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Research on spatial-temporal distribution characteristics and influencing factors of national cultural relics protection units in Shanxi Province

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ABSTRACT

This study takes 530 national cultural relics protection units in Shanxi Province as the research object, and uses mathematical statistics and GIS spatial analysis methods to explore the spatial-temporal distribution characteristics and influencing factors of national cultural relics protection units in Shanxi Province. The results show that there are differences in the number of national cultural relics protection units in Shanxi Province during different historical periods, showing a trend of first increasing and then decreasing. The formation of various types of national cultural relics protection units has a relatively concentrated historical period. The distribution center of national cultural relics protection units in Shanxi Province has changed with historical periods, showing a migration characteristic in the direction of south northeast southeast south southeast northwest northeast. The national cultural relics protection units in Shanxi Province are in a clustered distribution state, and the clustering characteristics of different types of national security units are also different. The gradient distribution characteristics of national cultural relics protection units in different administrative cities are obvious. The spatial and temporal distribution of national cultural relics protection units in Shanxi Province is influenced by factors such as topography, river systems, and transportation.

KEYWORDS

Cultural relics protection units; Space distribution; Shanxi Province.

1. INTRODUCTION

Cultural relics protection units, as cultural relics of human activities in historical periods, are important carriers for inheriting Chinese culture and have extremely high historical, artistic, and scientific values. Studying it not only helps to gain a deeper understanding of the development process of human civilization, but also helps to optimize the protection and utilization of cultural relics resources. At present, domestic scholars have conducted extensive and in-depth research on the utilization of cultural relics protection units from the perspectives of tourism, architecture, archaeology, geography and other disciplines[1]2,including cultural relics protection and tourism development[3[4], and the spatial-temporal distribution and influencing factors of cultural relics protection units [511]. In terms of the spatial-temporal distribution and influencing factors of cultural relics protection units, existing research still has the following shortcomings: in terms of types, the spatial-temporal distribution characteristics of a certain type of cultural relics are mainly focused on [12][13], and there are few studies that comprehensively analyze various types of cultural relics protection units; In terms of time, research mostly focuses on a certain historical period, and there is

an urgent need to systematically and comprehensively study the spatial-temporal distribution characteristics and influencing factors of cultural relics protection units throughout the entire historical period; In addition, research on national insurance units needs to be further deepened and expanded. Shanxi Province is located in the middle reaches of the Yellow River and is one of the central regions of the origin of Chinese civilization. It is known as "seeing Shanxi as a cultural relic on the ground". At present, Shanxi Province has a total of 531 national level cultural relics protection units , ranking first in the country in terms of quantity. Shanxi Province has a rich variety of national protection units with high grades, covering various historical periods, and has strong representative. Therefore, this study takes the national cultural relics protection units of Shanxi Province as the research object, and uses GIS spatial analysis method to study their spatial distribution characteristics and influencing factors, in order to provide reference for the protection and rational utilization of the national cultural relics protection units of Shanxi Province.

2. DATA SOURCES AND RESEARCH METHODS

2.1. Data sources

The information about the cultural relic protection units in this paper comes from the list of the 1-8 batches of national cultural relic protection units released by the State Administration of Cultural Heritage (http://www.ncha.gov.cn/). By 2023, there will be 531 such units in Shanxi Province, because there is only one other type of cultural relic protection unit. Therefore, it is not studied, and 530 national security units are finally determined as the research object. The base map of Shanxi Province is from the Data Center of Resources and Environmental Sciences, Chinese Academy of Sciences. The latitude and longitude coordinates of the national cultural relics protection units were obtained through the coordinate picking tool of Baidu Map API, and the spatial distribution map of the national cultural relics protection units in Shanxi Province was generated by ArcGIS10.4.

2.2. Research methods

The research methods mainly include Nearest Neighbor Index[10], Kernel Density[14], and Standard Deviation Ellipse (SDE)[14].

