mentioned methods[2,3,4,5,6], in addition to spatial

autocorrelation being used to analyze potential interdependencies among traditional villages[3]; geographically weighted regression analysis (GWR), superposition analysis and grid analysis methods are used to analyze the factors affecting village distribution[4, 7].

2.2.1. Kernel Density Analysis Method

The kernel density analysis method is an effective technique for measuring local density changes and exploring spatial hotspots. The density of point elements around each output raster can be calculated to present the degree of concentration and dispersion of the spatial distribution of traditional villages. The formula is:

$$SearchRadius = 0.9 * \min\left(SD, \sqrt{\frac{1}{\ln(2)}} * D_m\right) * n^{-0.2}$$

(1)

2.2.2. Average Nearest Neighbor Analysis

The average nearest neighbor tool can be used to measure the distance between the center of mass of each element and the location of the center of mass of its nearest neighbor element, and then averaged. The index R (means average nearest neighbor ratio) = the ratio of actual nearest neighbor distance/theoretical nearest neighbor distance.

The formula is as follows:

$$\overline{RO} = \frac{\sum\limits_{i=1}^{n} d_i}{n}$$

(2)

$$\overline{R}_E = \frac{0.5}{\sqrt{n/A}}$$

(3)

$$R = \frac{\overline{R}_O}{\overline{R}_E} = 2\sqrt{D}$$

(4)

If the R is less than 1, the pattern of performance is clustering. If the index is greater than 1, the pattern of performance tends towards diffusion. Using the average nearest neighbor method return Z values and P values that can be used to verify that the model has statistically significant class clustering or dispersion. When Z<-2.58 or Z>+2.58 with P<0.01, the model has more than 99% confidence.

2.2.3. Geographical Concentration Index Method

Geographic concentration index analysis is one of the commonly used methods in geographical research, which can be used to measure the concentration degree of traditional villages in Shaanxi Province. The formula is as follows:

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

(5)

i is the number of traditional villages in the Xth urban area of Shaanxi Province, T is the total number of traditional villages, n is the total number of urban areas in Shaanxi Province, and G is the traditional village concentration index, with a larger G value implying a higher degree of concentration.

2.2.4. Imbalance Index Analysis

Imbalance index analysis is usually calculated using a Lorenz curve with the following formula.

$$S = \frac{\sum\limits_{i=1}^{n} X_i - 50(n+1)}{100n - 50(n+1)}$$

(6)

Where n is the number of urban areas in Shaanxi Province, Xi is the cumulative percentage of the number of traditional villages in each urban area (in descending order of weight); S is the imbalance index of traditional villages, if S=0, it means that traditional villages are evenly distributed within Shaanxi Province, if S=1, it means that traditional villages are all distributed in the same urban area, therefore, 0<S<1.

2.2.5. SPSS Correlation Analysis

The Pearson's correlation coefficient in SPSS reflects the correlation between two variables and its calculated value ranges from [-1, 1].

A linear regression model (Linear Regression) was developed with the help of SPSS for the significant data to explore the relationship between the influencing factors and the number of traditional villages.

2.3. Data Sources

According to the Traditional Villages Evaluation and Recognition Index System (for Trial Implementation), the Ministry of Housing and Urban-Rural Development, the Ministry of Culture and the Ministry of Finance announced the first batch of the National Traditional Villages List in December 2012, and thereafter gradually announced the list of villages in the second, third, fourth and fifth batches of the Chinese Traditional Villages List. The study takes 113 traditional villages in Shaanxi Province up to the end of

