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GIS-Based Analysis of the Spatial Distribution and Influencing Factors of Traditional Villages in Hebei Province, China

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Abstract: Traditional villages are a valuable cultural asset that occupy an important position in Chinese traditional culture. This study focuses on 206 traditional villages in Hebei Province and aims to explore their spatial distribution characteristics and influencing factors using ArcGIS spatial analysis. The analysis shows that traditional villages in Hebei Province were distributed in clusters during different historical periods, and eventually formed three core clusters in Shijiazhuang, Zhangjiakou and Xingtai-Handan after different historical periods. Moreover, the overall distribution of traditional villages in Hebei Province is very uneven, with clear regional differences, and most of them are concentrated in the eastern foothills of the Taihang Mountains. To identify the factors influencing traditional villages, natural environmental factors, socio-economic factors, and historical and cultural factors are considered. The study finds that socio-economic and natural environmental factors alternate in the spatial distribution of traditional villages in Hebei Province. The influence of the interaction of these factors increases significantly, and socio-economic factors have a stronger influence on the spatial distribution. Specifically, the spatial distribution of traditional villages in Hebei Province is influenced by natural environmental factors, while socio-economic factors act as drivers of spatial distribution. Historical and cultural factors act as catalysts of spatial distribution, and policy directions are external forces of spatial distribution. Overall, this study provides valuable insights into the spatial distribution characteristics and influencing factors of traditional villages in Hebei Province, which can be used to develop effective strategies for rural revitalisation in China.

Keywords: traditional villages; rural heritage; spatial pattern; regional study; GIS; Hebei Province

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1. Introduction

The preservation and development of Chinese culture serves as a valuable legacy from the agricultural era [1]. However, urbanisation and industrialisation have led to the loss of the cultural characteristics and historical value associated with these villages. To address this issue, the Ministry of Housing and Urban–Rural Development, the Ministry of Culture and the Ministry of Finance have been identifying and announcing batches of traditional villages since 2012 [2]. In addition, the rural revitalisation strategy introduced in the report of the 19th National Congress has ushered in a new phase of protection and renewal of traditional villages [3].

Among the 206 traditional villages in Hebei Province included in the List of Traditional Villages in China [4], Handan, Xingtai, Shijiazhuang, Baoding and Zhangjiakou are the most numerous, showing great diversity and integration as material carriers of natural and cultural heritage. However, the province's relatively underdeveloped economy and complex topography pose challenges to the preservation and development of these villages. By analysing the spatial distribution characteristics of these villages and identifying factors that influence their formation, this study contributes to the existing body of knowledge

by providing insights into the specific context of traditional villages in Hebei Province. It offers a localized perspective that can help inform decision-making processes related to the preservation and development of these cultural heritage sites.

The study concludes that it is suggested that Hebei Province should make full use of the resources of traditional villages, especially the core gathering areas of traditional villages. It is necessary to formulate comprehensive and regional master plans based on ecology and centred on culture. These plans should balance conservation and development, inheritance and innovation. They should also explore cultural assets in depth, incorporate modern ways of thinking and inject new vitality into the development of traditional villages. Further research can build on these findings to explore specific interventions and policies for the sustainable development and conservation of traditional villages in Hebei Province and beyond.

2. Research Background

In the Chinese context, traditional villages are typically defined as rural settlements with a long history, unique architectural and cultural features, and a strong sense of community and social organization [4]. The inclusion of traditional villages on the National List is subject to a thorough and rigorous assessment process, which usually involves in-depth field surveys, recommendations at various levels of government and evaluation by experts in planning and heritage conservation [5]. These villages are often characterized by their traditional architectural styles, such as ancient buildings, temples and ancestral halls, as well as their well-preserved cultural traditions, such as folk customs, festivals and local handicrafts [6,7]. Traditional villages, formed by the accumulation of architectural activities in different periods along with historical development, carry the collective memory of local residents [3]. They also play an important role in preserving local ecological systems and biodiversity. In recent years, there has been growing interest in the protection and revitalization of traditional villages in China as part of broader efforts to promote sustainable rural development. With the continuous acceleration of urbanisation in China since the reform and opening up, the living space of traditional rural culture has become increasingly narrow, and the protection work has become extremely urgent [3].

Research on rural settlements by foreign scholars has undergone a rapid development phase since the 1980s. Researchers such as Friedrich Ratzel and Bruner conducted related studies on the spatial distribution of rural settlements in a particular region, the historical reasons for the formation of villages, and the division of village layout forms in the 19th century [8,9]. Lewis Mumford paid attention to factors such as the layout of village forms and site conditions in the 20th century [10]. From the 1960s to the 1980s, the content of research on rural settlements became increasingly diversified. Quantitative research methods were used to study settlements influenced by the 'metrological revolution' and the 'behavioural revolution' [11]. Peter Bigmore studied the evolution of rural settlement models, while Michael Woods explored rural conflicts through pluralism, class theory and actor network theory [12]. Since the 1990s, scholars have focused on research topics such as rural communities, rural landscapes, rural social issues and urban–rural relations, which have become hot topics in the field [13]. Research on changes in rurality and rural development [14] and rural reconstruction during socio-economic transition [15] have also received considerable attention. Yang and partners examined the impact of transport on the development of spatial patterns of rural settlements by combining the spatial patterns and impacts of rural settlements with research on road transport [16]. In addition, the content of research is no longer limited to form and the natural environment, but has expanded to a more diverse direction [17,18].

In recent years, GIS technology has been increasingly applied to the spatial analysis of rural areas [19]. Research has ranged widely from the study of rural settlement landscape types and land use visualisation using GIS [20], to the analysis of changes in population size in rural America [16], to the investigation of potential factors affecting rural population density using GIS [20]. Ayodeji E. Iyanda used GIS to examine disparities in COVID-19

mortality rates between urban and rural areas in the United States, identifying spatial and racial disparities in COVID-19 mortality rates in rural counties [21]. GIS has also been used to map the spatial distribution of epidemics, examining the spatial pattern of COVID-19 outbreaks in metropolitan and non-metropolitan communities and the correlation between socio-economic variables in US counties [22]. Furthermore, GIS has been used to investigate the causes and geographic distribution of the declining rural population in the US, which has been attributed to the second-order effects of declining fertility and increasing mortality rates typically associated with population ageing [23]. It has also been used to assess the interaction between physicians and the population by generating a special form of physician-population ratio that can be easily generated in a GIS environment with simple steps [14,15].

In the field of Chinese traditional villages, research on old village buildings began in the 1930s and gradually expanded into settlement studies in the 1990s [24,25]. Studies of traditional villages have focused on their spatial structure and layout [26]. For example, Xu Juan et al. conducted a quantitative geographical and GIS-based study on the spatial distribution characteristics and development conditions of traditional villages in Shaanxi Province, using information listed in the Directory of Chinese Traditional Villages [27]. This study provides a reference for China's rural revitalisation strategy. Studies have also been conducted on the development and protection of the cultural landscape of traditional villages [28,29]. Zheng Xiye et al. analysed the landscape model of traditional villages in southwest China [30], using ArcGIS 10.4 software to master the spatial characteristics and cultural interaction mechanisms of traditional villages [30]. The forms of protection, development and use of traditional villages were also studied. Ma Hedan et al. analysed the role of environmental factors in the formation and development of traditional villages using spatial analysis tools such as ArcGIS and GeoDa [3]. They also investigated the feasible way to properly design and protect the integrity of traditional villages [3]. Comprehensive value assessments of traditional villages were conducted, and a value assessment system was established to help determine the protection value of traditional villages through GIS analysis and calculation [31,32]. In addition, the spatio-temporal development analysis of traditional villages was carried out. Sun et al. (2017) published a study on the spatial evolution of the Beijing-Tianjin-Hebei poverty belt, using GIS and economic data analysis [33].

3. Research Design

3.1. Overview of the Study Area

Hebei Province is one of the cradles of Chinese civilization. Up to now, there are 276 national traditional villages in Hebei Province, 274 national traditional villages in Henan Province and 79 national traditional villages in Jiangsu Province, with Hebei Province ranking 2nd in the number of selected villages in northern China. However, domestic and foreign scholars' studies on the spatial distribution of traditional villages in China have mostly focused on Henan, Jiangsu, the Taihu Valley, the Huizhou region and Shanxi, with less attention being paid to the Hebei province. At a time when the collaborative development of Beijing, Tianjin and Hebei has been elevated to a national strategy and in the context of rural revitalization, the study of traditional villages in Hebei is very necessary and urgent [34].

Located in northern China, Hebei province comprises 11 prefecture-level cities, with the capital Shijiazhuang, and covers an area of 188,800 square km. Bordered by the Bohai Sea to the east, Beijing and Tianjin to the south, the Taihang Mountains to the west and the Yanshan Mountains to the north [25], Hebei lies between 36°05′–42°40′ north latitude and 113°27–119°50′ east longitude. It straddles two major water systems, the Haihe and the Luanhe. There are 206 national traditional villages in Hebei, accounting for 3% of the total number of traditional villages in China [3]. Traditional villages in Hebei are mainly located at the eastern foot of the Taihang Mountains and on the southern side of the Yanshan

Mountains, with an overall distribution pattern that is more common in the north and less common in the west and east, as shown in Figure 1 and Table 1.

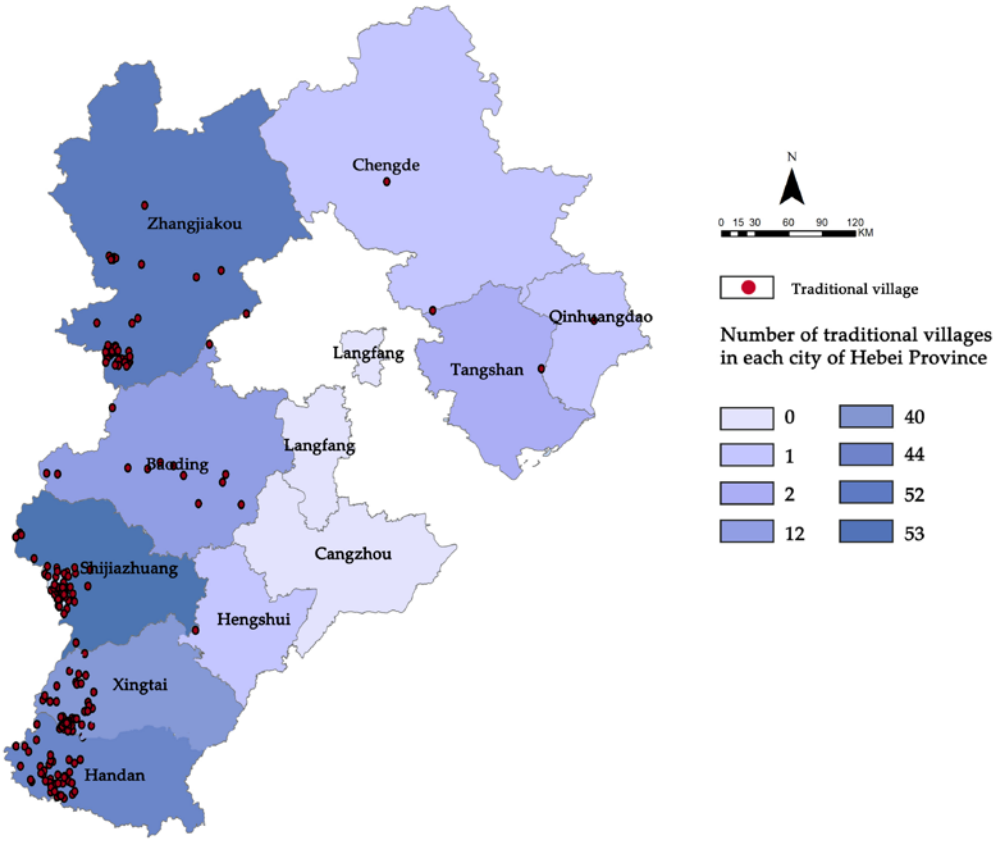

Figure 1. Distribution of traditional villages in Hebei province in 2022. Data source: The Ministry of Housing and Urban–Rural Development of the P.R.C. Map Source: http://bzdt.ch.mnr.gov.cn/ (accessed on 5 April 2023).

