

Article

Spatiotemporal Distribution of Inscription Sites in Henan Province

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Abstract: This paper takes 1929 inscription sites in Henan Province as the study object and uses methods such as kernel density and nearest neighbor index to analyze their spatiotemporal distribution patterns and influencing factors. It also studies those patterns of various levels of inscription cultural relics' protection units and content. All of these will help our understanding of the development process and characteristics of Central Plains art and provide reference for the protection and development of inscriptions in Henan in the future. The study indicates the following: (1) The spatial distribution of inscription sites is relatively uneven and the clustering is obvious, being mainly concentrated in the northern and northwestern regions of Henan, showing the characteristics of "one belt and four clusters" as a whole. The density is high in the north and low in the south, gradually decreasing from north to south. (2) In terms of time, the number of these inscription sites shows a fluctuating trend of first a slight increase and then a decrease with a significant increase and then a decrease. The center of the sites migrates from southwest to northeast over time. (3) These inscriptions can be divided into five primary themes and further subdivided into 16 secondary themes in terms of content. The main type is chronicle. (4) Inscriptions in Henan are mainly influenced by five major factors: topography, climate, economy and transportation, politics and society, culture and religion.

Keywords: Central Plains art; inscription; Henan Province; spatiotemporal distribution



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1. Introduction

Henan Province, located in the middle and lower reaches of the Yellow River, has been a core part of China's territory and civilization since ancient times. As the most brilliant pearl in Central Plains art, Henan Province is home to a large number of historical and cultural sites from the Shang and Zhou Dynasties to New China, and it has unearthed many cultural relics with high artistic value. Among them, the inscription, as a unique form of cultural expression, is the historical and cultural carrier that integrates various art forms such as carving, painting, and calligraphy. It not only records the process of the Chinese nation and civilization but also reveals the social, political, economic, and artistic development of various dynasties [1–3], reflecting the wisdom and creativity of the people in the Central Plains. The earliest appearance of stone text in China dated back to the Shang Dynasty, while tablets began in the Zhou Dynasty and inscriptions originated in the Qin and Han Dynasties. In the early days, inscriptions were only used in tombs or the front of family temples to mark and tie sacrificial animals, but they were not engraved and only appeared in some special occasions. It was not until the early Eastern Han Dynasty that some people carved tablets to record the life and achievements of their ancestors, and others followed suit. It was only then that the inscriptions that we see today gradually developed [4]. The earliest inscriptions in Henan can be traced back to the Eastern Han Dynasty with a large number of Han inscriptions ranking among the top in China. As the capital city of the Eastern Han, Wei, and Jin Dynasties, Luoyang in Henan was the political and cultural center of the country with a large population and convenient transportation. This unique geographical environment and historical conditions have made

Henan occupy an important position in China's inscriptions. In addition, these inscription have the characteristics of large quantity and high quality. Firstly, they have a large quantity. Henan has more than ten stone tablet forests, such as Longmen in Luoyang and the Yellow River in Zhengzhou. The Longmen Stone Tablet Forest alone has more than 3600 tablets, making it the province with the most stone tablet forests sites in China, with a total of over ten thousand inscriptions [5,6]. Secondly, they are of high quality, including the *Yin Zhou Inscription*, the recovered *Yuan An Inscription*, the *Twenty Inscriptions of Longmen Grottoes*, and the extremely rare Taoist inscription *Song Gao Ling Temple Inscription* [7], all of which provide a foundation for studying the historical facts and culture of Henan and even China as well as the development of Central Plains art.

Scholars, both domestic and international, have extensively studied the spatial and temporal distribution of cultural heritage sites. For instance, Chun Jiang and colleagues utilized GIS to analyze the spatiotemporal distribution characteristics of cultural sites in northern Pakistan and proposed corresponding protection strategies [8]. Mengdi Jiang and others employed GIS spatial analysis and binary logistic models to examine the spatial distribution characteristics, changing patterns, and influencing factors of Majiayao and Qijia cultural sites from the Neolithic period in the Lanzhou Basin [9]. Liwen Jiang and colleagues used GIS analytical methods to study the spatiotemporal distribution and evolutionary characteristics of ancient architectural heritage in southeastern Zhejiang [10]. Qifan Dai and others analyzed the spatiotemporal distribution, influencing factors, and environmental changes of 295 water-related cultural heritage buildings in the Lijiang River Basin using GIS analysis and random forest algorithms [11]. Lin Yang and colleagues utilized GIS to analyze the Neolithic archaeological cultural regional types in the Taihu Lake area of China [12]. These examples demonstrate that GIS spatial analysis methods can provide quantitative and scientific tools from a spatiotemporal perspective for studying the development and evolution of the inscription art in Henan.

In summary, combining principles such as GIS spatiotemporal analysis can make the study of cultural heritage sites more scientific. Currently, research on stela art in China lacks effective use of data and quantitative methods. Xiaojing Cai studied the historical process of the sinicization of religion in China based on Buddhist and Taoist inscription [13]. Peng Duan researched the spread and governance of the Jade Emperor belief in the border areas since the Ming and Qing dynasties based on the inscription of the Jade Emperor Pavilion in Yunnan [14]. Chengjie Zhao investigated the establishment of the Confucian system and its significance in Confucian history in Yunnan based on Ming dynasty Confucian inscription [15]. Regarding research subjects, the study of inscriptions in China mainly focuses on analyzing their cultural connotations and historical backgrounds, often dealing with individual inscriptions [16–19]. There is a lack of comprehensive research on inscription art at the provincial level. Methodologically, inscription research typically employs qualitative methods, relying on traditional field archaeology and textual criticism with little exploration of quantitative methods. There is no comprehensive and systematic study on the spatiotemporal distribution characteristics and influencing factors of inscription sites. GIS spatial analysis, due to its advantages in studying the spatial distribution, spatial relationships, and changing patterns of cultural heritage sites, provides an effective technical means for researching the spatiotemporal evolution and archaeology of inscription art sites [20]. This paper, based on quantitative GIS spatial analysis methods such as kernel density analysis, nearest neighbor index, and standard deviational ellipse [21–24], aims to identify the following: (1) the spatiotemporal distribution characteristics of inscription art sites in Henan Province, and (2) the impact of human and natural factors on the development and stylistic formation of Henan inscription art in conjunction with existing research findings.

This study focuses on the provincial-scale analysis of inscription art sites, aiming to explore the evolution and development of inscription art in Henan Province. By treating inscription art as a whole, we analyze the distribution density of sites and the stylistic changes in inscription to investigate the impact of natural and human factors on the development

and stylistic formation of inscription art in Henan. Additionally, utilizing quantitative GIS methods, we examine the spatiotemporal clustering and stylistic characteristics of Henan inscription art across different historical periods, revealing the development and evolution processes within the region. Combining the historical and cultural context of Henan with existing research on inscription, this study not only traces the overall development trajectory of Henan's inscription art but also considers the thematic types of inscription, providing a more comprehensive reflection of the development and evolution of inscription art in Henan. This research offers qualitative and quantitative analytical bases for Henan inscription art, thereby promoting the comprehensive development of cultural heritage protection and utilization in Henan Province [25].

2. Study Area, Data Sources, and Methods

2.1. Overview of the Study Area

Henan, known as the Central Plains and Zhongzhou, is located in central and eastern China and the middle and lower reaches of the Yellow River. It is named Henan because most of the area is in the south of the Yellow River. It has 17 prefecture-level cities including Zhengzhou, Kaifeng, Luoyang, Pingdingshan, Jiaozuo, Hebi, Xinxiang, Anyang, Puyang, Xuchang, Luohe, Sanmenxia, Nanyang, Shangqiu, Xinyang, Zhoukou, Zhumadian, and Jiyuan as well as one provincial-level city (Figure 1). The total land area is 167,000 km², accounting for approximately 1.73% of the total national area. At the end of 2022, its permanent population was about 98.72 million, with a total GDP of 6.13 trillion yuan, accounting for about 5% of the national economy. Therefore, it is an important driving force for the economic development of the Central Plains.