October 2021 as the research sample. The relevant information is mainly obtained from China Traditional Villages website (chuantongcunluo.com) and the Ministry of Housing and Urban-Rural Development website (mohurd.gov.cn), with the help of Google Earth to obtain the spatial attributes of traditional villages in Shaanxi Province, and the use of ArcGIS 10 was used to construct a database of the spatial attributes of traditional villages in Shaanxi Province and to draw a spatial distribution map of traditional villages in Shaanxi Province (Fig.1).
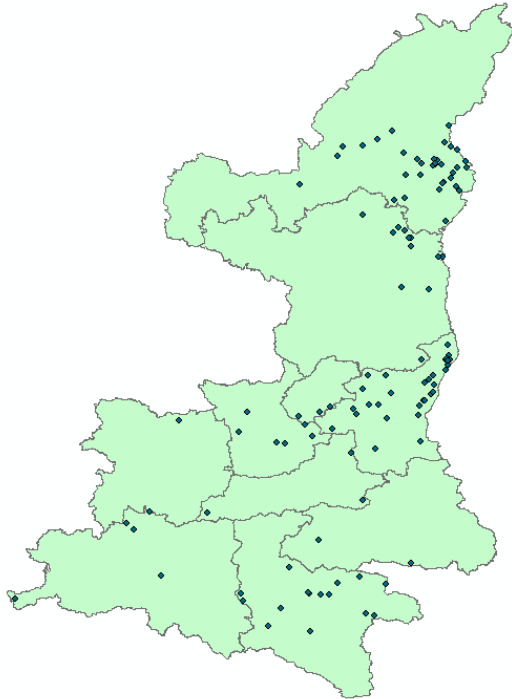

Figure 1 Distribution map of traditional villages in Shaanxi Province published by the Ministry of Housing and Urban-Rural Development, the Ministry of Culture and the Ministry of Finance

3. SPATIAL DISTRIBUTION CHARACTERISTICS

3.1. Types of Spatial Distribution

The mean nearest neighbor tool of Arc GIS was used to analyse 113 villages and measure the degree of clustering of villages.
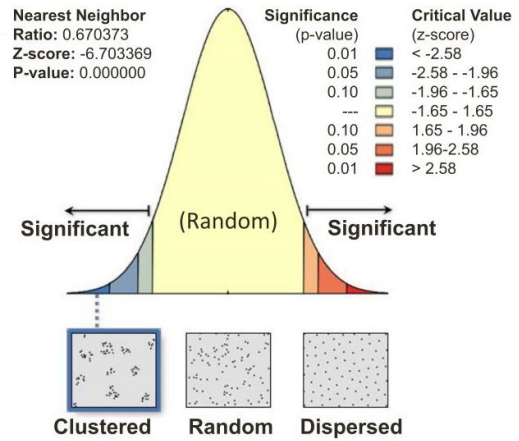

Figure 2 Average nearest neighbor analysis of traditional villages in Shaanxi Province

As shown in Fig.2, the average nearest neighbor ratio of traditional villages in Shaanxi Province is 0.6 < 1, so traditional villages in Shaanxi Province tend to be cohesively distributed.

3.2. Balanced spatial distribution

3.2.1. Analysis of the Degree of Concentration

The total number of traditional villages in Shaanxi Province is 113, and the total number of urban areas is 10. Through excel calculation, we can conclude that the geographical concentration index of traditional villages in Shaanxi Province is G=45.92. Meanwhile, assuming that all traditional villages are evenly distributed in Shaanxi Province, G'=113/10=11.3, which is much less than 45.92. Therefore, the distribution of traditional villages in Shaanxi Province is relatively concentrated, mainly in Yulin, Weinan and Ankang cities.

3.2.2. Analysis of the Degree of Equilibrium

Shaanxi Province can be divided into three major geographical regions according to geography and human folklore: northern Shaanxi, southern Shaanxi and central Guanzhou. Northern Shaanxi includes the cities of Yulin and Yan'an; southern Shaanxi includes the cities of Hanzhong, Ankang and Shangluo; and Guanzhong includes the cities of Xi'an, Xianyang, Baoji, Weinan and Tongchuan; statistics show that traditional villages in Shaanxi province are unevenly distributed among urban areas, mainly concentrated in northern Shaanxi and Guanzhong. The specific number of statistics is shown in Table 1.

Table 1. Statistics on the number of traditional villages by urban areas in Shaanxi Province

Region	Name of municipality	Total	Weighting	Ranking
Shanbei	Yulin City	34	30.09%	1
	Yan'an City	12	10.62%	4
Total		46	40.71%	1

	Tongchuan City	3	2.65%	7
	Xianyang City	6	5.31%	5
Guanzhong	Baoji City	1	0.88%	9
	Xi'an City	2	1.77%	8
	Weinan City	33	29.20%	2
Total		45	39.82%	2
	Shangluo City	2	1.77%	8
Shan'nan	Hanzhong City	5	4.42%	6
	Ankang City	15	13.27%	3
Total		22	19.47%	3