Table 1. Statistics on the number of traditional villages in Hebei Province according to different batches from 2012 to 2022. (Data source: The Ministry of Housing and Urban–Rural Development of the P.R.C.).

Cities \ Batches	First Batch (2012)	Second Batch (2013)	Third Batch (2014)	Forth Batch (2016)	Fifth Batch (2017)	Total
Zhangjiakou	7	2	7	31	5	52
Baoding	1	1	2	3	5	12
Shijiazhuang	8	3	0	27	15	53
Xingtai	2	1	4	11	22	40
Handan	14	0	4	13	13	44
Qinhuangdao	0	0	1	0	0	1
Tangshan	0	0	0	1	1	2
Chengde	0	0	0	1	0	1
Hengshui	0	0	0	1	0	1
Total	32	7	18	88	61	206

3.2. Data Sources

The reference to the five batches was made based on the available data at the time of the research. The complete list of traditional villages in Hebei Province was obtained from the official website of the Ministry of Housing and Urban–Rural Development [19], which included five batches of traditional villages published from 2012 to 2019 [27]. The first batch included 32 traditional villages, the second batch included 7 traditional villages, the third

batch included 18 traditional villages [35], the fourth batch included 88 traditional villages and the fifth batch included 61 traditional villages [36]. It is important to note that the dataset used in the study may not include all traditional villages in the region. There may be more batches or subsequent updates to the list as new information becomes available or as preservation efforts uncover additional villages that meet the criteria. The main focus of this research is to contribute a research method that can provide necessary reference for policymakers. The research findings may vary with changes in the selected samples.

The coordinates of each village were extracted using Baidu coordinates and identified as village coordinates after coordinate correction. In addition, 30 m resolution DEM data was obtained from the geospatial data cloud, from which elevation, slope and slope direction data were extracted [37]. Administrative area data for each municipality were obtained from the Statistical Yearbook 2019 [38]. Other historical and cultural information was collected from local chronicles, official websites of each region and relevant reference literature. The obtained data were visualised using ArcGIS software, and a database of traditional villages in Hebei Province was created [35].

3.3. Data Analysis

This study focused on analysing the distribution pattern of traditional villages in Hebei Province and the underlying mechanisms [17]. The latitude and longitude coordinates of 206 traditional villages were obtained using Baidu API 2023 and subjected to coordinate correction. The study employed various analytical techniques based on AreGIS 10.4, including nearest neighbour point analysis, kernel density analysis, superposition analysis, coefficient of variation, buffer zone analysis and geographic probe, to investigate the spatial distribution pattern of traditional villages in Hebei Province and their influence mechanisms. The nearest neighbour index and kernel density analysis were used to detect the evolution of the spatial distribution of traditional villages [39]. The study also used kernel density analysis, nearest neighbour analysis and coefficient of variation analysis to explore the spatial distribution balance and types of traditional villages [40]. Superposition analysis and buffer zone analysis were used to examine the spatial relationship between traditional villages and natural environmental [36], socio-economic, historical and cultural factors. In addition, geographical probes were used to investigate the weight of each influencing factor and the strength of the interaction.

3.3.1. The Nearest Neighbour Index Analysis

The nearest proximity index is a geographic indicator that quantifies the degree of spatial proximity of point elements, and can be expressed as follows [39]:

$$\overline{r_E} = \frac{1}{2\sqrt{n/A}} = \frac{1}{2\sqrt{D}}, \quad (1)$$

$$R = \frac{\overline{r_i}}{\overline{r_E}} = 2\sqrt{D}\overline{r_i}, \quad (2)$$

where R denotes the index of the nearest point, n refers to the number of points, A represents the area of the region and D reflects the density of the point [31]. A value of R equalling 1 indicates that the point elements are distributed randomly [41]; a value of R less than 1 denotes a condensed distribution of point elements, whereas a value greater than 1 indicates a uniform distribution. The intention was to utilize the closest neighbourhood index as a tool to assess the historical clustering and spatial relationships of traditional villages within their respective dynastic periods.

3.3.2. Kernel Density Analysis

The distribution of traditional villages in Hebei Province has a spatial unevenness that varies with the calculated area [39]. The method assumes that the event can occur anywhere in space, with different probabilities in different locations. Furthermore, the intensity of the

selected reference point is related to the probability of the event occurring, with a higher intensity of the point corresponding to a higher probability of the event occurring [27]. In this study, we use the kernel density analysis method to visually represent the concentration and dispersion of traditional villages in Hebei Province [36]. The kernel density is calculated using the following formula [40]:

$$f_n(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right), \quad (3)$$

3.3.3. The Coefficient of Variation Analysis

The coefficient of variation (CV) is a statistical measure that quantifies the degree of variation of observations in a data set. When the unit of measurement is the same as the mean, the standard deviation can be used directly to measure the variability. However, when the unit of measurement differs from the mean, the ratio of the standard deviation to the mean must be used to compare the degree of variation. In this study, the coefficient of variation is used to reflect the relative degree of spatial variation of point elements in traditional villages in Hebei Province, calculated using the Tyson Polygon analysis method. The formula for calculating the coefficient of variation is as follows:

$$c = \frac{x}{\varphi} \times 100\%, \quad (4)$$

where C is the coefficient of variation, x is the standard deviation and φ is the mean.

3.3.4. The Geographical Concentration Coefficient Analysis

The Geographical Concentration Coefficient (GCC) is an important index used to evaluate the degree of concentration of research objects [33]. This paper mainly uses the GCC to reflect the geographical spatial distribution of traditional village elements in Hebei Province [28], which is an important index for measuring the concentration degree of traditional villages [41]. The calculation formula of GCC is as follows [42]:

$$G = 100\sqrt{\sum_{i=1}^{n}\left(\frac{x_i}{T}\right)^2}, \quad (5)$$

where G is the geographical concentration index, x_i is the number of traditional villages in the ith city, T is the total number of traditional villages, and n is the number of cities. When the GCC value is between 0 and 100, a higher GCC indicates a more concentrated distribution of traditional villages [36]. Conversely, a lower GCC value indicates a more dispersed distribution. Assuming that G0 is the average geographical concentration coefficient, if G is greater than G0, the villages are clustered; if G is equal to G0, the villages are evenly distributed; if G is less than G0, the villages are dispersed.

3.3.5. The Imbalance Index Analysis and the Lorentz Curve Analysis

The imbalance index is a statistical method that reflects the degree of equilibrium in the distribution of research objects within the research area [43]. The Lorentz Curve analysis is commonly used to represent the imbalance index, and this paper uses it to evaluate the equilibrium distribution of traditional villages in different cities in Hebei Province [28]. A Lorentz Curve analysis is a graph that characterises concentration or dispersion using the frequency accumulation number. The imbalance index (S) is calculated by applying the formula for the concentration index in the Lorentz Curve analysis [27]. The equation for calculating the unbalance index is as follows:

$$r = \frac{\sum_{i=1}^{n}\beta_i - 50(N+1)}{100N - 50(N+1)}, \quad (6)$$

where n is the number of cities at the prefecture level, βi is the proportion of traditional villages in the total city of each municipality [27], and the cumulative percentage of the ith place in the order [36]. The imbalance index, Y, ranges from 0 to 1, and the closer its value is to 1, the more unbalanced the spatial distribution of the object of study [40].

3.3.6. The Geographical Concentration Coefficient Analysis

The geodetector is a quantitative method used to determine whether a geographical factor influences the spatial distribution of a given index and its weight [44]. This test evaluates the effectiveness of the evaluation index X on the dependent variable Y and can be quantified using the index QD and H. The higher the value, the greater the influence of the influencing factors and vice versa. Unlike other methods, the geodetector does not require too many assumptions and can process both numerical and qualitative data. It is also effective for quantitative analysis.

$$Q = 1 - \frac{1}{N\sigma^2}\sum_{1}^{h} N_h \sigma_h^2, \quad (7)$$

In this study, we used the Factor Detector to investigate the factors influencing the spatial distribution of traditional villages in Hebei Province [45]. We divided the variables Y and factor X into layers or partitions, denoted by h = 1 ... L. Nh and N represent the elements of layer h and the whole region, respectively [44]. The variances of the Y values of stratum h and the whole region are represented by σ_h^2 and σ^2 [39].

4. Spatial Distribution Characteristics of Traditional Villages in Hebei Province

Hebei Province, historically known as Youzhou, has a rich cultural and historical heritage and is considered one of the birthplaces of the Chinese nation. The province was divided into twelve states during the reign of Shun, and during the Spring and Autumn Period and the Warring States Period, it was known as Yan and Zhao due to its favourable geographical location. The traditional villages in Hebei Province have undergone a complex spatial and temporal evolution, forming in different historical periods. A comprehensive study of the spatial distribution of these traditional villages in different historical periods is an important aspect of understanding their development in the region [27].

This part of the article is primarily focused on analysing the historical dynasties and their influence on the spatial distribution of traditional villages. The calculation of the closest neighbourhood index, which is based on historical records and archaeological data, serves as a means to determine the degree of aggregation of these traditional villages across historical time and space. By emphasising the historical context, the study aims to provide a more accurate interpretation of the calculation and its relevance for understanding traditional village distribution throughout history. However, due to the variation in dynastic periods and the coexistence of older and newer villages, the result may not be as integrated.

4.1. Aggregate Distribution in Different Historical Periods

The distribution pattern of traditional villages in Hebei Province in different historical periods was analysed using the nearest neighbour index calculated using ArcGIS nearest neighbour distance [28]. The results indicate that, except for the pre-Qin period, which had a uniform spatial distribution, traditional villages in Hebei Province were spatially clustered in all other periods, showing strong clustering (see Table 2). The Sui and Tang dynasties showed a tendency towards spatially uniform distribution, with a larger nearest neighbour index compared to other periods. In contrast, the critical z-value reached-10.974663 in the Ming dynasty, indicating a significant increase in village agglomeration during this period, which can be attributed to the warfare in the early Ming dynasty and the two major migrations in the Ming dynasty.

Table 2. Nearest proximity index of traditional villages in Hebei province in different historical periods. (Data source: http://www.hebdfz.com/ (accessed on 5 April 2023).

Dynasty in Chinese History	Actual Nearest Distance Mean (m)	Theoretical Nearest Distance Mean (m)	Nearest Neighbour Exponent R	Distribution Pattern Type	Critical z Value
Before Qin	114,987.1397	108,627.8049	1.058542	Spatial uniformity	0.223992
Qin and Han	28,178.6181	54,313.9025	0.518810	Spatial aggregation	−3.682198
The Wei, Jin and Northern and Southern Dynasties	57,017.1558	88,694.2313	0.642851	Spatial aggregation	−1.673618
Sui and Tang	49,647.6328	54,313.9025	0.914087	Spatial aggregation	−0.657430
Song, Liao and Jin	17,495.1938	51,207.6383	0.341652	Spatial aggregation	−5.343461
Yuan	24,587.9384	45,300.9262	0.542769	Spatial aggregation	−4.194986
Ming	9375.1390	20,809.3134	0.450526	Spatial aggregation	−10.974663
Qing	34,807.6748	58,064.0041	0.599471	Spatial aggregation	−2.867009

Traditional villages in Hebei Province were established from before the Qin dynasty to the Ming and Qin dynasties, covering a long period of time [33]. The table shows that most traditional villages were established during the Ming dynasty, with 109 villages, accounting for 52.94% of the total. This is related to the migration activities in Shanxi during the Ming dynasty, from Dahuai Shu in Hongdong, Shanxi to Hebei and other places in the early Ming dynasty, when the Central Plains suffered a hundred years of war, drought and locusts, And when Hebei and other places were severely depopulated and desolate after the Battle of Jingnan, Zhu Di, the founder of the Ming dynasty, decided to migrate from Shanxi, and now many of the residents of Shijiazhuang Zhengding are descendants of the Shanxi immigrants. The number of traditional villages before the Ming dynasty is low, probably because the villages had already died out due to the long history [46]; however, the low number of villages formed during the Three Kingdoms, two Jin dynasties and North and South dynasties are related to the fact that there were more wars and the population plummeted during this period; the scale and structure of traditional villages were basically formed during the Ming dynasty, and the villages had already stabilised during the Qing dynasty, so the number of villages formed during the Qing dynasty was low [45].

