Analysis On Spatial Distribution And Influencing Factors Of China National Forest Villages Based on GIS

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Analysis On Spatial Distribution And Influencing Factors Of China National Forest Villages Based on GIS

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Abstract

As a carrier to promote rural greening and beautification and further implement the rural revitalization strategy, it is of great significance to study the spatial distribution characteristics of China national forest villages and its influencing factors. Taking 7586 China national forest villages as examples, the spatial distribution characteristics and influencing factors of China national forest villages were studied by using such methods as nearest neighbor index, Tyson polygon, cold hot spot analysis, standard deviation ellipse and kernel density index. The results showed that: (1) the overall clustering distribution characteristics of China national forest villages were significant, and the distribution type was agglomeration. There was no breakthrough in the Hu Huanyong Line, and the southeast of the line was the main concentration area. (2) From the perspective of spatial clustering, it shows the distribution characteristics of "hot spots in the south and cold spots in the north". Hot spots are mostly located in the south, represented by Sichuan, Guangdong, Hunan, etc., while cold spots are mostly in the north, mainly in Xinjiang, Xizang, etc.(3) From the perspective of spatial distribution direction, the standard deviation ellipse coincidence degree of the two batches is relatively high. The two batches are distributed in a dense direction from northeast to southwest with Suizhou city, Hubei as the geometric center. The concentration degree of the second batch increases on the basis of the first batch, showing a trend of migration and distribution in the southwest.(4) From the perspective of the distribution characteristics of kernel density, the distribution of kernel density has a strong correlation with two factors, one is the forest vegetation coverage, the other is the distribution location of urban agglomeration;(5) Elevation, slope direction, river basin, traffic are important factors affecting the distribution of China national forest villages, which show the spatial distribution characteristics of "low altitude, positive, near water and convenient transportation". Based on the spatial distribution characteristics and influencing factors, the paper puts forward policy Suggestions for the evaluation and construction of China national forest villages in the future.

Key words China National Forest Villages • Spatial distribution • Influencing factors • GIS

1 Introduction

China national forest village refers to the administrative village which is organized and guided by the National Forestry and Grassland Administration and meets the evaluation standard through comprehensive evaluation through the application of certain quantitative indicators, evaluation methods and evaluation standards[1]. It is the model in the countryside, in the greening degree, ecological civilization, environmental protection industry, quality of life and other aspects of outstanding performance. In the Strategic Plan for Rural Revitalization, it is clearly proposed that the construction of China national forest villages should be taken as a key action, the building of green, beautiful and livable villages should be taken as a key content, and the green coverage rate

should be taken as the main index of assessment to continuously and steadily promote rural greening and beautification[2].In response to the central strategic deployment, the National Forestry and Grassland Administration has published the Rural Greening and Beautification Action Plan. According to the plan, China plans to build 20,000 unique and ecologically livable national forest villages and local forest villages by 2020.With the construction of forest villages as the carrier, the natural ecological features of villages can be effectively protected, people's living environment can be improved, green coverage rate can be significantly increased, and green industry can develop rapidly [3].Up to now, China has published the first and second batch of list of national forest villages. Take the lead of national forest villages, gradually develop local forest villages and national model counties for rural greening and beautification, and finally drive all villages to jointly promote rural greening and beautification, so as to realize rural revitalization strategy. In view of this, this paper has two batches of national forest country geographical spatial distribution, the influence mechanism and study about whether its distribution is breakthrough Hu Huanyong Line, not only to the rich geography research object and the content is of great significance for further research, but also to improve the popularity and the evaluation of China national forest country and construction to provide the reference value.

Scholars at home and abroad to a lot of research on rural afforestation theme, foreign scholars mainly involves internal social form in the country [4], rural types and changes [5], balanced rural development [6], rural culture protection and inheritance [7], rural environmental diagnosis [8], rural tourism management and operation [9], rural aggregation characteristics [10-11] and other aspects to explore ways and strategies to promote rural development. Chinese scholars also made a lot of exploration and the contribution in this study, through combing, can be roughly divided into the following several parts: (1) Rural greening plan: Ding Yanfen et al. [12] revealed that the research on rural greening tends to be quantitative, scientific and standardized, and the introduction of rural landscape evaluation method in the research field is a general trend; Zhang Shaolei et al. [13] used landscape evaluation method to give detailed guidance on the newly built green landscape in Xudian Village when exploring and analyzing the greening scheme in south Jiangsu.(2) Spatial distribution of rural settlements: Xu Xiantang et al.[14] explored the spatial distribution and influencing factors of national rural tourism destinations; Yan Huili et al.[15] studied the spatial pattern and influence mechanism of the demonstration sites of the most beautiful leisure villages in China by taking them as research objects.(3) Rural green industry development: Wang Bin et al.[16] emphasized the importance of green industry development, and green industry helps rural revitalization; In the study of Qiu Haiyang et al.[17], it was found that the green food industry has a positive promoting effect on rural development, and the marginal efficiency is increasing.(4) Rural tourism construction: Zhang Gaojun et al.[18]concluded that tourism development can promote the revitalization of local economy, population, culture, environment and other aspects; Zhang Zhong [19] studied the correlation between rural tourism and rural revitalization strategy, and pointed out that rural tourism plays a vital role in realizing rural revitalization strategy as soon as possible.(5) Revitalization of rural culture: Lu Bin[20] proposed the way to revitalize rural culture -- remolding rural culture; Xiao Ziyang et al.[21] believe that public libraries can effectively cope with the dilemma of rural cultural construction.

