RETRACTED ARTICLE: Distribution of rural tourism development in geographical space: a case study of 323 traditional villages in Shaanxi, China

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ABSTRACT
Spatial distribution of traditional village is the key factor for the sustainable development of rural tourism. Analyzing distribution characteristics and development conditions of traditional villages have profound implications for rural revitalization and all-for-one tourism. Firstly, this research introduced the characteristics and historic value of traditional villages in each region of Shaanxi province. Secondly, this paper analyzed the spatial distribution characteristics of 323 provincial-level traditional villages by using the method of quantitative geography through geographic information systems (GIS). Then, according to spatial type division, this research divided the spatial distribution of rural tourism in Shaanxi province into five areas, including linear tourist area, facial health area, distributed leisure area, low-density scenic area, self-driving tourist area. Finally, this paper summarized the development conditions of rural tourism in Shaanxi’s traditional villages and took case studies. The natural environment, social, and economic characteristics are crucial conditions for the sustainable development of traditional villages, influencing the spatial distribution of these villages. This paper summarized the spatial distribution of rural tourism development and proposed a guide for future space planning and construction for all-for-one tourism in other areas through empirical research on spatial distribution. Meanwhile, this research provides new ideas for rural revitalization.

Introduction
China is a largely agricultural country, the economic development and living environment in rural areas have been the focus of attention for a long time. From the late 1970s to the present, with the process of urbanization and the integrated development of urban and rural areas, the income of Chinese agricultural workers has continued to increase, and their living standards have improved significantly (Feng et al., 2019). However, unprecedented urbanization has caused many problems such as the loss of the agricultural population, the waste of land resources, and the destruction of the ecological environment (C. Gu, 2019; Ma et al., 2018). Therefore, China announced the implementation of the Rural Revitalization Strategy in 2018 and proposed to build the countryside into a regional complex with natural, social, and economic characteristics (Yin et al., 2019). Rural tourism is an important way to realize rural revitalization in China. The more urban leisure consumption demand, the more rural tourism increases. The analysis and research on the characteristics of rural spatial distribution is the premise of the reconstruction of rural space. The reconstruction of rural space driven by tourism is the result of internal and external forces.

The Rural Revitalization Strategy has brought new inspiration to rural development. As an important space for human activities, the countryside has multiple functions such as production, life, ecology, and culture (Castro-Arce and Vanclay, 2020). Compared with a rural economy driven by single traditional agriculture, a diversified industrial structure can stimulate rural productivity, improve business efficiency, and promote economic development (Gong et al., 2019; Ma et al., 2019). In recent years, many rural areas have adjusted their industrial structure and developed new industries, such as rural tourism, agricultural leisure, and online sales of agricultural products (Zhu et al., 2018). Among them, rural tourism is an important part of China’s tourism industry, with the most obvious economic benefits and huge potential. Rural tourism can promote industrial integration, provide value-added for agricultural products, increase farmers’ income, and consolidate the rural collective economic foundation (Randelli and Martellozzo, 2019). Besides, rural tourism provides a large number of employment opportunities and on-the-job positions for the society and attracts a large number of migrant workers and urban unemployed people to choose to return to their hometowns to start businesses (B. Li et al., 2020).

In the 2017 Chinese government work report, the proposal of All-for-one tourism has attracted widespread public attention (X. Feng & Xia, 2018). All-for-one tourism refers to the construction and operation...
of a region as a tourist destination, which can integrate regional superior resources, integrate industrial development, and promote and promote coordinated economic and social development with tourism (Jiang et al., 2018). All-for-one tourism can be combined with rural tourism to promote the scale and cluster development of rural tourism (X. Li et al., 2013). Taking the countryside of historical culture and high-quality ecological resources as a tourist destination can promote the sustainable development of the rural economy and tourism industry.

Traditional villages are a valuable cultural heritage of the Chinese nation and a potential resource for the development of rural tourism (Sarrión-Gavilán et al., 2015). Exploring the spatial layout of traditional villages and the rational use of traditional villages can promote the coordinated development of rural tourism areas (Gao and Wu, 2017). The spatial distribution of traditional villages involves two space dimensions. On the one hand, some researchers study on village spatial distribution regularities macroscopically and discuss the village’s overall space form (Kim et al., 2018; Sarrión-Gavilán et al., 2015). On the other hand, the other researchers study on village inner space patterns microscopically and discuss the layout of village internal elements (H. Li et al., 2019; Lu et al., 2020; Ma et al., 2019; Zhang et al., 2018). Currently, though geographers have obtained great achievements in traditional village spatial distribution macroscopically by using the methods of quantitative geography and GIS, the studies still mainly focused on the micro-scale. Besides, the macro studies concerned mainly nationwide and province-wide including Hunan, Guizhou, Anhui, Jiangsu Province, etc. (Chen, 2017; Gu et al., 2019; Hu et al., 2019; Jiang et al., 2020; Zhang et al., 2017). However, it ignored the results of the most developed inland provinces. Meanwhile, the researches only elaborated on the overall layout, lacking the deep analysis of the impact of the spatial distribution of traditional villages on rural tourism.

Traditional villages, containing rich traditional culture, are the historical heritages left by Chinese agricultural civilization (Tao et al., 2019). Various regions in Shaanxi province have obvious different climate characteristics, diversified humanistic characteristics, multiple geomorphic types and comparatively unsophisticated socio-economic, forming and conserving a large number of traditional villages (Gao and Wu, 2017; Guo and Sun, 2016; Zhang et al., 2016; Zhao and Zhang, 2017). Xi’an has passed the site selection of 13 ancient dynasties and it is the capital city of Shaanxi province of China. It has a large number of traditional villages. Shaanxi province is one of the important birthplaces of Chinese civilization with a long history and has a large number of cultural relics.