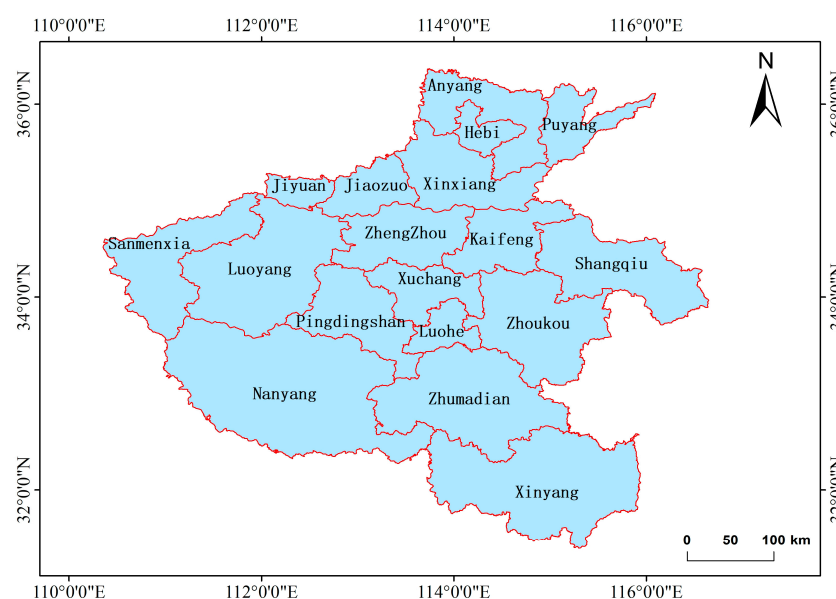


Figure 1. Administrative map of Henan Province (source: drawn by the author).

2.2. Overview of the Study Time Period

This paper describes the Chinese dynasties covered in the study, which covers the period from the Han Dynasty, when inscribed sites first appeared in Henan, to the New China period, and it is summarized into twelve time periods by combining shorter periods and removing the Sui Dynasty, which had no inscribed sites (Figure 2). These include the Han Dynasty, the Three Kingdoms and the Jin Dynasties, the Northern and Southern Dynasties, the Tang Dynasty, the Five Dynasties and Ten Kingdoms, the Song Dynasty, the Jin Dynasty, and the New China Period, including the Song Dynasty, the Jin Dynasty, the Yuan Dynasty, the Ming Dynasty, the Qing Dynasty, and the Republic of China, New China. Since the Han, Three Kingdoms, and the Jin Dynasties are in the early stages of the development of Henan inscriptions, and their numbers are small and not illustrative,

the above periods are grouped into the same group for analysis in the study of this paper. The Song Dynasty and the Jin Dynasty overlapped considerably, but both dynasties ruled separately over Henan. However, both dynasties ruled Henan for a long time, leaving a large number of monumental sites and having a great influence on the development of monumental inscriptions in Henan; therefore, this paper regards the Song Dynasty and the Jin Dynasty as two periods of time and discusses them separately. Because of the simultaneous existence of the old and new dynasties, this paper takes the year of the destruction of the previous dynasty as the demarcation point of the two periods.

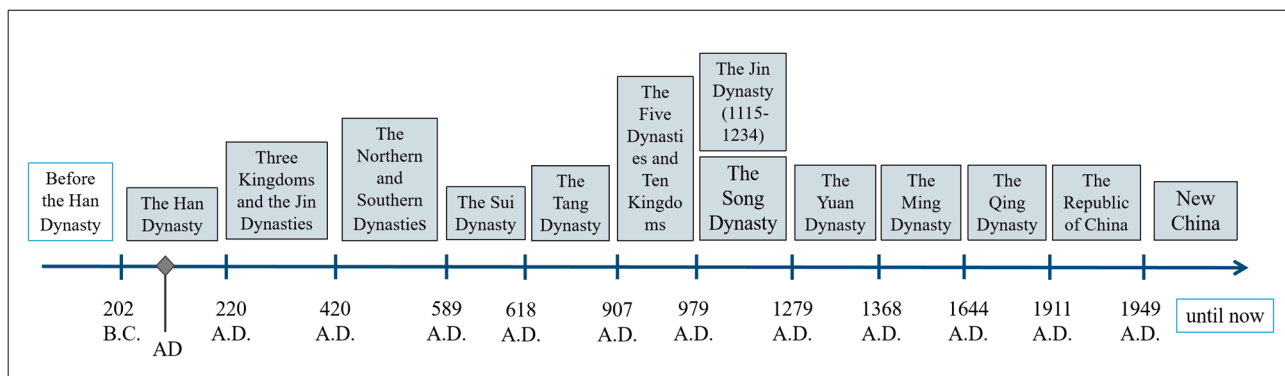


Figure 2. Timeline of Chinese dynasties from the Han Dynasty to the New China period (source: drawn by the author).

2.3. Data Sources

The data and information of the inscription sites in this paper mainly come from the *Atlas of Chinese Cultural Relics—Henan Branch*, *Annals of Henan Province*, *Henan Geographical Annals*, which contains the lists of cultural relics protection units in Henan Province (1~8 batches) and various cities, including the location and names of the inscriptions in Henan as well as data and materials on climate, topography, and the evolution of the Yellow River channel in the study area.

2.4. Methods

This paper uses GIS analysis methods such as kernel density analyses from two perspectives. On the one hand, by examining the spatial distribution and temporal evolution characteristics of inscription sites, it explores the development process, distribution patterns, and influencing factors of Henan's inscription art from a macro-level perspective. The study employs methods such as kernel density analysis, nearest neighbor index, and standard deviation ellipse, providing quantitative analysis for the macro-distribution of Henan's inscription art sites. On the other hand, the study reviews the themes and content types of Henan inscription art using existing archaeological data and employs GIS spatial analysis methods to quantitatively describe the core distribution areas of inscriptions with different themes across various periods. It investigates the evolutionary trends in their spatial and temporal distribution patterns with a focus on the changes in styles and content types of Henan inscription art during different historical periods. By integrating these two research perspectives, the study comprehensively analyzes the spatiotemporal evolution characteristics and influencing factors of Henan's inscription art.

2.4.1. Nearest Neighbor Index

This paper uses the nearest neighbor index to reflect the spatial distribution types of Henan inscription sites and obtain the proximity values of each cultural site. When the index is less than 1, it indicates that the spatial distribution of the site belongs to the clustered distribution. When the index is equal to 1, it indicates that it is uniform distribution. Meanwhile, when it is greater than 1, the sites are spatially dispersed [26].

2.4.2. Nuclear Density Analysis

The kernel density is used to effectively reflect the spatial density and clustering characteristics of Henan inscription sites. The degree of clustering is visualized through the kernel density values. It means that the higher the kernel density value, the denser the distribution of cultural sites [27].

2.4.3. Standard Deviation Ellipse (SDE)

In this paper, the standard deviation ellipse is used to determine the distribution direction of inscription sites in different periods. The long axis of the ellipse represents the main direction of the sites, the short axis represents the secondary direction, and the inclination angle of the ellipse represents their distribution trend. By comparing the trend and direction of inscription sites in different periods, the evolution of their spatiotemporal distribution direction can be obtained [28].

3. Spatiotemporal Evolution and Distribution of Henan Inscription Sites

This paper uses the kernel density to study the spatiotemporal distribution pattern of inscription sites in Henan Province. There are a total of 1929 sites in the study area from the Han Dynasty to the present (see Table 1). The spatial clustering of these inscription sites is obvious, showing the distribution pattern of “one belt and four clusters”. They are mainly distributed in the northern, northwestern, southern, southwestern, eastern, and central regions of Henan Province. Among them, the northern and northwestern regions show a more obvious southwest–northeast strip clustering feature, mainly located in five cities, including Anyang and Zhengzhou, while the northern and northwestern regions are the center’s inscriptions. The spatial distribution of these sites is relatively uneven and the clustering is obvious. The density is high in the north and low in the south, gradually decreasing from north to south (Figures 3 and 4).

Table 1. Number and spatiotemporal distribution of inscription sites in Henan Province (source: drawn by the author).

City	The Number of Inscription Art Sites in Henan Province/Place													Total
	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	
Zhengzhou	1		11	17		11	8	9	23	77	14	2		173
Kaifeng						1			6	25	6	4		42
Pingdingshan	2			1				2	7	46	7			65
Luoyang		1	4	10		9	1	6	24	119	16	4	1	195
Jiaozuo			4	4		5	4	6	22	95	5	3		148
Jiyuan				5	1	10	5	11	9	14	1			56
Hebi			3	3	1	1			24	88	2	14	1	137
Xinxiang			10	5		4		14	50	57	19			159
Anyang			4	3		7	1	7	24	95	22	5		168
Puyang				1		1	1	2	17	37	15	3	1	78
Xuchang	1							5	6	11	3	2		28
Luohe		2				1			4	22	6			35
Sanmenxia			1	11		1		2	15	55	5	5		95
Shangqiu								1	19	86	6			112
Zhoukou			1	1		2			11	33	11	1		60
Zhumadian						1	1		13	74	3			92
Xinyang				1		1			14	85	4			105
Nanyang	3		1	1		2	3	8	31	103	26	3		181
total	7	3	39	63	2	57	24	73	319	1122	171	46	3	1929

Note: ① The Han Dynasty; ② Three Kingdoms and the Jin Dynasties; ③ The Northern and Southern Dynasties; ④ The Tang Dynasty; ⑤ The Five Dynasties and Ten Kingdoms; ⑥ The Song Dynasty; ⑦ The Jin Dynasty; ⑧ The Yuan Dynasty; ⑨ The Ming Dynasty; ⑩ The Qing Dynasty; ⑪ The Republic of China; ⑫ New China; ⑬ Unknown.