Other scholars conducted studies from various aspects, such as rural resource utilization [22], improve education in rural areas [23], and drawing on foreign experience to provide new ideas for rural revitalization [24].

The existing exploration on various aspects of rural revitalization has laid a solid foundation for the study of this paper. However, China national forest village is a new term emerging in response to the development of The Times. In the academic world, it is a new field waiting to be explored and analyzed by scholars. Few scholars begin to explore national forest village. In view of this, this article possible innovation point is that fill a vacancy to China national forest village as the research object, and the integrated use of spatial analysis methods and tools, to determine the spatial distribution features, and clarify the distribution pattern of the various factors, as well as to whether the breakthrough Hu Huanyong Line problem answer, subsequent evaluation and development of forest country will provide theoretical basis and reference.

2 Theoretical analysis framework and research methods

2.1 Theoretical analysis framework

Forest countryside refers to the countryside with the characteristics of relatively complete original natural features, rich rural atmosphere, prominent forestry development, rich forest resources, orderly management of the countryside and beautiful and tidy living environment. The national forest village is a typical representative of the forest villages. By building the China national forest village in the first batch, the demonstration will drive the rural greening and beautification step by step and contribute the forestry power to the rural revitalization. By studying its spatial distribution and making a superposition analysis with Hu Huanyong Line, we can explore the correlation between its distribution and Hu Huanyong Line, and further excavate the formation causes and influencing factors.

Hu Huanyong Line is one of the classical theoretical achievements of Chinese geography. It is the boundary line of population density proposed by Chinese geographer Hu Huanyong in 1935, also known as Heihe-Tengchong line. It is of great significance in geography and demography, and to a certain extent it has also become the boundary line of urbanization level[25].96% of the population lives on 36% of the land in the southeast of the line, and the urbanization level of most provinces and cities in the southeast is higher than the national average. The two parts of the line are extremely unbalanced. Whether Hu Huanyong Line can break through has been the focus of academic attention.

Therefore, the question is raised: can the spatial distribution of China national forest villages break through the Hu Huanyong Line?

According to its spatial distribution characteristics, this paper analyzes the problem, discusses the conclusions, and finally provides reasonable policy Suggestions for the construction and evaluation of China national forest villages in the future.

2.2 The research methods

2.2.1 Nearest distance

Clark et al. [26], 1954 first proposed the adjacent analysis method and applied to the analysis of characteristics of spatial distribution of population, but at the time of the adjacent analysis method is not perfect enough and mature, the later scholars Pinder et al. [27] on the improvement of the adjacent analysis method developed for arbitrary spatial point elements distribution types can be researched methods of mature.

Take China national forest village macroscopically as point element. The distribution of points can be divided into three types: uniform, random and condensed. The distribution characteristics of points can be analyzed by using the nearest point index R, which is a geographical indicator of the proximity between points [28].Its formula is:

$$R = r_1 / r_E \tag{1}$$

$$r_E = 1/2\sqrt{n/A} \tag{2}$$

Where, r_1 represents the closest distance in practice, r_E represents the closest distance in theory, n represents the total number of research objects, and A represents the area of the research area. When R>1, the distribution is uniform. When R=1, the distribution is random; When R<1, the distribution is a condensed distribution.

2.2.2 Tyson polygon

The criteria for defining the nearest point index used to determine the spatial distribution of point elements are still controversial. In order to ensure the accuracy of determining the spatial distribution types of China national forest villages, the coefficient of variation method for calculating the area of Tyson polygon is used for testing. Since the area of Tyson polygon varies with the degree of agglomeration of point elements, the coefficient of variation can be calculated according to the area of Tyson polygon, which can be used to judge the spatial distribution type of the research object. The variation coefficient formula is:

$$CV = R/S \times 100\% \tag{3}$$

Where, R represents the standard deviation of the area of Tyson polygons, and S represents the average value of the area of Tyson polygons. Duyckaerts pointed out that when CV=57%

(including 33%-64%), the point elements were randomly distributed. When CV=92% (including >64%), the point elements are clustered distribution. When CV=29% (including <33%), the point element is uniformly distributed [29].

2.2.3 Hot spot analysis

Hot spot analysis is a comprehensive analysis of the elements themselves and the surrounding elements. The so-called hot spot refers to the element itself has high value and every element in the surrounding element environment has high value at the same time. By calculating the statistics of Getis-OrdG_i * for each element in the data set, the spatial clustering location of high and low value elements was determined based on the obtained Z score and P value[30].Its formula is:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{ij} x_j - \bar{x} \sum_{j=1}^{n} w_{ij}}{s \sqrt{\frac{\left[n \sum_{j=1}^{n} w_{ij}^2 - \left(\sum_{j=1}^{n} w_{ij} \right)^2 \right]}{n-1}}} \tag{4}$$

Where, n represents the total number of elements, x_j represents the attribute value of element J, w_{ij} represents the space weight between element i and j, and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n}; S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - \left(\bar{X}\right)^2} \tag{5}$$

For a statistically significant positive Z score, the higher the Z score, the closer the clustering of the high value (hot spot) will be. For negative Z-scores with significant statistical significance, the lower the Z-score, the tighter the clustering of low values (cold points).