It is now China’s largest inland tourism destination. The traditional village is a significant representative of the farming culture in China. This paper analyzes the spatial distribution characteristics and influencing factors of traditional villages, hoping to enrich cultural geography in the development of the rural settlements and preserving the material carrier of farming culture. It can provide some references for the development planning and future development of traditional villages. Through the analysis of the spatial distribution characteristics and influencing factors of traditional villages, it can understand the distribution of local natural environment, transportation, and social economy, and then fully comb the rural tourism resources. Then it integrates the tourism resources according to the spatial distribution of villages in the planning stage.

Based on the information of villages listed in Traditional Chinese Villages Catalog, by using the methods of quantitative geography and GIS, the article explains the spatial distribution of Shaanxi traditional villages with the main features and development conditions. As a result, this article provides a data basis for the establishment of a panoramic tourism province in Shaanxi, a new perspective for the sustainable development of village tourism, and a case reference for China’s rural revitalization strategy.

Materials and methods

Study area

Chinese traditional villages, formerly called traditional villages, are natural villages or village communities. They are formed by large single settlement or several settlements, carrying historical and cultural traditions. Different from tangible and intangible cultural heritages, traditional village is another type of heritage, which comes from traditional production and life practice. As traditional villages were built before the establishment of China, they reflected the territorial, ethnic characteristics in the specific historical periods on the aspects of site selection and urban planning. Since the traditional buildings, layouts, historical features, and intangible cultural heritage were well preserved, the traditional villages have historical, cultural, scientific, artistic, social, and economic values. Despite the advanced age of the traditional villages, they were still used by villagers. Traditional villages with different regional characteristics spread all over Shaanxi Province, and the villages’ characteristics have an important influence on their spatial distribution. Shaanxi province is divided into three regions according to the different geographical environments. The physiognomy of northern Shaanxi is characterized by the loess plateau. Guanzhong is characterized by the Weihe plain.
And southern Shaanxi is located between the Qinling mountains and the Daba mountains, it is mountain regions. Figure 1 shows the characteristics of traditional villages in different regions in Shaanxi Province respectively.

**Guanzhong area**
The landform of Guanzhong is plain. The architectures are neatly laid out, which makes a compact distribution of settlement. The residential clusters are surrounded by large farmlands and woodlands. Under specific natural, cultural and historical conditions, the integral structure of the village in this region was unified with nature. Meanwhile, the physical environment of the landform affects the production and lifestyle of residents. Traditional dwellings in the Guanzhong area always have courtyards. The traditional dwellings usually have only one, two, or three courtyards. The courtyard is composed of principal rooms, wing-rooms, and subsidiary rooms. They are massive and closed, located along the street. They usually have complete drainage systems inside the courtyards by using open trenches and dark pipelines to drain the sewage.

**Southern Shaanxi**
Large mountain terrain in Southern Shaanxi is dotted with villages gathering in a small range, but decentralizing in greater scope. The villages kept a harmonious coexistence with the surrounding environment and traditional cultural features. By utilizing the topography, the altitude of terrain, leaning the construction method on flat, the architectures make full use of natural terrain. Based on the topography, the courtyards could become spacious, small, structured and flexuous respectively on the open, narrow, neat and flexural terrains. Because the local traditional dwellings have been largely affected by Chu-culture, the architectural morphology, especially the ornament, was extremely similar to the building form in the Jingchu area in Jiangnan plain. In the aspects of architectural plan layout, construction method, material application, and structural method, the traditional villages created the styles with regional characteristics of Southern Shaanxi. It used courtyard, mostly facing the south, as the main form. However, influenced by the roadways and topography, few courtyards are orientated in an east-west direction.

**Northern Shaanxi**
The landform of Northern Shaanxi, near the mountain and by the river, is Loess Plateau, which has its natural characteristics. This area is surrounded on three sides by mountains, having complex terrains such as gully, slope, ridge, and mound. It has abundant jujube trees and traditional trees, forming a special natural landscape zone. The residential dwellings in Northern Shaanxi often use the building type combining cave-dwelling and normal dwelling. Cave dwelling came from nature, reflecting “Unity of Heaven and Man”. The layout patterns of the settlements are determined by various environmental surroundings. Adjusting measures to local conditions following the mountain-shaped is the main principle for the construction of settlements. The specific nature climate gave birth to the earth cave dwellings, widely distributed around the miles-wide platform. In general, with good natural conditions, cave dwellings face the sun and against mountains, with open spaces in front. By making full use of terrains, the building’s layout follows the terrain’s shape. When the terrain has a high altitude and square shape, the cave-dwelling was constructed on the cliff and the terrace was built on the square platform. When the terrain has a low altitude and hollow shape, the cave-dwelling and courtyard were both constructed on the low area. The ingenious layout of the cave-dwelling, completely incorporating its natural surroundings, makes it blend with nature.

