Article

The Evolution of the Spatial Distribution Pattern of Mosques in the Kashgar Region from 1955 to 2004

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Abstract: The spatial differences in the distribution of mosques reflect to a certain extent the diversity of the interaction between natural and human elements and Islamic beliefs in different geographic spaces. The Kashgar region of Xinjiang is one of the most developed regions of Islamic culture in China, its dominant religion is Islam, and the survival of Islamic culture in the region has a long history. The development of Islam in the region, after the founding of the People's Republic of China, was influenced by the religious policy of Chinese Socialism, and the spatial distribution of mosques in the region has changed significantly. However, the distribution pattern of mosques in the spatial features of the region that had been especially indicated by the transformations in religious practice on the development of Islam impacted by geographical conditions and social factors has been less explored. Based on the Chinese Religious Digital Map dataset provided by the China Information Center at the University of Michigan, mathematical statistics and spatial analyses are used to analyze the spatial distribution pattern of mosques in the Kashgar region from 1955 to 2004, and the causes of the pattern characteristics in the context of the historical background of the study period. The results show that, during the study period, the spatial clustering of mosques occurred mainly in the northwestern and central parts of the Kashgar region. In all districts and counties, the number of mosques had increased and there was a growing gap in the number of mosques. Islam in the area had been well developed and the trend of spatially concentrated distribution of mosques had been increasing. The mosques in the region are mostly clustered in areas with gentle terrain, rivers and a dense population. In terms of the causes affecting the spatial distribution pattern of mosques in the Kashgar region, geographical conditions and population were the underlying factors that set the basic pattern for the location of mosques. In addition, the different effects of social factors, such as the improvement of productivity, the administrative system, religious management policies, and the historical background on the development of Islam in the area had led to a variation in the development of Islam, thus causing changes in the spatial distribution pattern of mosques in the area. In the period from 1976 to 1992, for example, the end of the Cultural Revolution and the shift in China's foreign policy had a very major impact on Islam so that during this period the spatial distribution pattern of mosques varied the most in the area. This research has implications for learning about the spread of Islam in the Kashgar region after the founding of the People's Republic of China, and the changes in the spatial distribution of mosques, and the causes of such variations.

Keywords: mosques; Kashgar region; spatial distribution pattern; spatial analysis; GIS

1. Introduction

The religious landscape is an intuitive reflection of religious culture in material or non-material phenomena (Yu 2011). Many entities' religious landscapes, such as religious shrines, places of worship, temples, churches, funeral places, mosques, etc., while carrying religious culture and playing a religious role, also reflect the spatial interaction between religious culture and natural and human environment through their location in the space,

and most intuitively reflect the interaction between spirituality and geographical space (Jordan and Domosh 1999; Peach 1999). In general, the interaction of religious landscape and space can be summarized in three forms. The influence of the characteristics of space on the layout of landscape; the influence of the religious function on the masses in space; and the ideological and cultural attributes embodied in the landscape giving new elements to space. (Dann 1976; Stump 1986). When people rely on the religious landscape for their religious activities, they have actually engaged in an exchange of beliefs and geographic space, which at this point becomes the carrier for the continuation and development of religion (Kong 2005; Brzozowski 2013).

As a spatial landscape, religious sites have been classified by scholars as "officially sacred sites" and "unofficially sacred sites" (Brace et al. 2006; Holloway 2003; Gokariksel 2009; Kong 2001). Official sacred sites, such as pilgrimage sites of various religions and clan shrines, carry a more formal religious function. It is generally accepted that the spatial distribution of those sites reflects the interaction between the sacred and the secular (Kong 2002, 2005; Preston 2002). Scholars have mostly approached the forms in which these interactions work from a religious, theoretical and philosophical perspective (Valins 2003; Campbell 2005; Preston 2002). With the intersection of the research paradigm of religion in geography, the content of the study of the geography of religion as a discipline was clearly identified in the 1980s (Sopher 1981). In recent years, spatial data on religion have often been used in geographic studies, and some religious studies have drawn on geographic research methods, with many developments in data-driven spatial perspectives on the study of religion emerging (Gregory 2003; Sunier 2013; Zhou 2022). Some scholars have explored the spatial evolution of religion and its causes based on the geographic information data of religious officially sacred sites (Song et al. 2016; Zhu et al. 2019; Jiang 2019; Liu and Wan 2022). Among the many research results, the spatial distribution of religious sites is often correlated to be closely integrated with the distribution of population, and the size of the population determines whether the religion can survive in its area (Xue et al. 2009, 2013; Lloyd 2012).

In China, the most populous country in the early 20th century, some results have been made in the study of the interaction between religious sites and space. Scholars have combined religious studies with spatial analysis to study different religions from a geographical perspective, exploring the divergence of religious development patterns in different regions. Many Chinese scholars have studied the religious environment of different periods and regions (Ma 2012; Zhong and Bao 2014; Bao et al. 2014; Liu and Wang 2022). Most of these studies are based on a macro perspective and provide an analysis of the layout of religion across China. In addition, Chinese research on theories of religion has been very fruitful in recent years, and scholars have combined methods from other disciplines to focus more on the social rather than the political significance of studies (Lu 2022; Zhang 2021).