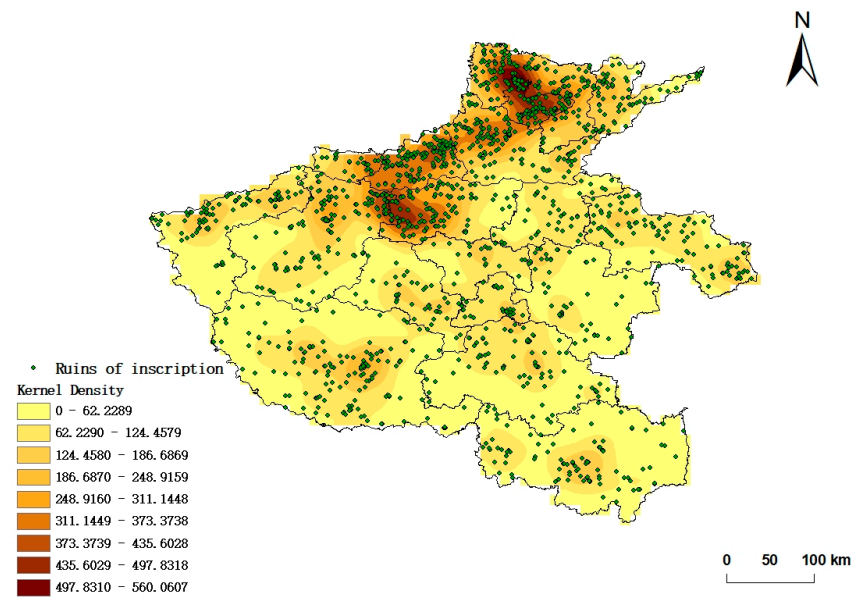


Figure 3. Analysis of nuclear density of inscription sites in Henan Province (source: drawn by the author).

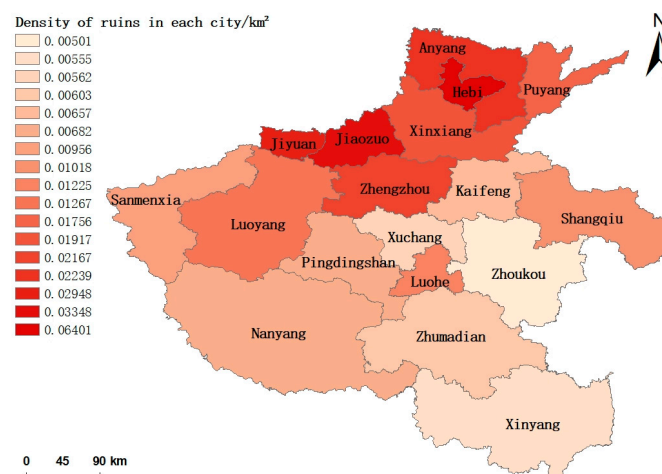


Figure 4. Density of inscription sites in various cities of Henan Province (source: drawn by the author).

In terms of time, the number of Henan inscription sites has shown a slight increase from the Han Dynasty to the Tang Dynasty, a decrease from the Five Dynasties and Ten Kingdoms period to the Jin Dynasty, a significant increase from the Yuan Dynasty to the Qing Dynasty, and a decrease from the Republic of China to the New China. The center of inscription sites has changed over time, migrating from southwest to northeast.

3.1. Clustering Characteristics of Henan Inscription Sites in Different Periods

The nearest neighbor index is used to analyze Henan inscription sites and explore their spatial distribution pattern. The results show that the distribution pattern of these sites in the Han, Three Kingdoms, and the Jin Dynasties was spatial dispersion, while in the other periods, it was spatial clustering, and the trend of the nearest neighbor index R was consistent with that of the number of inscriptions. The nearest neighbor index R during the Northern and Southern Dynasties and the Jin Dynasty was relatively close to 1 with the least significant spatial clustering. Meanwhile, during the Qing Dynasty, the index was the smallest with the most significant clustering. Overall, the nearest neighbor index R and critical value Z changed significantly from the Han Dynasty to the New China, reaching

0.128152 and -55.267914 in the Qing Dynasty, respectively, indicating a significant increase in the degree of site clustering during this period (see Table 2). The main reason for this is that during the Han to the Jin Dynasties, the development of Henan inscriptions had just begun with a relatively small quantity and low correlation. Fortunately, the Central Plains was relatively stable from the Tang Dynasty to the Song Dynasty. With the increase in population and the progress of productivity, the number of inscription sites slightly increased during this period, and the concentration increased as well. However, due to the impact of war in the Jin Dynasty, the number and concentration of these inscriptions decreased. From the Yuan Dynasty to the Qing Dynasty, the Central Plains remained stable. With the further development of productivity, the study of inscriptions gradually matured. During this period, the number of these sites increased significantly, and the degree of site clustering increased, which was the most obvious. During the Republic of China and New China, the inscriptions lost their functional value, and the number and spatial concentration decreased because of modern technology.

Table 2. Nearest neighbor index of Henan inscription sites in different periods (source: drawn by the author).

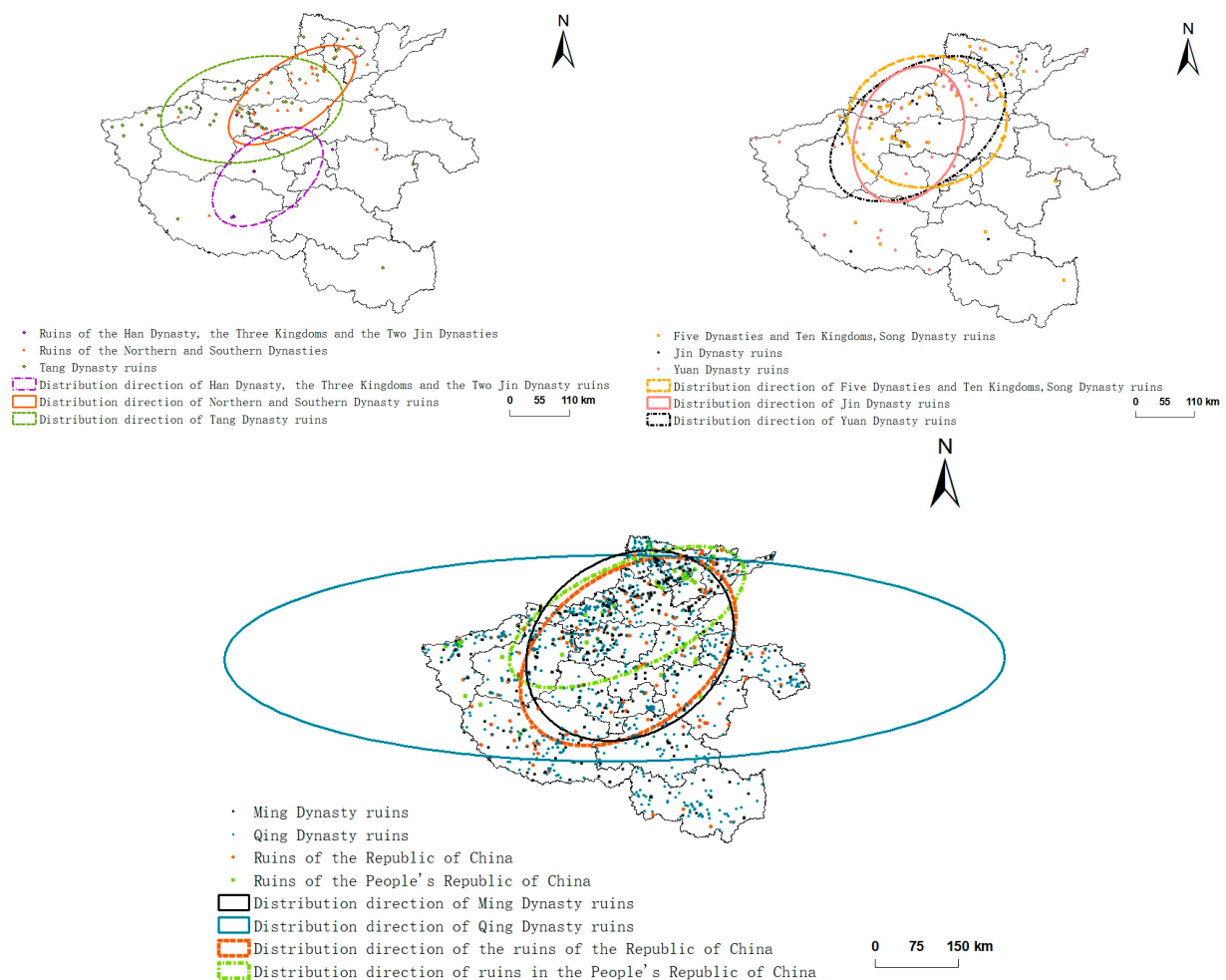
Period	Site Number/ Place	Actual Average Nearest Neighbor Distance/m	Theoretical Average Nearest Neighbor Distance/m	Nearest Neighbor Index R	Type	Critical Value Z
Han Dynasty, Three Kingdoms, Jin Dynasties	10	30,437.161957	29,739.066967	1.023474	dispersion	0.127017
Northern and Southern Dynasties	39	20,322.7062	20,595.5021	0.986755	clustering	-0.158245
Tang Dynasty	63	19,594.0702	27,511.0514	0.712225	clustering	-4.228724
Five Dynasties, Ten Kingdoms, Song Dynasties	59	18,272.2616	26,283.4357	0.695201	clustering	-4.284911
Jin Dynasty	24	27,884.4790	32,824.8347	0.849493	clustering	-1.410562
Yuan Dynasty	73	14,390.6961	25,555.3654	0.563118	clustering	-6.99268
Ming Dynasty	319	8956.9436	14,756.4989	0.606983	clustering	-13.323155
Qing Dynasty	1122	4308.9258	33,623.6832	0.128152	clustering	-55.267914
Republic of China	171	13,122.369	18,928.0629	0.693276	clustering	-7.58293
New China	46	14,571.0867	25,907.0387	0.562437	clustering	-5.615357