**Data sources**
Shaanxi Province, with the total area of 205,800 square kilometers, is located 105°29′~111°15′ east longitude and 31°42′~39°35′ north latitude. It is long and narrow in the north-south direction. In terms of the geographical regionalization, Shaanxi province stretches from south to north, so that it has the climatic characteristics of the north, the south, and the
central parts. Northern Shaanxi, Southern Shaanxi, and Guanzhong area respectively have the climate features of the north, the south, and the central parts. From the views of climate, humidity, temperature and geographic features, the ecological development model of traditional villages in Shaanxi province have the significance to spread in China. Identified by the Traditional Village Defense and Development Council, by April 2017, Shaanxi Province has four-batch, 323 national-level traditional villages, which account for 10.22% of Chinese traditional villages (Feng et al., 2019).

By taking these traditional villages as samples, making 1:500,000 vector map of Shaanxi Province as working map, using Google geographic information system searching, based on ArcGIS 10.3 technology platform, the study sets the geographic coordinates of Shaanxi traditional villages, builds a database for the spatial properties of Shaanxi traditional village and draws the spatial distribution maps of Shaanxi traditional villages (Figure 2).

**Research methods**

A large number of papers at home and abroad have carried out detailed research on the distribution characteristics of space. The research methods in these papers are diverse. Since 2007, Kyushik et al. (Mihailović et al., 2015; Neruda, 2017; Oh and Jeong, 2007; Peng et al., 2014; Seyedmohammadi et al., 2019) applied GIS technology to analyze the same type of land or resources of the same attribute in space and to depict the distribution image; From 2008 to now, A. Druckman et al. (Ben-Elia and Benenson, 2019; Druckman and Jackson, 2008; Lee et al., 2019; Tomul, 2009) used the Lorenz curve and the Gini coefficient to quantify the equilibrium or fairness of the allocated resources in space, and proposed corresponding solutions; Laasasenaho et al. (Anderson, 2009; Z. Chen et al., 2019; Laasasenaho et al., 2019; Lin et al., 2018; Schivo et al., 2019) used the kernel density methods to simulate the probability of event occurrence, and applied GIS to image the hot spot. According to the above research content, this paper uses GIS, spatial uniformity analysis and kernel density methods to systematically analyze the distribution type, distribution uniformity and distribution position of traditional villages in Shaanxi Province, and apply ArcGIS 10.4 and other related software.

**GIS**

ArcGIS 10.4 is used as the technical analysis platform. The geographic map of each village is determined by Google Maps Coordinate System (Nowak et al., 2020). The nearest neighbor index of traditional villages in...
Shaanxi Province is calculated and the spatial distribution type is determined.

The mean nearest-neighbor distance is a geographical indicator that represents the proximity of point elements in geographic space (Beck et al., 2019). Measure every \( r_1 \) (the distances of two nearest-neighbor points) before taking an average \( r_E \) (the mean nearest-neighbor distance). When the point elements in the research region are randomly distributed, the formula of theoretically nearest-neighbor distance \( (r_E) \) is:

\[
    r_E = \frac{1}{2 \sqrt{m/A}} = \frac{1}{2 \sqrt{D}}
\]

Where \( m \) is the number of data points, \( A \) is region areas, and \( D \) is point density. Adjacent-point index \( (R) \) is the ratio between actual nearest-neighbor distance and theoretically nearest-neighbor distance. Its formula is:

\[
    R = \frac{r_1}{r_E} = 2\sqrt{\frac{1}{D}}
\]

If \( R = 1, r_1 = r_E \), it means the distribution of point elements is random; If \( R > 1, r_1 > r_E \), it means the distribution of point elements is uniform; If \( R < 1, r_1 < r_E \), it means the distribution of point elements is agglomerative.

**Spatial uniformity analysis**

In metrological geography, the Lorenz curve, the centralization index, and the Gini coefficient are all common indicators for determining the equilibrium of point features. Among them, the Lorenz curve can graphically describe the degree of concentration of point features; the centralization index is to compare the concentration of geographic elements in space, and the Gini coefficient is a quantitative description of the equilibrium (Ganjoei et al., 2020).

(1) Lorenz curve

The Lorenz curve is a curve drawn using the frequency accumulation number to characterize the degree of concentration or dispersion (Mihailović et al., 2015). The formula for calculating the concentration index in the Lorenz curve is used to calculate the imbalance index \( (S) \):

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

The study selected the appropriate research model, such as adjacent-point index, used Excel and ArcGIS10.3 spatial analyst tool to make quantitative analysis and kernel density calculation of traditional villages in Shaanxi Province. Then it overlaid the elements, such as the distribution and geographical environment of Shaanxi traditional villages, economic development, national culture, etc., to discuss the factors influencing the distribution of traditional villages in Shaanxi Province.

(2) Geographic centralization index

The geographic centralization index is an important indicator to evaluate the concentration degree of the study object (Ganjoei et al., 2020). The article uses it to measure the spatial distribution of traditional villages in Shaanxi Province on an urban scale. Its formula is:

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

Where \( G \) is the index of geographic concentration; \( X_i \) is the number of traditional villages in the No. city in Shaanxi Province; \( T \) is the total number of traditional villages, \( N \) is the number of cities. \( G \) is between 0 and 100, and the bigger \( G \), the more concentrated traditional villages are. On the contrary, the smaller \( G \), the more decentralized traditional villages are. Supposing \( G \) is the index of geographic concentration when the traditional villages are evenly distributed in every city. If \( G > G_0 \), it represents the traditional village has the character of centralized distribution and vice versa.