3. TEMPORAL DISTRIBUTION CHARACTERISTICS OF NATIONAL CULTURAL RELICS PROTECTION UNITS IN SHANXI PROVINCE

3.1. General Characteristics

The time span of national cultural relics protection units in Shanxi Province is large, and they have been left behind in various historical periods. Based on archaeological and chronological research, as well as the phased characteristics of the development of Chinese civilization, the age of national security units can be divided into eight periods: prehistoric, pre-Qin, Qin Han, Wei, Jin, Southern and Northern Dynasties, Sui, Tang, and Five Dynasties, Song, Yuan, Ming, Qing, and Since modern times. Overall, there are differences in the number of national security units in Shanxi Province during different historical periods, showing a trend of first increasing and then decreasing (Figure 1). The number of national cultural relics protection units in Shanxi Province is relatively concentrated during the Song and Yuan dynasties and the Ming and Qing dynasties. The number of national cultural relics protection units during the Song and Yuan dynasties was the highest, accounting for 47.83% of the total, followed by the Ming and Qing dynasties, accounting for 30.13% of the total. The number of national cultural relics protection units during the Qin and Han dynasties was the lowest, only 6, accounting for 1.13% of the total.

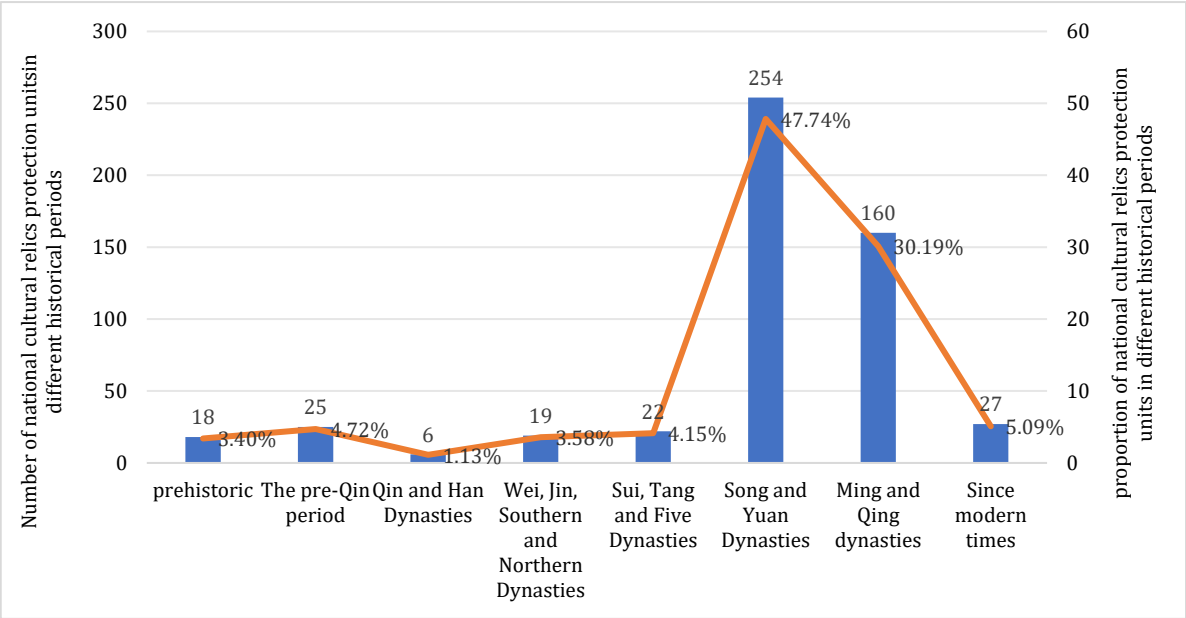

Figure 1. Number and proportion of national cultural relics protection units in different historical periods

