A study of spatial-temporal pattern and influencing factors of traditional villages in Shaanxi Province

Yang Xiaojun¹²*, Fang Chuanshan¹ and Zhu Kaikai¹

¹Xi'an International Studies University, tourism Academy·Institute of Human Geography, Xi'an, Shaanxi Province, 710128, China
²Shaanxi Tourism Research Institute, Xi'an, Shaanxi province, 710128, China
*Corresponding author. E-mail: yangxiaojun@xisu.edu.cn

Abstract. Taking the 323 villages which were listed in China and Shaanxi province traditional villages as the research object, through analysis the spatial distribution characteristics of traditional villages in Shaanxi province and their correlation with natural environment and socioeconomic factors by applying the method of quantitate geography and GIS spatial methods. The result of the study shows that in terms of space, the traditional villages in Shaanxi are generally clustered, and the distribution is relatively scattered on the local city scale; it is basically equal in the three major areas, but there are great differences among areas. Because of relatively closed regional environment, dangerous terrain, less convenient transportation and relatively back-ward socioeconomic and urbanization level, which provide important conditions for the protection of traditional villages, those factors also affect the spatial distribution of the traditional villages in Shaanxi. Through the above research to provide a scientific reference for the systematic development and protection of traditional villages in Shaanxi.

1. Introduction

Traditional villages are important places for human survival and proliferation in history, as well as the foundation of human civilization development. As an important part of the historical and cultural heritage, the traditional village bears the rich historical, cultural, economic, and scientific research value of the local history and culture [1]. With the rapid urbanization, a large number of traditional villages with precious values have been rapidly disappeared. So, the rescue of these traditional villages and the inheritance of rural civilization have attracted more and more attention from government and academia. As we all known, geographical differentiation and temporal-spatial pattern evolution of traditional villages reveal the footprints of human interaction in different periods. So, studying their spatial distribution pattern and influencing factors, as well as exploring their inherent evolution rules are conducive to formulate scientific traditional village optimization and regulation policy, and guide to the protection and development of the traditional villages and the implementation of the National Rural Revitalization Strategy.

In the western geography field, the study of traditional village settlements have begun in 1820s and the key study begun after 1840s[2-3].German geologist J. G. Kohl made a systematic study of settlements, then the subsequently study involved traditional settlement geography, traditional settlement pattern, rural landscape, traditional folk house protection, and the evolution of traditional settlements[4-9].In the early 1990s, China begun to take the "traditional village" as the name of the
relevant studies. Among them, Liu Peilin’s ‘image of traditional Chinese village’ is one of the earliest achievements[10]. At present, the study of the traditional villages is more abundant than before, including the traditional village tourism development, the traditional village development and protection, the traditional village space layout, the traditional village culture and landscape and the traditional village building, and so on [11-15]. With the wide application of GIS technology in recent years, more and more scholars have applied the methods of computer database and model mathematical analysis to the traditional village research [16-17]. Some scholars have used GIS and other spatial analysis techniques to study the characteristics and rules of the spatial distribution of the traditional villages or historical and cultural villages throughout the country, as well as explored the influence factors of the traditional village layout [18-20]. In general, scholars have matured for the study of traditional villages, and the research on the spatial pattern of traditional villages by GIS spatial analysis method has also made fruitful research achievements. Most of those research achievements are based on spatial dimension, however, there is a lack of research on the historical characteristics of traditional villages on the time scale [21]. Previous studies have analyzed the influencing factors of traditional village layout in isolation, and few studies have conducted in-depth analysis of their influencing factors relevance [22].

Shaanxi as the source of Chinese traditional culture, it had a long historical culture, and it also created a large number of Shaanxi traditional villages. However, in recent years, with the speeding up of industrialization and urbanization, the decline and disappearance of the traditional villages in Shaanxi has become more and more serious, so it is urgent to strengthen the protection and development work. Therefore, this paper analyzes the spatial and temporal scales of the traditional villages distribution in Shaanxi province by using the quantitative geographical method and GIS spatial analysis method to discuss their distribution characteristics, and to study the influencing factors of its distribution, this study provides a reference for the systematic development and protection of the traditional villages in Shaanxi Province.