The Lorenz curve can be used to visually compare and analyse the equality or inequality in the distribution of traditional villages. A Lorenz curve analysis of the distribution of traditional villages in Shaanxi Province (Fig.3) shows that Yulin, Weinan, Ankang and Yan'an are the main distribution areas of traditional villages, with the number of villages combined exceeding 80% of the total.
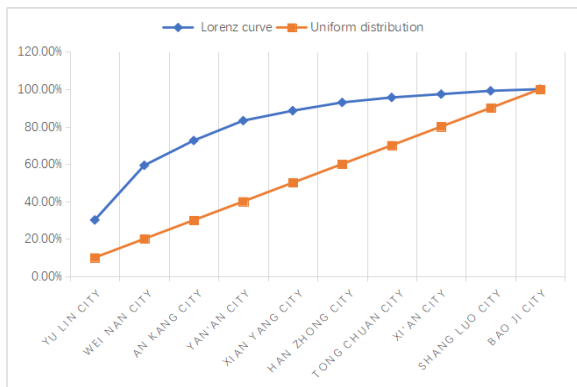

Figure 3 Lorenz curve analysis of traditional villages in Shaanxi Province

In summary, the distribution of traditional villages in Shaanxi Province shows a concentrated distribution from the provincial area and an uneven distribution between municipalities, with Guanzhong and northern Shaanxi being the main distribution areas, with Yulin City(30.09%), Weinan City(29.20%), Ankang City(13.27%) and Yan'an City(10.62%) being the three most concentrated cities.

3.3. Spatial Distribution Density

ArcGIS 10 was used to analyse the nuclear density of 113 traditional villages in Shaanxi Province, resulting in Fig.4, which shows that the distribution of traditional villages in Shaanxi Province shows a pattern of "large concentration and small distribution", forming two high-density areas, one in the northeastern part of Guanzhong and the other in the central-eastern part of northern Shaanxi. The northern part of Shaanxi Province is relatively backward in terms of transportation and economy, which provides a basis for the preservation of

traditional villages, thus creating a high-density area. The northeastern part of Guanzhong is a high-density area, and the proximity of this area to the famous historical cities of Xianyang in the Qin Dynasty and Chang'an in the Sui and Tang Dynasties, with their long history and culture, may have been the basis for the good preservation of the villages.
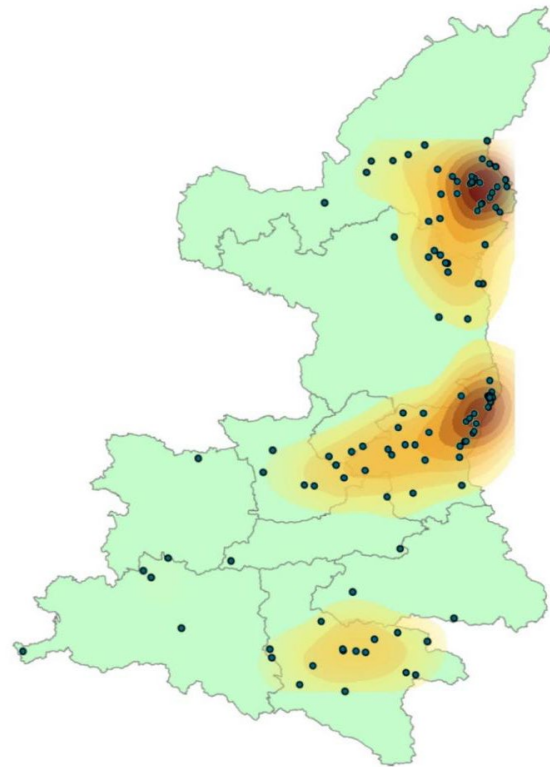

Figure 4 Analysis of the nuclear density of traditional villages in Shaanxi Province

4. RELEVANT INFLUENCING FACTORS

The spatial layout of traditional villages is influenced by the combined effect of many factors. Based on the existing research results, this paper analyses the influencing factors on the spatial distribution of traditional villages in Shaanxi Province in terms of the natural environment, social economy, transportation conditions, history, and culture.