3.2. Type characteristics

According to the regulations of the application list, national security units are divided into six categories: ancient sites, ancient tombs, ancient buildings, grotto temples and stone carvings, important historical sites and representative buildings of modern and contemporary times(short for modern and contemporary), and others. Overall, Shanxi Province has a large number and diverse types of national cultural relics protection units, and various types of national cultural relics protection units are distributed throughout the province, but the number varies greatly. 421 ancient buildings ranked first, accounting for 79.28% of the total; There are 46 ancient sites, accounting for 8.66% of the total; There are 20 ancient tombs, accounting for 3.77% of the total; There are 15 grotto temples and stone carvings, accounting for 2.82% of the total; There are 28 important historical sites and representative buildings in modern times, accounting for 5.27% of the total; The number of other categories is very small, only one, accounting for 0.19% of the total. From the proportion of types of national protection units in different periods (Table 1), it can be seen that the prehistoric national cultural relics protection units were all ancient sites, with a total of 18 locations. During the pre Qin period, the proportion of national cultural relics protection units was still the highest among ancient sites, followed by ancient tombs, accounting for 68% and 28% of the total amount during the same period, respectively. During the Qin and Han dynasties, there were relatively few types of national cultural relics protection units left behind, with the largest number of ancient tombs being only four. During the Wei, Jin, Southern and Northern Dynasties, grotto temples and stone carvings accounted for the highest proportion, accounting for 57.89% of the total during the same period. During the Sui, Tang, and Five Dynasties periods, the proportion of ancient architecture began to increase, reaching 77.27. During the Song, Yuan, Ming, and Qing dynasties, ancient architecture still dominated, accounting for 96.85% and 97.50% respectively. Since modern times, the proportion of important historical sites and representative buildings in modern times has been the highest, accounting for 96.3%.

Overall, apart from other types, there are significant temporal differences in the types of national protection units in Shanxi Province. Ancient sites, ancient tombs, ancient buildings, grotto temples and stone carving , important historical sites and representative buildings of since modern times are distributed the most in prehistoric, pre Qin, Song and Yuan, Wei, Jin, Southern and Northern Dynasties, and since modern times, respectively.

Table 1. The number and proportion of various types of national cultural relics protection units in different historical periods

Historical periods	Ancient buildings (NO., %)	Ancient tombs (NO., %)	Ancient sites (NO., %)	Grotto temples and stone carvings (NO., %)	Modern and contemporary (NO., %)	Total (NO., %)
Prehistoric	0 (0.00)	0 (0.00)	18 (100)	0 (0.00)	0 (0.00)	18 (100)
Pre-Qin period	1 (4.00)	7 (28.00)	17 (68.00)	0 (0.00)	0 (0.00)	25 (100)
Qin and Han Dynasties	0 (0.00)	4 (66.67)	2 (33.33)	0 (0.00)	0 (0.00)	6 (100)
Wei, Jin, Southern and Northern Dynasties	0 (0.00)	4 (21.05)	4 (21.05)	11 (57.89)	0 (0.00)	19 (100)
Sui, Tang and Five Dynasties	17 (77.27)	1 (13.64)	3 (13.64)	1 (4.55)	0 (0.00)	22 (100)
Song and Yuan Dynasties	246 (96.85)	3 (0.79)	2 (0.79)	2 (0.79)	0 (0.00)	253 (100)
Ming and Qing dynasties	156 (97.50)	1 (0.00)	0 (0.00)	1 (0.63)	2 (1.25)	160 (100)
Since modern times	1 (3.70)	0 (0.00)	0 (0.00)	0 (0.00)	26 (96.3)	27 (100)
Total	421 (79.43)	20 (3.77)	46 (8.68)	15 (2.83)	28 (5.28)	530 (100)

3.3. Center of gravity transfer characteristics

Using a gravity model to analyze the migration trajectory and distance of the center of gravity of national cultural relics protection units in historical periods. Comprehensive analysis of the direction and distribution of national cultural relics protection units in different historical periods using standard deviation ellipses. Eight periods of national cultural relics protection units showed migration characteristics from south to northeast, southeast to south, southeast to northwest to northeast (Figure 2). Without using historical periods, the center of gravity coordinates are located in different regions. In prehistoric times, the center of gravity of the national cultural relics protection units was in the central part of Linfen City (111.47 ° E, 36.17 ° N). During the pre-Qin period, it moved 7km south of Linfen City (111.43 ° E, 35.80 ° N). During the Qin and Han dynasties, it moved 300km to the central part of Taiyuan City (112.25 ° E, 37.98 ° N). During the Wei, Jin, Southern and Northern Dynasties, it moved eastward to the southeastern part of Taiyuan City (112.48 ° E, 37.65 ° N), During the Sui, Tang, and Five Dynasties periods, it moved 63km southward to the northwest of Changzhi (112.39 ° E, 36.59 ° N). During the Song and Yuan dynasties, it remained in the northwest of Changzhi (112.43 ° E, 36.52 ° N). During the Ming and Qing dynasties, it moved to the southwest of Jinzhong (112.15 ° E, 37.06 ° N). Since modern times, it has returned to Taiyuan and is located in the northeast of Taiyuan (112.64 ° E, 38.12 ° N). The center of gravity shifted a total of 477.82km during 8 periods.