2.2.4 Standard deviation ellipse

Standard deviation ellipse is one of the commonly used methods to analyze the spatial distribution direction characteristics. The elliptic area reflects the agglomeration degree of elements. The major axis of the ellipse reflects the main distribution direction of the elements. The greater the difference (bias) between the long axis and the short axis is, the stronger the directivity of element distribution is. If the long axis and the short axis are equal, it means that they have a non-directional distribution characteristic [31]. Its formula is:

$$\tan\theta = \frac{\left(\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2 - \sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2 + \sqrt{\left[\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2 - \sum_{i=1}^{n}\left(y_i - \bar{y}\right)^2\right] + 4\left[\sum_{i=1}^{n}\left(x_i - \bar{x}\right)\sum_{i=1}^{n}\left(y_i - \bar{y}\right)\right]^2}\right)}{2\sum_{i=1}^{n}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)\sum_{i=1}^{n}\left(y_i - \bar{y}\right)} \quad (6)$$

$$\sigma_x = \sqrt{\sum_{i=1}^{n}\left[\left(x_i - \bar{x}\right)\cos\theta - \left(y_i - \bar{y}\sin\theta\right)\right]^2 / n} \quad (7)$$

$$\sigma_y = \sqrt{\sum_{i=1}^{n}\left[\left(x_i - \bar{x}\right)\sin\theta - \left(y_i - \bar{y}\cos\theta\right)\right]^2 / n} \quad (8)$$

Where, (x_n, y_n) represents element coordinates; $\bar{x}$、$\bar{y}$ respectively all the elements of x, y axis average; θ represents the direction of rotation; $\tan\theta$ represents the standard deviation of the ellipse; σ_x、σ_y represent the maximum and minimum standard deviation distances, namely, the length of the long axis and the short axis of the ellipse.

2.2.5 Kernel density analysis

The kernel density estimation method is used to reflect the condensate by the spatial distribution of point density. Each grid node was taken as a center, and the circular area was searched with a certain radius. The point elements falling into the circular area were counted, and different weights were given to the point elements. The weight of the point elements closer to the center was greater, and then the grid node density value was calculated [32].Its formula is:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right) \quad (9)$$

In the formula, n represents the coordinate points, h represents the bandwidth, k represents the kernel function, x_i represents the coordinates of point i, and $(x-x_i)$ represents the distance between two points. The larger f(x) is, the denser the distribution is. ArcGIS10.3 software kernel density analysis tool was used to analyze the core density of national forest villages, and the kernel density index was divided into 5 sections from high to low according to the natural break point classification method.

3 Data Sources

A total of 7,586 China national forest villages in the first and second batch were selected as the research objects. The list is from the official website of National Forestry and Grassland Administration (www.forestry.gov.cn).Then the coordinate picker of Baidu map is used to determine the geographic coordinates of China national forest villages. The spatial data comes from 1:400,000 map database of China Basic Geographic Information Center (www.ngcc.cn), and the vector data is obtained through ArcGIS vectorization.

4 Results analysis

4.1 Spatial distribution characteristics

4.1.1 Population distribution

As shown in Figure 1, the spatial distribution characteristics of China national forest villages are obvious. From the perspective of the four comprehensive geographical divisions of China, the southern region is the main gathering place, followed by the northern region, and the northwestern region and The Qinghai-Tibet region are the least distributed. Fewest from provinces distribution, Tianjin, Henan, the amount according to the statistics, Henan, Zhejiang, Sichuan, Guangdong, Jiangxi, Hunan, Shandong, Guangxi is the main distribution area of eight provinces, accounted for 46.12%, followed by Hubei, Fujian, Hebei, Shanxi, Anhui, Guizhou, Jiangsu, Shanxi, Yunnan nine provinces, accounted for 34.83%, accounts for only 19.05% of the total number of the other 14 provinces; According to the three regions, the proportion of eastern, central and western regions is 40.23%, 36.70% and 23.07% respectively, showing a decreasing distribution in eastern and western regions. From the perspective of the seven regions, east China, Central China and southwest China are in the top three, accounting for 28.71%, 17.06% and 15.03% respectively. The gap between North China and South China is not large, while the gap between northwest China and northeast China is at least 8.04% and 6.25% respectively. In terms of batches, the total number of the first batch is 3947, and the number of the second batch is 3639. There is not much difference between the two batches, and the spatial distribution characteristics of the two batches are similar. From the perspective of Hu Huanyong Line, the number of the southeast area of the line is 7, 167, accounting for up to 94.48%, while the northwest area only accounts for 5.52%. There is a significant gap between the two areas divided by the line.

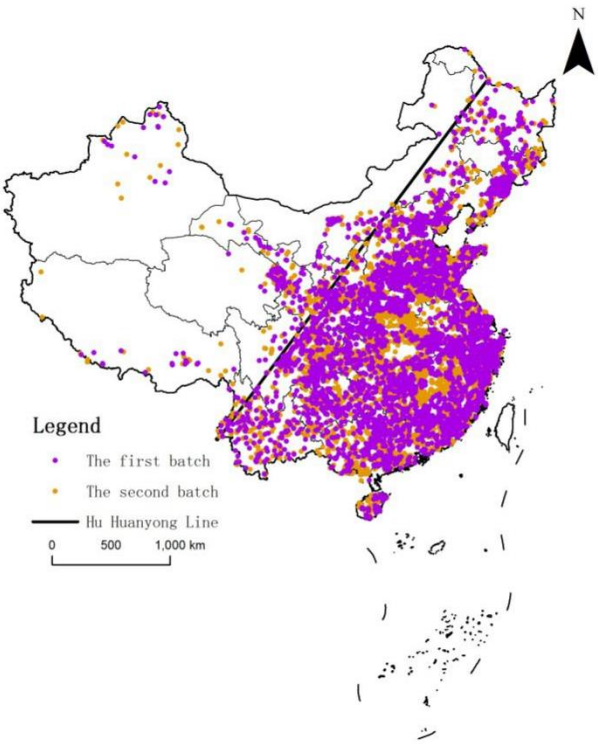


Figure 1 Spatial distribution of China national forest villages

4.1.2 Spatial distribution type

The mean nearest neighbor tool in ArcGIS10.3 was used to analyze the spatial distribution types of China national forest villages, and the spatial distribution types were preliminarily determined according to the nearest neighbor index obtained. The mean nearest neighbor results are shown in Table 1.