(3) Gini coefficient

The Gini coefficient is an important method to study the spatial distribution of scattered zones in geography science and compare the spatial differentiation of regional geographical elements (Lee et al., 2019). This article uses the Spatial Gini coefficient to measure the spatial distribution conditions of the traditional villages in the main geographical regions in Shaanxi Province. Its formula is:

\[
    G = \frac{-N}{\ln N} \sum_{i=1}^{N} P_i \ln P_i
\]

Where \( P_i \) is the proportion of traditional villages in the province’s total, and \( N \) is the number of regions. The spatial Gini coefficient is between 0 and 1, and the bigger \( G \), the more concentrated traditional villages are.

**Kernel density methods**

The traditional villages in Shaanxi are unevenly distributed in the area, and their unevenness will change with the area of the computing unit. Therefore, we can learn from the kernel density methods on the physical plane, assuming that geographical events can occur anywhere in space, and the probability of events occurring at different locations is different (Laasasenaho et al., 2019). The intensity of the reference point is related to the probability of occurrence of the event. The higher the intensity of the point, the higher the probability of occurrence of the event, and vice versa. The nuclear density calculation formula is:
\[ f_n(x) = \frac{1}{nh} \sum_{i=1}^{n} k\left(\frac{x-x_i}{h}\right) \]  

In the formula, \( f_n(x) \) is the kernel function; \( x_i \) represents the coordinate position of the \( i \)-th village; \( k \) is the threshold of the kernel function. To ensure the accuracy and visibility of nuclear density estimation, this paper introduces geographic model information into ArcGIS for kernel density analysis and draws images.

### Results

#### The overall distribution characteristics

Traditional villages in Shaanxi Province, numerous in quantity, are widely distributed all over the province and the cities. The uneven distributions of traditional villages are located mainly in Ankang and Yulin city. Generally speaking, there are more traditional villages in northern and southern Shaanxi than Guanzhong area, more around tourist attractions than along the transportation tracks and dynamic urban areas.

#### Spatial distribution patterns

At the macro level, traditional villages could be abstracted as point elements. According to formula of nearest-neighbor distance, the theoretical nearest-neighbor distance of the three hundred and twenty-three provincial level traditional villages is 18.88 km. Based upon the measurement of ArcGIS 10.3, the nearest-neighbor distance is 16.97 km, meaning the adjacent-point index: \( R = 0.9 \). That means the spatial distribution patterns of Shaanxi national level traditional villages are identified agglomerate. Table 1 shows the adjacent-point index of typical landforms and the main distribution features of traditional villages. Northern Shaanxi presents a uniform and random distribution. The loess plateau region has a typical uniform distribution, mainly including the large agglomerative settlements in the southern part of the region, such as Luochuan plateau, Jiaodao plateau, Jiuxian plateau, the west side of Fenchuan River and the north side of Shiwang River. Northern Shaanxi, a hilly and gully region, has complex terrains. In most cases, the small region not only has linear settlements along valleys but also has decentralized punctiform settlements on hills. As a result, the settlements in Northern Shaanxi present the character of random distribution. By using GIS to analyze traditional villages in this region, the calculation of mixed distribution maps shows that the traditional villages are randomly distributed in most of the Guanzhong area. In general, settlements in plain should have a uniform distribution. However, the Guanzhong area lies on terrace plains and small plains mostly. In addition, with the influence factors such as well-developed social-economic, convenient traffic routes, and numerous cities, rural settlements centralized around traffic lines and cities, leading to an unbalanced distribution in space. Although the settlements in both Northern Shaanxi and Guanzhong areas show a random trend, they have different reasons for generation. Furthermore, the uneven distribution of settlements in the Guanzhong area is at an advanced stage of its spatial distribution evolution.

#### The balances of the spatial distribution

**The concentration degree of the traditional village distribution**

Due to the differences in natural conditions, humanistic environments, and economic development levels in different regions, Table 2 shows the number of traditional villages in different cities. It can be seen that the numbers were quite fluctuating.

The current total number of traditional villages in Shaanxi Province is 323\((T = 323)\), the number of cities is 12\((T = 12)\). According to the formula of the geographic concentration index, the geographic concentration index of traditional villages in Shaanxi Province is 42.09\((G = 42.09)\). If we assumed that the 323 traditional villages in Shaanxi Province are uniformly distributed in each region, the amount of traditional villages in every city is 27, meaning the current geographic concentration index is 27.88\((G_0 = 27.88)\). The result, \( G > G_0 \) shows that in terms of the urban scale, the distributions of traditional villages are concentrated mainly in Ankang, Yulin, and Weinan city.

| Geographic region      | Regional representatives | Typical landforms     | Percentage (%) | R    | Macroscopic distribution          |
|------------------------|--------------------------|-----------------------|----------------|------|-----------------------------------|
| Northern Shaanxi       | Huangling; Luochuan; Yan'ch'ang; Zhi'd'an; Xi'an; Gaoling; Wei'an; Tong'guan. | River valley road; Loess Plateau; Hills and gullies; Terrace plain | 15 | 0.45 | Centralized distribution         |
| Guanzhong              |                          | Loess Plateau; Hills and gullies; Terrace plain | 47 | 1.73 | Evenly distributed               |
| Southern Shaanxi       | Ankang; Shanyang.        | Loess Plateau; Hills and gullies | 80 | 1.36 | Evenly distributed               |

Table 1. The adjacent-point index of typical landforms and the main distribution features of traditional villages.
The balance degree of the traditional village distribution