4.2. Spatial Distribution Characteristics of Traditional Villages

An analysis of the nuclear density of traditional villages in different periods (see Figure 2) shows that although the number of traditional villages formed before the Qin dynasty was relatively small, their location basically corresponded to the Zhangjiakou core agglomeration area and the Xingtai-Handan core agglomeration area. The spatial distribution became known as the Shijiazhuang core agglomeration. During the Three Kingdoms, the Jin Ddnasty, and the Northern and Southern dynasties, the core area expanded in a circular fashion, mainly in the Handan area. During the Sui and Tang dynasties, the core area of Shijiazhuang expanded in a circle, while the core area of Xingtai-Handan became more closely connected, forming a belt-like shape. During the Song, Liao and Jin dynasties, the core agglomeration of Zhangjiakou developed rapidly and was on a par with the cores of Shijiazhuang and Xingtai-Handan in terms of agglomeration density, by which time the spatial distribution pattern of traditional villages in Hebei Province had been basically determined [47]. After the Yuan, traditional villages in Hebei province continued to expand with three core areas, Zhangjiakou, Shijiazhuang and Xingtai-Handan, but the main core areas differed in each period.

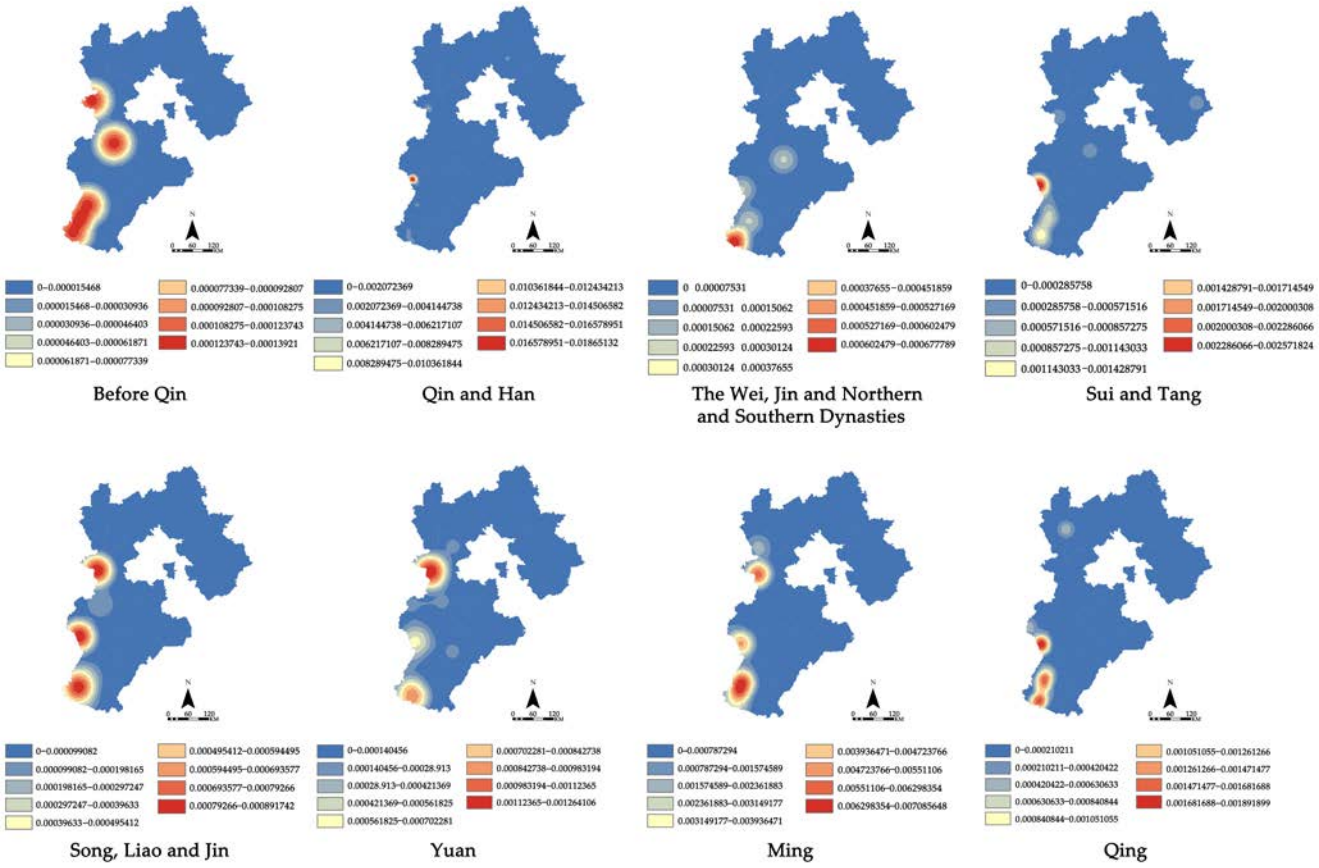

Figure 2. Kernel density of traditional villages in Hebei province in different historical periods. Data source: http://www.hebdfz.com/ (accessed on 5 April 2023). Map Source: http://bzdt.ch.mnr.gov.cn/ (accessed on 5 March 2023).

5. Overall Spatial Distribution of Traditional Villages in Hebei Province

The paper uses a macro perspective and quantitative analysis to present a data-based analysis of traditional villages in Hebei Province by presenting a study of 206 traditional villages in Hebei Province [44], analysing their spatial distribution and the mechanisms that influence it [19]. The evolution of the spatial distribution of traditional villages is found to follow a clear pattern of aggregation in different periods [48], from the Pre-Qin to the Song-Liao-Jin, forming a concentrated core area of Shijiazhuang, Zhangjiakou and Xingtai-Handan. In the Yuan-Ming Qing period, this pattern continued to expand outwards. Traditional villages in Hebei Province show a high degree of cohesion and heterogeneity within the study area.

5.1. Analysis of Spatial Distribution Types

In this study, the nearest neighbour index of traditional villages in Hebei Province was calculated using the average nearest neighbour tool in ArcGIS [27]. The results showed that the actual nearest neighbour distance was 7.11 km, the ideal nearest neighbour distance was 15.14 km, and the nearest neighbour index R was 0.47 [46], which is less than 1. These results indicate that the overall spatial distribution of traditional villages in Hebei Province is coherent [49]. To further validate the accuracy of the nearest neighbour index [40], the study created Tyson Polygons analysis for the traditional village point data in Hebei Province and accounted for them using the coefficient of variation method. The standard deviation of the Tyson Polygons analysis of traditional villages in Hebei Province was found to be 8158.881458 km^2, with an average area of 2089.390107 km^2 and a coefficient of variation value of 390.491054%. These results suggest that the spatial distribution of traditional villages in Hebei Province is also coherent (see Figure 3). Both methods used

in this study showed that traditional villages in Hebei Province have a high degree of cohesion [50].

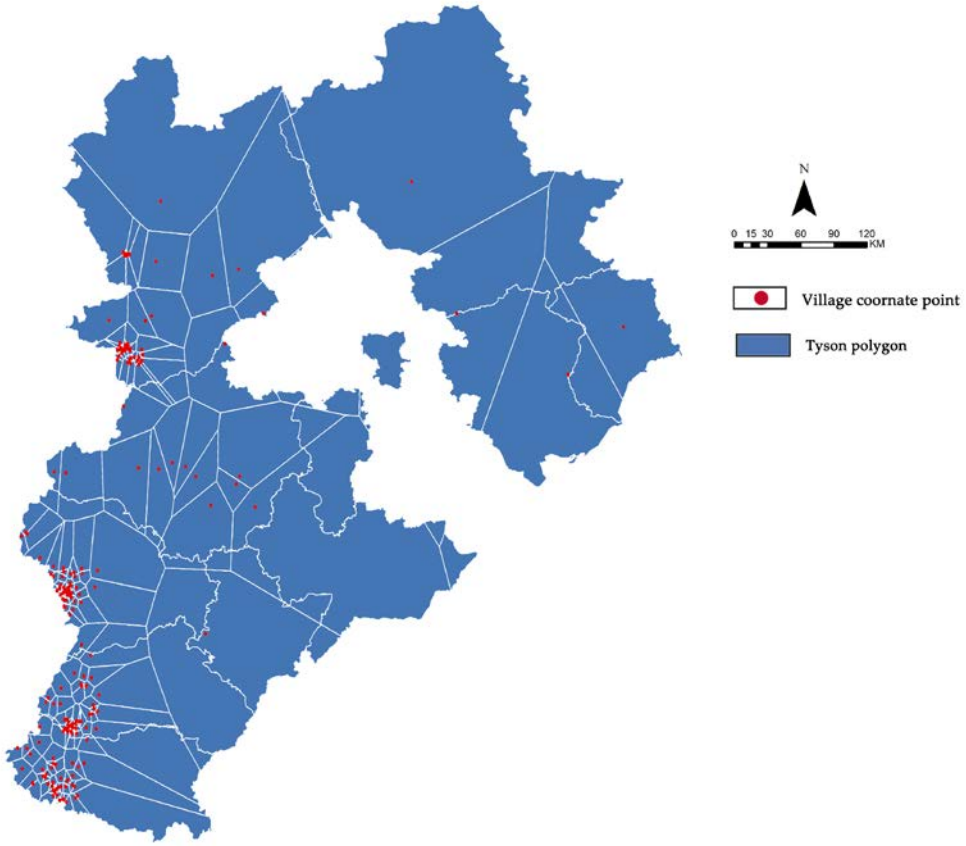

Figure 3. Tyson Polygon analysis, a traditional village in Hebei Province. Data source: The Ministry of Housing and Urban–Rural Development of the P.R.C. Map Source: http://bzdt.ch.mnr.gov.cn/ (accessed on 5 April 2023).

5.2. Analysis of Spatial Distribution Concentration and Homogeneity

The value of the geographical concentration coefficient can well reflect the degree of agglomeration of traditional villages in Hebei Province [28]. The geographical concentration index of traditional villages in Hebei Province is G = 32. If the traditional villages are evenly distributed in each prefecture-level city [27], the number of traditional villages in each city is 206/11 = 18.73. The geographical concentration index is G = 32 > 18.73 [28], which shows that the traditional villages in Hebei Province are concentrated at the prefecture-level city level and the degree of concentration is high. Using the kernel density analysis tool of ArcGIS [28], we can also conclude that the spatial distribution of traditional villages in Hebei Province is highly aggregated (seeFigure 4) [41]. The core areas of Shijiazhuang and Xingtai-Handan are very weakly connected, while the other prefecture-level cities are less numerous and more evenly distributed without forming more concentrated clusters.

The imbalance index can reflect the balance of the distribution of the study object within the study area, and this paper uses it to measure the balance of the distribution of traditional villages in the municipalities of Hebei Province. By applying the Formula (5), we can obtain the imbalance index S = 0.54 for traditional villages in the lower municipalities of Hebei Province, which indicates that the distribution of traditional villages in the prefecture-level municipalities of Hebei Province is unbalanced. By plotting the Lorenz curve of the municipal distribution of traditional villages in Hebei Province (see Figure 5), it can be seen that the traditional villages in Hebei Province are mainly distributed within the borders of four cities, namely Shijiazhuang, Zhangjiakou, Handan and Xingtai, and the number of

traditional villages in these four areas accounts for more than 90% of the total number of traditional villages in Hebei Province [28].