Table 1 Mean nearest-neighbor results for China national forest villages

Project	Value
Average observation distance	10433.91
Expected average distance	22682.15
Nearest neighbor ratio	0.46
Z score	-89.98
P value	0.00

It can be seen from Table 1 that R=0.46<1, so the spatial distribution type of China national

forest villages is preliminarily determined as condensed type.

In order to ensure the accuracy of the results, the tyson polygon method was used to verify the results obtained by mean nearest neighbor. The Tyson polygon of China national forest village was created by ArcGIS10.3 (Figure 2a), and the average area and area standard deviation of the Tyson polygon were calculated. According to the results, R=8753.9342, S=1222.4104, so CV=716.12%, much higher than 64%, indicating that the distribution of China national forest villages is of agglomeration type, and the degree of agglomeration is obvious. Based on the mean nearest neighbor results, the spatial distribution type of China national forest villages can be determined as cohesive type.

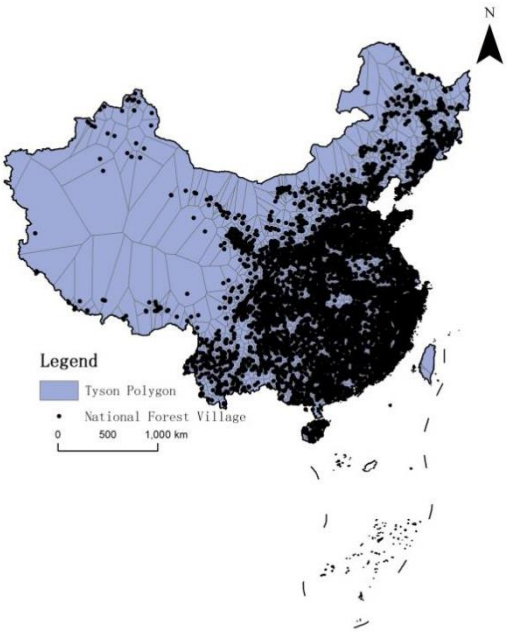
4.1.3 Cold hot spot analysis

In ArcGIS10.3 tool, the China national forest village was firstly connected with the vector map of China in space, and then the hot spot analysis was carried out in the space statistical tool to produce the cold spot map of the spatial distribution of the China national forest village (Figure 2b).The Z value is divided into four stages by natural break point classification method, which are respectively represented as four intervals of hot spot area, sub-hot spot area, sub-cold spot area and cold spot area. It can be seen from the figure that hot spots include nine provinces, namely Sichuan, Shandong, Henan, Hubei, Hunan, Jiangxi, Zhejiang, Guangxi and Guangdong, accounting for 19.65% of the country's total area. There are eight provinces (cities) as sub-hotspots, namely, Hebei, Shanxi, Shaanxi, Jiangsu, Anhui, Fujian, Yunnan and Guizhou, accounting for 15.41%.There are also eight provinces (cities) in the sub-cold spots, namely Heilongjiang, Jilin, Liaoning, Inner Mongolia, Gansu, Qinghai, Beijing and Chongqing, accounting for 33.80%.Xinjiang, Xizang, Ningxia, Tianjin, Shanghai and Hainan were among the cold spots, accounting for 31.15 percent. In general, the number of provinces (cities) belonging to hot spots is more than that of cold spots, but in terms of coverage area, cold spots account for 64.95% of the total area, accounting for more than half of the total area. From the figure, we can also intuitively observe the distribution characteristics of "hot spots in the south and cold spots in the north". Hot spots are mainly in the south, and most areas in the north are cold spots.

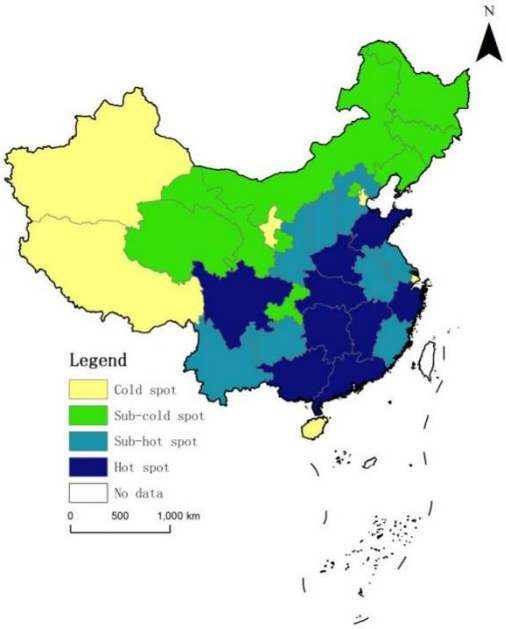
4.1.4 Spatial distribution direction characteristics