4.1. Natural Environment Factors

Topography, as one of the components of the geographical environment, can have different effects on the distribution of road traffic, economic exchanges, cultural exchanges, and other activities in the region[8]. As one of the traditional Chinese cultures, "geomancy" means the study of topography and geomorphology, with emphasis on the description of landforms, it is clear that people have long developed that the natural geographic environment around them affects their choice of place to live, and are constantly exploring the relationship between them. This study used ArcGIS 10 to overlay a spatial distribution map of traditional villages in Shaanxi Province with a topographic elevation map and a river map.

4.1.1. Elevation Factors

The plains have traditionally been the highlands for the development of agricultural civilization, and they provide a stable topographic environment for the formation and development of villages. Therefore, traditional villages in Shaanxi Province are mainly distributed in the plains areas of Guanzhong and northern Shaanxi, with a small proportion in the foothills and a very small number in the mountainous areas with higher altitudes and more treacherous terrain.
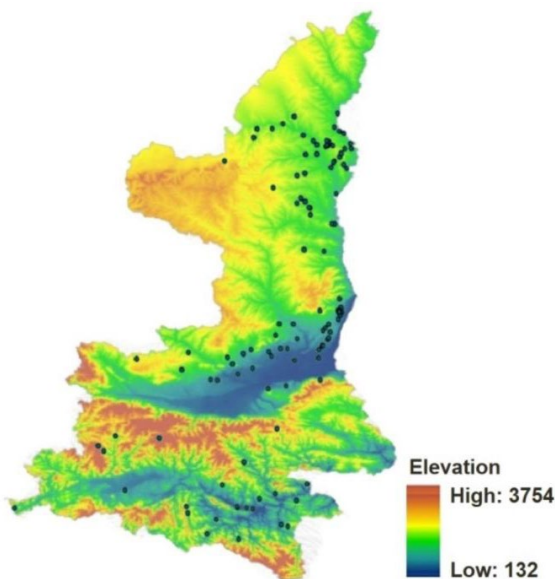

Figure 5 Elevation distribution of traditional villages in Shaanxi Province

4.1.2. Water System Factors

By obtaining information on water systems in Shaanxi Province at levels 1-5 through OpenStreetMap and overlaying it with the distribution of traditional villages (Figure 6), it is clear that the distribution of villages is closely related to the direction of water systems. More than 80% of the villages are located along rivers, with the Wuding and Wei rivers being important survival dependencies.
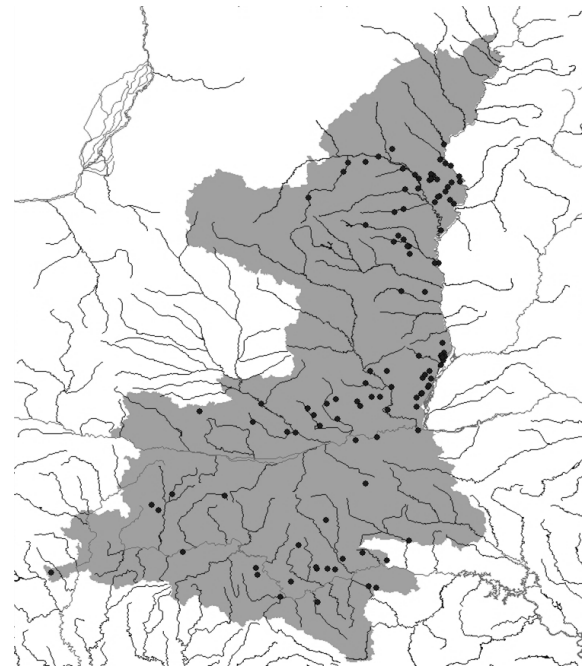