Shaanxi Province is divided into three geographic regions, which are the Guanzhong area, Southern Shaanxi and Northern Shaanxi. Guanzhong area has seven cities, including Xi’an, Xianyang, Weinan, Tongchuan, Baoji city, Xixian New Area, and Yangling Demonstration Zone. Northern Shaanxi has two cities, containing Yulin and Yan’an city. Southern Shaanxi has three cities, involving Shangluo, Hanzhong, and Ankang city. The distribution of traditional villages in these three geographic regions in Shaanxi Province shows in Table 3 the numbers of traditional villages in Northern Shaanxi and Southern Shaanxi are the same, it has the number of 110 in Northern Shaanxi and Southern Shaanxi. It is slightly more than the number 103 of villages in the Guanzhong area. The geomorphic units in these two regions are special, the economic level and transportation location are poor. So the number of traditional villages remains a little more than the Guanzhong area. Based on the formula of the spatial Gini coefficient, we calculated the spatial Gini coefficient of Shaanxi traditional villages, G = 0.7744. It illustrates that the balanced distributed traditional villages in these three geographic regions in Shaanxi Province have the concentration trend. By the formula of an unbalanced index, we calculated the unbalanced index of Shaanxi traditional villages, S = 0.6115. It represents that there are unbalanced distributions of traditional villages in each urban area in Shaanxi Province. The study also finds that, by the Lorenz curve of distributions of traditional villages in each urban area. Figure 3 shows almost 80% of traditional villages are located in Ankang, Weinan, and Yulin city.

Spatial distribution density

The spatial distribution density of Shaanxi traditional villages is 17/10,000 km². Yulin has the highest density, 18.6/10,000 km², closely followed by Ankang, 15.4/10,000 km². The densities of Tongchuan, Xianyang, Weinan are over 10/10,000 km², compared with the densities, less than 1/10,000 km, in Baoji, Hanzhong, Yan’an, Xi’an and Shangluo. By using the “Density” tool in ArcGIS 10.3 ToolBox, the kernel density analysis of Shaanxi traditional villages is made to generate diagrams of Shaanxi kernel density distribution map. As shown in Figure 4, there are two high-density zones of Shaanxi traditional villages distributions, which are Yulin and Ankang area. Ankang is located in the Qin mountain area, while Yulin is in loess plateau gully region. Although both of them have inconvenient transportation and backward economy, the less external influence provides the basis for the conversation of traditional villages. Thus, high-density zones of traditional villages have been formed in Yulin, Ankang, and Weinan under the impacts of the natural environment, transportation, and economic development. The traditional villages in Ankang are mainly located in Shuhe Town and Xenhe Town in Hanbin District. And in Yulin, the villages are concentrated in Jia County and Mizhi County. Suhe Town and Xianhe Town are national historical and cultural towns. Jia County, Mizhi County, and Hancheng County are national historical and cultural counties. The extraordinary local culture and the luxuriant historical sedimentation provided a good foundation for traditional village conversation. Besides, the secondary high-density zones are in Suid, Pucheng, and Xunyang.

Through analyzing a large-scale map, in terms of the density of Shaanxi traditional villages, Guanzhong area has the highest settlement density, while Northern Shaanxi and Southern Shaanxi are relatively sparse. By sampling survey, in these three regions, there are huge differences in the size of the population and the distribution patterns of traditional villages based on the major landforms. Table 4 shows the areal densities and main distribution patterns of traditional villages. Guanzhong area, the density of traditional villages being 0.26, constituting almost 60% of the entire population in Shaanxi province, has better natural conditions and socio-economic environment. The average population there is much more than Northern Shaanxi and Southern Shaanxi. The density of traditional villages in Northern Shaanxi is lower than Southern Shaanxi, however, the scales are on the contrary.

Table 2. The number of traditional villages in different cities.

| City     | Number | Rank | Percentage (%) | Cumulative percentage (%) |
|----------|--------|------|----------------|---------------------------|
| Ankang   | 79     | 1    | 24.46          | 24.46                     |
| Yulin    | 77     | 2    | 23.84          | 48.3                      |
| Weinan   | 64     | 3    | 19.81          | 68.11                     |
| Yan’an   | 33     | 4    | 10.22          | 78.33                     |
| Xianyang | 22     | 5    | 6.8            | 85.13                     |
| Shangluo | 20     | 6    | 6.19           | 91.32                     |
| Baoji    | 11     | 7    | 3.41           | 94.73                     |
| Hanzhong | 11     | 7    | 3.41           | 98.14                     |
| Xi’an    | 2      | 8    | 0.62           | 98.76                     |
| Yangling | 2      | 8    | 0.62           | 99.38                     |
| Tongchuan| 1      | 9    | 0.31           | 99.69                     |
| Xixian   | 1      | 9    | 0.31           | 100                       |

Table 3. The distribution of traditional villages in these three geographic regions in Shaanxi Province.

| Geographic region   | Number | Percentage (%) | Cumulative percentage (%) |
|---------------------|--------|----------------|---------------------------|
| Northern Shaanxi    | 110    | 34.06          | 100                       |
| Guanzhong           | 103    | 31.88          | 31.88                     |
| Southern Shaanxi    | 110    | 34.06          | 65.94                     |
Spatial type division

In this research, we describe the spatial distribution of traditional villages according to the comprehensive application of the above five indicators. Then we take Shaanxi province as the case study to divide the types of traditional villages, such as medium density arc type, high density scattered type, medium and high density clustered type, low density scattered type, and low-density broadband type.