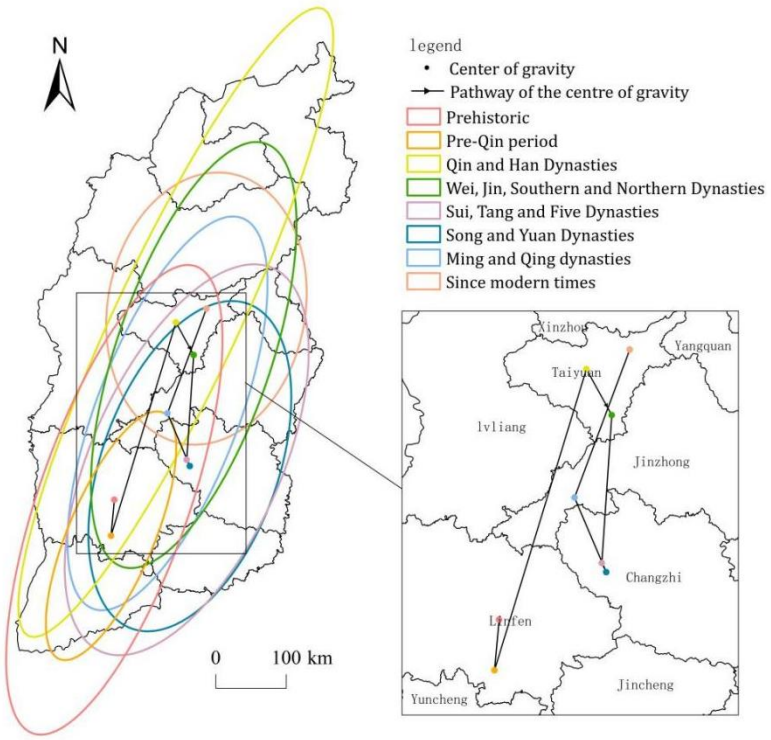

Figure 2. The center of gravity and migration direction of national cultural relics protection units in Shanxi Province in historical period

Table 2. Variation of standard deviation ellipse parameter of national cultural relics protection units in historical period

Historical periods	Center X, Y	XStdDist (km)	YStdDist (km)	Moving direction	Rotation (°)	Distance (km)
Prehistoric	111.47°E,36.17°N	106.79	349.75	—	19.32	0
Pre-Qin period	111.43°E,35.80°N	60.87	189.00	south	22.90	7.74
Qin and Han Dynasties	112.25°E,37.98°N	87.21	490.11	northeast	25.25	300.76
Wei, Jin, Southern and Northern Dynasties	112.48°E,37.65°N	110.15	315.95	southeast	18.85	8.88
Sui, Tang and Five Dynasties	112.39°E,36.59°N	134.09	297.09	south	24.38	63.44
Song and Yuan Dynasties	112.43°E,36.52°N	125.24	243.85	southeast	19.78	0.33
Ming and Qing dynasties	112.15°E,37.06°N	100.93	295.66	northwest	21.05	20.70
Since modern times	112.64°E,38.12°N	140.15	193.83	northeast	10.34	75.97

During the 8 historical periods , there was little change in the direction of the standard deviation ellipse(Table 2), ranging from 10.34 ° to 25.25 °, and the overall distribution trend tended to be northeast southwest. The elliptical short half axis decreased from 106.79km in prehistoric times to 60.87km in pre Qin times, from 87.21km in Qin Han period to 134.09km in Sui Tang and Five Dynasties period, from 125.24km in Song Yuan period, and then continued to increase to 140.15km in modern times, indicating that the spatial distribution of national cultural relics protection units has undergone an evolutionary process of aggregation dispersion aggregation dispersion. The long half axis of the ellipse decreased from 349.75km in prehistoric times to 189km in pre Qin times, from 490.11km in Qin and Han dynasties to 243.85km in Song and Yuan dynasties, increased to 295.66km

in Ming and Qing dynasties, and decreased to 193.83km in modern times, indicating that the spatial distribution of national cultural relics protection units has undergone an evolutionary process of agglomeration dispersion agglomeration dispersion agglomeration dispersion agglomeration agglomeration. Overall, the distribution characteristics of national cultural relics protection units in historical periods have been characterized by alternating agglomeration and dispersion.