2. Data sources and research methods

2.1 Data sources

Shaanxi Province is located at 105°29′~111°15′ E and 31°42′~39°35′ N with a total area of 20.58×10^5 km². Shaanxi is divided into three major areas in space: Guanzhong, Northern Shaanxi and Southern Shaanxi with diverse natural and geographical environment in each area. The long history, rich culture, different economic and social development levels have created numerous and diverse traditional villages in Shaanxi. However, war destruction, historical factors and other destructive reasons have caused relatively a few intact traditional villages preserved. By the end of December 2016, the Ministry of Housing and Urban-Rural Development and other departments made public four batches of Chinese traditional village list, there are 4157 altogether, and 71 villages in Shaanxi province are selected. In addition, 323 were rated as provincial-level traditional villages.

The data of traditional villages selected for this study came from the list of traditional villages published jointly by the Ministry of Housing and Urban-Rural Development of Shaanxi and the Ministry of Culture. In the study of spatial characteristics of the traditional villages, the data of 323 traditional villages are mainly based on the integration of two pieces of data. While in the study of temporal characteristics of the spatial distribution of traditional villages, the 71 traditional villages on state-level are more typical and their data integrity are higher. Moreover, use Google map to mark its geographical coordinates, take the mass point of village patches as coordinate, through ArcGIS10.2 to map vectorization, build the traditional village spatial properties database of Shaanxi Province, so as to make the traditional village spatial distribution map of Shaanxi Province (Figure.1).
3.1 Spatial distribution balance analysis

3.1.1 Concentration degree analysis. The concentration degree of traditional villages is usually studied by means of geographic concentration index. The formula is as follows:

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

In the formula, $G$ is represented for the geographical concentration index of the traditional villages; $X_i$ for the amount of traditional villages in the $i$ city; $T$ for the total number of traditional villages in Shaanxi province; $n$ for the total number of the cities. The value is between 0–100, the larger the value is, the more concentrated the traditional villages are; while the smaller the value is, the more scattered the traditional villages are[23].
Through the calculation, we have got the geographical concentration index of Shaanxi traditional villages is \( G = 2.8 \). Assuming that 323 traditional villages are evenly distributed in different cities, the geographical concentration index \( G = 32.3 \) and 2.8 are far less than 32.3. It shows that the distribution of traditional villages is scattered on the city scale, and they are distributed in the northern, central and southern areas of Shaanxi, and the distribution is relatively balanced.

3.1.2 Analysis of balance degree. The imbalance index can be used to reflect the balance degree of traditional villages in different areas of Shaanxi. The formula is as follow

\[
S = \frac{\sum_{i=1}^{n} Y_i - 50(n+1)}{100n - 50(n+1)}\]

In the formula: \( n \) is represented for the number of cities; \( Y_i \) for the cumulative percentage of traditional villages ranked in the total area from large to small. The imbalance index is between the interval of \( S > 0 \) and \( S < 1 \). If the traditional villages are distributed in different areas, then \( S = 0 \); if the traditional villages are all concentrated in one area, then \( S = 1 \). By calculating the imbalance index and measuring the distribution balance of traditional villages in the three major areas of Shaanxi Province, then the imbalance index \( S = 0.53 \) is obtained, it shows that the distribution of traditional villages in Shaanxi is imbalanced. Through the Lorenz curve of the traditional villages in cities (Figure.2), it can be seen that the traditional villages in Shaanxi province are mainly distributed in the 4 cities of Ankang, Yulin, Weinan and Yan'an, and the number of traditional villages in these four cities is close to 80% of the whole province.

Based on the above statistics, the spatial distribution of traditional villages in Shaanxi has the following characteristics: The most concentrated area of traditional villages is in Ankang which accounts for 24.5% of the total; the second concentrated area is in Yulin which accounts for 23.8% of the total; Weinan accounts for 19.8% of the total and ranking in the third of the total; The number of traditional villages in other areas is relatively small, for example, Xi'an and Tongchuan account for only 1.2% and 0.3% separately.

Visualize the distribution of traditional villages in Shaanxi province by means of ArcGIS10.2. The distribution of traditional villages in Shaanxi is imbalanced(Figure.3). Among them, the most concentrated cities are Yulin, Ankang, and Weinan; and the more concentrated cities are Xianyang, Shangluo, Yan'an, etc. And Hanzhoung, Baoji, Xi'an and Tongchuan are sparsely distributed.