However, at present, in Chinese academia, research on the theoretical aspects of religion still mostly focuses on the political and unifying role of religion in modern Chinese society and is accustomed to exploring how religion can better serve the development of the socialist political system from the perspective of macro governance (He and Wang 2021). Indeed, these theoretical studies had a positive effect on exploring how religions in China can better adapt to the political environment, but to a certain extent they neglected the positive interaction between religious development and regional development at the micro level, as well as the different development patterns of religions due to regional differences. Therefore, for conducting empirical studies on the historical changes and spatial and temporal evolution of religious sites on small scales such as counties, cities, and regions, Chinese scholars still need to further explore and study from a regional and geographic perspective based on reliable data and in the context of the times.

The Kashgar region is the most densely populated region of Muslims in China, and a typical region where Islam has adapted to the socialist system, either spontaneously or passively. In the process of continuous improvement of the socialist system, both

Islam, its followers, and mosques inevitably have to adapt to the development guidelines of the "Chinese-ized religion" (Khosravi 2019; Dai 2019). A study of the mosques in the region from a spatial perspective can provide further insight into the history of the development of Islam in the region. However, there are few relevant studies on the spatial distribution of mosques in this region, and the spatial and temporal evolution and causes of the development of contemporary mosques in the Kashgar region have not been explored. Therefore, this study will examine the changes in the spatial distribution of mosques in the Kashgar region from 1955 to 2004 based on the Chinese Religious Digital Map dataset provided by the China Information Center at the University of Michigan, using spatial analysis and statistical methods, and in the context of the relevant era.

2. Overview of the Study Area

The Kashgar region is located in the middle of Eurasia, southwest of the Xinjiang Uyghur Autonomous Region, China. As a major transportation route along the ancient Silk Road, the region has been a crossroads for exchanges between China and Central Asia since ancient times. The region has a rich and long history of culture, and many civilizations have emerged here. Islamic civilization was introduced to the Kashgar region in the middle of the 10th century A.D. The rulers of the Kara-Khan dynasty at that time made Islam the state religion, and Islam became the dominant religion of the region (Pa 2006).

In 1955, the People's Republic of China changed the jurisdiction of Xinjiang Province to the Xinjiang Uyghur Autonomous Region. In the same year, all counties in the Kashgar region were placed under the jurisdiction of the South Xinjiang Administrative Office, and religious affairs enjoyed a high degree of autonomy in jurisdictional governance within the region. The Kashgar region is one of the regions in China where the spread of Islam has continued for a long time, has a large influence, has a large religious population, and has the closest combination of religion and ethnicity. As a representative religious landscape of Islam, mosques are densely distributed in the region and play an important function in the religious and social life of the contemporary faithful. According to the administrative division of the People's Republic of China, the Kashgar region consists of 12 counties, including Kashgar, Payzawat, and Maralbexi, etc. In order to make the study area spatially complete, Tumxuk, which is managed by the Xinjiang Production and Construction Corps, is also included in the study area. Therefore, in this study, the Kashgar region was considered to have a total of 13 districts and counties, as shown in Figure 1. The basic geographical information of the study area is shown in Figure 2.
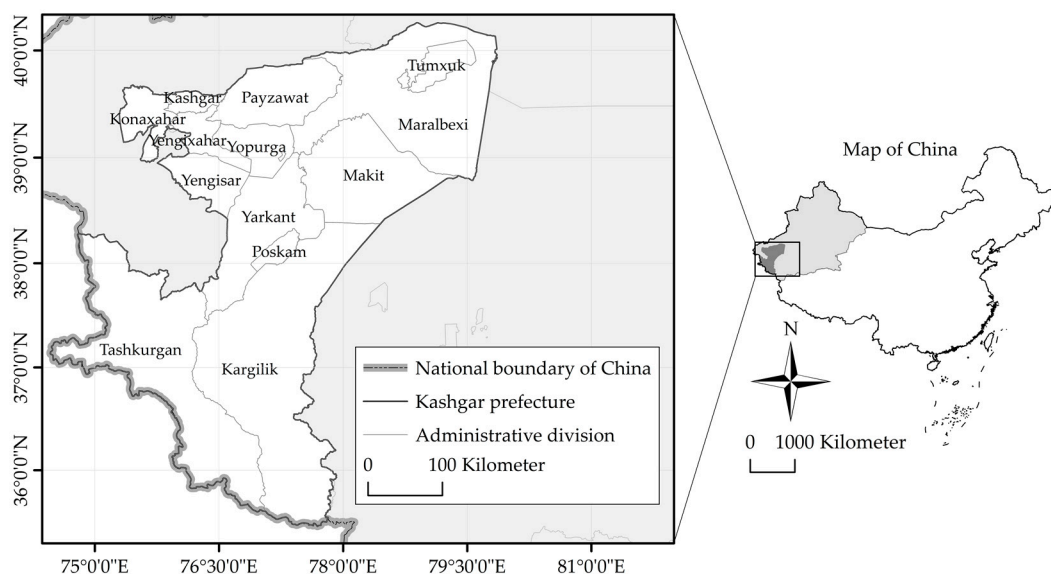