4. SPATIAL DISTRIBUTION CHARACTERISTICS OF NATIONAL CULTURAL RELICS PROTECTION UNITS IN SHANXI PROVINCE

4.1. General Characteristics

According to the formula for calculating the nearest neighbor distance, using the Average Nearest Neighbor in ARCGIS 10.4 spatial statistical tool, the actual nearest neighbor distance of intangible cultural heritage resources was measured to be 5634.0058 meters, and the theoretical nearest neighbor distance was 8567.5729 meters. The ratio of the two was 0.657596<1, indicating that the national cultural relics protection units in Shanxi Province are in a clustered distribution state.

4.2. Type distribution characteristics

Using the kernel density analysis tool in ArcGIS 10.4 software, various national cultural relics protection units in Shanxi Province were analyzed , and their kernel density distribution map was obtained(Figure 3) . Overall, the distribution of national cultural relics protection units in Shanxi Province showed uneven spatial distribution characteristics, forming one high density area - Jincheng Changzhi, and two secondary density areas - Taiyuan and Yuncheng. Overall, the density distribution in southern Shanxi is higher than that in northern Shanxi.

The clustering characteristics of different types of national cultural relics protection units are also different. Ancient buildings exhibit a spatial distribution pattern of "small clustering, large dispersion", mainly concentrated in the three major basins of Changzhi, Taiyuan, and Yuncheng. Although they are distributed in other areas, they are relatively scattered. Taiyuan was mostly a political center in ancient times with a long history and culture. During the Ming and Qing dynasties, Jin merchants flourished, and a large number of ancient buildings were built here. The dry climate was conducive to the preservation of ancient buildings. One of the important reasons for its good preservation is the scarcity of natural disasters such as earthquakes and volcanoes in Shanxi Province. The ancient tombs are distributed in clusters, mainly concentrated in Yuncheng and Datong. Ancient tombs indirectly reflected the way people lived and the level of science and technology at that time. The ancient sites form a core area in Yuncheng, with scattered distribution in other areas. Yuncheng is one of the core areas where Chinese civilization originated and is also one of the important ancient human evolution fields in East Asia. Over the long course of time, it has left a brilliant history, and these ancient sites are witnesses of its history. The Ruicheng West Houdu Site and the Yuanqu Nanhaiyu Site are both distributed here. The grotto temples and stone carving generally exhibit a multi-core distribution pattern, mainly concentrated in five core areas, three high density areas - Taiyuan, Datong Xinzhou, and Linfen, and two secondary density areas - Yangquan and Jincheng. The cultural relics of grottoes in China began during the Wei, Jin, Southern and Northern Dynasties. During the Northern Wei period, Tuo Bagui moved the capital to Pingcheng (now Datong) and vigorously promoted Buddhism. During this period, a large number of grottoes were built, and Yungang Grottoes were an outstanding representative of them. Important historical sites and representative architectural units under national protection in modern times have spatial cluster distribution characteristics, with uneven distribution, mainly distributed in the Taiyuan Xinzhou area. In history, Taiyuan and Xinzhou became battlegrounds for military strategists due to their special location and topography. In modern times, they were revolutionary bases for the Chinese Anti

Japanese War, leaving behind numerous important historical sites and representative buildings of modern times.