3.2. Distribution Direction of Henan Inscription Sites in Different Periods

By analyzing the standard deviation ellipses of the distribution of Henan inscription sites in different periods (Table 3 and Figure 5), the overall direction is “south (west) to north (east)”, and the main axis of the ellipses moves toward the northeast. During the Han, Three Kingdoms, and Jin Dynasties, it mainly covered the southwestern and central regions of Henan. During the period from the Northern and Southern Dynasties to the Song Dynasty, it covered the northern and northwestern regions. During this period, the azimuth angle gradually increased, and the distribution trend in the southwest–northeast direction gradually weakened, reaching its weakest point by the Song Dynasty. From the Jin Dynasty to the Ming Dynasty, it mainly covered most of the northern and central regions, with a significant increase in coverage, and the distribution trend was strengthened. The standard deviation ellipse of the Qing Dynasty basically covered the entire area of Henan, with a large number of inscription sites distributed in its various cities. During this period, the azimuth angle was close to 90° , and the distribution trend basically disappeared. From the Republic of China to the New China, it mainly covered the northern and central regions, with a gradually decreasing azimuth angle and a strengthening distribution direction.

Table 3. Standard deviation elliptical parameters and changes of Henan inscription sites in different periods (source: drawn by the author).

Period	Coordinate	Distance/km	Direction	City	Rotation Angle
Han Dynasty, Three Kingdoms, Jin Dynasties	113°7′41″ E, 33°39′11″ N			Pingdingshan	51.88°
Northern and Southern Dynasties	113°32′3″ E, 35°0′41″ N	155.55	northeast	Jiaozuo	55.46°
Tang Dynasty	112°51′57″ E, 34°46′26″ N	66.44	southwest	Luoyang	79.20°
Five Dynasties, Ten Kingdoms, Song Dynasties	113°22′6″ E, 34°51′53″ N	46.98	northeast	Zhengzhou	84.05°
Jin Dynasty	113°3′24″ E, 34°39′4″ N	37.07	southwest	Zhengzhou	24.67°
Yuan Dynasty	113°12′56″ E, 34°44′50″ N	18.03	northeast	Zhengzhou	56.93°
Ming Dynasty	113°43′31″ E, 34°35′1″ N	50.05	southeast	Zhengzhou	56.59°
Qing Dynasty	113°28′48″ E, 34°22′33″ N	32.21	southwest	Zhengzhou	89.80°
Republic of China	113°41′43″ E, 34°29′11″ N	23.26	northeast	Zhengzhou	54.75°
New China	113°40′50″ E, 35°2′41″ N	62.08	northwest	Xinxiang	65.62°

**Figure 5.** Distribution direction of Henan inscription art sites in different periods (source: drawn by the author).

The distribution of inscription sites in the above historical periods corresponds to the characteristics of the migration of the center of these sites in different historical periods. The scattered distribution of the inscription sites in different periods mainly focuses on the central (northwest) region of Henan. During the Han Dynasty to the Southern and Northern Dynasties, the center shifted significantly toward the northeast by 155.55 km and reached Jiaozuo. From the Southern and Northern Dynasties to the Sui and Tang Dynasties, the center shifted 66.44 km to the southwest and reached Luoyang. During the Sui, Tang, Five Dynasties, and the Song dynasty, the center shifted 46.98 km northeast and reached

Zhengzhou. From the Song Dynasty to the Republic of China, the center slightly moved within Zhengzhou. During the New China era, the center shifted 62.08 km to the northwest and reached Xinxiang. All of these show that the center shifted toward the northeast on the whole, and its speed gradually slowed down.

3.3. Nuclear Density of Henan Inscription Sites in Different Periods

The study of the spatial distribution of inscription sites in Henan during different historical periods is helpful to deepen our understanding and recognition of the relationship between humans and nature, environmental changes, and cultural evolution in Henan [29].

The number of inscription sites during the Han Dynasty, Three Kingdoms, and the Jin Dynasties only accounted for 0.52% of the total, showing a dotted distribution pattern. They mainly concentrated in Luohe and Nanyang, indicating that the central and southwestern regions of Henan were the center of inscriptions during this period (Figure 6).

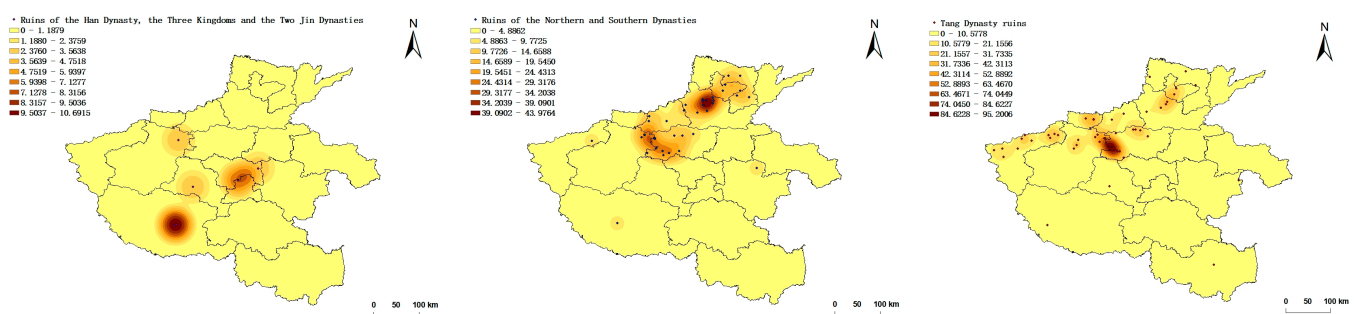


Figure 6. Analysis of nuclear density of Henan inscription sites from the Han Dynasty to the Tang Dynasty (source: drawn by the author).

The number of these sites during the Northern and Southern Dynasties accounted for about 2.04% of the total, showing a clustered distribution. They mainly concentrated in Xinxiang and Zhengzhou, and then they spreading toward the northeast and southwest with Xinxiang as the center. Compared with the Han Dynasty, Three Kingdoms, and the Jin Dynasties, the high concentration areas during the Northern and Southern Dynasties migrated northward, and the northern region of Henan became the center of inscriptions during this period (Figure 6). It was in this period that the number of the sites increased, indicating that their development was relatively good [30].

The number of Tang Dynasty inscription sites accounted for about 3.28% of the total, and a trend of strip distribution has begun to emerge. There are multiple clusters, which are mainly concentrated in three cities, including Zhengzhou. The most significant one is the high-density cluster located in the west of Zhengzhou. The high-density area has migrated from northern to central and western Henan, indicating that the central and western regions became the center of inscriptions during this period (Figure 6). The number of Tang Dynasty inscriptions further increased compared to those of the Northern and Southern Dynasties, maintaining a growing trend.