1) The characteristics of medium density arc type traditional village are listed as follows. The nearest neighbor index is between 0.9–1. The kernel density is between 10–15 per 104 km². The spatial autocorrelation is higher than in other districts. Meanwhile, the...
spatial distribution patterns of traditional villages are consistent with the trend of roads or rivers, which present curve forms. For example, Shi Quan County in Hanzhong City and Zhashui County in Shangluo City, characterized by more concentrated residential areas, higher density, and smaller-scale settlements, are along rivers and roads with arc types.

(2) The characteristics of high density scattered type traditional villages are listed as follows. The nearest neighbor index is between 1–1.5 and the kernel density is between 20–25 per 104 km². The spatial Gini index is between 0–0.2, meaning the villages are distributed at a certain distance from rivers and waters. The Spatial Autocorrelation is in the low shovel area. This type is characterized by the scattered distribution of traditional village settlements. For example, Suide and Mizhi county are located in the hilly beam gully area with village settlements. For example, Suide and Mizhi county are located in the hilly beam gully area with small scales, simple shapes, but high densities.

(3) The characteristics of medium and high density clustered type traditional village are listed as follows. The nearest neighbor index ranged from 0.85–1, with a randomized clustered distribution with a core density between 15–20 per 104 km². The spatial Gini index is between 0.8–1. This type is mainly distributed in the watersheds of the low mountain hilly areas in the Hanbin area of Ankang city and Xunyang County. This area is characterized by the scattered distribution of traditional village settlements. For example, Suide and Mizhi county are located in the hilly beam gully area with small scales, simple shapes, but high densities.

(4) The characteristics of low density scattered type traditional villages are listed as follows. The nearest neighbor index is much larger than 1, with a randomized clustered distribution with a core density between 15–20 per 104 km². The spatial Gini index is close to 0, and the spatial autocorrelation is in the low shovel area. This type is mainly distributed in Ningqiang County, the high mountain area of Chenggu County, and the northern blown-sand area of Dingbian, Jingbian, Hengshan, and Shenmu. This area is characterized by low density, simple settlement shape, and small land size.

(5) The characteristics of low-density broadband type traditional village are listed as follows. The nearest neighbor index is between 0.93–1. The core density is less than 10 per 104 km². The space Gini index is between 0.4–0.7, and the spatial autocorrelation is in the high shovel area. This type is mainly distributed in Heyang, Pucheng, Huaxian, and Huayin of the Wei river basin. This area is characterized by the sparse distribution of residential areas, the low density, the large scale, and the complex shape.

### Analysis of development conditions

#### Natural environment

Physical geographic environment, including topography, altitude, and natural environment pattern, is the primary determinant influencing the spatial distribution of traditional villages. The agriculture-oriented economic structure occupies a dominant position in traditional villages. As a result, Physical geographic environment is the main factor to impact the economy and spatial structure of traditional villages. The land resources are the controlling point for the spatial distributions and features of traditional villages (Hu et al., 2019).

The geomorphic type of Shaanxi Province is complex and diverse. As Qin Mountain runs through east and west, Shaanxi Province is divided into three parts: Northern Shaanxi, Guanzhong area, and Southern Shaanxi. North Shaanxi loess plateau, accounting for 45% of the entire area of Shaanxi province, has an altitude of 800–1300 m. It has less annual precipitation and arid climate. Furthermore, upstate Yulin City is dusty and windy. Guanzhong area, constituting 19% of the entire area of Shaanxi, is mainly loess-plateau and river terrace. The climate in this area, with moderate rainfall, is a continental monsoon climate of medium latitudes. Southern Shaanxi, occupying 36% of the entire area of Shaanxi, throughout 90% for the mountains and hilly terrain, lies in Qinba Mountain and the intermountain basin. This area is located in the northern subtropics monsoon climate, with a humid climate, much precipitation, many rivers, and abundant water resources. Shaanxi Province, lying north-south high, intermediate low, from east to west gradually tilted.

The traditional villages in Shaanxi Province are mainly distributed in Ankang City in Southern Shaanxi and Yulin City in Northern Shaanxi, gradually forming stable settlement areas. Figure 5 shows the traditional villages superimposed on the elevation map in Shaanxi Province. The various topographic types of Southern Shaanxi mountainous regions are intermountain basins, low mountains, hills, middle mountains, and high mountains, presenting a “two-mountains with one-valley” pattern. The relatively independent geographical environment and small external influence provide the foundation for the development and conservation of traditional villages there. Northern Shaanxi, with

### Table 4. The areal densities and main distribution patterns of traditional villages.

| Area            | Main terrain | density (/km²) | Average population | Main distribution pattern               |
|-----------------|--------------|----------------|--------------------|-----------------------------------------|
| Northern Shaanxi| Plateau      | 0.19           | 100–200            | Scattered; Small reunion                 |
| Guanzhong       | Plain        | 0.26           | 300–400            | Concentrated reunion                     |
| Southern Shaanxi| Mountain     | 0.15           | <100               | Large dispersion; Small agglomeration    |

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the poor climatic condition, diversified landforms, and affluent soil types, formed a particularly arid and semi-arid geographical feature. It is a farm pastoral region. Traditional villages there are widely dispersed, mainly in Jia County and Mizhi County, where belongs to typical loess hilly-gully region with the average altitude of 1020 m. Therefore, the relatively special and closed landform is vital for the formation and development of traditional villages.