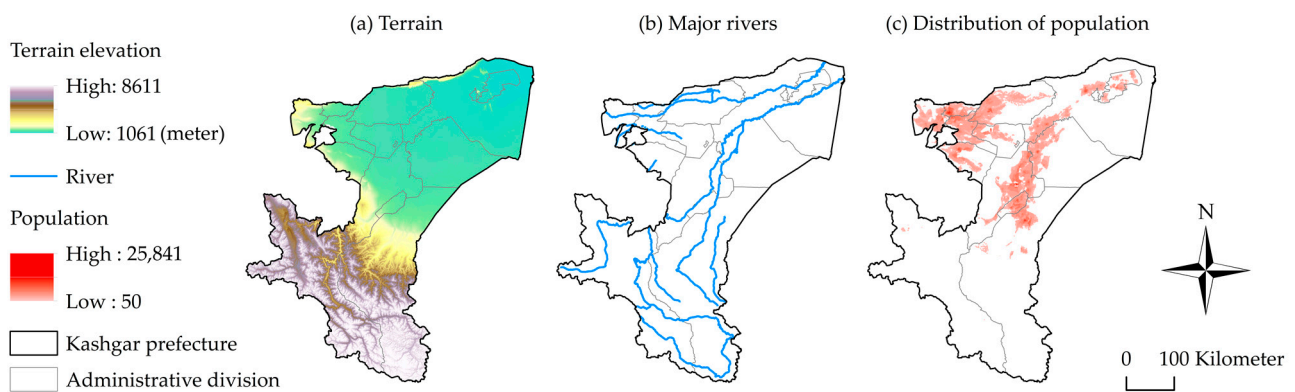**Figure 1.** Schematic diagram of the Kashgar region division.

Figure 2. Schematic diagram of nature and population of the Kashgar region.

The study region is located between 74.39′ E and 79.52′ E and 35.28′ N and 40.16′ N, with a total area of 162,000 km^2, a width of about 750 km from east to west and a length of 535 km from north to south. The region is surrounded by mountains to the west, south and east, open to the Tarim Basin to the northeast, with the Pamir Plateau towering to the west, the Karakorum Mountains to the south, the Taklamakan Desert to the east, Tajikistan to the west, Afghanistan and Pakistan to the southwest, and several neighboring countries such as Kyrgyzstan, Uzbekistan and India. In order to avoid possible territorial disputes, neighboring countries and regions are not shown in Figure 1.

3. Data

3.1. Mosques Data

Under the current political system in China, the religious beliefs of the Chinese people are generally respected. However, as an atheist state with a socialist system, the Chinese government does not always release data on the development of its religions to society, which has led to less progress in empirical research on religion in Chinese academia. In 2004, the Chinese Census Bureau launched China's first economic census, and for the first time religious organizations and sites were included in the survey. Thereafter, as China's socialist system continued to improve, the Chinese government became stricter in its management of religious affairs, and no religious data of a census nature have been disclosed to society since then.

The economic census data involving religion were further compiled by the China Information Center at the University of Michigan to produce the China Religion Digital Map database. The various types of data information about religious organizations and sites contained in this database can well reflect the spatial distribution characteristics of religious sites in China. In this study, data from the database about mosques in the Kashgar region were selected. The main information used is as follows.

3.1.1. Location and Name of the Mosques

The names of most of the religious sites in the dataset contained information about the administrative districts and townships in which they are located (e.g., the mosque in group 1 of the village Seriqduvi 8, Azhil Township, Sacha County). This allowed us to observe the actual addresses of all recorded mosques that were selected as the sample for our study in the Kashgar region. In addition, because in China's religious affairs management system religious sites may also be used as the premises of religious affairs management agencies, there may be cases where the same mosque was counted multiple times in the Religion Digital Map. To avoid observation error due to sample duplication, we manually eliminated duplicate entries when processing the data.

3.1.2. Longitude and Latitude Coordinates of the Mosques

The dataset contained the latitude and longitude coordinates of all mosques. For sample points with mismatched latitude and longitude information and actual addresses, they could be corrected based on the address information in the mosque names. For multiple sample points with overlapping latitude and longitude, if their names duplicated each other only one was retained. Therefore, after compiling the data, up to the data cut-off (2004) the dataset contained a total of 9876 mosques in the Kashgar region.

3.1.3. Information on the Operation Nature of the Mosques

Religious sites are strictly regulated in China, and require administrative permission from the relevant authorities (usually the religious affairs administration office) to operate and survive. Organizations that apply for registration of religious sites will only be allowed to conduct religious activities in its approved sites. The mosques involved in this study are all legally registered religious sites of Islam, and do not include sites that are unregistered or registered for uses of another nature. In addition, mosques in the Kashgar region are of different sizes and play different functions in the religious life of the faithful, but the first economic census did not record the size of religious places. Therefore, this study assumes that all mosques are homogeneous. The database also contains information about the juridical person of each mosque, such as gender, ethnicity, etc.

3.1.4. The Year the Mosques Started

During China's first economic census, only religious sites that were still in existence as of the statistical node (2004) were recorded, so the dataset used in this paper did not include religious sites that were established and then died out in the past. It is assumed in this study that the starting year of all mosques selected is prior to 2004 and that they have been in continuous existence since their establishment. In the dataset used for this study, the longest-standing mosque started in 947 AD. The information on the starting year of the religious sites allowed us to clearly observe the growth in the number of mosques in different years in the Kashgar region. In this study, four time points were selected to study the spatial distribution characteristics of the mosques: the official establishment of the Xinjiang Uyghur Autonomous Region in 1955, the end of the Cultural Revolution in 1976, Deng Xiaoping's Southern Tour speech in 1992, and the data cut-off period in 2004.