During the Five Dynasties, Ten Kingdoms, and the Song Dynasties, the number of inscription sites accounted for about 3.02% of the total. The overall trend of strip distribution was weakening, and the high-density clusters located in the western part of Zhengzhou continued to gather. At the same time, a high-density cluster located in Jiyuan was formed. In terms of space, the high-density areas of these sites stopped migrating to the west and began to develop toward the northern part of Henan, indicating that the northwest and central regions became the center of inscriptions (Figure 7). During this period, there was a slight decrease in the number of sites, showing a decreasing trend.

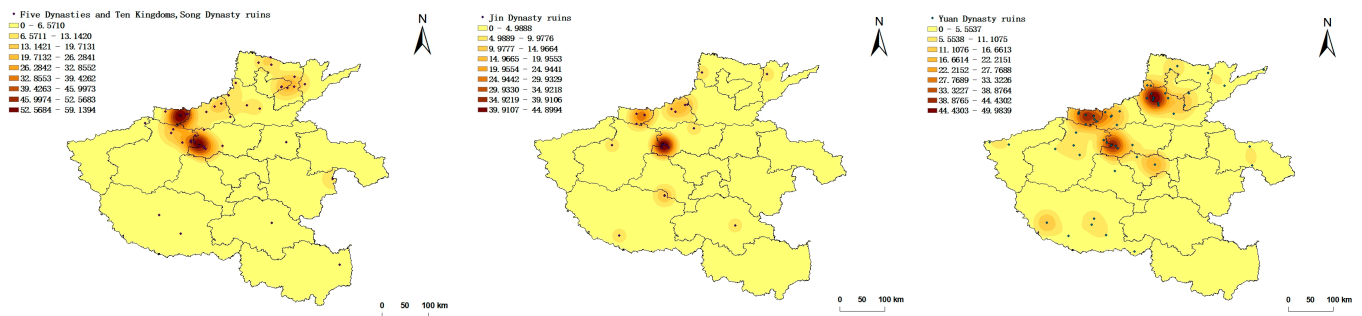


Figure 7. Analysis of nuclear density of Henan inscription sites from the Five Dynasties and Ten kingdoms to the Yuan Dynasty (source: drawn by the author).

The number of sites in the Jin Dynasty accounted for about 1.25% of the total, with a disappearing trend of strip distribution and a more scattered spatial distribution, returning to the cluster. The high-density clusters located in Jiyuan disappeared, and the same located in the west of Zhengzhou also weakened. However, they still spread from Zhengzhou to the surrounding areas, and the central region of Henan became the center of inscriptions during this period (Figure 7). The number of these sites showed a significant decrease, further showing a decreasing trend.

The inscription sites during the Yuan Dynasty accounted for about 3.86% of the total number, and their spatial distribution still clustered. However, compared to the Jin Dynasty, they were larger in scale and had a higher degree of clustering. In addition to the high-density cluster located west of Zhengzhou, the cluster located in Jiyuan reclustered and further formed a high-density cluster located in Xinxiang. The central and northern regions of Henan became the center of inscriptions (Figure 7). The number of these sites increased, showing a growing trend.

The number of the Ming Dynasty inscription sites accounted for about 16.58% of the total, showing a belt spatial distribution. Several high-density clusters further gathered and formed a northeast–southwest belt distribution. The number of sites in the northern region of Henan increased rapidly, which were mainly located in three cities, including Anyang City. The northern region became the center of the Ming Dynasty inscriptions (Figure 8). The number of these sites continued to increase and maintained a growing trend.

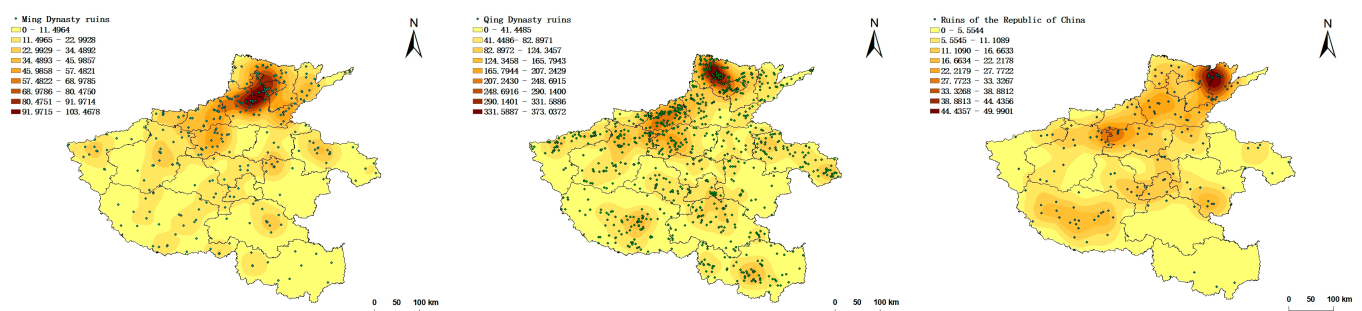


Figure 8. Analysis of nuclear density of Henan inscription sites from the Ming Dynasties to the Republic of China (source: drawn by the author).

The number of the Qing Dynasty inscription sites accounted for about 58.11% of the total, showing a belt spatial distribution. The high-value areas in the north further gathered on the basis of the Ming Dynasty, and the nuclear density value greatly increased. In addition to the high-value areas in the north, another high-value area was formed in three cities, including Jiaozuo in the northwest of Henan, and showed a scattered trend toward the surrounding areas. The spatial characteristics of northeast–southwest belt clustering in the north and northwest of Henan were basically formed, and the northern

and northwestern regions of Henan became the center of inscriptions (Figure 8). The number of these sites significantly increased, accounting for more than half of the total.

The number of inscription sites during the Republic of China accounted for about 8.71% of the total, still showing a trend of belt spatial distribution. However, compared to the Qing Dynasty, the distribution area of the sites was more concentrated and contracted, mainly concentrating in the northeast, central, and southwest regions of Henan. High-value areas migrated from the north and northwest to the northeast, indicating that the northeast region became the center of inscriptions (Figure 8). The number of these sites decreased significantly compared to the Qing Dynasty but still exceeded the number of those in other periods except the Ming and Qing Dynasties.

The number of inscription sites during the New China period accounted for about 2.39% of the total with a clustered spatial distribution. The distribution area further contracted compared to the Republic of China and was mainly concentrated in the northern region. Except for the higher density in the northern region, the density in other regions was lower. The northern region of Henan became the center of inscriptions (Figure 9). The number of these sites in the New China period further decreased compared to the Republic of China. This is mainly due to the decrease in the theme and form of Henan inscriptions after the founding of New China. Most of the inscriptions built during this period were monuments to martyrs, and modern methods were used to record major historical events. Inscriptions only played a commemorative role, resulting in a further decrease in the number of Henan inscriptions during this period.

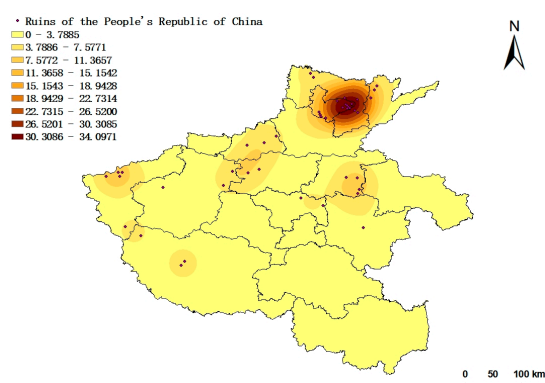


Figure 9. Analysis of nuclear density of Henan inscription sites during the New China (source: drawn by the author).