Social economy

Most of the traditional villages in Shaanxi Province are either located in areas with backward economies or advanced economy (Table 5). It represents that the spatial distribution of traditional villages is influenced by the area’s economic developing level. Throughout the distribution of Shaanxi traditional villages, Ankang and Yulin are the places where rural settlements concentrated. Northern Shaanxi area has a large temperature difference between day and night, providing good growing conditions for distinctive agricultural products. In addition, relying on the advantage of mineral resources, Northern Shaanxi became economically developed area. Guanzhong area, with good natural conditions for farming, is the production base for grain and economic crops. The obvious commercialization of the agricultural industry gives the area an abundant economic base so that the traditional villages have strong vitality. In the meantime, under the impact of clan interests, the rich merchant splashed out on building dwellings and ancestral halls, accomplishing traditional architectural complexes with Guanzhong culture. After the reform and opening-up policy, there is a huge transformation in the man-land relationship. As ordinary people have the ability to repair ancestral dwellings and halls, and the government consciously protects and evaluates traditional villages, that is, to some extent, beneficial for the conservation of traditional villages. In contrast, the economically backward Southern Shaanxi is a historical farming area. It is still the economically underdeveloped area, since the transportation, communication, and information exchange lag behind relatively. The slow process of urbanization and the backward process of the social-economy make a stable man-land relationship so

Figure 5. The traditional villages superimposed on the elevation map in Shaanxi Province.
that there retain abundant original ecological villages.

**Urbanization**

The urbanization levels are positively associated with the growth of GNP. Due to the rapid development of cities and the changes in people's lifestyles, traditional villages are in the process of renewal and vanishing. These are important factors to affect the distribution of traditional villages.

*Figure 6*, the overlay of traditional villages and administration centers, shows that, except for Xi'an, areas around other administration centers seldom have traditional villages. Modern lifestyles in cities directly impact the traditional lifestyle in villages, easily assimilating neighboring villages, posing a great threat to traditional village conservation. With the overlay of traditional village distributions and urban GDPs, *Figure 6* shows a negative relationship between them.

Xunyang County, Jia County, and Mizhi County, with relatively low GDPs, have 17, 23, and 31 villages respectively. The major tourist cities, Weinan, Shangluo, and Baoji, with a huge rural tourism contribution to GDP, have significant tourism value and tourism exploitation potential. Weinan is a national historical and cultural city. There are many historical and

| Area     | City      | GDP (100 million yuan) | Primary Industry | Secondary Industry | Tertiary Industry | Per Capita GDP (yuan) | Number of traditional villages |
|----------|-----------|------------------------|------------------|--------------------|------------------|----------------------|--------------------------------|
| Guanzhong| Xi'an     | 7471.89                | 281.12           | 2596.52            | 4594.25          | 78368               | 2                              |
|          | Tongchuan | 348.43                 | 24.54            | 179.1              | 144.79           | 41465               | 1                              |
|          | Baoji     | 2191.61                | 175.32           | 1417.64            | 598.65           | 58010               | 11                             |
|          | Xianyang  | 2292.51                | 312.17           | 1320.18            | 660.16           | 52445               | 22                             |
|          | Weinan    | 1650.63                | 230.53           | 771.54             | 648.59           | 30697               | 64                             |
|          | Yangling  | 136.96                 | 7.75             | 74.19              | 55.02            | 66600               | 2                              |
| Southern | Hanzhong  | 1333.3                 | 209.98           | 617.88             | 505.44           | 38671               | 11                             |
| Shaanxi  | Ankang    | 974.66                 | 104.63           | 527.8              | 342.23           | 36662               | 79                             |
|          | Shangluo  | 757.06                 | 98.18            | 398.43             | 260.45           | 31856               | 20                             |
| Northern | Yan’an    | 1312.59                | 119.88           | 757.43             | 435.28           | 58132               | 34                             |
| Shaanxi  | Yulin     | 3361.29                | 167.68           | 2150.53            | 1043.08          | 99076               | 77                             |

*Table 5*. Shaanxi's GDP in 2017.

*Figure 6*. Traditional village distributions and urban GDPs.
cultural sites, such as Dang Jia village, Si Maqian, Confucian Temple, and so on. Shangluo has many natural landscapes, such as Jinsi valley, Luo he and so on. Baoji is the hometown of bronze ware. It has historical relics such as Hezun. There are many wetland parks and the Taibai mountains. These cities with huge rural tourism contribute a lot to the growth of GDP. Both government and the public have a strong awareness of declaration, protection, and development of traditional villages, making good bases and conditions to develop and protect traditional villages.

**Historical and cultural**

The accumulation of historical culture is the vital factor influencing the distribution of traditional villages. In terms of the distribution of traditional villages, the natural and cultural environments various considerably in the north and south. As a result, traditional villages centralized at Hanbin in Southern Shaanxi, Hancheng in Guanzhong area, and Mizhi in Northern Shaanxi, where have rich historical legacies. Influenced by the culture in Qin, Chu, Bashu areas, the culture of Huaxia, and central plains, Southern Shaanxi has integrated cultural and frontier characteristics. Ankang City has a combination of Bashu and Jingchu culture. The factors, such as a good natural environment, historical culture, river system connecting natural resources, agricultural civilization, and ancestral survival wisdom, provide the basis for the conservation and concentration of traditional villages. The Guanzhong Plain, with rich Qin culture, provides a comfortable habitat and production environment. As Hancheng has a long history and many cultural relics in Ming and Qin dynasty, the government has begun to protect historic and cultural architectures very early. As a result, Hancheng has kept many intact traditional villages in Ming and Qing dynasties. Northern Shaanxi is located in a remote area. Because of the transportation limits and isolation, it formed a closed and heavy-headed cultural circle. Yulin City is a place combined with nomadic culture and agricultural civilization. The massy loess layer and the cultural collision make the traditional villages here maintain original cultural ethos.