Figure 6 Traditional villages in Shaanxi Province concerning to water systems

4.2. Socio-Economic Factors

The distribution of traditional villages in Shaanxi Province is correlated with economic development. As can be seen from the figure, the three cities with the largest distribution of traditional villages in terms of GDP in 2020 ranked second (34), fifth (33) and eighth (15) respectively. Through SPSS 22 analysis, the Pearson correlation coefficient is 0.868 (Table 2), so the distribution of traditional villages in Shaanxi Province is strongly correlated with economic development. Using a linear regression model for testing, a p-value = 0.001 < 0.005 can be obtained, so the model is statistically significant. According to the values given in the coefficient table, the regression equation can be listed: number of traditional villages = 2.664 + 0.004*city GDP, so there is a positive correlation between the number of traditional villages and economic development in each city in Shaanxi Province, probably because cities with better economic conditions can receive more support and are more conducive to the research, development and protection of traditional villages.
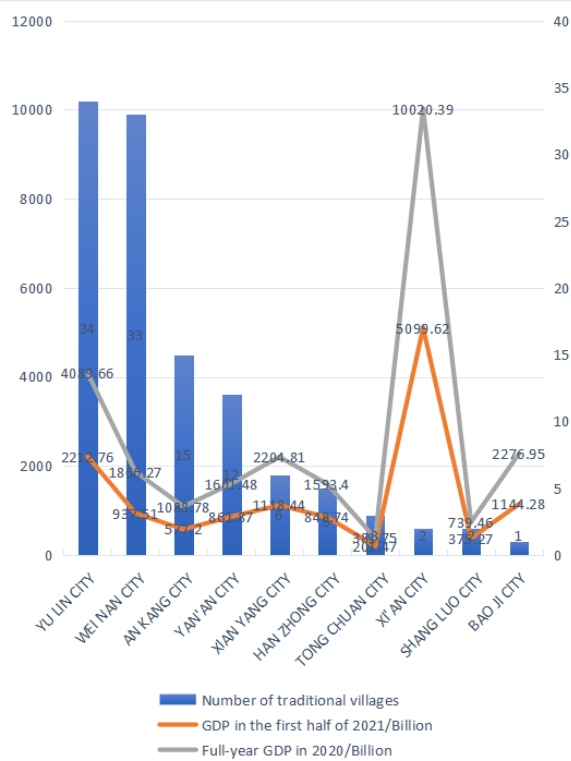
Figure 7 Statistics on GDP and the number of traditional villages by city in Shaanxi Province

Table 2. Correlation analysis between traditional villages and GDP of Xi'an city

		Number of traditional villages	2020 GDP of Xi'an city
Number of traditional villages	Pearson correlation	1	.868**
	Significance (two-tailed)		.001
	N	11	11
2020 GDP of Xi'an city	Pearson correlation	.868**	1
	Significance (two-tailed)	.001	
	N	11	11

**. The correlation was significant at 0.01 level (two-tailed)

4.3. Traffic Factors

Through the official website of Shaanxi Provincial Bureau of Statistics[9], the road mileage and road density of each city (district) in Shaanxi Province at the end of 2020 were collated as shown in the Table 3 below. Through SPSS 22 analysis, the Pearson correlation coefficient is -0.001, so the distribution of traditional villages in Shaanxi Province is not correlated with the density of the traffic road network.

Table 3. Statistics on road mileage and density by urban areas in Shaanxi Province at the end of 2020

Region	Name of municipality	Number	Road mileage/km	Administrative district area/km2	Density/(km/100km2)	Ranking
Shanbei	Yulin City	34	29107	43578	66.79	9
	Yan'an City	12	18279	37000	49.40	10
Guanzhong	Tongchuan City	3	4086	3882	105.26	5
	Xianyang City	6	16680	10196	163.59	1
	Baoji City	1	17717	18196	97.37	6
	Xi'an City	2	13755	10108	136.08	3
	Weinan City	33	19495	13000	149.96	2
Shan'nan	Shangluo City	2	14812	19293	76.77	8
	Hanzhong City	5	20976	27246	76.99	7
	Ankang City	15	25359	23529	107.78	4

4.4. Historical and Cultural Factors

History and culture are important factors influencing the distribution of traditional villages, and the dense distribution of villages was historically a place where culture and commerce flourished or where fortifications were important[10]. Shaanxi province, which straddles the Yellow River and Yangtze River basins, is the

birthplace of the Western Zhou culture and has several ancient city sites within its borders. The Qin, Sui and Tang dynasties all built their capitals here, including the Qin Shi Huang who moved 120,000 wealthy families here at one time after the founding of the state and built villages for defense around the capital Xianyang, providing the soil for traditional villages, which were mainly farming civilizations, to grow. Chang'an was the starting point of the Silk Road and was one of the four ancient capitals, along with Rome, Cairo, and Athens, which shows the influence of Chang'an on a global scale. This may be one of the reasons for the concentration of traditional villages in the Guanzhong area. The eastern part of Guanzhong was also an important military defense area, used to resist the long period of warfare that followed the annihilation of the Sui and Tang dynasties[10]. Suicide in northern Shaanxi was a major frontier town during the Ming and Qing dynasties, from where the famous Zhaogun set out on her historic mission to the fortress, and an important trading town, all of which laid the foundation for the creation and development of traditional villages.