3.4. Analysis of the Theme and Content of Henan Inscription Sites

Inscription is a common cultural carrier in ancient China and an important way of recording. It not only has diverse forms but also carries a large amount of social information, making it an important part of traditional Chinese culture. It has played an important role in the recording and dissemination of Chinese culture. In terms of the purpose of dissemination and the content of the text, inscriptions can be divided into various types, such as marking, achievement, chronicle, sacrifice and notice [31]. The 1929 inscription sites in Henan can be divided into five primary themes in terms of content, and they can be further subdivided into 16 secondary themes (see Table 4). The five primary themes include recording historical events (chronicle tablets), recording historical figures (achievement tablets), religious art (cultural and artistic tablets), boundary tablets (marking tablets), and others (unidentifiable or wordless tablets). Among them, the highest number of inscriptions recording historical events is 1216, accounting for more than 60% of the total, indicating that the main type is chronicle tablets. The recording of historical events can be divided into seven secondary themes: recording the renovation and creation of buildings, major events during the Anti-Japanese War, warning policies, customs and prohibitions, major family events, hydrology and water control of the Yellow River, and major historical events. Among them, the number of events such as the renovation of buildings is up to

592, accounting for more than half of the total number of this category, and it is the main content of chronicle tablets. The recording of historical figures can be divided into five secondary themes: those who praised loyalty and filial piety, those who praised virtue and achievements, the hometown of famous people, those who made contributions during the Anti-Japanese War, and tombstones. Among them, there are up to 110 praising virtue and achievements, accounting for about one third of the total number. It is an important component of achievement tablets. Religion and art can be divided into two secondary themes: statue and portrait, and religious themes. Among them, religious themes have a maximum number of 211, accounting for more than two thirds of the total number of this category. They are the main components of Henan cultural and artistic inscriptions. There is only one secondary theme for boundary tablets, which is the main content of Henan marking tablets. Only 13 of them account for 0.67% of the total number of Henan inscriptions. This is mainly due to the functional nature of boundary tablets, but their position in the theme of Henan inscriptions cannot be ignored.

Table 4. Classification of the content of Henan inscriptions (source: drawn by the author).

Primary Themes	Quantity/Place	Percentage/%	Secondary Themes	Quantity/Place	Percentage/%
recording historical events (chronicle tablets)	1216	63.04	recording the renovation of buildings	592	30.69
			recording the creation of buildings	138	7.15
			major events during the Anti Japanese War	36	1.87
			warning policies, customs and prohibitions	55	2.85
			major family events	76	3.94
			hydrology and water control of the Yellow Rive	41	2.12
recording historical figures (achievement tablets)	362	18.77	recording historical events	278	14.42
			Praise those who loyalty and filial piety	53	2.75
			Praise those who have merit and achievements	110	5.70
			hometown of famous people	36	1.87
			Praise those who made contributions during the Anti Japanese War	96	4.97
religious art (cultural and artistic tablets)	299	15.50	tombstones	67	3.48
boundary tablets (marking tablets)	13	0.67	statue and portrait	88	4.56
others (unidentifiable or wordless tablets)	39	2.02	religious themes	211	10.94
			boundary tablets	13	0.67
			others	39	2.02

From a temporal perspective, the themes of Henan inscriptions are mainly chronicle tablets during the Han Dynasty, Three Kingdoms, Jin Dynasties, Yuan Dynasty, Ming Dynasty, and Qing Dynasty. In the Republic of China and New China periods, they are mainly achievement tablets. In the Northern and Southern Dynasties, Tang Dynasty, Five Dynasties, Ten Kingdoms, Song Dynasty, and Jin Dynasty, they are mainly cultural and artistic tablets (see Table 5). The content of the Henan inscriptions during the Han, Three Kingdoms, and Jin Dynasties mainly consist of two categories: recording major historical events and recording and praising people who have merits and achievements. During the Five Dynasties, Ten Kingdoms, Song Dynasty, Jin Dynasty, and Yuan Dynasty, Henan inscriptions are still mainly based on religion. In the Ming and Qing Dynasties, they were mainly related to the renovation and creation of buildings. In the period of the Republic of China and New China, they focus on those who contributed to the Anti-Japanese War (see Table 6).

Table 5. Number of different inscription protection units in different periods in Henan (source: drawn by the author).

Period	Recording Historical Events (Chronicle Tablets)	Recording Historical Figures (Achievement Tablets)	Religious Art (Cultural and Artistic Tablets)	Boundary Tablets (Marking Tablets)	Others (Unidentifiable or Wordless Tablets)
Han Dynasty, Three Kingdoms, Jin Dynasties	5	4	2		
Northern and Southern Dynasties	2	2	33		1
Tang Dynasty	4	9	49		1
Five Dynasties, Ten Kingdoms, Song Dynasties	21	10	26		3
Jin Dynasty	10		14		
Yuan Dynasty	36	10	25		2
Ming Dynasty	205	35	69		8
Qing Dynasty	863	153	77	10	21
Republic of China	65	97	4	3	1
New China	4	42			
Unknown	1				2

Table 6. Number of inscription protection units of different themes in different periods in Henan (source: drawn by the author).

Themes	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	Unknown
recording the renovation of buildings			1	7	7	14	119	435	9		
recording the creation of buildings				5	2	7	30	89	5		
major events during the Anti Japanese War									32	4	
warning policies, customs and prohibitions							1	53	1		
major family events	1	1	1				6	65	2		
hydrology and water control of the Yellow Rive					1	1	6	27	6		
recording historical events	4	1	2	9		14	43	194	10		1
Praise those who loyalty and filial piety			1	1			9	40	2		
Praise those who have merit and achievements	4	1	3	1		3	11	63	23	1	
hometown of famous people		1					9	21	5		
Praise those who made contributions during the Anti Japanese War									55	41	
tombstones			5	8		7	6	29	12		
statue and portrait	1	31	18	6	1	1	17	12	1		
religious themes	1	2	31	20	13	24	52	65	3		
boundary tablets								10	3		
others		1	1	3		2	8	21	1		2

Note: ① The Han Dynasty, Three Kingdoms and the Jin Dynasties; ② The Northern and Southern Dynasties; ③ The Tang Dynasty; ④ The Five Dynasties and Ten Kingdoms, the Song Dynasty; ⑤ The Jin Dynasty; ⑥ The Yuan Dynasty; ⑦ the Ming Dynasty; ⑧ The Qing Dynasty; ⑨ The Republic of China; ⑩ New China.

From the perspective of spatial distribution (Figure 10), the inscriptions on the recreation of buildings are distributed in various cities in Henan with more in the north and less in the south. They are mainly distributed in the northern and western regions of Henan, coinciding with the geographical location of the southern section of the Taihang Mountains. The core areas are located in two cities, including Anyang. The spatial distribution characteristics of creating buildings are similar to those of renovating inscriptions. They are still distributed in the northern and western regions of Henan with the core area located in the northeast–southwest distribution zone of five cities, including Hebi and Luoyang. This is mainly because these areas, as the central cities of Henan Province, are often the development centers of an era with high social prosperity and productivity, featuring frequent building and construction. At the same time, they are more susceptible to war and turmoil, and architectural landmarks are more prone to damage. Therefore,

these areas are much more compared to other regions. The distribution of inscriptions on major family events is relatively scattered—mainly in the northern, eastern, and southern regions of Henan. The main core area is located in four cities, including Hebi and Xinyang. Meanwhile, the secondary core area is located in two cities, including Kaifeng. This is mainly because Henan has been the political, economic, and cultural center of China for three thousand years, and there are large families with a long history and lush branches. Inscriptions on the Yellow River hydrology and water control are relatively concentrated, being mainly distributed in its northern part with a small amount in Nanyang. The core area is located in Jiaozuo, which is mainly due to the geographical overlap of these areas with the southern section of the Yellow River. Inscriptions on warning police, village regulations, and customs prohibitions are relatively concentrated, mainly in the central and western regions of Henan, with the core area located in Zhengzhou. This is mainly because in order to face the threat of chaos from the grassroots society, the government has strengthened the grassroots governance and vigorously promoted the village rules and folk conventions. Zhengzhou is located in the center of Henan and is an important area for practicing village regulations and agreements. Inscriptions on major historical events are widely distributed in all cities of Henan, mainly in its north, central and south. The core area is located at the junction of three cities, including Jiaozuo. Due to its long history, major events occurred all over the country, so it is widely distributed. Inscriptions on major events during the Anti-Japanese War are concentrated mainly in the northern and central areas. The core area is located at the junction of three cities including Hebi, where major battles occurred during this period. Inscriptions with themes such as famous people's hometowns are widely distributed in all cities. The main core area is located at the junction of three cities, including Jiaozuo, as well as the junction of Xinxiang and Hebi. Meanwhile, the sub-core distribution area is located in Nanyang. Inscriptions on tombstones are concentrated, mainly in central Henan, and the core area is located in Luohe and the west of Luoyang. Inscriptions with themes that made contributions during the Anti-Japanese War are relatively concentrated mainly in the northern and central regions. The main core area is located at the junction of three cities, including Anyang, while the sub-core area is located at the junction of three cities, including Jiaozuo. This is mainly because these areas fought major battles during the Anti-Japanese War, commemorating the martyrs and heroic deeds sacrificed here. The distribution on praising meritorious deeds and achievements is relatively wide, with the main core area located in Nanyang and the sub-core area located at the junction of two cities, including Hebi. Inscriptions on praising loyalty and filial piety are scattered mainly in the southern and northern regions of Henan. The main core area is located in Xinyang, and the sub-core area is located in the junction of two cities including Hebi, as well as Zhengzhou and Jiaozuo. This is mainly because all the people in Henan will spontaneously or intentionally praise those who have made contributions to the people and have good qualities such as loyalty and filial piety [32] so as to guide the correct folk customs [33]. The distribution of statue and portrait inscriptions is relatively concentrated mainly in its central and northern regions. The main core area is located at the junction of three cities, including Jiaozuo, and the sub-core area is located at the junction of two cities, including Xinxiang. These are mainly the inscriptions suitable for depicting this type of theme in these areas with Longmen Grottoes being the example. The distribution of religious themes is concentrated mainly in the central and northern parts; the core area is located in Zhengzhou, which is mainly represented by many famous temples in these areas. The distribution of boundary tablets is scattered, mainly in the north, south and southwest regions of Henan and the junction with other provinces. Its core area is located in three cities, including Jiaozuo, which is mainly determined by the functional nature of these tablets, which are used in the junction of various regions as markers.