**Road traffic factors**

In terms of the three regions in Shaanxi Province, because of the difference in natural conditions, economic developments, residents’ demands for transportation, and the investments on transportation, the economy, and social development vary significantly. Because of the terrain restrictions in Northern Shaanxi, the transportation system is undeveloped. Partial areas even do not have freeways. The density of the railway network is under 0.01 km/km². The highway density is under 0.183 km/km². The traffic construction in Southern Shaanxi lags behind as it has technical difficulties and costs too much. The railway network density is only 0.015 km/km², while the highway density is 0.264 km/km². However, the backward status of transportation made a solid foundation for the conservation of traditional villages. Figure 7, the overlay of traditional villages and traffic lines, shows that there are sparse distributions of traditional villages along railways and main highways. Poor accessibility made the villages in an “inaccessible” mode so that they are seldomly influenced by globalization and modernization. As a result, it greatly delayed the process of traditional villages’ evolution, making them be conserved naturally. Guanzhong area has an advanced traffic construction. The railway network density is 0.046 km/km², and there are freeways connecting every city. The highway density reaches 0.491 km/km². The traditional villages here are equally distributed and have a poor preserving situation.

Figure 7 shows a negative relation between transportation development and traditional village distribution since traditional villages are widely distributed in Northern and Southern Shaanxi, whereas rarely in the Guanzhong area.

**Discussion**

To introduce these ideas into practice, there must be conversations between scientists, planners, and geographers. So, researches should focus on more practical problems. And the research results should be applicable to solve practical planning and conservation problems of traditional villages. The article discussed the features and reasons for traditional village spatial distribution on the macro level. It has a positive research significance on the geographic space pattern of traditional villages. In addition, it also has reference value on the protection, exploitation, and utilizing the decision of regional traditional villages.

1. The article debates the distribution features of three hundred and twenty-three traditional villages in Shaanxi Province macroscopically, but excluding the internal structure and cultural traits on the micro-level. The influence factors focus mainly on the macroscale. However, it lacks the microelements, such as village economic conditions, agricultural production, the population’s cultural degree, and village cultural heritage, affects the distribution of traditional villages. That would be the further research field.

2. Traditional villages are often located in ecological environmental fragility. We should figure out how to coordinate the relationship between the development of traditional villages and the protection of the cultural ecological environment and pay close attention to the sustainable development of traditional villages.
Traditional villages do have human factors, which could not make a comprehensive response to objective laws. Influence factor analysis, such as the formation, development, protection, and evaluation of traditional villages, should be focused on studying the distribution of traditional villages on different levels.

**Conclusions**

The article analyzed the spatial distribution characteristics and development conditions of 323 traditional villages in Shaanxi Province by using the methods of quantitative geography. Conclusions are as follows:

1. The spatial distribution patterns of the traditional villages in Shaanxi province are identified agglomerate, providing resource advantages for all-for-one tourism. On the urban scale, traditional villages have the character of centralized distribution mainly in Ankang, Yulin, and Weinan City in Shaanxi Province. In addition, there are three high-density zones of traditional villages as a potential tourist hub including Hanbin, Hancheng, and Mizhi.

2. Based on the analysis of the spatial distribution characteristics of 323 traditional villages in Shaanxi Province, it is suggested that the spatial distribution of traditional villages can be described by the nearest neighbor index, geographical concentration index, Lorenz curve, and kernel density. This method can be used to divide the spatial distribution of traditional villages into basic types such as medium density arc type, high density scattered type, medium and high density clustered type, low density scattered type, and low-density broadband type. The spatial distribution types of traditional villages can provide a theoretical basis for the development of tourist routes and the development of diverse and characteristic tourism spaces in Shaanxi Province.

3. The research describes the spatial distribution of traditional villages according to the basic types. Then it takes Shaanxi Province as the case study to divide the development space of rural tourism, including linear tourist area, facial health area, distributed leisure area, low-density scenic area, self-driving tourist area.

4. The natural environment, social economy, urbanization, historical culture, and transportation are the crucial conditions affecting the sustainable development of rural tourism. The research shows that cities with low urbanization levels have better-preserved traditional villages, with a long history and
distinctive culture have extensive and numerous traditional villages. Economically backward cities and towns can serve the surrounding traditional villages by establishing tourist distribution centers, thereby driving their emergency development. The relatively closed mountainous area and Northern Shaanxi area with abundant resources have more traditional villages. But these regions with bad traffic to limit tourism development of traditional villages.

Traditional villages have become an important part of all-for-one tourism. This paper takes the traditional villages in Shaanxi as an example to reveal spatial distribution, establish a macro tourism development space, and explore conditions of tourism development. This research provides a theoretical basis for dynamic monitoring, protection management, and tourism planning. Meanwhile, the research has great significance in the protection and inheritance of Chinese cultural heritage, and promoting sustainable development of rural revitalization.

**Author contributions**

Conceptualization, Juan Xu; Data curation, Dan Liu; Funding acquisition, Juan Xu; Methodology, Mengsheng Yang; Software, Mengsheng Yang and Ziliang Lu; Supervision, Juan Xu; Validation, Ziliang Lu and Dan Liu; Writing – original draft, Juan Xu; Writing – review & editing, Mengsheng Yang.

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