Figure.2 Lorenz curve of spatial distribution of traditional villages in Shaanxi Province
3.1.3 Analysis of spatial distribution and concentration area. The analysis of spatial concentration area is generally measured by the distribution density. This study using the Kernel analysis tool of ArcGIS 10.2 software Spatial Analyst to analyze the Kernel of 323 traditional villages in Shaanxi Province, thus generated the distribution pattern of nuclear density of traditional villages in Shaanxi province(Figure.4). As shown in figure 4, there are 3 high density areas of the traditional villages spatial distribution in Shaanxi Province, namely, Han Bin District and Xunyang County of Ankang City; Suide, Mizhi and Jia County of Yulin City; Hancheng County and Heyang County of Weinan City. In which Ankang is located in the hinterland of Qinling Mountains and Yulin in the hilly area of the Loess Plateau, etc. The complicated and bumpy terrain makes the local transportation development relatively backward, thus holding back the socioeconomic development of the area. Although the terrain conditions in Weinan are better than in Ankang and Yulin, the transportation and economic development are relatively slow due to geographical location and other factors. But the lack of economic development has positive significance for the protection of traditional villages. Isolated from the outside world for a long time makes this area less affected by the outside. So under the influence of many factors, a high density spatial distribution is formed.

3.2 Analysis of factors affecting the spatial distribution of traditional villages

3.2.1 Terrain Factors. Through ArcGIS 10.2 we can see that the spatial distribution map of traditional villages in Shaanxi is superimposed with the elevation map of Shaanxi province. The traditional villages in Shaanxi are mainly distributed in Qinling Mountain areas of southern Shaanxi, Loess Plateau of Northern Shaanxi and Loess Tableland of Weibei (Figure. 5). The majestically lofty Qinling Mountains and the crisscross Loess Plateau make the geographical environment is relatively independent and the terrain is complex, which makes the outside world less interfering with the traditional villages, and provides an important external environment for the formation and development of the traditional villages. Moreover, those traditional villages are located in the terrain which is difficult to access. Traditional villages can also form and develop their own characteristics which forming a unique local folk culture and can be preserved in a more intact way.
3.2.2 Transportation factors. The distance among the provincial traditional village of Shaanxi Province and the Shaanxi Province highway and the main highway in Shaanxi Province are analyzed by using the field analysis of ArcGIS 10.2, it is found that there are 105 traditional villages in the range of highway 5km which accounting for only 32.6% of all traditional villages (Figure 6), it shows that most traditional villages are far away from important traffic lines. In the areas where the road density is low and the traffic accessibility is poor, it is restricted by the contact with the outside world, which leads to the formation of relatively remote and independent regional environment, and it is also less influenced by foreign cultures. Therefore, it can form and preserve the rural settlements with very regional cultural characteristics. On the contrary, the poorer traffic accessibility, the weaker development and the lagging development sequence provide favorable conditions for the protection of traditional villages.

3.2.3 Socioeconomic factors. Terrain and transportation affect the economic development, so compare to Guanzhong area, the development in northern and southern Shaanxi are relatively backward and the process of urbanization are slow, which makes the large number of traditional villages have been preserved. By analyzing the GDP data of Shaanxi provinces in 2017 published on the website of Shaanxi Statistical Bureau (Table 1), the per capita GDP of Ankang and Weinan ranked in the second and third respectively, although Yulin GDP is ranked in the second, its per capita GDP is in the first place, it’s mainly profit from the development of energy economy in recent years. In the past few decades, economic development in Shaanxi Province has been relatively backward, and these cities in the table 4 are also analyzed in the previous analysis of the traditional villages distribution are as concentrated areas.

| City    | GDP (Billion RMB) | Growth | Population | Per capita GDP | Ranks |
|---------|------------------|--------|------------|----------------|-------|
| Xi’an   | 7469.85          | 8.65   | 883.21     | 70846          | 2     |
| Yulin   | 3318.39          | 6.54   | 338.20     | 81994          | 1     |
| Xianyang| 2340.65          | 7.65   | 498.66     | 48050          | 5     |
| Baoji   | 2179.81          | 9.26   | 377.50     | 51182          | 3     |
| Weinan  | 1488.62          | 7.45   | 537.16     | 27713          | 10    |
| Hanzhong| 1333.3           | 9.08   | 344.63     | 33557          | 7     |
Yan’an 1266.39 1.32 225.28 48069 4
Ankang 974.66 11.35 265.60 32073 8
Shangluo 800.77 10.04 237.17 29485 9
Tongchuan 348.59 7.02 84.72 36781 6