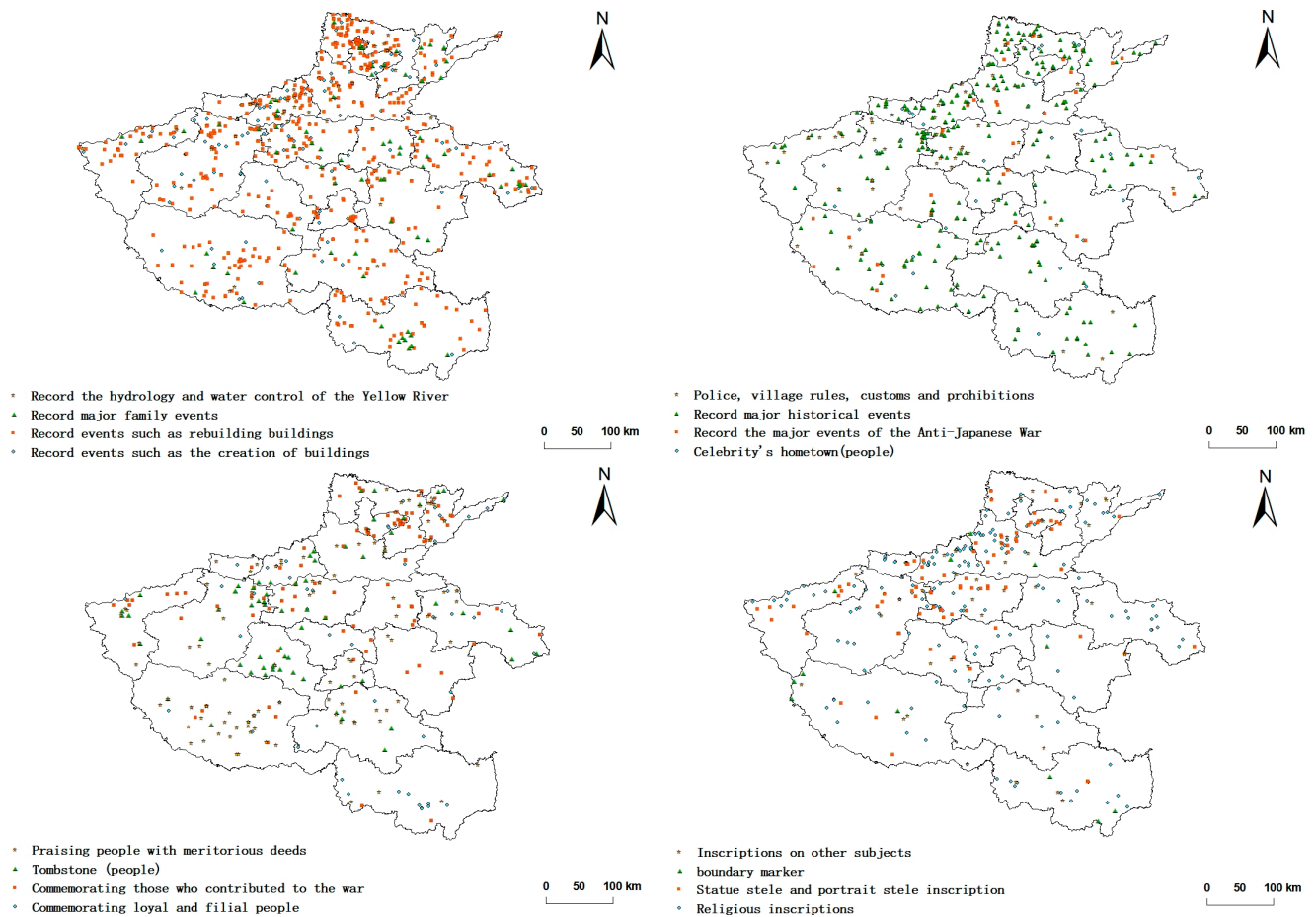


Figure 10. Distribution of protection units of various themes of inscriptions in Henan (source: drawn by the author).

4. Factors Influencing the Distribution of Inscription Art Sites

4.1. Topography

Henan has a rich variety of terrain, including plains, mountainous areas, hills, and areas with abundant water systems. The high-value areas of Henan inscription sites are mainly concentrated in a northeast–southwest distribution belt in the northern and northwestern parts of Henan. The location of this belt coincides with the height of the Taihang Mountain, indicating that Henan inscription is closely related to topography [34]. This is mainly due to the abundant stone resources in the Taihang Mountains, such as marble and granite. These high-quality stones provide a material foundation for inscription art. With the limitations of economy and technology, the weight and size of the stones limit their ability to be transported over long distances, making stone resources more superior. The northern and northwestern parts of Henan are more likely to become the center of inscription development. In addition, the rich and diverse terrain and landform provide more possibilities for the layout and display of inscriptions [35]. Inscriptions can be embedded in the mountains or placed on peaks, increasing their ornamental and artistic value. Therefore, the development of statue and portrait inscriptions near famous mountains and rivers is better, laying the foundation for the prosperity and development of the Longmen Grottoes in Luoyang, making Luoyang the center of Henan inscription art [36]. Furthermore, this factor also affects the development of boundary tablets, which is mainly because they are located at the junction of various regions as markers.

4.2. Climate

Henan has a warm temperate monsoon climate with hot and humid summers and cold and dry winters. The Yellow River Basin is relatively humid, while the southern part is relatively dry. On the whole, the climate conditions are relatively mild, which helps to preserve the cultural heritage of inscriptions. Relatively low humidity and mild temperature can slow down the corrosion and erosion of stone inscriptions, which is conducive to their preservation and inheritance, and to a certain extent, promotes the development and prosperity of Henan inscription art. However, due to the uneven distribution of precipitation, the Yellow River often undergoes diversion and breaches. It has changed its course more than 1500 times in history with six major changes occurring within Henan. These natural disasters have caused significant damage and destruction to the cultural heritage along the Yellow River, especially the inscription culture. Therefore, the development of inscription art is better in the northern, northwestern, and southwestern regions of Henan, which are far from the Yellow River floodplain. However, these events have also stimulated people's demand for flood control and water control projects [37], thereby promoting the development of commemorative inscriptions and objectively increasing the scale and quantity of inscriptions along the Yellow River [38,39]. However, there is still a significant gap compared to the northern and northwestern regions.

4.3. Economy and Transportation

Henan, located in central China, is an ancient economic center and transportation hub, making it a hub for various dynasties and promoting the collision and integration of different regional cultures. This economic advantage and diverse exchange also promotes Henan inscription art, making the degree of clustering of inscription sites highly overlapping with ancient transportation roads and economically prosperous areas. For example, during the Tang Dynasty, Henan's economy was prosperous, and the inscription art in Sanmenxia was prosperous due to frequent trade exchanges between Luoyang and Chang'an. Zhengzhou also became a trade center because of the establishment of a tiger prison warehouse, promoting the development of inscription art in Zhengzhou. Economy and transportation have provided convenient conditions for Henan inscriptions, making it a convenient place for their development. These inscriptions have more diverse cultural elements and artistic styles [40]. In addition, with the high level of social and economic development in the Ming and Qing Dynasties, the people had a material foundation for studying the art of inscriptions, and public buildings and temples were repaired and rebuilt. The scale and quantity of inscriptions recording the relevant content grew rapidly, promoting their development in the Ming and Qing dynasties.