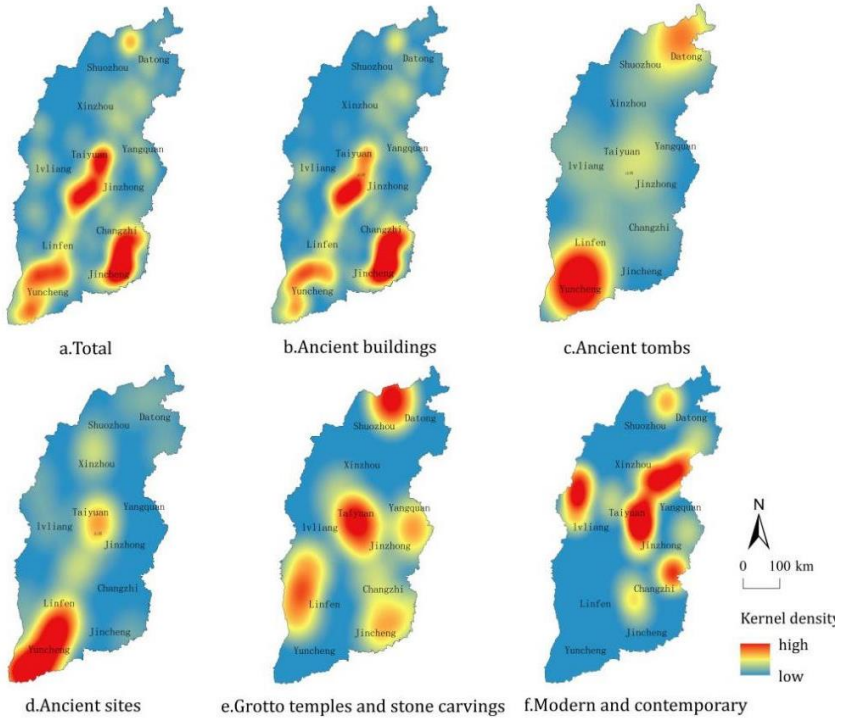

Figure 3. Nuclear density analysis of different types of national cultural relics protection units

4.3. Spatial distribution of administrative cities

Taking the city area as the administrative unit, the location entropy is used to measure the concentration degree of different types of national cultural relics protection units, and the location entropy of national cultural relics protection units in 11 cities in Shanxi Province is calculated through the location entropy formula (Table 3). Using the natural breakpoint method in ArcGIS, the obtained location quotient values were divided into three gradients: high density area, middle density area, and low density area, and the results were visualized and expressed (Figure 4).

Table 3. Location quotient of different types of national cultural relics protection units in each city

Cities	Ancient buildings	Ancient tombs	Ancient sites	Grotto temples and stone carvings	Modern and contemporary
Taiyuan	0.83	0.70	1.52	1.86	2.49
Changzhi	1.16	0.36	0.00	0.97	0.78
Yuncheng	0.91	1.84	2.40	0.00	0.00
Jinzhong	1.09	0.38	0.50	0.51	1.10
Linfen	0.91	0.98	1.92	1.96	0.35
Lvliang	0.90	1.36	0.59	1.81	2.43
Jincheng	1.21	0.00	0.16	0.98	0.00
Datong	0.76	4.42	1.15	1.18	1.89
Shuozhou	0.90	3.79	1.65	0.00	0.00
Xinzhou	0.94	0.00	0.32	0.98	3.68
Yangquan	1.14	0.00	0.00	3.21	0.00

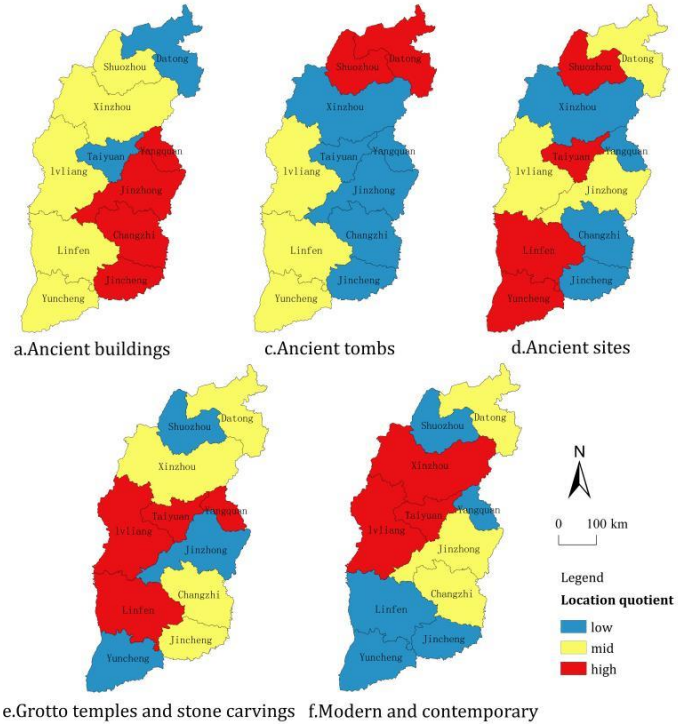

Figure 4. Location quotient level of different types of national cultural relics protection units