3.2. Maps and Geographic Data

The GCS_WGS_1984 coordinate system was used for all the geoprocessing procedures in this study. All maps produced in this study, and the administrative boundaries and national borders of the relevant regions involved, were made with reference to the maps provided by the Resource and Environmental Science and Data Center of the Institute of Geographical Sciences and Resources of the Chinese Academy of Sciences (https://www.resdc.cn/, accessed on 31 December 2022) as the base map. The geographic elevation data were obtained from NASA's SRTMDEM public data with a resolution of 90 m and processed by a Geospatial Data Cloud site, Computer Network Information Center, Chinese Academy of Sciences (http://www.gscloud.cn, accessed on 31 December 2022). River data are derived from publicly available data from the Ministry of Natural Resources of China (https://www.mnr.gov.cn/, accessed on 31 December 2022). Population data were obtained from the 2004 global population raster data published by Worldpop (https://www.worldpop.org/, accessed on 31 December 2022).

4. Methods

4.1. Standard Deviation Index and Coefficient of Variation

The number of mosques in a given area reflects to some extent the prosperity of Islam in it. To measure the differences in the number of mosques distributed in varying districts and counties in the Kashgar region, the standard deviation index was selected to measure the absolute differences in the number of mosques between regions, and the coefficient of

variation was selected to measure the relative differences between regions in this study. The standard deviation index, SD, and the coefficient of variation, CV, are calculated as follows.

$$SD = \sqrt{\frac{\sum_{i=1}^{N}(Y_i - Y_0)^2}{N}} \tag{1}$$

$$CV = \frac{SD}{Y_0} \tag{2}$$

In Formulas (1) and (2), Y_i represents the number of mosques in region i; N represents the total number of mosques in the Kashgar region, and Y_0 represents the mean number of mosques in all regions. The higher values of SD and CV represent the greater absolute and relative differences in the development of mosques in each region, respectively.

4.2. Global Moran's I

To observe whether differences in the spatial distribution of mosques in a given region are influenced by neighboring regions, the spatial autocorrelation of mosques is observed using global *Moran's I*.

$$Moran's\ I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(x_i - \overline{x})(x_j - \overline{x})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \tag{3}$$

$$Z = \frac{I - E(I)}{\sqrt{VAR(I)}} \tag{4}$$

In Equations (3) and (4), *Moran's I* reflects the correlation of the number of mosques in certain regions, taking values in $[-1,\ 1]$, greater than 0 indicating that there is a positive spatial correlation between neighboring regions, and negative correlation if the other way around, and equal to 0, indicating that there is no significant spatial correlation. $\overline{x}$ is the mean value of the number of mosques in certain regions, and S^2 is the variance in the number of mosques across the whole region. x_i and x_j represent the number of mosques in region i and region j, respectively. W_{ij} is the spatial weight: if i and j are connected by a shared boundary, W_{ij} takes 1; otherwise, it takes 0. n is the number of regions. $E(I)$ and $VAR(I)$ represent the expected value and variance of *Moran's I*, respectively. A positive and significant Z-score indicates that the mosques tend to be clustered; a negative and significant Z-score indicates that the mosques tend to be dispersed; and 0 means that the mosques are independently and randomly distributed in space.

4.3. Dot Density Estimation

The method of dot density estimation, DDE, is used to observe the areas where mosques are concentrated. In order to reflect the spatial clustering characteristics of mosques in the Kashgar region, all mosques are abstractly considered as vector points in space and the degree of spatial concentration of the sample was measured using DDE. Based on the location of point x_i as the center, the density of each grid cell of the point within the specified range (circle of radius h) is calculated by considering the data and bandwidth related to the point as parameters through the kernel function, which is linearly superimposed and normalized. The following is the formula used.

$$f(x) = \frac{1}{nh^d} \sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) \tag{5}$$

In Formula (5), $f(x)$ is the DDE value at point x; n is the number of mosques; d is the dimensionality, and $(x - x_i)$ represents the distance from point x to sample point x_i. The closer the distance from the center point, the higher the DDE value and the more significant the trend of the concentrated distribution of mosques.

4.4. Standard Deviational Ellipse

The standard deviation ellipse, SDE, is a method of spatial statistics that can accurately reveal the multifaceted characteristics of the distribution of elements across space. Mosques in the Kashgar region are not uniformly distributed in space. To explore the migration trajectory, influence, and direction of the diffusion of Islam from a macro perspective, it is necessary to observe the centrality, extension, direction, and spatial pattern of the overall distribution of mosques. The SDE quantitatively characterizes the distribution of mosques in space by generating ellipses with the center, *x* axis (long axis), *y* axis (short axis), and azimuth as the basic parameters. The formula is as follows.

$$\overline{X_w} = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i} \; ; \; \overline{Y_w} = \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i} \tag{6}$$

$$tan\theta = \frac{\left(\sum_{i=1}^{n} w_i^2 \tilde{x}_i^2 - \sum_{i=1}^{n} w_i^2 \tilde{y}_i^2\right) + \sqrt{\left(\sum_{i=1}^{n} w_i^2 \tilde{x}_i^2 - \sum_{i=1}^{n} w_i^2 \tilde{y}_i^2\right)^2 + 4\sum_{i=1}^{n} w_i^2 \tilde{x}_i^2 \tilde{y}_i^2}}{2\sum_{i=1}^{n} w_i^2 \tilde{x}_i \tilde{y}_i} \tag{7}$$

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^{n} (w_i \tilde{x}_i cos\theta - w_i \tilde{y}_i sin\theta)^2}{\sum_{i=1}^{n} w_i^2}} \tag{8}$$

$$\sigma_y = \sqrt{\frac{\sum_{i=1}^{n} (w_i \tilde{x}_i sin\theta - w_i \tilde{y}_i cos\theta)^2}{\sum_{i=1}^{n} w_i^2}} \tag{9}$$