4.4. Politics and Society

Henan, located in the Central Plains, has always been the political center of China since ancient times, which inevitably affects its inscription art due to politics and society. It is mainly reflected in different historical periods that the political center of Henan was constantly changing, and the location of the capital or state government was more conducive to inscription art. For example, Nanyang in the Eastern Han Dynasty and Luoyang in the Tang Dynasty were the centers of inscription art. In addition, rulers of different dynasties would leave inscriptions to publicize policies, commemorate events and inherit authority, and form the themes of warning polices [41], village regulations, customs and prohibitions focused on specific areas of Henan [42]. These inscriptions reflect the influence of the evolution of social and political environment on its inscription art. At the same time, war also affects regional stability and development, which directly or indirectly affects its material foundation. Therefore, it has a significant impact on the development, distribution, and genre of inscription art. For example, from the Five Dynasties and Ten Kingdoms to the Song Dynasty, Henan was full of chaos and turbulence, and inscriptions could not be fully developed, resulting in a slight decrease in the number of inscriptions. In modern times, Henan was invaded by foreign enemies and lacked a stable material

foundation, and the number of its inscriptions decreased. In terms of the distribution and themes of inscriptions, a large number of benevolent and righteous individuals who made contributions to the Anti-Japanese War, education, and other aspects emerged in places such as Anyang and Zhengzhou where major battles occurred. Therefore, the themes that recorded major events and achievements during the Anti-Japanese War are more concentrated here. At the same time, influenced by wars, the themes of inscriptions in the Republic of China and New China mainly focus on these two types. Therefore, inscriptions have become carriers for recording and praising these deeds.

4.5. Culture and Religion

Culture and religion have a significant impact on Henan inscription art. Nanyang [43], Zhengzhou and Luoyang, where the culture is more profound, have more advantages in inscription art [44]. These regions have a larger number and scale of inscriptions, and their clustering phenomenon is more obvious. At the same time, different cultural and religious factors have created different characteristics of inscriptions in different periods, and they have also shaped the unique style and aesthetic appreciation of Henan inscriptions. Henan is a place where various religious and philosophical ideas, such as Buddhism, Taoism, and Confucianism, spread and developed. These religious and cultural ideas have had a profound impact on the inscription art, and they are reflected in the themes, symbols, and other elements. For example, the Shaolin Temple in Zhengzhou is the world's most famous temple, and a large amount of inscriptions are related to its construction, major events, and the deeds of high monks throughout history. Compared to different historical periods, dynasties that held a positive and open attitude toward culture and religion had a better development in their inscription art. For example, the Tang Dynasty was relatively open and free in terms of ideology and culture, and its inscriptions were actively developed. Influenced by foreign cultures, it brought new vitality to inscriptions in the Tang Dynasty [45]. The rulers of the Jin Dynasty were ethnic minorities from the north, with a greater emphasis on the northern and northeastern regions of China, resulting in a relatively low recognition of Central Plains culture. In addition, the Jin Dynasty ruled Henan for a relatively short time, which resulted in a further reduction in the number of inscription sites and a slow development rate [46]. The prevalence of religion in the Yuan Dynasty promoted religious culture, temple construction, and the art of inscriptions on important figures. During the Ming and Qing Dynasties, epigraphy gradually developed, and the form of inscriptions on stone tablets also matured. Therefore, the inscription art became popular in the Ming Dynasty [47]. In addition, influenced by the cultural atmosphere of the Qing Dynasty, especially the preferences of the emperors during the Kangxi and Qianlong periods, many literati began to develop a strong interest in the culture of inscriptions, promoting the rise of inscription studies. Not only did they conduct extensive research and collection of inscriptions, but they also began to organize and classify them, forming some theories and methods [48]. There are more chronicle tablets with cultural and religious atmosphere.

On the whole, the five major factors of topography, climate, economy and transportation, politics and society, and culture and religion have played an important role in the formation and development of Henan inscription art. These factors endow the inscription art with unique cultural connotations, making it an important component of Chinese cultural heritage.

5. Conclusions and Discussion

5.1. Conclusions

This paper uses kernel density in ArcGIS to analyze the Henan inscription sites and their influencing factors from the Han Dynasty to the New China. The main conclusions are as follows:

1. The spatial distribution of Henan inscription sites is uneven and the degree of clustering is relatively high, mainly concentrated in the northern and northwestern regions of

Henan, showing an overall trend of high in the north and low in the south, gradually decreasing from north to south. The inscription sites exhibit the characteristics of belt and clustering coexistence, forming a belt distribution area with a southwest–northeast direction and the highest degree of clustering. In addition, it has formed a high-density cluster in the southwest centered on Nanyang, an eastern high-density cluster centered on the intersection of Kaifeng and Shangqiu, a southern high-density cluster centered on Xinyang, and a central high-density cluster centered on the intersection of Luohe, Zhumadian, and Zhoukou. All of these show the characteristics of “one belt and four clusters”.

2. The number of Henan inscription sites in different historical periods shows the first slight increase and decrease, which is followed by a significant increase and decrease. The center of inscription art during the Han Dynasty, Three Kingdoms, and the Jin Dynasties was in the southwestern and central regions of Henan. The center during the Northern and Southern Dynasties was in its northern region. The center in the Tang Dynasty was in the central and western regions. The center during the Five Dynasties, Ten Kingdoms, and the Song Dynasties was in the northwest and central regions. The center of the Jin Dynasty was in the central region of Henan. The center of the Yuan Dynasty was in the central and northern regions. The center of the Ming Dynasty was in the northern region. The center of the Qing Dynasty was in the northern and northwestern regions. The center during the Republic of China was in the northeastern, central, and southwestern regions. The center of New China was in the northern region. The overall center of all sites shows a trend from southwest to northeast over time.
3. The Henan inscription sites can be divided into five primary themes and further subdivided into 16 secondary themes in terms of content. The main type is the chronicle tablets. In terms of time, the subject types of Henan inscriptions are mainly chronicle inscriptions during the Han, Three Kingdoms, Jin Dynasties, Yuan Dynasty, Ming Dynasty, and Qing Dynasty. In the Republic of China and New China, they are mainly achievement inscriptions. In the Northern and Southern Dynasties, Tang Dynasty, Five Dynasties, Ten Kingdoms, Song Dynasty, and Jin Dynasty, they are mainly cultural and artistic inscriptions. From the perspective of spatial distribution, the distribution of theme inscriptions such as recording the creation, renovation of buildings, recording major family events, recording major historical events, praising meritorious deeds, praising loyalty and filial piety, famous people’s hometowns, and boundary markers is relatively scattered. The distribution of the Yellow River hydrology and water control, police policies and local customs and prohibitions, major events during the Anti-Japanese War, documenting people who made contributions during the Anti-Japanese War, tombstone inscriptions, statue and portrait inscriptions, and religious inscriptions is relatively concentrated. This is mainly because the former content tends to be humanistic and not easily influenced by geographical factors, while the latter tends to be documentary and can be easily influenced by the factors.
4. There are five major factors affecting the distribution of Henan inscription sites: topography, climate, economy and transportation, politics and society, and culture and religion.

In addition to these theoretical findings, our research has practical implications. First, from the perspective of the provincial-scale cultural heritage protection system, studying the spatiotemporal distribution characteristics of inscription art sites can provide a basis for Henan Province to formulate more scientific and refined cultural heritage protection policies. Second, the distribution characteristics of inscription art sites in Henan Province are significant, with higher densities in the northern and northwestern regions, while the southern and central regions are relatively sparse. Therefore, Henan Province can adopt differentiated protection measures based on the distribution characteristics and themes of inscription art sites in different regions. For instance, the northern and northwestern regions, with their concentrated and diverse inscription art sites, can focus on showcasing

the historical and cultural significance of Henan's inscription art, forming a distinctive cultural heritage display system. In contrast, the southern and central regions can integrate local natural landscapes to compensate for the relatively fewer and less diverse inscription sites, promoting the integration of inscription art with ecological tourism. Finally, the use of interdisciplinary technologies such as GIS spatial analysis can better manage and monitor the distribution changes of inscription art sites, providing strong technical support for the cultural heritage protection and tourism development in Henan Province.

5.2. Discussion

Inscription artifacts play an indispensable role in the study of ancient society, history, culture, and Central Plains art. With the improvement of the country's cultural soft power, a macro-level and comprehensive understanding of Henan inscription sites is of great significance for studying Central Plains art and enhancing its global influence. In addition, from the perspective of studying the development process of Central Plains art, using geographical techniques and methods to study the spatiotemporal distribution of Henan inscription sites can help to reorganize the existing inscription art resources in Henan and excavate their profound cultural value. It can provide support for analyzing the social and cultural development status of Central Plains in different historical periods, and it can also provide a new perspective for studying the protection and development of Central Plains art and Henan inscription art.

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