In the ArcGIS10.3 geographical distribution tool, the standard deviation ellipse was made for the first and second batches of China national forest villages and the average center point location was determined respectively (Figure 2c). It was found that the standard deviation ellipse and the average center point of the two batches had a high degree of coincidence, indicating that the spatial distribution direction characteristics and the degree of agglomeration of the two batches were almost the same. Take the first group as an example for analysis. The standard deviation of the ellipse is 1044273.14 on the long axis and 726345.12 on the short axis. The difference (skewness) between the two is 317,928.02.The long axis is from northeast to southwest, indicating that the China national forest villages are densely distributed from northeast to southwest. The average center is located in Suizhou city of Hubei Province, indicating that the geometric center of national forest and rural intensive areas is Suizhou City of Hubei Province. To sum up, the first

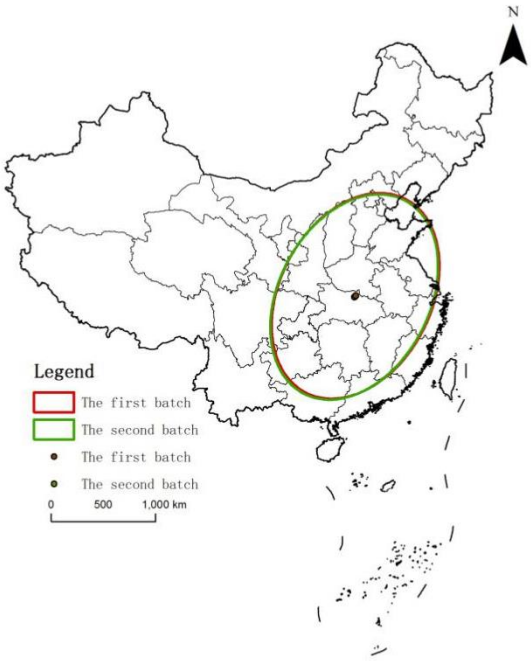
batch of China national forest villages showed a significant spatial distribution direction with Suizhou city in Hubei province as the center and extending to the northeast to the southwest. Second, compared with the first batch of ellipse area slightly smaller show that the second batch of concentration increased, from the Angle of rotation 27.2989 ° and 27.7063 °, slightly to the clockwise rotation Angle, the second batch of northeast to southwest is more significant, the average center moved to the southwest of small distance, shows that the trend of the development of the China national forest village has to southwest direction, but in general the second batch of characteristics on the basis of the first changes not by much.



a Spatial distribution of Tyson polygons



b Spatial distribution of cold hot spots

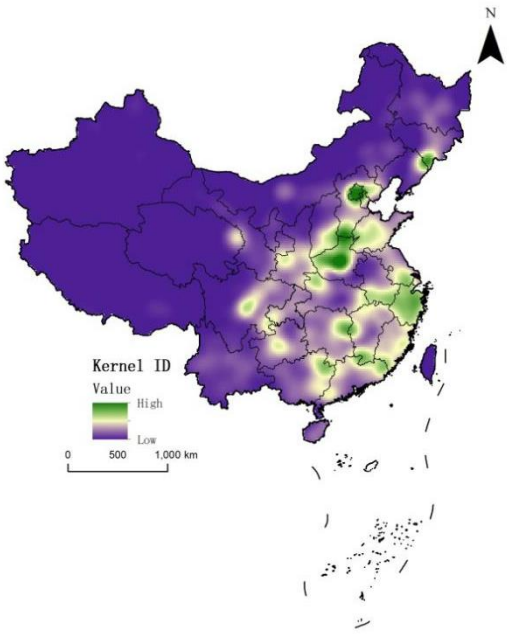


c Chart of standard deviation ellipse and mean center point

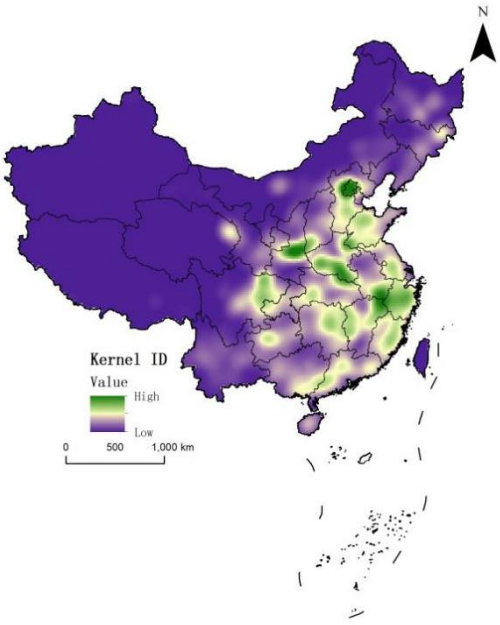
Figure 2 Spatial distribution characteristics of China national forest villages