In Formula (6) to Formula (9), (x_i, y_i) denotes the coordinates of each mosque; w_i denotes the weight of site *i* in that region, and $(\overline{X_w}, \overline{Y_w})$ represents the coordinates of the center of the ellipse. θ is the azimuth of the ellipse, which indicates the angle of rotation clockwise from due north to the *x* axis of the ellipse. $\tilde{x}_i$ and $\tilde{y}_i$ represent the deviation of each site along the *x* axis and *y* axis to the $(\overline{X_w}, \overline{Y_w})$, respectively. σ_x and σ_y denote the standard deviation and the lengths along the x-axis and y-axis, respectively.

5. Analysis

5.1. Temporal Evolutionary Features of Mosques in the Kashgar Region

5.1.1. Changes in the Number of Mosques

The year-by-year number and growth of mosques in the Kashgar region are plotted as shown in Figure 3. From 1955 to 2004, the number of mosques in the area grew from 5803 to 9876, an increase of 70.19%. Judging purely from the number of mosques, the development of Islam in the study area has not been significantly resisted since the establishment of the Xinjiang Uyghur Autonomous Region.

The growth of the number of mosques in the Kashgar region can be clearly divided into three stages. From 1955 to 1976, the number of mosques grew more steadily and at a slower rate. Although there was a relatively large increase in the quantity of mosques in a few years, overall the number grew by no more than 100 per year. From 1976 to 1992, the curve became steeper during this period, and the quantity grew more rapidly. In particular, in 1980, the number of mosques increased by more than 600. This time period is the most significant year for the increase of mosques in the area during the study period. From 1992 to 2004 the growth rate slowed down, but still maintained a steady growth of 60 to 70 mosques per year; the growth rate was slower compared to 1978 to 1990, but faster compared to 1955 to 1978.
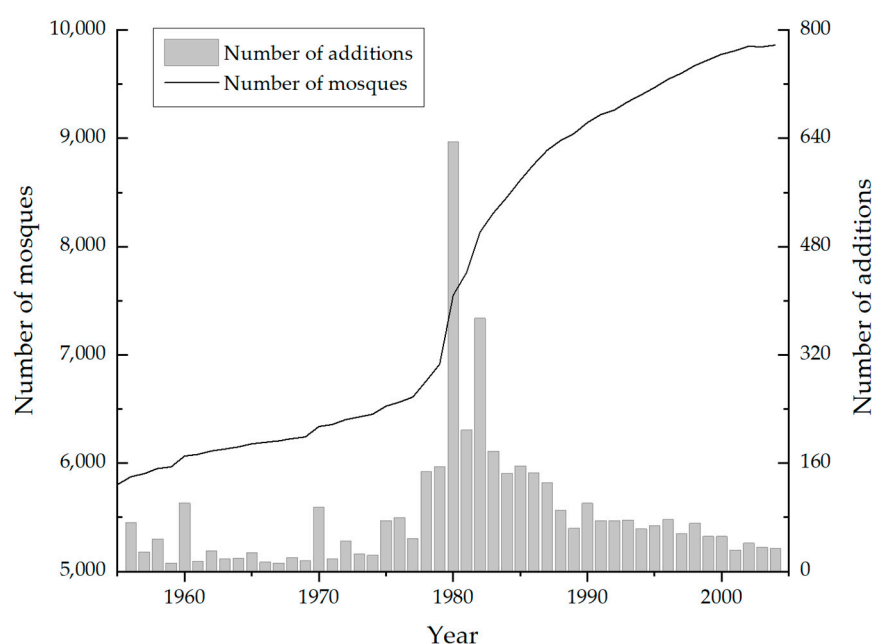
Figure 3. Trends in the number of mosques in the Kashgar region from 1955 to 2004.

The number of mosques within the 13 districts and counties in the study area was compared, and the data for four years, 1955, 1976, 1992, and 2004, were selected as shown in Table 1. In general, mosques are distributed within the districts and counties in the study area, and the number of mosques in each district and county has increased to varying degrees during the study period. Yarkant, Konaxahar, and Payzawat consistently rank in the top three of all districts in terms of the quantity of mosques, and these districts are more prosperous in terms of Islamic development. From 1976 to 1992, all districts and counties had higher growth rates compared to the rest of the years. Some districts such as Kashgar, Maralbexi, etc., with a relatively large number of mosques, still achieved a high growth in 1992 compared to 1976.

Table 1. Changes in the number of mosques by administrative counties in the Kashgar region.