5. CONCLUSION

The article takes traditional villages as the research object and studies their spatial distribution in Shaanxi Province. The results show that traditional villages in Shaanxi Province show aggregation in the overall spatial distribution. In terms of urban differences, there are obvious differences in distribution, mainly concentrated in Yulin, Weinan, and Ankang cities. Traditional villages in Shaanxi Province show two major high-density aggregation areas, one in the eastern part of northern Shaanxi and one in the northeastern part of Guanzhong.

The distribution of traditional villages in Shaanxi Province is greatly influenced by natural environmental factors and socio-economic factors, with 80% of traditional villages distributed along the Wei River in the Guanzhong Plain and along the Wuding River in the Loess Plateau of northern Shaanxi. Analysis shows that the distribution of traditional villages is strongly correlated with the economic development of urban areas and shows a positive correlation; the relationship with the density of the transport network is weaker.

Traditional villages are the carriers of history and culture and are easily influenced by the outside world. In the context of rural revitalisation, it is particularly important to develop and protect traditional villages. This study only responds to the spatial distribution characteristics and influencing factors of traditional villages in Shaanxi Province, and the research on the industrial revitalization and strategies of traditional villages based on geographically weighted regression analysis (GWR) will be the next research focus.

AUTHORS' CONTRIBUTIONS

Ting Li contributed to the conception of the study and performed the wrote the manuscript;

Yan Liang, Wei Luo, Jin Zhang contributed significantly to data analysis and manuscript preparation;

Wenchao Dong performed the data collection.

REFERENCES

[1] Li, Jiangsu, Wang, Xiaorui, Li, Xiaojian. Analysis of spatial distribution characteristics and influencing factors of traditional villages in China. Economic Geography, 2020, vol. 40, pp. 143-153.

[2] Li BH, Yin SH, Liu PELIN, Dou YINDI. Analysis of spatial distribution characteristics and influencing factors of traditional villages in Hunan Province, Economic Geography, 2015, vol. 35, pp. 189-194.

[3] Liu Dajun, Hu Jing, Chen Junzi, Xu Xiantang. Study on the spatial distribution pattern of traditional villages in China, China Population-Resources and Environment, 2014, vol. 24, pp. 157-162.

[4] Xu Jianhe,Liu Su,Mao Zhou,Hou Qianqian. Spatial distribution characteristics of Chinese traditional villages and conservation system scheme, Journal of Hunan University (Social Science Edition), 2021, vol. 35, pp. 152-160.

[5] Feng Yafen,Yu Wanyuan,Lei Rulin. Study on the spatial distribution characteristics and influencing factors of traditional villages in Guangdong Province, Geoscience, 2017, vol. 37, pp. 236-243.

[6] Wang Yanxiang,Li Shuai,Wine Jiangtao,Ren Mengyu,Fan Yi,Su Jinle. Spatial distribution characteristics and influencing factors of traditional villages in Henan Province, China Agricultural Resources and Zoning, 2019, vol. 40, pp. 129-136+204.

[7] Kang JINGYAO,Zhang JINHE,Hu Huan,Zhou JUN,Xiong J. Analysis of spatial distribution characteristics of traditional villages in China, Advances in Geographical Sciences, 2016, vol. 35, pp. 839-850.

[8] Xue M.Y., Wang C.X., Dou W.S., Wang Zhaohan. Spatial distribution characteristics of traditional villages in the Yellow River Basin and their influencing factors, Arid Zone Resources and Environment, 2020, vol. 34, pp. 94-99.

[9] Shaanxi Bureau of Statistics, Shaanxi Statistical Yearbook 2020, China Statistics Press, 2021.

[10] Xiang Yuanlin,Cao Mingming,Yan Fang,Sun Fei. Spatial and temporal characteristics of traditional villages in Shaanxi and their conservation strategies, Urban Development Research, 2019, vol. 26, pp. 27-32.