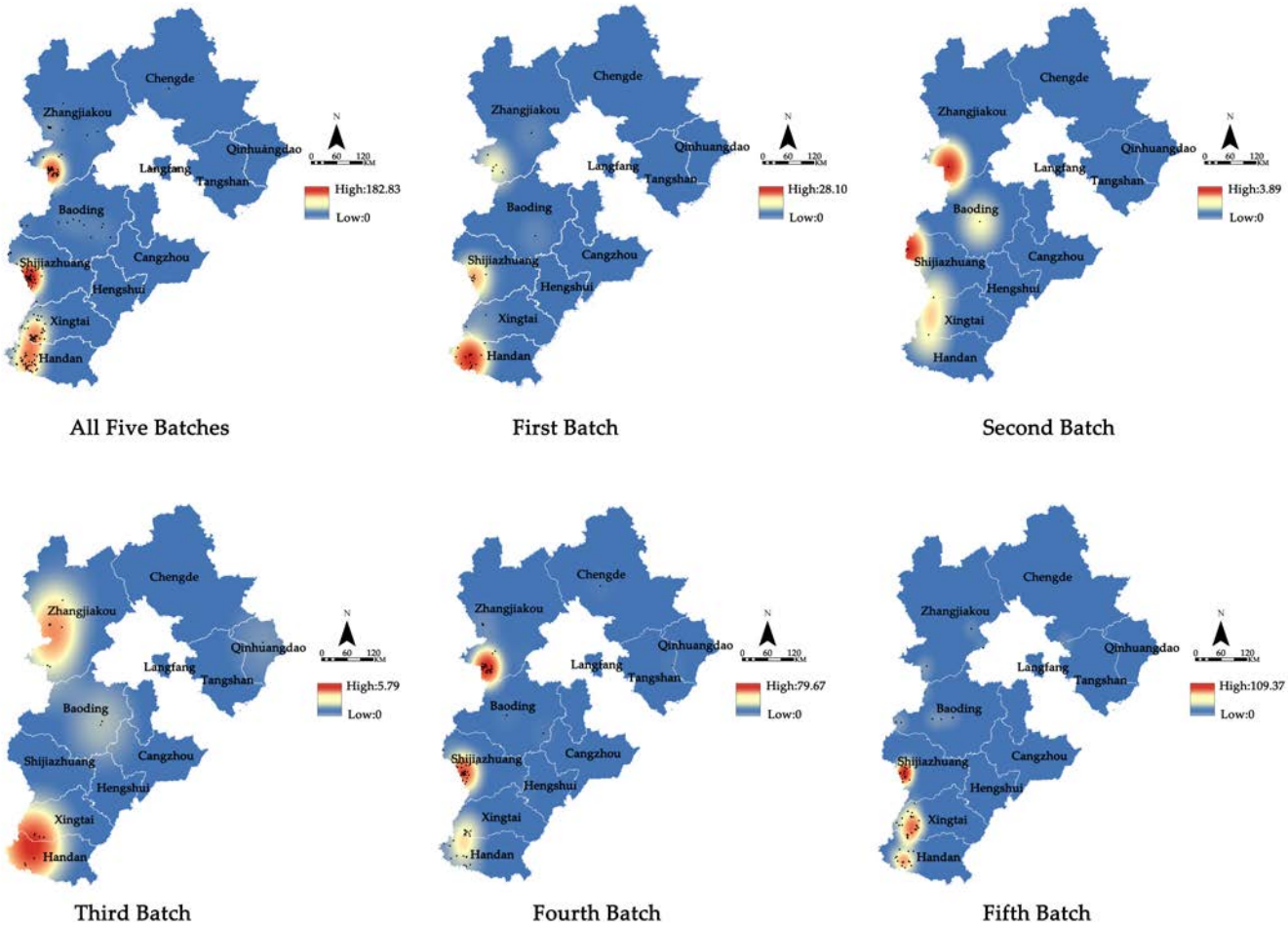

Figure 4. Kernel density of different batches of traditional villages in Hebei Province. Data source: The Ministry of Housing and Urban-rural Development of the P.R.C. Map Source: http://bzdt.ch.mnr.gov.cn/ (accessed on 5 April 2023).

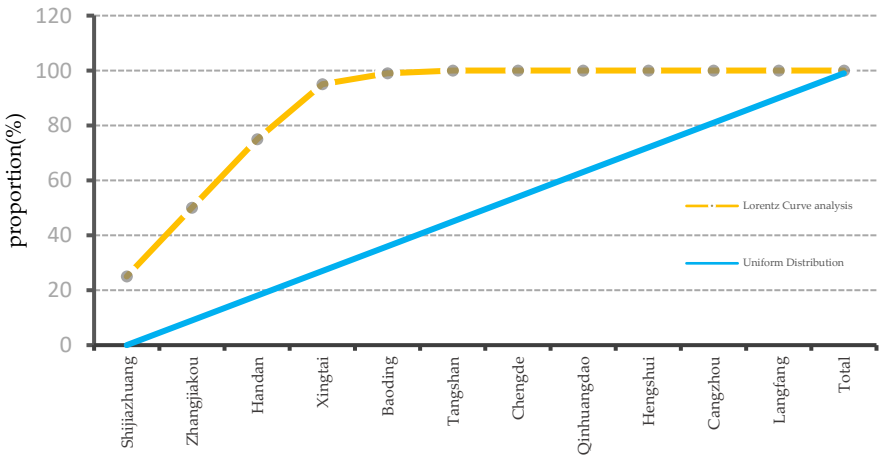

Figure 5. Lorentz Curve analysis of distribution space of traditional villages in Hebei Province. Data source: The Ministry of Housing and Urban-Rural Development of the P.R.C.

The first batch of traditional villages was basically created by identifying three core collection areas in Shijiazhuang, Zhangjiakou and Handan, with scattered pockets in

Xingtai and Baoding. The second batch of traditional villages, which is smaller in number, has further strengthened and consolidated the core gathering areas of Shijiazhuang and Zhangjiakou. The third batch of traditional villages was established in large numbers in the Xingtai area, defining the location of Xingtai. The fourth batch of traditional villages continues to reinforce the three core areas [36], with the classification expanding outwards with Shijiazhuang Jingfu, Zhangjiakou Weixian, Xingtai Shahe, Handan Magxian and Handan Shibian as the centre. The other areas have only a few scattered villages, and no core collection areas have formed.

6. Factors Influencing Spatial Distribution

6.1. Factors Influencing the Natural Environment

6.1.1. Elevation

Hebei Province has a varied and complex landscape, consisting mainly of plains in the south-east, mountains in the west and plateaus in the north. The topographic classification based on elevation distinguishes hilly areas between 200–500 m, low mountain areas between 500–1000 m, medium mountain areas between 1000–3500 m and high mountain areas above 3500 m. Analysis of the Digital Elevation Model (DEM) data for Hebei shows that there are no high mountain areas, with higher elevations concentrated in the north of Zhangjiakou and Chengde. Notably, traditional villages in Hebei Province are mainly located in hilly and low mountainous areas at low and medium altitudes. Using ArcGIS calculations, we extracted elevation values for traditional villages and found that there are 19 villages in the plains, 90 in the hills, 80 in the low mountains and 17 in the mountains (see Figure 6).

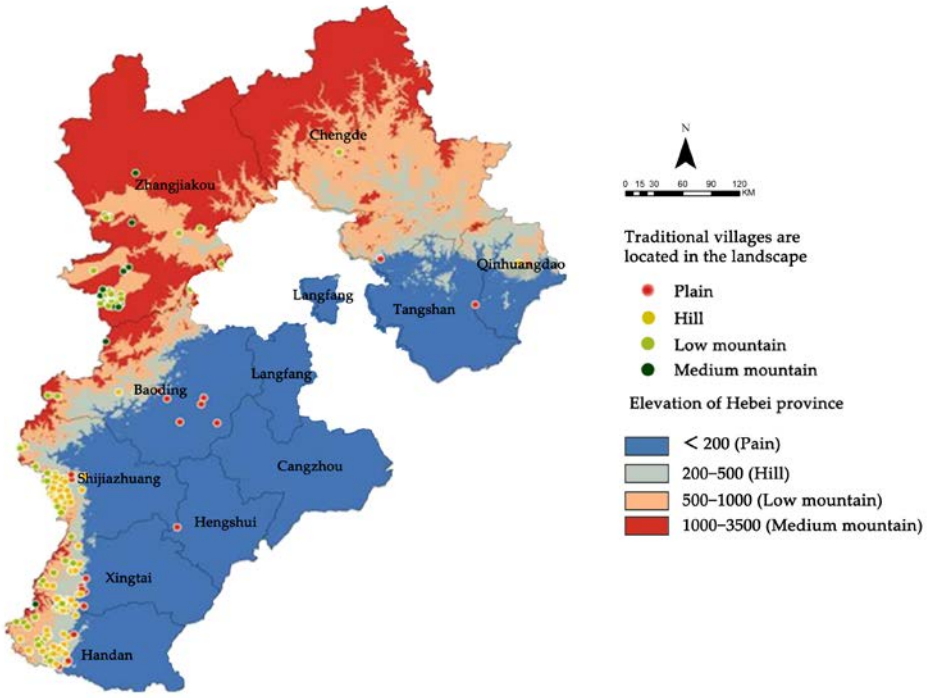

Figure 6. Elevation distribution of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

Hebei Province is geographically bordered by the eastern foothills of the Taihang Mountains in the west and the Yanshan Mountains in the north, which separate the North China Plain from the Inner Mongolia Plateau. The Taihang and Yanshan Mountains converge in Beijing, and the natural dividing line between the two mountain ranges is the Guan Gou, which stretches from Nankou in Changping District to the Badaling Great Wall in Yanqing County, with a total length of 40 kilometres. The Guan Gou served as a

dangerous route from the central plains to the northwest plateau. Traditional villages in Hebei Province are mainly located in the eastern foothills of the Taihang Mountains [28], with a total of 182 villages, while only 18 villages are located in the North China Plain, five in the Yanshan Mountains and one in the Zhangbei Damshang area on the southern edge of the Inner Mongolia Plateau (see Figure 7).

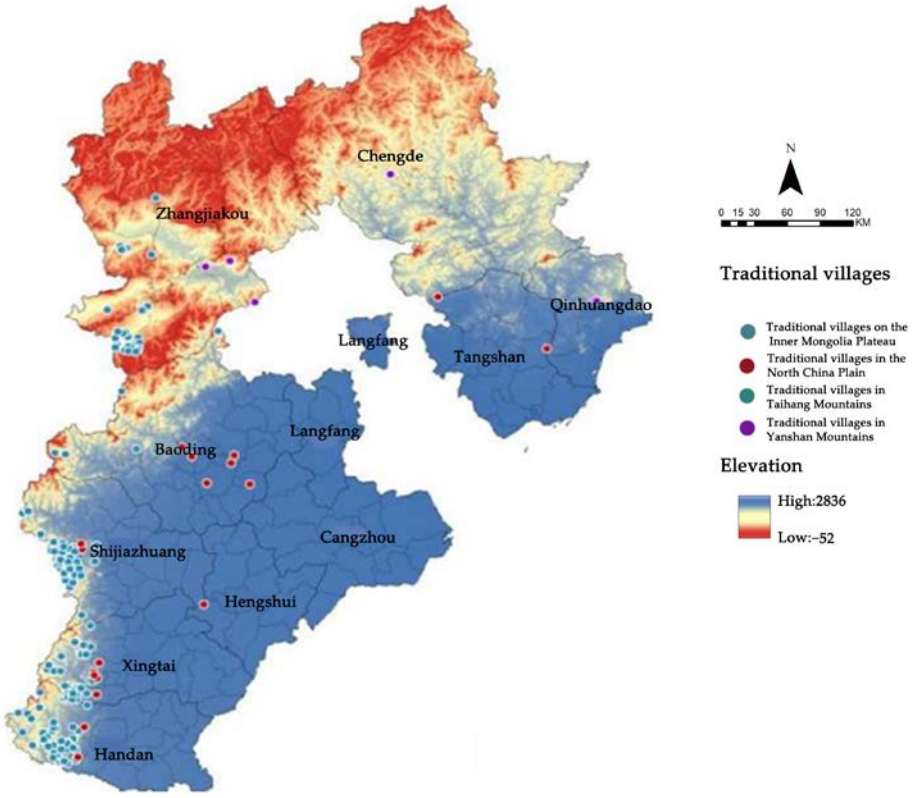

Figure 7. Terrain distribution map of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

The site selection for traditional villages in Hebei Province favoured locations with a mountainous backdrop and a waterfront, as mountainous terrain provided good defence and was safer during times of war. However, mountainous terrain is mostly inaccessible, leading to less population movement, which has resulted in the better preservation of traditional villages in mountainous areas compared to those in plain areas, which have undergone renewal due to better economic development.