	1955		1976		1992		2004	
	Number of Mosques	Growth Rate	Number of Mosques	Growth Rate	Number of Mosques	Growth Rate	Number of Mosques	Growth Rate
Maralbexi	120	-	229	90.83%	668	191.70%	784	17.37%
Payzawat	857	-	1024	19.49%	1164	13.67%	1168	0.34%
Kashgar	385	-	438	13.77%	590	34.70%	623	5.59%
Makit	171	-	212	23.98%	435	105.19%	455	4.60%
Yarkant	1459	-	1580	8.29%	1840	16.46%	1868	1.52%
Konaxahar	634	-	751	18.45%	1194	58.99%	1454	21.78%
Yengixahar	617	-	668	8.27%	912	36.53%	942	3.29%
Tashikurgan	9	-	10	11.11%	20	100.00%	20	0.00%
Tumxuk	2	-	2	0.00%	4	100.00%	8	100.00%
Kargilik	509	-	561	10.22%	899	60.25%	968	7.68%
Yengisar	316	-	337	6.65%	655	94.36%	684	4.43%
Yopurga	365	-	384	5.21%	485	26.30%	499	2.89%
Poskam	359	-	369	2.79%	399	8.13%	403	1.00%

It can be noted that the number of mosques in Tumxuk, Tashikurgan was not only low but also had no significant increase during the study period. Since the founding of the People's Republic of China, Tumxuk has been transformed from the initial management system of a people's commune to an administrative system under the direct manage-

ment of the Xinjiang Production and Construction Corps. Due to the limitations of the management and administrative system, the development of Islam in Tumxuk was more strictly regulated, so the number of mosques in the city was far less than in other districts and counties. Tashikurgan is located on the southwest border of Xinjiang, the territory is mountainous, and belongs to the plateau alpine arid climate. Although its area is large and borders several countries and regions, as shown in Figure 2, the deficiencies of its natural environment make the region sparsely populated (the 2019 Chinese census shows a population of just over 40,000 people in Tashikurgan); the quantity of mosques was low. The number of mosques owned by the remaining districts and counties during the study period is considerable, and the overall situation of Islamic development in the Kashgar region was good.

5.1.2. Statistical Characteristics of the Number of Mosques

The standard deviation index, coefficient of variation, and global *Moran's I* were used to measure the quantitative characteristics of mosques in the Kashgar region spatially, as shown in Table 2.

Table 2. Statistical characteristics of mosque distribution in the Kashgar region from 1955 to 2004.

	1955	1976	1992	2004
N	5803	6565	9265	9876
Growth rate	-	13.13%	41.13%	6.59%
SD	379.1082	415.203	481.2163	509.8243
CV	0.849286	0.822184	0.675209	0.671093
Moran's I [1]	0.257986 ***	0.266054 ***	0.280559 ***	0.290587 ***
Z	4.029865	4.102548	4.118258	4.251173

[1] *, **, and *** represent significance at 10%, 5%, and 1%, respectively.

The increasing *SD* of the number of mosques during the study period reflects the increasingly significant absolute differences in the distribution of mosques in the Kashgar region across districts and counties. Districts with a dominant number of mosques are more likely to gain further numerical growth than those with a smaller number. The *CV* has a slight tendency to decrease, reflecting a decrease in the dispersion of the number of mosques in each district and county. This indicates that the districts and counties with a relatively small number of mosques during the study period gained more significant growth compared to the statistical base period, and the increase was greater than that of the regions with dominant numbers.

The study area consisted of 13 county-level units, but the global *Moran's I* suggested a sample size of at least 26. Therefore, a square was constructed based on the approximate area of the study region, and the Kashgar region was divided into 103 grid cells with a standard length and width of 50 km to meet the requirements of global *Moran's I* for the examination of sample size.

The *Moran's I* was greater than 0 from 1955 to 2004, and all passed the 99% confidence test. This indicates that there is a positive autocorrelation in the spatial distribution of the number of mosques in the Kashgar region, i.e., the number of mosques within a certain area is influenced by the neighboring areas.

During the global *Moran's I* test, if the Z-score is greater than 2.58 the sample can be considered to be spatially clustered. The results show that the Z-scores of the number of mosques in the study area were all greater than 2.58, and it can be concluded that mosques showed a concentrated distribution.

It is noted that the *SD* increased more rapidly from 1976 to 1992, and the *CV* plummeted during that period, but the changes in the *Moran's I* and Z-score were less pronounced than the changes in the *SD* and *CV*. This suggests that the development of Islam and the rapid increase in the number of mosques in each region from 1976 to 1992 did not break the spatial autocorrelation of religious development in the region, nor did it signif-

icantly affect the spatial clustering characteristics of mosques. It is just that the absolute disparity in development between regions was significantly magnified, and the growth rate of the quantity of mosques in regions was more significant in that period compared to other periods.