4.1.5 Kernel density distribution characteristics

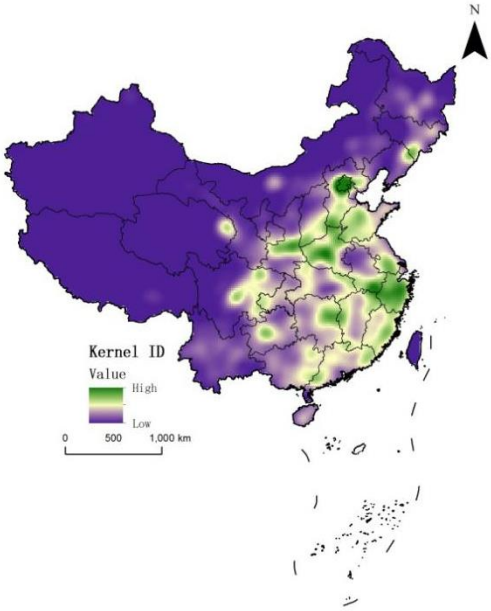
The kernel density function in ArcGIS10.3 spatial analysis tool was used to study the spatial distribution density of two batches of China national forest villages. The results are shown in Figure 3.According to the figure, the spatial distribution density of China national forest villages was significantly different, and the two batches of kernel density map had similar characteristics. On the one hand, the density distribution of China national forest villages is highly correlated with the coverage of vegetation. The density and high-value areas are almost all within the coverage of forest vegetation, which also conforms to the selection conditions of China national forest villages. On the other hand, the high density area can be found in accordance with the distribution of urban agglomeration degree is high, the first formed the Yangtze river delta, the central plains, the Bohai sea, the pearl river delta, the Yangtze river middle reaches high density area and Chengdu-Chongqing density area, formed the second batch of the Yangtze river delta, the central plains, Beijing-Tianjin-Hebei, Chengdu-Chongqing high density area and the pearl river delta, the Yangtze river middle reaches density area. Urban agglomeration as the future economic development pattern in the core of the most dynamic and potential region, is important and optimized development zone, the strategy of development priority zones in urban agglomeration based on country often is in the leading level in the afforestation, the establishment of China national forest country, step by step to achieve rural afforestation all over the country.



a The first kernel density maps



b Second batch density map approved



c Total kernel density map

Figure 3 Kernel density map of China national forest villages

4.2 Influencing factors

4.2.1 Elevation factor

The difference of elevation means that climate, precipitation, temperature, soil, vegetation and other conditions are different, and thus determine the factors that directly affect the spatial distribution of China national forest villages, such as population distribution, economic

development, forest resources and so on. In ArcGIS10.3, China's topographic elevation map is divided into five levels according to the classification method of natural discontinuity points, and then superimposed with China national forest villages to obtain the topographic distribution map of national forest villages (Figure 4a), and the number of them is counted (Table 2).From table 2, with the increase of grade, the higher elevation country quantity is less, the elevation in rural - 152-788 m between 5793, proportion is as high as 76.36%, followed by 789-2092 m between rural number is 1572, accounting for 20.72, the first two level country accounted for 97.08%, only 2.92% of national forest village is located in elevation above 2093 m, and the elevation between 4669-8848 - m rural existence, has not been found country presents the obvious characteristics of "low altitude" distribution. Low altitude tends to be characterized by small topographic relief, flat terrain, developed transportation and convenient living conditions, which are conducive to population concentration and residence. In addition, the humid airflow from the eastern ocean, due to the low altitude, can directly enter the inland and bring abundant precipitation, which is conducive to the cultivation and growth of vegetation. The distribution of vegetation directly affects the evaluation of China national forest villages.

Table 2 China national forest village elevation statistics table

Grade	Level 1	Level 2	Level 3	Level 4	Level 5
Elevation(m)	-152-788	789-2092	2093-3570	3571-4668	4669-8848
Quantity(number)	5793	1572	203	18	0
Proportion(%)	76.36	20.72	2.68	0.24	0

4.2.2 Aspect factor

The slope direction is the direction projected by the normal line of the tangent plane of a point on the slope surface on the horizontal plane. The direction is defined as the included Angle formed between the projection and the positive north of the point, so the value range is 0~360°.Different elevation has great influence on climate, precipitation, vegetation, temperature, etc., and the geographical position of different slope direction at the same height also makes the difference significantly. In order to explore the influence of slope direction on the distribution of China national forest villages, the elevation map was introduced into ArcGIS for slope direction analysis, and the obtained slope direction map was superimposed with China national forest villages, and the number of different slope direction villages was counted, as shown in Table 3.It can be seen from the table that the distribution of China national forest village slope is diverse due to the complexity of topography, among which the distribution of west slope, northwest slope and southeast slope is large, with a total proportion of 39.36%, while the distribution of north slope and northeast slope is small. According to the yin-yang slope, the yang-Yang slope ranges from 90° to 270°, while the yin-Yang slope ranges from 0° to 90° and 270° to 360° [33].The Yin-Yang

slope usually needs to be analyzed in combination with different regions. In arid and semi-arid areas, the soil on the Yin slope is moist and suitable for the growth of forest trees, while the sunny slope has sufficient illumination, large moisture evaporation, low soil humidity and more grasses. In the south, due to abundant precipitation, there is little difference in soil moisture on the Yin-Yang slope. At this time, the sunny slope is full of sunshine and the vegetation coverage density is higher than that on the shady slope. According to statistics, there are 3,764 Yang slopes and 3,316 Yin slopes in rural areas of the national forest, respectively. From the perspective of quantity, the number of Yang slopes is slightly higher than that of Yin slopes, which is highly correlated with the characteristics of Yin and Yang slopes of southern vegetation.

Table 3 Statistical table of China national forest country slope

Aspect	North slope	Northeast slope	East slope	Southeast Slope	South slope	Southwest slope	West slope	Northwest slope
Angle range (°)	0~22.5，337.5~360	22.5~67.5	67.5~112.5	112.5~157.5	157.5~202.5	202.5~247.5	247.5~292.5	292.5~337.5
Quantity(number)	689	758	863	987	863	970	1004	995
Proportion(%)	9.08	9.99	11.38	13.01	11.38	12.79	13.23	13.17