6.1.2. Slope Orientation

Because China is located in the northern hemisphere, traditional villages are often built on sunny slopes to take advantage of good sunlight. Such slopes have greater solar radiation, which can meet the villagers' needs for sunlight and heat in their production and daily lives, and are also conducive to agriculture. To extract the slope direction from the DEM elevation data of Hebei Province, the slope direction tool in ArcGIS was used. The resulting slope direction was classified into nine categories: flat (−1), north (0°–22.5°, 337.5°–60°), northeast (22.5°–67.5°), east (67.5°–112.5°), southeast (112.5°–157.5°), south (157.5°–202.5°), southwest (202.5°–247.5°), west (247.5°–292.5°) and northwest (292.5°–337.5°). Among these, the east, southeast, south and southwest directions are classified as sunny slopes, while the west, northwest, north and northeast directions are classified as shady slopes. The location of traditional villages was used to determine the slope direction of villages.

Figure 8 shows that the slope direction of traditional villages in Hebei Province is predominantly on east, southeast and south slopes, accounting for a total of 113 or 54.8% of the total. In cold northern regions, there can be a temperature difference of up to 3–4 °C

between shaded and sunny slopes at the same altitude. In terms of the distribution of traditional villages on sunny and shady slopes, there are 124 and 82 traditional villages respectively, giving a ratio of 1.51:1 between the number of traditional villages on sunny and shady slopes.

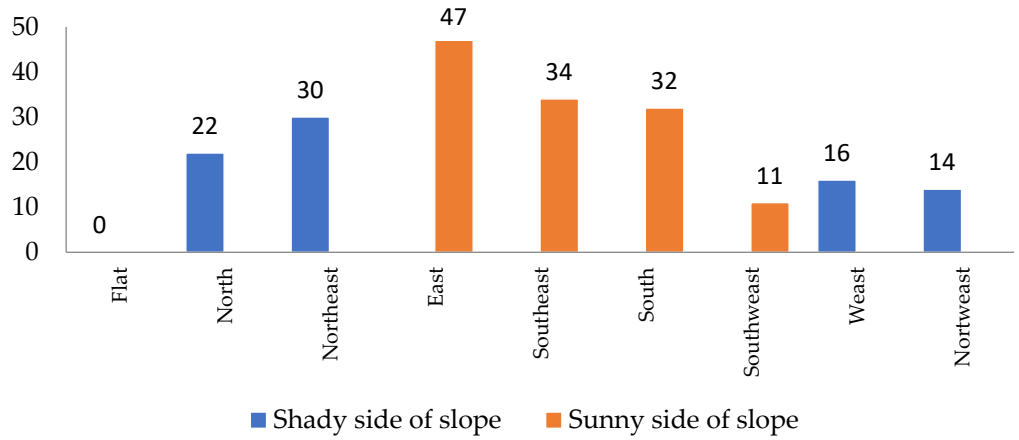

Figure 8. Slope aspects of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

6.1.3. Slope Gradient

Slope is a critical factor in determining the complexity of the living environment, with steeper slopes being less suitable for village construction, cultivation, vegetation growth, soil conservation and protection against natural disasters. To classify slopes in Hebei Province, the slope tool in ArcGIS was used to extract slope from digital elevation models, and the Technical Regulations for Current Land Use Survey was consulted, which classifies slopes into five categories: ≤2°, 2°–6°, 6°–15°, 15°–25° and >25°. Slopes with an angle of ≤2° are most suitable for cultivation, while those between 2° and 25° require attention or measures to protect the cultivated land and soil. If the slope is greater than 25°, the Soil and Water Conservation Law restricts land development and requires reforestation, which prohibits cultivation. The slope of traditional villages was determined by their location. Figure 9 shows that the number of traditional villages decreases as the slope angle increases [33], with 90.3% of traditional villages located in areas with a slope angle of less than 15° [30], indicating that such slopes are more suitable for production and living.

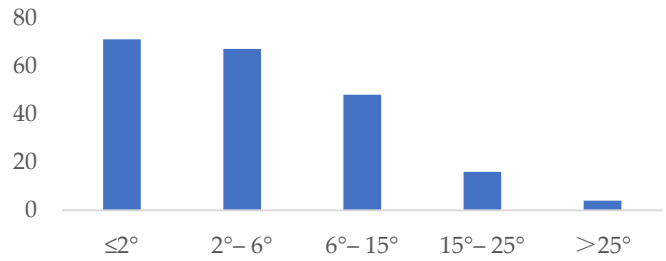

Figure 9. Slope gradient of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

6.1.4. Rivers

When choosing a location for a village, water supply is of paramount importance. Therefore, rivers are a critical factor influencing the spatial distribution of traditional villages [31]. Based on the river data in Hebei Province, buffer zones of 1 km, 3 km and 6 km were created using the buffer zone tool in ArcGIS, and the number of traditional villages within these areas was counted (see Figure 10) [46]. The results show that 22 traditional villages in Hebei Province are within 1 km of a river [46], 48 are between 1 km and 3 km

from a river, 51 are between 3 km and 6 km from a river, and 58.7% of the total number of traditional villages are within the 6 km buffer zone of a river [49]. This shows that traditional villages in Hebei Province, which are mainly located in mountainous areas, still tend to be distributed along rivers. In addition to providing water for production and subsistence, rivers can create flatter terrain for building houses and cultivating farmland, and larger rivers can also alleviate transportation difficulties.

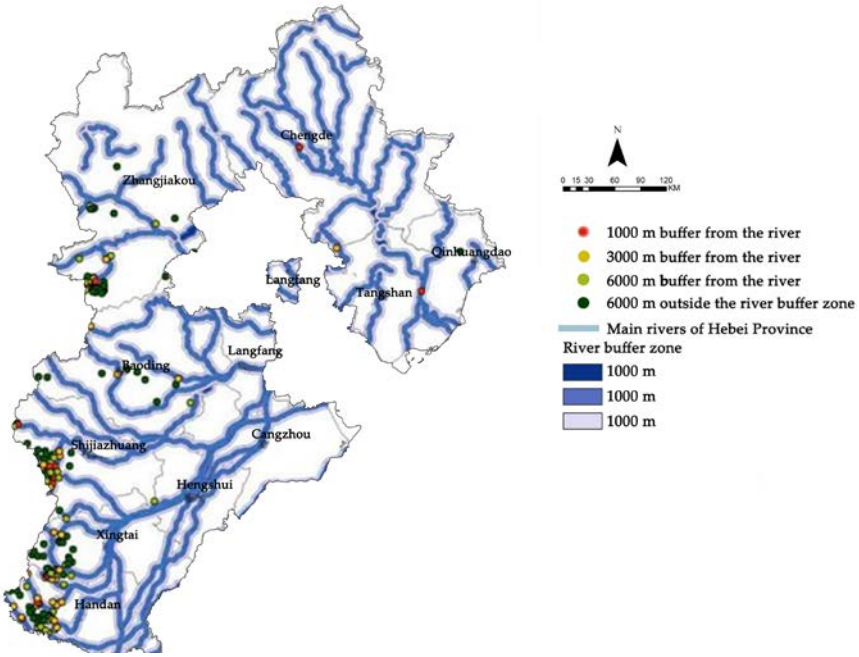

Figure 10. River Distribution of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

6.2. Socio-Economic Factors

The analysis of socio-economic factors serves as an exploratory approach to identify potential associations between contemporary indicators and the spatial distribution of traditional villages. These findings should be interpreted as correlations rather than direct causal relationships, acknowledging the temporal gap between the present and past phenomena.

6.2.1. Population Distribution

Villages are important places for human beings to carry out production and life, and at the same time human activities also cause changes in villages, so, to a certain extent, the distribution of population affects the spatial distribution of traditional villages [28]. Through the 2020 Hebei Statistical Yearbook (2019 data), the population density of each county and district in Hebei Province was counted and analysed by ArcGIS overlay [42], and it was found that most traditional villages are concentrated in areas with low population density (see Figure 11) [39], with a total of 177 traditional villages distributed in the range of population density less than 650 people/km^2, accounting for 86% of the total, concentrated in Zhangjiakou Weixian, Shijiazhuang Jingfu County, Xingtai County, Shahe City, Handan Shibu County and Wu'an City. Areas with low population density are usually less economically advanced, with less population movement and less inflow of foreign culture, so traditional villages are more likely to be preserved.

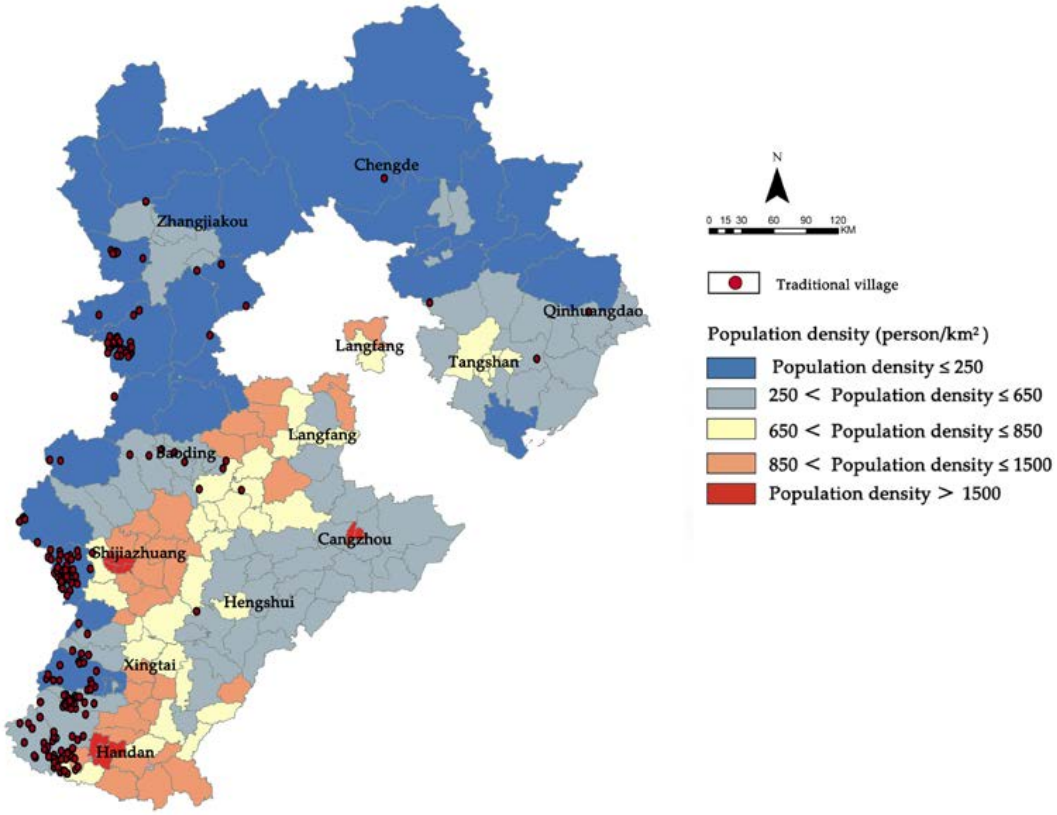

Figure 11. Population density distribution map of traditional villages in Hebei Province. Data source: Statistical Yearbook of Hebei Province 2019, Map Source: http://bzdt.ch.mnr.gov.cn/ (accessed on 5 April 2023).