5.2. Spatial Evolution Characteristics of Mosques in the Kashgar Region

5.2.1. Spatial Distribution of Mosques

The formation and development of religion and its spread depend on a specific geographical environment. Additionally, once a religion is formed, it can react to the geographic environment and its landscape will become an important part of the space. Geography has had a profound influence on the formation and survival of religious sites. Considering that the geographical conditions of the Kashgar region were basically unchanged during the study period and the population movement was less frequent, in order to explore the interaction between mosques and geographical space in Kashgar region three aspects of topography, rivers and population schematic in the study area can be referred to from Figure 2 in the previous text. Four years, 1955, 1976, 1992 and 2004, were selected to observe the spatial distributions of mosques in Kashgar region using DDE, as shown in Figure 4. For comparison purposes, the DDE values for 2004 were categorized by natural breaks and, subsequently, the values for the remaining three years were displayed using this categorization as a criterion.
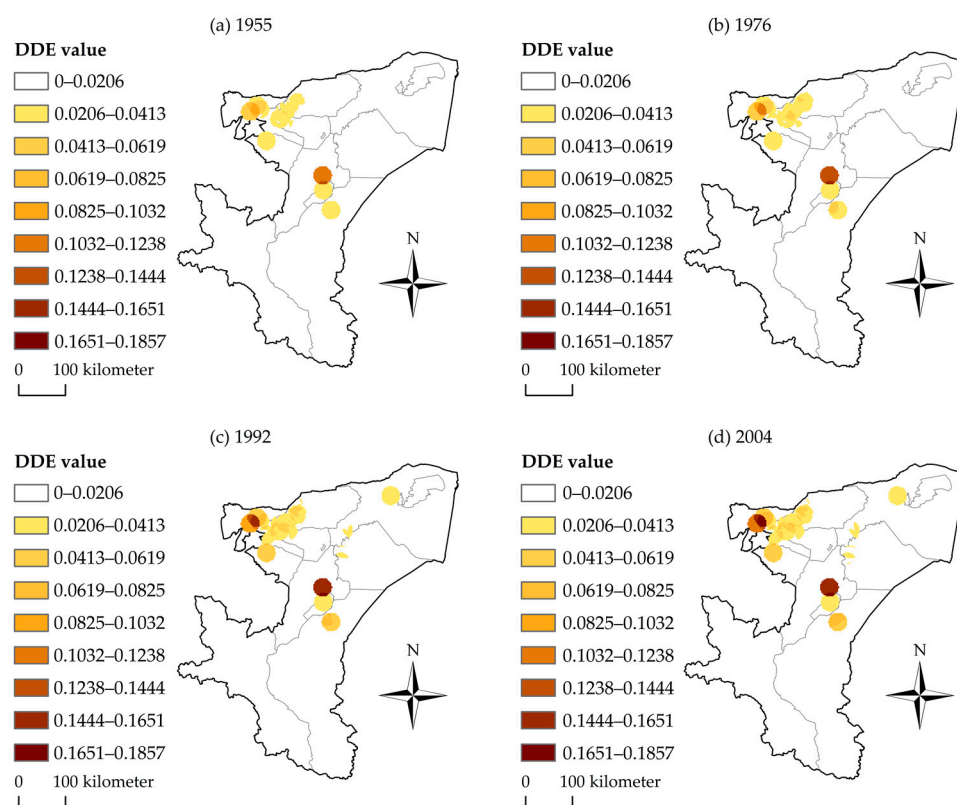

Figure 4. Dot density of mosque distribution from 1955 to 2004.

The high value area of DDE reflects the concentrated distribution of mosques in the Kashgar region. It can be seen that the mosques were mainly distributed in the northwestern and central parts of the region, with a concentration in the northeastern part of the region at a later stage. These areas are relatively low in elevation and have rivers, and the population is more densely distributed. Islam in the Kashgar region focuses on the integration of religious and social life (Pa 2006), while human social activities give preference to areas with a better natural environment. The advantageous location has allowed Muslims to

concentrate their social and religious activities, resulting in a more prosperous Islam and a relatively larger quantity of mosques. Secondly, the mosque, which has both religious and social functions, will become an important place in the daily life of Muslims once it is built (Jani et al. 2015). Muslims in the Kashgar region use the mosques for their daily worship, scripture study, weddings, funerals and other activities. In addition, the important religious and social functions of the mosque can attract the population to gather around it, thus accelerating the prosperity of Islam in its locality. Therefore, the organic interaction between the beliefs carried by the mosques and the geographical environment has resulted in a spatially clustered distribution of mosques in the Kashgar region.

5.2.2. Clustering of Mosques

From the color differences of DDE values in Figure 4 in different years, it can be seen that the distribution of mosques in the northwestern, central, and northeastern regions of the Kashgar region from 1955 to 2004 showed a more obvious clustering feature and a growing trend of concentration. From 1955 to 1976, there was no significant increase in the agglomeration of mosques in the Kashgar region and the DDE values were elevated only in Konaxahar and Yarkant. Between 1976 and 1992, the DDE values were significantly elevated in Konaxahar and in the population agglomerations of Yarkant and Poskam. This period also saw the emergence of new agglomerations in the areas along the river, in Makit in the central part of Kashgar and in Maralbexi in the northeast where there is a relatively large population distribution. From 1992 to 2004, the DDE values in the Kashgar region showed a small increase in a small part, although the overall change was not significant. On the whole, the agglomeration of mosques in the study region has strengthened, and the scope of clustering has increased, especially from 1976 to 1992.

DDE is able to mark the macroscopic distribution and concentration of samples in a region at a large scale. In order to observe the agglomeration distribution of mosques on a small scale, the Kashgar region was divided into 7667 units with a grid of 5 km × 5 km. If the number of mosques in a unit is greater than 50, it is judged that the unit has a strong agglomeration effect, and is said to be an aggregation unit. The units were divided into four classes based on the number of mosques. The distribution of the aggregation units for the four selected years of 1955, 1976, 1992, and 2004 is shown in Figure 5. The number of aggregation units in each district and county of the Kashgar region at four time points is counted as shown in Table 3, and the numbers in parentheses after the place names represent the number of aggregation units of a certain class owned by the place.

In terms of the spatial location of the aggregation units, the spatial clustering of mosques reflected by Figure 5 is not significantly different from the clustering reflected by DDE. During the study period, the aggregation units in the Kashgar region were mostly clusters of 50 to 100 mosques, and it was less common that more than 100 mosques occurred simultaneously in a unit. A small number of units received a rank upgrade during the study period. It is worth noting that, as of 1976, there were only two clustering cells at the junction of Makit and Maralbexi (which are bounded by the river, and the cities along the river have always been relatively well developed and densely populated), but by 1992 many new clusters had appeared there. Otherwise, the spatial distribution of aggregation units in 2004 did not differ much from that in 1955.