In the range of city, the traditional villages are often far away from the local central cities, so they are affected less by the urbanization. Analyze the spatial distance between 323 traditional villages and 10 central cities in the province by using the Generate Near Table tool of ArcGIS 10.2 (Table 2), the average linear distance between the traditional village and the central city is about 125.65 km, the minimum distance is 2.5 km, and the maximum distance is 374 km. There are only 76 (23.5% of the total) traditional villages within 50 km around the central city, 115 within 50~100 km (35.6% of the total), and there are 132 which is further than 100 km, accounting for 40.9% of the total. In reality, the actual distance is much further than the straight line distance. So the traditional villages are far away from the central city in the whole, deviating from the development area of the city center, and they are in the remote areas with weak influence of urbanization development.

| Distance from central cities | 0~50km | 50~100km | 100~150km | 150~200km | More than 200km |
|-----------------------------|--------|----------|-----------|-----------|-----------------|
| Amount                      | 76     | 115      | 76        | 40        | 16              |

It can be seen from the above analysis that relatively backward social and economic development level, relatively weak urbanization development and relatively stable human-land relationship make the traditional villages in those areas are preserved more intact to some extent.

4. Spatial distribution and time characteristics of Shaanxi traditional villages

4.1 Time analysis of the ages of village building

By consulting literature materials, local chronicles and on-the-spot visits, the distribution of 71 national-level traditional villages building age in Shaanxi Province has obtained (Table 3). Due to the lack of historical records of Chinese villages for a long time, the building ages of the individual villages can only be limited to a certain extent, the specific age is unknown.

| The village building age | The spring and autumn period | Han dynasty | Wei Jin and the Northern and Southern dynasties | Sui and Tang dynasties | Song dynasty | Before Yuan dynasty |
|--------------------------|-----------------------------|-------------|-----------------------------------------------|-----------------------|------------|-------------------|
| Amount                   | 1                           | 2           | 3                                              | 5                     | 5          | 10                |
| The village building age | Yuan dynasty | Late Yuan and early Ming | Ming dynasty | Qing dynasty | The republic of China |
| Amount                   | 7                           | 2           | 19                                             | 15                    | 3          |                   |

Through the collation and analysis of the time data of the above villages information, it can be seen that the age of the traditional villages in Shaanxi be roughly divided into several historical stages.

Firstly, the villages were built before the Tang Dynasty (including the Tang Dynasty) with more than 1000 years history, such as Dengjiapo village of Yongshou county in Xianyang which was built in the Tang Dynasty has a history of more than 1300 years; Bai Sheng village of Sanyuan County in Xianyang which was built in the Jin Dynasty has a history of more than 1600 years; Yangjiagou village of Mizhi County which was built in the Spring and Autumn Period has a history of more than 2000 years from now.

Secondly, the villages were built after the Tang Dynasty, before the Yuan Dynasty and in Yuan Dynasty with a history of 600-1000 years. For example, Dangjia village is the first batch of Chinese traditional villages which is hailed as "Living Fossil of Ancient Human Settlements in The East" by international academic circles, the village has built from yuan to the second year (1331) of shun, which has a history of more than 680 years.

Thirdly, the villages were built in the Ming and Qing Dynasties have a history of 200–600 years generally, also the number of villages that preserved intact is the largest. Many of them are distributed in the south of Shaanxi Province, such as Qingmu village of Ningqiang County in Hanzhong which
was formed in the Ming Dynasty and flourished in the middle and late Qing Dynasty; Guojia Laoyuan of Zhongshan Village in Xunyang County of Ankang which was built in the late Ming and early Qing Dynasty; Xinghe Village of Hanyin County in Ankang which was built in the early years of Ming Dynasty; Heiyaogou Village of Zhen’an County in Shangluo which was built in the Periods of Qianlong of Qing Dynasty and others.

4.2 Spatial analysis of the village building age

From positioning the traditional villages of Shaanxi in space according to the village building age through the ArcGIS10.2 software(Figure.7), we can see that, the distribution of villages in different ages shows a regular pattern in space:

(1) The villages before the Yuan Dynasty were mainly distributed in Guanzhong area and along the Yellow River in Yulin. This is mainly because Guanzhong area in the early period of Zhou, Han and Tang Dynasty was the capital city of the state, the heavily populated area and rich cultural deposits make the amount of preserved traditional villages is the most abundant; On the other hand, the Yellow River in Yulin City of Northern Shaanxi has been an important frontier fortress in history, and many traditional villages have evolved from the frontier military fortress.