6.2.2. Level of Economic Development

The spatial distribution of traditional villages is also influenced by various economic factors. To investigate the relationship between economic development and the spatial distribution of traditional villages in Hebei Province [48], four indicators were used for evaluation, including GDP per capita, the proportion of GDP in primary and secondary industries, and the urbanisation rate at the county, district, and county-level city levels. These data were obtained from the Hebei Statistical Yearbook 2020 (2019 data) for each county and district in Hebei Province.

Given the uneven distribution of traditional villages in Hebei Province, with most of them concentrated in Shijiazhuang [35], Zhangjiakou, Handan and Xingtai, these four prefecture-level cities with the largest number of traditional villages were selected as the research sample for analysis [36]. The results show that most of the traditional villages in the sample are located in economically underdeveloped areas [27], characterised by lower per capita income, a smaller share of primary and secondary industries in GDP, and a lower urbanisation rate. However, some regions with higher scores were observed due to the presence of specific industries within the administrative division of the county. For example, Jingfu Mining District and Fengfeng Mining District had higher scores due to the development of the coal mining industry (see Figure 12).

Traditional villages are more likely to be found in mountainous areas with less arable land, less developed traditional agriculture, less industrialisation and less influence from urbanisation and modernisation. These factors may contribute to the preservation and continued existence of traditional villages in such regions [44].

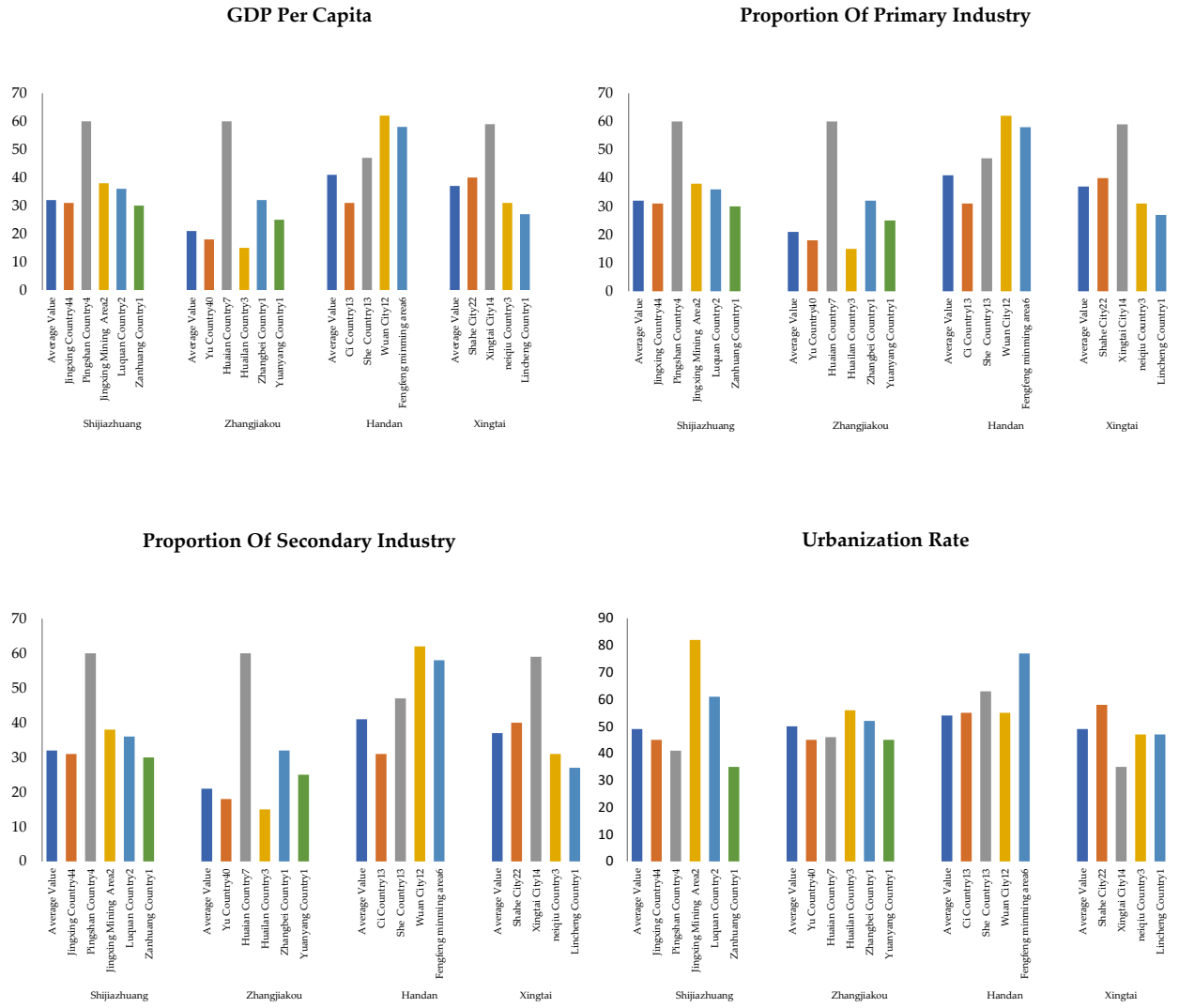

Figure 12. Distribution of economic development level of main traditional villages in Hebei Province. Data source: Statistical Yearbook of Hebei Province 2019).

6.3. Historical and Cultural Factors

The spatial distribution of traditional villages in Hebei Province is influenced not only by natural and socio-economic factors, but also by historical and cultural factors. One of the largest concentrations of traditional villages is in Jingfu County, Shijiazhuang, named after the fifth gully of the Taihang Mountains. The eight Taihang Gorges were important channels connecting Shanxi, Hebei and Henan provinces and served as the borders of these three provinces. Of these eight gorges, five (Busan Gorge, Jing Gorge, Feixu Gorge, Puyin Gorge and Jundu Gorge) are located in Hebei Province, and 80 traditional villages are distributed along these gorges, with the majority concentrated in the Jing Gorge and Feixu Gorge. In addition, the distribution of traditional villages in Hebei Province along the old stagecoach routes is also remarkable [46]. There are five stagecoach routes in Hebei Province, and 95 traditional villages are located along these routes, mainly within the Ui Zhou-He Ma Fu section and the Jing Fu ancient post route (see Figure 13).

In general, the spatial distribution of traditional villages in Hebei Province shows a linear concentration along major transport routes and passes [44]. These routes historically served as highways and were necessary links between the plains of northern China and the Loess Plateau, facilitating the integration of the economies and cultures of Shaanxi, Shanxi and the plains, and forming a unique regional culture. Thus, historical and cultural factors

have played an important role in the spatial distribution of traditional villages in Hebei Province [35].

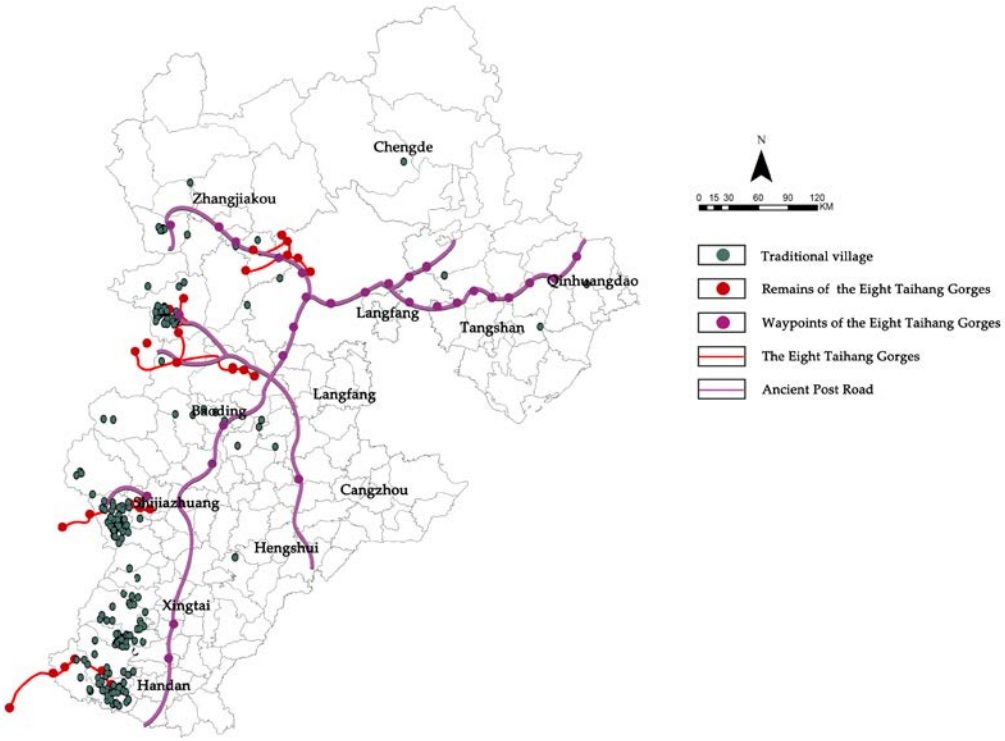

Figure 13. Distribution of traditional villages along eight Xing and ancient Post Roads of Taihang in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

6.4. Spatial Divergence Factor Detection

6.4.1. Single Impact Factor Detection

The factors influencing the spatial distribution of traditional villages in Hebei Province are a combination of natural environment [51], socio-economic, historical and cultural factors. To capture the spatial heterogeneity of traditional villages in Hebei Province, nine influencing factors were selected: altitude (X_1), slope (X_2), slope direction (X_3), river network density (X_4), population density (X_5), GDP per capita (X_6), proportion of primary industry (X_7) and urbanisation rate (X_8) [45]. Each influence factor was divided into five categories and the q-value of each influence factor was calculated by the geodetector (See Table 3).

Table 3. Geographical detection Q value of influencing factors of spatial distribution of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023).

Influence Factor	Altitude (X_1)	Slope (X_2)	Slope Aspect (X_3)	Stream Density (X_4)	Population Density (X_5)	GDP Per Capita (X_6)	Proportion of Primary Industry (X_7)	Urbanization Rate (X_8)
Unit	m	°	°	km/km^2	Person/km^2	CNY 10,000/person	%	%
Class I	<200	<2	<45	<0.012	<200	<0.75	<8	<45
Class II	200–500	2–6	45–135	0.012–0.025	200–500	0.75–1.5	8–15	45–50
Class III	500–1000	6–15	135–225	0.025–0.05	500–800	1.5–4	15–20	50–55
Class IV	1000–3500	15–25	225–315	0.05–0.25	800–1400	4–8.5	20–28	55–65
Class V	>3500	>25	>315	>0.25	>1400	>8.5	>28	>65
Q value	0.051046	0.024483	0.001145	0.023717	0.020244	0.061053	0.08202	0.024889

The results of the geographical probe analysis indicate that the proportion of primary industry (X_7) has the greatest influence on the spatial distribution of traditional villages in Hebei Province, followed by GDP per capita (X_6), altitude (X1), urbanisation rate (X_9),

slope (X_2), river density (X_4), population density (X_5) and slope direction (X_3). These results show the alternating influence of social and natural factors in shaping the spatial distribution of traditional villages [29]. Economic development is an important factor influencing the emergence and inheritance of traditional villages [26], and the proportion of primary industry directly reflects the agricultural development of the region. GDP per capita and the urbanisation rate directly reflect the level of economic development of the region, and areas with faster economic development are more protective of traditional villages. Elevation and slope, among the natural factors, have an important influence on natural factors such as light, temperature, humidity, wind speed and soil, and play an essential role in the selection and development of villages [33]. Conversely, the influence factors with q-values less than 0.024 have a weak explanatory power.