At the administrative and municipal level, the gradient distribution characteristics of different types of national cultural relics protection units in Shanxi Province are obvious. The high gradient area of national cultural relics protection units for ancient buildings is mainly located in Jinzhong, Yangquan, Changzhi, and Jincheng; The national cultural relics protection units for ancient tombs are mainly in low dense and middle density areas, with Datong and Shuozhou having the highest density; Shuozhou, Taiyuan, Linfen, and Yuncheng ancient sites have the highest density of national cultural relics protection units; For grotto temples and stone carvings, Taiyuan, Yangquan, Linfen and Luliang have the highest gradient level; The high gradient areas of modern national security units are mainly located in Taiyuan, Xinzhou and Luliang.

5. FACTORS INFLUENCING OF NATIONAL CULTURAL RELICS PROTECTION UNITS IN SHANXI PROVINCE

5.1. Topography

Shanxi is located in the eastern part of the Loess Plateau, with higher terrain in the northeast and lower terrain in the southwest. There are various types of landforms within the territory, including basins, plains, mountains, hills, and plateaus. Most areas have an altitude of over one kilometer, with mountains and hills accounting for more than two-thirds of the total area of the province. Within Shanxi Province, there are numerous ravines and valleys, with a total terrain of "two mountains sandwiched by one river". The two mountains are the Taihang Mountains in the east and the Lvliang Mountains in the west, with a series of basins in the middle and plains distributed among them. The Yanbei Basin, Xinzhou Basin, Taiyuan Basin, Lvliang Basin, Yangquan Basin, Changzhi Basin, Jincheng Basin, Linfen Basin, and Yuncheng Basin, which are separated by the Pearl River from north to south, are nine "multiple" shaped fault basins.

Altitude is the main indicator for measuring terrain elements, and the spatial distribution of national cultural relics protection units at different altitudes can be used to reflect their terrain distribution characteristics. Overlay the spatial coordinates of the national cultural relics protection units with the

elevation (Figure 5), and use the value extraction point tool of ArcGIS software to statistically analyze the elevation of the national cultural relics protection units in Shanxi Province. The elevation difference of the national cultural relics protection units in Shanxi Province is 317-1718 meters, with an average elevation of about 819 meters. 63.02% of national cultural relics protection units are distributed in areas between 500 and 1000 meters, while 14.53% and 22.45% of national cultural relics protection units are respectively distributed in areas below 500 meters and above 1000 meters above sea level. The results show that the spatial distribution of national cultural relics protection units in Shanxi Province is closely related to their terrain and landforms. National cultural relics protection units are mainly concentrated in the central and southern basin areas, and spread outward to low altitude areas as the core.

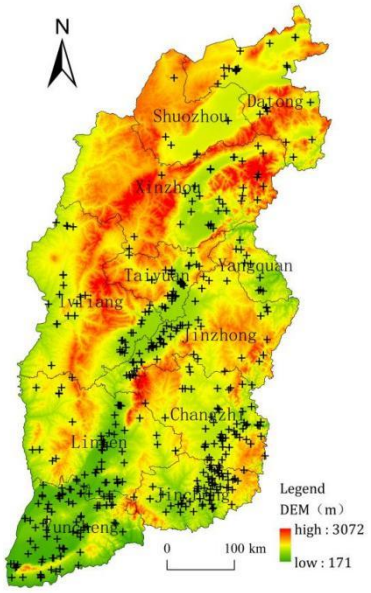

Figure 5. Analysis of national cultural relics protection units and DEM in Shanxi Province

5.2. River system

As the birthplace of human civilization, rivers were an important place for early human production and life activities. Shanxi Province is known as the "mountains and rivers on the surface and inside". The terrain conditions of thousands of valleys make the rivers in Shanxi Province densely distributed. The main famous ones include the Fen River and Sushui River in the Yellow River system, and the Sanggan River and Hutuo River in the Hai River system. Overlay the spatial coordinates of national cultural relics protection units with the water system of Shanxi Province (Figure 6), and perform 5km and 10km buffer zone analysis on the fourth level and above river water system in Shanxi Province. Overall, the national cultural relics protection units in Shanxi Province are mainly distributed around river systems, while those in northern Shanxi are mainly distributed in the Fen River and Qin River basins. In southern Shanxi, the national cultural relics protection units are mainly concentrated in the Sanggan River and Hutuo River basins. Further analysis reveals that there are a total of 310 national cultural relics protection units within the 5km buffer zone, accounting for 58.38% of the total; There are a total of 444 locations within the 10km buffer zone, accounting for 83.62% of the total, indicating that the distribution pattern of national cultural relics protection units in Shanxi Province is decreasing outward from the main river systems, indicating the distribution direction of "hydrophilicity" of national cultural relics protection units.