4.2.3 River factor

Water sources play an important role in people's daily life, agricultural irrigation, shipping and transportation, vegetation growth and other aspects [34]. Rivers are an important source of water supply. Taking the secondary river as the center, three buffer zones of different levels were made, namely 30km, 60km and 90km. The China national forest village and river buffer zones were superimposed (Figure 4b), and the corresponding number of buffer zones of each level was counted respectively (Table 4).According to Table 4, the proportion of China national forest villages within 30km of the river is 37.66%, 25.73% within 30-60km, 17.18% within 60-90km, and 80.57% within 90km of the river. In addition, China's terrain is high in the west and low in the east, and most rivers flow from the west to the east. In contrast, the central and eastern regions have more water than the west. According to Figure 4b, it can be intuitively observed that most villages are located in the middle and lower reaches of rivers. As can be seen from the above information, most of the country's forest villages are located around rivers, and their location close to water sources can provide a lot of help for residents' life and rural development. As rural

afforestation model of national forest village, river conditions are necessary, on the one hand, water, rural greening coverage on the development of forestry plays an important role, on the other hand, water is the rural residents the necessities of life, has a population of water source place to gather, thus forming various unique country. In addition, the utilization of rivers can also be further explored. River resources can often be turned into tourism resources, and promoting the development of local tourism is an important direction to promote the development of rural economy. To sum up, watershed factor is an important factor affecting the spatial distribution of China national forest villages.

Table 4 Statistical table of distance between China national forest villages and rivers

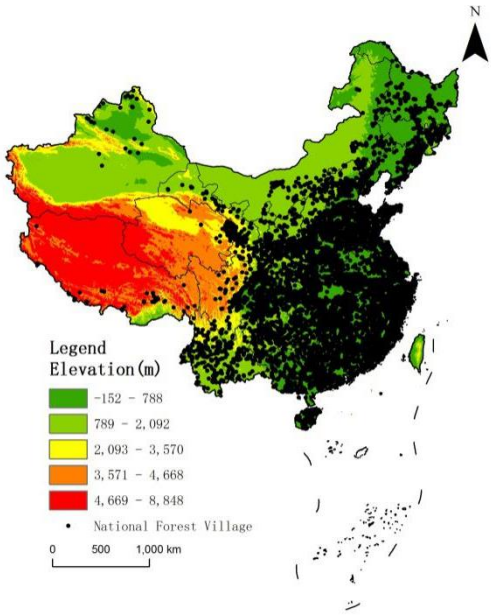
Grade	Level 1	Level 2	Level 3	Total
Distance (m)	0-30km	30-60km	60-90km	90km
Quantity(number)	2857	1952	1303	6112
Proportion(%)	37.66	25.73	17.18	80.57

4.2.4 Traffic factor

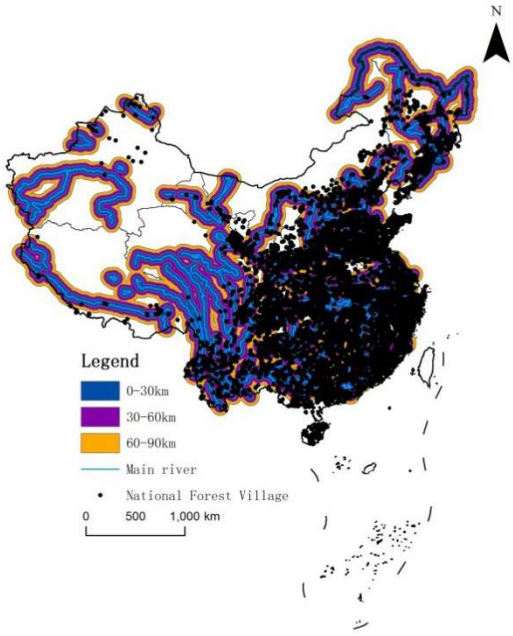
Accessibility has an important impact on all aspects of rural areas, such as the dissemination and development of rural traditional culture, the quality of life of residents, the influence of the outside world on it, the degree of rural greening, and the level of economic development. Traffic developed directly decided the country accessibility, which represented by main highway and railway, respectively make 50 km, 100 km from the buffer, and compared with China national forest village, national forest rural transportation network distribution (Figure 4c), and statistics of the different distance within the buffer country number, as shown in table 5.According to statistics, 83.42% of China national forest villages are located within 100km of the main road, of which 58.87%, more than half, are within 50km.86.04% of China national forest villages are located within 100km of the main railway, among which 61.84% are within 50km, accounting for a relatively high proportion. According to Figure 4c, most of the China national forest villages are located near the main roads and railways, indicating that the vast majority of the China national forest villages are located near the dense transportation network, that is, the China national forest villages have strong accessibility. Rural greening and beautification cannot be separated from the support and help of the outside world. Strong accessibility provides conditions for the communication within and outside the countryside. In addition, as the saying goes, "If you want to get rich, build roads first", rural economic development must rely on convenient transportation facilities. Rural revitalization requires rural economy to be improved and rural residents' living standards to be improved. If you don't keep up with The Times, you will eventually fall behind and be eliminated.