6.4.2. Interactive Influence Factor Detection

The spatial distribution of traditional villages in Hebei Province is influenced by several factors, and their interaction can either strengthen or weaken their explanatory power. To detect the interactive influence of these factors, a geodetector with an interactive detector module is used to detect the interaction between the eight influencing factors separately [29]. This study determines whether two factors play a separate or interactive role in the spatial distribution of traditional villages by comparing their influence through five different relationships.

Table 4 presents the results of the interaction analysis, which shows that the proportion of primary industry ∩ GDP per capita, proportion of primary industry ∩ altitude, and GDP per capita ∩ altitude are the three single factors with the greatest influence on traditional villages in Hebei Province. These three factors show non-linearly reinforced interactions, with the dual influence of the proportion of primary industry and GDP per capita having the greatest impact. Furthermore, the interactions of urbanisation rate ∩ proportion of primary industry and proportion of primary industry ∩ population density also have a significant influence on the spatial distribution of traditional villages in Hebei Province. These interactions have more influence on the distribution of traditional villages than the ability to influence them individually.

Table 4. Interactive factor detection results of influencing factors of spatial distribution of traditional villages in Hebei Province. Data source: https://www.gscloud.cn/ (accessed on 5 April 2023)).

	Altitude	**Slope**	**Slope Aspect**	**Stream Density**	**Population Density**	**GDP per Capita**	**Proportion of Primary Industry**
Slope	0.075252						
Slope Aspect	0.055629	0.030651					
Stream Density	0.062863	0.036977	0.025637				
Population Density	0.087789	0.05966	0.023241	0.049813			
GDP Per Capita	0.204642	0.109374	0.06418	0.128615	0.210236		
Proportion of Primary Industry	0.345711	0.182341	0.085897	0.245638	0.373471	0.346339	
Urbanization Rate	0.079597	0.046181	0.02802	0.066753	0.050466	0.181374	0.389454

It is important to note that the spatial distribution pattern of traditional villages in Hebei Province is not only influenced by a single factor, but also interactively coupled with other influencing factors. Among the interaction results, only four interactions are enhanced by two factors, indicating the complexity of the factors and mechanisms influencing the spatial distribution of traditional villages in Hebei Province.

7. Discussion

Through statistical analysis using ArcGIS, the paper quantifies the number and distribution of traditional villages affected by each factor [44], and identifies the influence of each factor on the spatial distribution of traditional villages in Hebei [40]. The study

explains the spatial distribution of traditional villages in Hebei Province by factors such as the proportion of primary industry, GDP per capita and altitude, which are alternately influenced by natural environmental factors. The spatial distribution of traditional villages in Hebei is the result of continuous development and change over time and space [41]. This distribution is influenced by four main factors: natural environment, socio-economic, history and culture, and policy.

The natural environment plays a fundamental role in shaping the spatial distribution of traditional villages in Hebei Province [51]. Factors such as elevation [29], slope and gradient influence the location, layout and orientation of villages, as well as the scale of village development and water resources for daily production and subsistence. The majority (82.5%) of traditional villages in Hebei Province are located in hilly and low mountainous areas [52], with 60.2% on sunny slopes, 90.3% within <15° slope and 58.7% within 6 km of rivers, making them hilly and low mountainous, sunny, gently sloping and distributed along rivers. The fertile land and abundant water resources in Hebei Province have made it an ideal location for agricultural production. As a result, many traditional villages in the province were established in areas where agriculture was the main economic activity.

Socio-economic factors are the driving forces behind the spatial distribution of traditional villages in Hebei Province [51]. Population density reflects the scale of population and population movement, with the scale of population directly reflecting the size of the village. The level of economic development can have both positive and negative effects on the development of traditional villages [51]. While areas of relatively low economic development may limit the renewal of villages, it may also encourage their preservation. Conversely, better economic development may be less conducive to the preservation of traditional villages, but it may increase villagers' awareness of the importance of protecting them, which in turn may promote their preservation. Traditional villages in Hebei Province are mostly located in low population density areas, with a density of less than 650 people per square kilometre, and in less economically developed areas, with lower per capita income, proportion of primary industry, proportion of secondary industry, and urbanisation rate.

Historical and cultural factors play a significant role in shaping the spatial distribution of traditional villages in Hebei Province [51]. Hebei Province has a long history and a rich cultural heritage that has been passed down from generation to generation [27]. The traditional villages in the province are a reflection of this cultural heritage and represent a unique blend of historical, cultural and architectural features [27]. The traditional villages in the province are characterized by their distinctive architectural style, which reflects the local culture and customs. For example, many traditional villages in Hebei are built in a style that emphasizes the importance of family and community, with houses arranged around a central courtyard. In addition, Religious and spiritual beliefs have also influenced the spatial distribution of traditional villages in Hebei Province. Many traditional villages in the province are located near temples, shrines, or other religious sites, reflecting the importance of religion in the lives of the local people. Among the traditional villages in Hebei Province, 80 traditional villages are distributed along the 'Eight Taihang Passes' [28], while 95 traditional villages are distributed along the ancient postal routes.

Government policies and regulations have also played a role in shaping the spatial distribution of traditional villages in Hebei [29]. In the past, the government encouraged the establishment of traditional villages in areas with abundant natural resources and favourable environmental conditions. Today, the government is promoting the revitalisation of traditional villages as part of its efforts to promote sustainable development in rural areas. In fact, political factors are an external driving force influencing the spatial distribution of traditional villages in Hebei [27]. The selection process of traditional villages is a bottom-up approach, and the degree of attention and support from local governments, as well as the awareness of local government authorities, will affect the spatial distribution of traditional villages in Hebei Province to varying degrees. In conclusion, the spatial

distribution of traditional villages in Hebei Province is influenced by a combination of natural environment, socio-economic, historical and cultural, and policy factors. These factors interact and are interrelated, with different factors working together to form the spatial pattern of traditional villages in Hebei Province, and the same factors working in different ways to produce the common characteristics and unique charm of traditional villages [47].

This study sets itself apart from previous research by not only analysing the spatial distribution of traditional villages but also exploring their historical development over time and space. Moreover, instead of solely investigating natural, socio-economic, and historical/cultural factors, this study employs a geographical approach to identify the relative influence of these factors and their criticality in preserving and promoting the growth of traditional villages. The influencing mechanism of traditional village spatial distribution in Hebei Province encompasses natural factors, social economy, history and culture, and policy guidance, where natural factors serve as the fundamental influence, social economy acts as the driving force, history and culture act as a catalyst, and policy guidance acts as an external push. Given the implementation of the rural revitalisation strategy, traditional villages have become a crucial platform, and it is imperative to study their spatial distribution and influencing factors. Hebei Province can harness the potential of traditional villages, especially in core collection areas, by formulating systematic and regional plans that balance protection and development, thus infusing new vitality into their development.

In terms of policy system, a three-level system should be established for the protection of traditional villages in Hebei province, including cultural and ecological protection (macro), regional development (meso) and the villages themselves (micro), and a cluster-based protection and development system should be proposed to form a 'Handan-Xingtai-Jinan traditional village cluster', a 'Jingxing-centred Jizhong traditional village cluster' and a 'Yuxian-centred Jibei traditional village cluster'. Traditional villages in Hebei Province will be protected in clusters, forming the 'Handan-Xingtai-Jinan Traditional Village Cluster', the 'Jingfu-Jizhong Traditional Village Cluster' and the 'Weixian-Jibei Traditional Village Cluster', integrating the resources in the region, highlighting the individual characteristics of traditional villages, achieving complementary advantages and avoiding the homogenisation of traditional villages. The development and protection of traditional villages in Hebei Province will be based on their individual characteristics, so that they can be protected and developed in a precise manner. It promotes the formation of a balanced development pattern of traditional villages in Hebei Province. Specific measures are proposed to continue the traditional style and character and to build a harmonious spatial environment and to establish a guarantee system.

However, there are some limitations in this study. It does not address the specific characteristics and attributes of each traditional village, which may affect the explanatory power of the influencing factors. Future research should include the natural environment, social economy, history and culture, structure and mechanism, architectural features, customs and culture of each traditional village in Hebei Province to better explore the mechanisms of their spatial distribution. In subsequent studies, it will be important to take into account climatic factors, specifically rainfall, and changes in livelihoods. Furthermore, it is important to note that the existing dataset only includes the traditional villages listed in the fifth inventory of traditional villages in China, and there are numerous other traditional villages in China that remain unlisted. The primary objective of this paper is to present a comprehensive assessment methodology. However, it should be acknowledged that the results may be subject to alteration with the availability of a more comprehensive database.

8. Conclusions

With the introduction of the rural revitalisation strategy, traditional villages have become important platforms for the implementation of rural revitalisation. Therefore, studying the spatial distribution and influencing factors of traditional villages is of great

significance. By recognising the factors that shape the distribution patterns of traditional villages, policy makers and stakeholders can better preserve and promote these valuable cultural assets while addressing regional disparities. Socio-economic and natural environmental factors were found to alternate in influencing the spatial distribution, with socio-economic factors playing a stronger role. Natural environmental factors influenced the spatial distribution, while socio-economic factors acted as drivers. Historical and cultural factors acted as catalysts for spatial distribution, and policy directions acted as external forces.

These findings provide valuable insights for understanding the spatial distribution characteristics of traditional villages in Hebei Province and can inform the development of effective strategies for rural revitalisation in China. It is suggested that Hebei Province should make full use of the resources of traditional villages, especially the core gathering areas of traditional villages. It is necessary to formulate comprehensive and regional master plans based on ecology and centred on culture. These plans should balance conservation and development, inheritance and innovation. They should also explore cultural assets in depth, incorporate modern ways of thinking and inject new vitality into the development of traditional villages. Further research can build on these findings to explore specific interventions and policies for the sustainable development and preservation of traditional villages in Hebei Province and beyond.

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References

1. Zhang, L.; Lu, P.; Lau, R.; Yan, L.; Li, X.; Yang, R.; Leung, H.H.; Chen, P.; Wang, X. Unique Traditional Villages on the Loess Plateau of China: Historic Evolution and Challenges to Sustainable Development of Silo-Caves. *Herit. Sci.* **2021**, *9*, 118. [CrossRef]
2. Ministry of Housing and Urban-Rural Development of the P.R.C. Notice on the Demonstration of the Conservation and Utilization of Traditional Villages in a Concentrated and Contiguous Manner. Available online: https://www.mohurd.gov.cn/gongkai/zhengce/zhengcefilelib/202304/20230427_771341.html (accessed on 17 May 2023).
3. Ma, H.; Tong, Y. Spatial Differentiation of Traditional Villages Using ArcGIS and GeoDa: A Case Study of Southwest China. *Ecol. Inform.* **2022**, *68*, 101416. [CrossRef]
4. UNESCO. World Heritage Center Ancient Villages in Southern Anhui–Xidi and Hongcun. Available online: https://whc.unesco.org/en/list/1002/ (accessed on 12 May 2023).
5. The State Council of P.R.C China Adds 1336 Traditional Villages to State Protection List. Available online: http://english.www.gov.cn/statecouncil/ministries/202303/22/content_WS641a3db2c6d0f528699db77a.html (accessed on 17 May 2023).
6. The State Council of P.R.C Traditional Villages with Local Characteristics Built to Develop Rural Tourism in Hebei. Available online: http://english.www.gov.cn/news/photos/202011/27/content_WS5fc056b2c6d0f72576940c28.html (accessed on 17 May 2023).
7. China National Institute of Standardization Protection and Utilization of Traditional Villages 2015. Available online: https://www.mohurd.gov.cn/ (accessed on 5 April 2023).