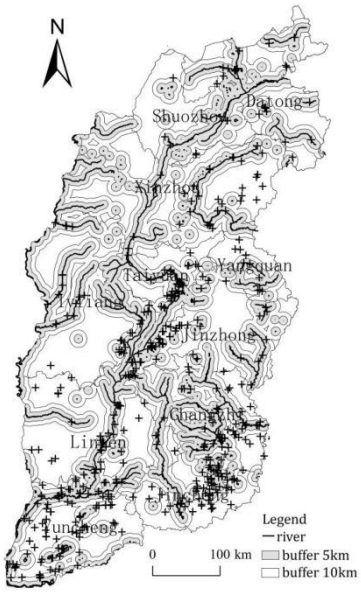

Figure 6. Analysis of national cultural relics protection units and buffer areas of Grade 4 and above rivers in Shanxi Province

5.3. Traffic

Transportation is an important link connecting regional economic development, and the development and progress of transportation indirectly reflect the level of development and civilization of human society. Overlaying the spatial coordinates of national cultural relics protection units with the transportation (railway, highway) of Shanxi Province (Figure 7), statistical analysis revealed that there were 300 (56.50% of the total) and 406 (76.46% of the total) national cultural relics protection units distributed in the 5km and 10km buffer zones of the railway, and 218 (41.05% of the total) and 324 (61.02% of the total) national cultural relics protection units distributed in the 5km and 10km buffer zones of the highway, respectively. This indicates that there are differences in the correlation between the distribution of national cultural relics protection units in Shanxi Province and the distribution of railways and highways. The correlation between national cultural relics protection units and the distribution of railways is higher than that of highways. Most national insurance units are located near railways, which is significantly related to the spatial distribution of railways and highways in Shanxi Province.

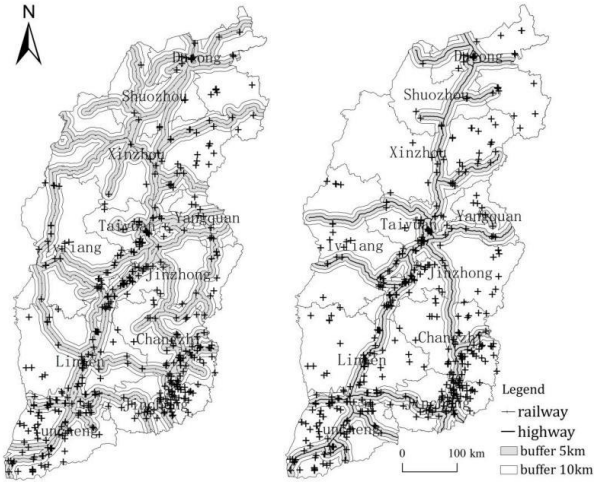

Figure 7. Analysis of national cultural relics protection units and traffic buffer area in Shanxi Province

6. CONCLUSION

Based on the data of 530 national security units in Shanxi Province, the spatial-temporal distribution characteristics and influencing factors were analyzed using mathematical statistics and GIS spatial analysis. The main conclusion is as follows: From pre-Qin to modern times, there were significant differences in the number of national cultural relics protection units in different historical periods, showing an overall trend of first increasing and then decreasing. The formation of various types of national cultural relics protection units has a relatively concentrated historical period. The distribution center of national cultural relics protection units has changed with historical periods, showing a migration characteristic in the direction of south northeast southeast south southeast northwest northeast. The national cultural relics protection units in Shanxi Province are in a clustered distribution state, and the clustering characteristics of different types of national cultural relics protection units are also different. The gradient distribution characteristics of national cultural relics protection units in different administrative cities are obvious. The spatial and temporal distribution of national cultural relics protection units in Shanxi Province is influenced by factors such as topography, river systems, and transportation.

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