Table 5 Statistical table of distance between China national forest villages and roads and railways

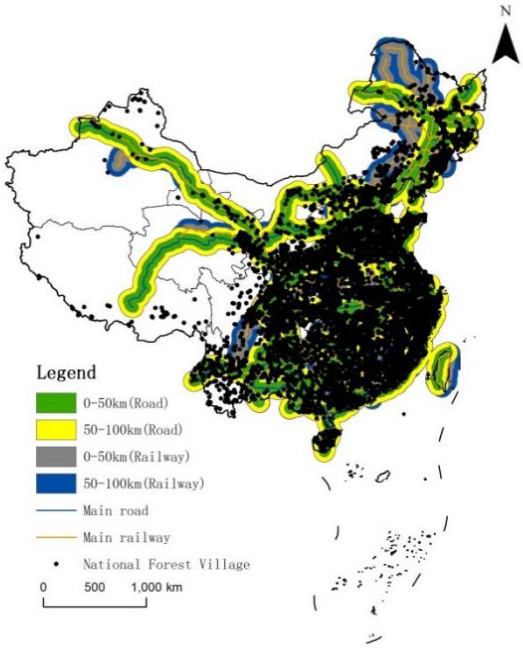
Distance(km)	0-50km	50-100km	Total
Main road	4466	1862	6328
Main railway	4691	1836	6527



a Elevation map



b River distribution map



c Road map

Figure 4 Influencing factors of China national forest villages

5 Conclusion, discussion and policy implication

5.1 Conclusion

(1) According to the nearest neighbor ratio R=0.46<1, it was preliminarily determined that the spatial distribution type of China national forest villages was condensed type. The results were verified by using the variation coefficient of the calculated area of Tyson polygon, CV=716.12%, far greater than 64%, and the China national forest village was comprehensively identified as the condensed distribution. The spatial distribution of China national forest villages failed to break through the Hu Huanyong Line, the southeast of which is the main gathering place.

(2) According to the analysis of cold spots, the distribution characteristics of China national forest villages are "hot in the south and cold in the north". Hot spots include Sichuan, Shandong, Henan and other nine provinces, accounting for 19.65% of the total area of the country. Sub-hotspots included Eight provinces (cities), including Hebei, Shanxi and Shaanxi, accounting for 15.41%.The secondary cold spots include Eight provinces (cities) including Heilongjiang, Jilin and Liaoning, accounting for 33.80%.Six provinces (municipalities), including Xinjiang, Xizang and Ningxia, are cold spots, accounting for 31.15 percent. The number of hot-spot areas is more than that of cold-spot areas, but cold-spot areas account for more than half of the total area.

(3) According to the elliptic analysis of the standard deviation, the spatial directional characteristics and degree of agglomeration of the two batches are very similar, presenting the significant spatial distribution direction characteristics that extend from northeast to southwest mainly with Suizhou in Hubei as the center. On the basis of the first batch, the second batch changed slightly: the aggregation degree increased, the average center moved to the southwest direction, and the direction of the spatial distribution between northeast and southwest strengthened.

(4) According to kernel density analysis, it is found that the high-density areas are significantly correlated with vegetation coverage and urban agglomeration distribution. On the one hand, most of the high-density areas are located within the forest vegetation cover. On the other hand, the first group formed high-density areas in urban agglomerations such as the Yangtze River Delta, the Central Plains and the Bohai Rim, and the second group formed high-density areas such as the Yangtze River Delta, the Central Plains and the Beijing-Tianjin-Hebei region.

(5) Select the elevation, slope direction, river and traffic in the terrain as impact factors to explore their correlation with the spatial distribution of China national forest village. It is found that elevation, river and traffic are all significantly correlated with their spatial distribution, but the correlation is weak because slope direction needs to combine elevation, region and other complex factors. On the whole, China national forest villages are characterized by low altitude, sunny distribution, close proximity to water sources, and dense transportation network.

5.2 Discussion

The proportion of China national forest villages in the southeast area of Hu Huanyong Line is as high as 94.48%, and only a small amount are distributed in the northwest area. It can be seen that the spatial distribution of China national forest villages still has not broken through Hu Huanyong Line, which is consistent with the view of "Hu Huanyong Line is not broken" proposed by Chen Mingxing et al [35].First, the population distribution is extremely uneven, which has a pattern of dense population in the east and sparse population in the west for a long time. It is inevitable that all kinds of villages can be formed in the places where people gather. Second, the main urban agglomerations in the coastal or plains of the Midwest, as can be seen from the China national forest village kernel density figure, first two batch of all form high density urban agglomerations area, urban agglomeration is the economy, information, transportation and so on various aspects development center, is the key point of urbanization area, construction of rural afforestation in a leading position, meet the conditions of the country is more; Third, inborn natural geographical factors play a decisive role. The northwest part of the line is dominated by deserts, grasslands and plateaus, with a relatively harsh climate, while the southeast part of the line is dominated by plains and hills, with a climate more suitable for human survival. Fourth, the topography from the west to the east leads to dense water network, developed transportation and high vegetation coverage in the east, which are important factors affecting the distribution of China national forest villages. In

conclusion, various factors determine the spatial distribution of national forests and villages without breaking through the Hu Huanyong Line.

5.3 Policy implication

First, from the perspective of evaluation indicators, China national forest village spatial distribution not overcome Hu Huanyong Line is determined by many factors, but in order to try to balance development trend, the China national forest village selection index can begin, do not apply to the selection of a nationwide, should consider the actual situation in different areas, especially the line integral parts of the two, take different evaluation criteria, cold spots in selection of the future to bring more rural area are selected as a successful breakthrough gradually.

Second, from the perspective of incentives and subsidies, rural construction needs a large amount of capital investment. The southeast area of the line is relatively superior in all aspects, so it is relatively easy to build a China national forest village, while the northwest area of the line is relatively difficult due to various restrictions. Therefore, it is suggested that the state issue relevant policies and give more incentives and subsidies to rural construction in the northwest area of the line.

Third, from the perspective of industrial development, Tan Mazhuang Village is a "China national forest village deep in the mountain". It can be seen from this example that only the villages located in good geographical location can be selected successfully. Local governments should combine local conditions, develop characteristic industries, drive economic development, get rid of poverty circle, and gradually realize rural greening and beautification.

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