8. Ratzel, F. *The History of Mankind*; Macmillan and Company, Limited: New York, NY, USA, 1898.
9. Brunhes, J. *Human Geography: An Attempt at a Positive Classification, Principles and Examples*; Forgotten Books: London, UK, 2018; ISBN 978-1-330-29929-6.
10. Mumford, L. *The City in History: Its Origins, Its Transformations, and Its Prospects*; Mariner Books: San Diego, CA, USA; New York, NY, USA; London, UK, 1968; ISBN 978-0-15-618035-1.
11. Li, H.; Zhang, X. A Review and Trend on Rural Settlement Geography Abroad. *Hum. Geogr.* **2012**, *27*, 103–108. [CrossRef]
12. Woods, M. Researching Rural Conflicts: Hunting, Local Politics and Actor-Networks. *J. Rural Stud.* **1998**, *14*, 321–340. [CrossRef]
13. Lim, J.-C.; Choi, B.-K.; Kim, S.-Y.; Eom, B.-C.; Kim, J.-W. Korean Traditional Village Forest (Ma-Eul-Soop) and Potential Natural Vegetation: A Case Study on the Sachon-Ri Garo-Soop in Gyeongsangbuk-Do, South Korea. *J. Plant Biol.* **2016**, *59*, 515–524. [CrossRef]
14. Shubin, S. The Changing Nature of Rurality and Rural Studies in Russia. *J. Rural Stud.* **2006**, *22*, 422–440. [CrossRef]
15. Kiss, E. Rural Restructuring in Hungary in the Period of Socio-Economic Transition. *GeoJournal* **2000**, *51*, 221–233. [CrossRef]
16. Yang, R.; Xu, Q.; Xu, X.; Chen, Y. Rural Settlement Spatial Patterns and Effects: Road Traffic Accessibility and Geographic Factors in Guangdong Province, China. *J. Geogr. Sci.* **2019**, *29*, 213–230. [CrossRef]
17. Smailes, P.J.; Argent, N.; Griffin, T.L.C. Rural Population Density: Its Impact on Social and Demographic Aspects of Rural Communities. *J. Rural Stud.* **2002**, *18*, 385–404. [CrossRef]
18. Argent, N.; Smailes, P.; Griffin, T. Tracing the Density Impulse in Rural Settlement Systems: A Quantitative Analysis of the Factors Underlying Rural Population Density Across South-Eastern Australia, 1981–2001. *Popul. Environ.* **2005**, *27*, 151–190. [CrossRef]
19. Wu, C.; Chen, M.; Zhou, L.; Liang, X.; Wang, W. Identifying the Spatiotemporal Patterns of Traditional Villages in China: A Multiscale Perspective. *Land* **2020**, *9*, 449. [CrossRef]
20. Sevenant, M.; Antrop, M. Settlement Models, Land Use and Visibility in Rural Landscapes: Two Case Studies in Greece. *Landsc. Urban Plan.* **2007**, *80*, 362–374. [CrossRef]
21. Iyanda, A.E.; Boakye, K.A.; Lu, Y.; Oppong, J.R. Racial/Ethnic Heterogeneity and Rural-Urban Disparity of COVID-19 Case Fatality Ratio in the USA: A Negative Binomial and GIS-Based Analysis. *J. Racial Ethn. Health Disparities* **2022**, *9*, 708–721. [CrossRef] [PubMed]
22. Zhang, C.H.; Schwartz, G.G. Spatial Disparities in Coronavirus Incidence and Mortality in the United States: An Ecological Analysis as of May 2020. *J. Rural Health* **2020**, *36*, 433–445. [CrossRef] [PubMed]
23. Johnson, K.M.; Lichter, D.T. Rural Depopulation: Growth and Decline Processes over the Past Century: Rural Depopulation. *Rural Sociol.* **2019**, *84*, 3–27. [CrossRef]
24. Luo, W.; Wang, F. Measures of Spatial Accessibility to Health Care in a GIS Environment: Synthesis and a Case Study in the Chicago Region. *Environ. Plan. B Plan. Des.* **2003**, *30*, 865–884. [CrossRef]
25. Luo, W.; Whippo, T. Variable Catchment Sizes for the Two-Step Floating Catchment Area (2SFCA) Method. *Health Place* **2012**, *18*, 789–795. [CrossRef] [PubMed]
26. Gao, C.; Wu, Y.; Bian, C.; Gao, X. Spatial Characteristics and Influencing Factors of Chinese Traditional Villages in Eight Provinces the Yellow River Flows Through. *River Res. Appl.* **2021**, rra.3880. [CrossRef]
27. Xu, J.; Yang, M.; Hou, C.; Lu, Z.; Liu, D. Distribution of Rural Tourism Development in Geographical Space: A Case Study of 323 Traditional Villages in Shaanxi, China. *Eur. J. Remote Sens.* **2021**, *54*, 318–333. [CrossRef]
28. Yang, X.; Fang, C.; Zhu, K. A Study of Spatial-Temporal Pattern and Influencing Factors of Traditional Villages in Shaanxi Province. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *242*, 052011. [CrossRef]
29. Li, B.; Wang, J.; Jin, Y. Spatial Distribution Characteristics of Traditional Villages and Influence Factors Thereof in Hilly and Gully Areas of Northern Shaanxi. *Sustainability* **2022**, *14*, 15327. [CrossRef]
30. Zheng, X.; Wu, J.; Deng, H. Spatial Distribution and Land Use of Traditional Villages in Southwest China. *Sustainability* **2021**, *13*, 6326. [CrossRef]
31. Yang, L.; Long, H.; Liu, P.; Liu, X. Traditional Village Protection Degree Evaluation System and Its Empirical Research—In the First Group of Chinese Traditional Village in Hunan Province as an Example. *Hum. Geogr.* **2018**, *33*, 121–128. [CrossRef]
32. Tan, S.; Zhang, M.; Wang, A.; Ni, Q. Spatio-Temporal Evolution and Driving Factors of Rural Settlements in Low Hilly Region—A Case Study of 17 Cities in Hubei Province, China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 2387. [CrossRef]
33. Sun, Y.; Fan, W. A Study on Spatial Distribution and Influencing Factors of Hakka Traditional Villages in Northeast Guangdong Based on GIS. In Proceedings of the 2020 International Conference on Big Data and Informatization Education (ICBDIE), IEEE, Zhangjiajie, China, 23–25 April 2020; pp. 444–448.
34. Cheng, M.; Jiao, X.; Guo, W.; Wang, S.; Pan, Y.; Zhang, H.; Sang, H. Temporal and Spatial Distribution Characteristics of Irrigation Water Requirement for Main Crops in the Plain Area of Hebei Province. *Irrig. Drain.* **2020**, *69*, 1051–1062. [CrossRef]
35. Wu, K.; Su, W.; Ye, S.; Li, W.; Cao, Y.; Jia, Z. Analysis on the Geographical Pattern and Driving Force of Traditional Villages Based on GIS and Geodetector—A Case Study of Guizhou. *Res. Sq.* **2023**, 1–37. [CrossRef]
36. Bian, J.; Chen, W.; Zeng, J. Spatial Distribution Characteristics and Influencing Factors of Traditional Villages in China. *Int. J. Environ. Res. Public Health* **2022**, *19*, 4627. [CrossRef]
37. Wang, Q.; Bing, H.; Wang, S.; Xu, Q. Study on the Spatial Distribution Characteristics and Influencing Factors of Famous Historical and Cultural Towns or Villages in Hubei Province, China. *Sustainability* **2022**, *14*, 13735. [CrossRef]

38. China Statistical Yearbook. 2019. Available online: http://www.stats.gov.cn/sj/ndsj/2019/indexch.htm (accessed on 5 April 2023).
39. Su, H.; Wang, Y.; Zhang, Z.; Dong, W. Characteristics and Influencing Factors of Traditional Village Distribution in China. *Land* **2022**, *11*, 1631. [CrossRef]
40. Li, M.; Ouyang, W.; Zhang, D. Spatial Distribution Characteristics and Influencing Factors of Traditional Villages in Guangxi Zhuang Autonomous Region. *Sustainability* **2022**, *15*, 632. [CrossRef]
41. Li, L.; Zhang, J. Image Simulation of Traditional Village Spatial Layout Based on Computer Numerical Analysis. *Mob. Inf. Syst.* **2022**, *2022*, 1–7. [CrossRef]
42. Li, T.; Li, C.; Zhang, R.; Cong, Z.; Mao, Y. Spatial Heterogeneity and Influence Factors of Traditional Villages in the Wuling Mountain Area, Hunan Province, China Based on Multiscale Geographically Weighted Regression. *Buildings* **2023**, *13*, 294. [CrossRef]
43. Zheng, G.; Jiang, D.; Luan, Y.; Yao, Y. GIS-Based Spatial Differentiation of Ethnic Minority Villages in Guizhou Province, China. *J. Mt. Sci.* **2022**, *19*, 987–1000. [CrossRef]
44. Jin, J.; Yan, H.; Wang, G.; Su, G. Spatial Scanning of Traditional Villages and Geographical Exploration of Spatial Differentiation Mechanism: A Case Study of Gansu Province. In Proceedings of the 2021 28th International Conference on Geoinformatics, IEEE, Nanchang, China, 3–5 November 2021; pp. 1–5.
45. Yuan, C.; Jiang, M. Migration and Land Exploitation from Yuan to Qing Dynasties: Insights from 252 Traditional Villages in Hunan, China. *Sustainability* **2023**, *15*, 1001. [CrossRef]
46. Zhang, Y.; Zhang, Z. Visualization Analysis of Spatial Characteristics of Traditional Villages in Southeast Shanxi Province. *SHS Web Conf.* **2023**, *157*, 03025. [CrossRef]
47. Jin, L.; Wang, Z.; Chen, X. Spatial Distribution Characteristics and Influencing Factors of Traditional Villages on the Tibetan Plateau in China. *Int. J. Environ. Res. Public Health* **2022**, *19*, 13170. [CrossRef] [PubMed]
48. Duan, Y.; Yan, L.; Lai, Z.; Chen, Q.; Sun, Y.; Zhang, L. The Spatial Form of Traditional Villages in Fuzhou Area of Jiangxi Province Determined via GIS Methods. *Front. Earth Sci.* **2022**. [CrossRef]
49. Ma, X.; Peng, S.; Lin, Z. Research on Spatial Distribution Characteristics of Traditional Villages in Baoshan City Based on GIS. In Proceedings of the 2021 IEEE 4th Advanced Information Management, Communicates, Electronic and Automation Control Conference (IMCEC), IEEE, Chongqing, China, 18–20 June 2021; pp. 295–298.
50. Liu, Y.; Ke, X.; Wu, W.; Zhang, M.; Fu, X.; Li, J.; Jiang, J.; He, Y.; Zhou, C.; Li, W.; et al. Geospatial Characterization of Rural Settlements and Potential Targets for Revitalization by Geoinformation Technology. *Sci. Rep.* **2022**, *12*, 8399. [CrossRef]
51. Li, S.; Song, Y.; Xu, H.; Li, Y.; Zhou, S. Spatial Distribution Characteristics and Driving Factors for Traditional Villages in Areas of China Based on GWR Modeling and Geodetector: A Case Study of the Awa Mountain Area. *Sustainability* **2023**, *15*, 3443. [CrossRef]
52. Liu, S.; Ge, J.; Bai, M.; Yao, M.; He, L.; Chen, M. Toward Classification-Based Sustainable Revitalization: Assessing the Vitality of Traditional Villages. *Land Use Policy* **2022**, *116*, 106060. [CrossRef]