(2) The traditional villages in Yuan Dynasty were mainly distributed in the Hancheng area of Weinan. The main reason is that Shaanxi was the political, economic and cultural center of the Jin and Yuan Dynasties, while Hancheng is adjacent to Shaanxi, from that we’ve known that Jin Dynasty and Yuan dynasty have ruled Hancheng for 240 years, of which the Yuan dynasty ruled Hancheng for nearly 140 years. Therefore, the traditional villages which were built and preserved in the Yuan Dynasty were mostly in Hancheng.

(3) The largest number of traditional villages in Ming and Qing Dynasties and later periods were distributed in every places of Shaanxi, and nearly half of them distributed in Ankang, Shangluo, and Hanzhong in southern Shaanxi. This is mainly because the development of immigrants in the Qinba Mountains and the development of Trade and Commerce in Sichuan and Shaanxi.

Traditional villages as a traditional culture gathering area with "life", It provides important data reference and factual basis for the study of the village building history and the specific spatial distribution of villages, as well as for combing the development of the villages, inheriting the historical culture of the villages, and protecting the cultural characteristics of the villages.
5. Conclusion and discussion

By means of quantitative geography and GIS spatial analysis, the spatial distribution and influencing factors of 323 traditional villages in Shaanxi province are analyzed, then the main conclusions are as follows:

Firstly, on the whole, the traditional villages of spatial distribution in Shaanxi with the characteristics of concentration on the whole, and the degree of concentration is higher; On the local city scale, the distribution of traditional villages is scattered, they are mainly distributed in Northern Shaanxi, Guanzhong area and southern area of Shaanxi, and the distribution is relatively balanced; The spatial distribution of the traditional villages is basically balanced in the three areas, but there are great differences in the distribution within the area, in north of Shaanxi they are most distributed in Yulin, in Guanzhong area they are mainly distributed in Weinan, and in south of Shaanxi they are mainly distributed in Ankang. The spatial distribution of traditional villages of Shaanxi are mainly in 3 high concentration areas, they are the Xunyang County and Hanbin District of Ankang, Suide, Mizhi, and Jia County of Yulin, and Hancheng City and Heyang County of Weinan. The relatively closed regional environment, difficult accessed terrain, less convenient transportation and relatively backward socioeconomic and low urbanization level have provided important conditions for the protection of traditional villages, as well as the important factors affecting the distribution of the traditional villages in Shaanxi.

Secondly, The following conclusions were drawn from the analysis of the built years of the 71 traditional villages on the state-level: ① the existing traditional villages in Shaanxi were first found in the period of the Spring and Autumn Period, and most of the villages were built in the period of the Yuan, Ming and Qing Dynasties, but the villages before the Yuan Dynasty were kept less. ② The traditional villages before Yuan Dynasty mainly distributed in Guanzhong area and along the Yellow River in Yulin, and the traditional villages during Yuan Dynasty mainly distributed in the area of Hancheng City of Weinan Province. The largest number of traditional villages existed in Ming, Qing Dynasties and later periods, and they distributed in everywhere of Shaanxi, nearly half of them appeared in Ankang, Shangluo, Hanzhong and other places of southern Shaanxi.
It has practical value and significance for the protection and development of traditional villages to excavate the deeper value and landscape features of traditional villages. Under the background of rapid urbanization, the rural and regional culture of rural areas are faced with great threats. The development policies such as the beautiful countryside construction, the picturesque town construction, the construction of new type urbanization and other various development policies have been put forward in succession, those policies have provided new opportunities and ideas for the development of rural areas. The study on the interface, transition and integration of rural nature and urbanization is the historical mission of the scholars in the era, and the practice of Rural Revitalization needs more perfect rural planning theory to guiding the way. Compared with the urban planning, the preparation of rural planning in theory, method and practice are insufficient. So deepen the investigation of the traditional villages as specialized resources with high historical values and cultural connotations and the type of material space form, and explore the objective laws of the spatial pattern differentiation and evolution of the traditional villages, also in-depth to explore the influence factors of the traditional village differentiation and the theory and practice of the driving mechanism, as well as make the rural planning theory under the background of Rural Revitalization. All the above have great significance to improve the theory and promote the development of urban rural planning and rural geography.

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