By district, the distribution of aggregation units was found in all districts except Tumxuk and Tashikurgan. The quantity of aggregation units in Maralbexi, Makit, and Kargilik increased during the study period. All three areas were located in the eastern part of the study area, and the increased units were located in districts with rivers passing through and high population, which reflects the trend of clustering of mosques to the eastern districts and counties.
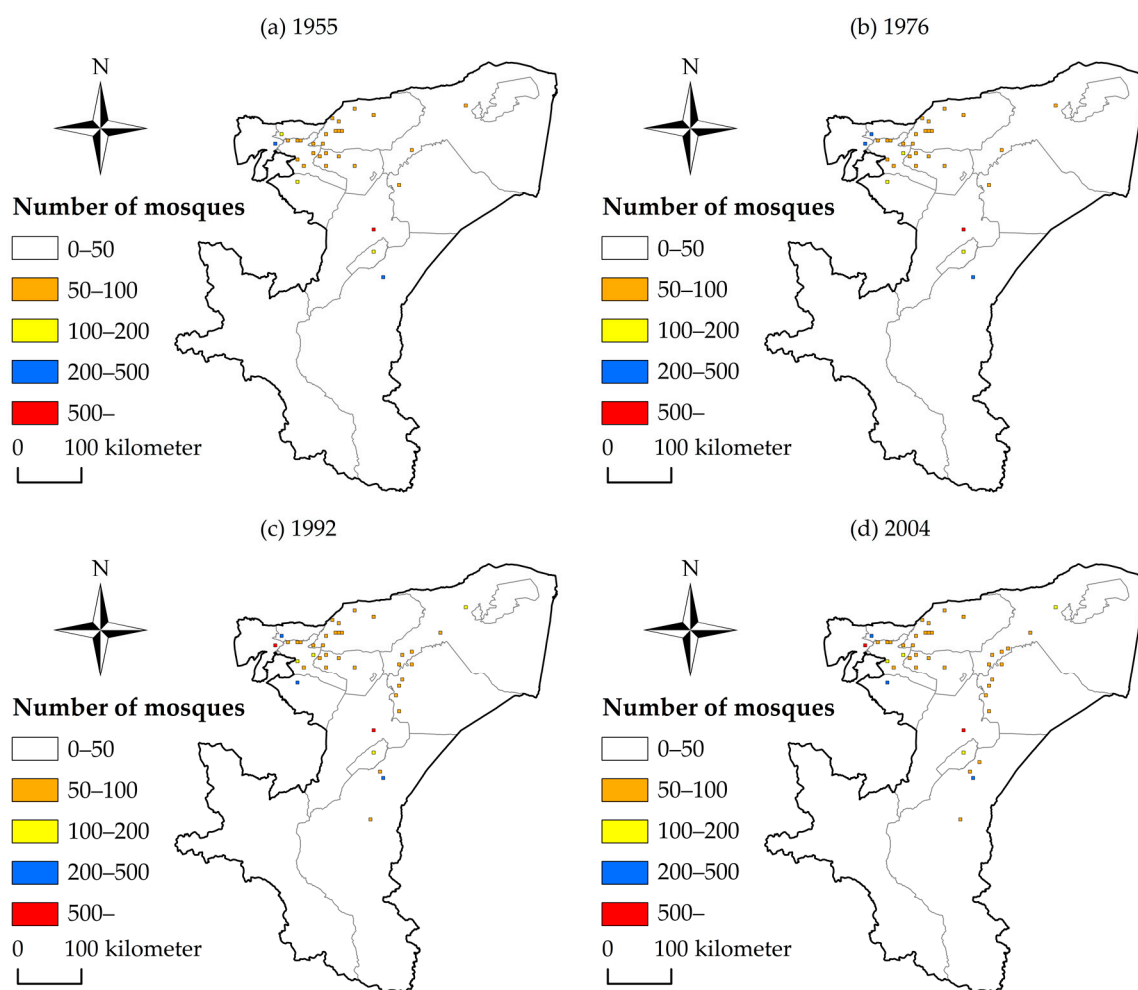
Figure 5. Spatially concentrated distribution of mosques in a fishnet of 5 km × 5 km in the Kashgar region from 1955 to 2004.

Table 3. Rank distribution of aggregation units owned by each district and county of the Kashgar region.

Rank	1955	1976	1992	2004
50–100	Payzawat (10) Yengixahar (6) Yopurga (5) Maralbexi (2) Makit (1)	Payzawat (10) Yengixahar (5) Yopurga (5) Maralbexi (2) Makit (1)	Payzawat (10) Yopurga (5) Makit (5) Maralbexi (4) Yengixahar (4) Kargilik (2)	Payzawat (10) Yopurga (5) Makit (5) Maralbexi (5) Yengixahar (4) Kargilik (3)
100–200	Kashgar (1) Yengisar (1) Poskam (1)	Yengixahar (1) Yengisar (1) Poskam (1)	Yengixahar (2) Poskam (1) Maralbexi (1)	Yengixahar (2) Poskam (1) Maralbexi (1)
200–500	Konaxahar (1) Kargilik (1)	Konaxahar (1) Kargilik (1) Kashgar (1)	Kargilik (1) Kashgar (1) Yengisar (1)	Kargilik (1) Kashgar (1) Yengisar (1)
500–	Yarkant (1)	Yarkant (1)	Yarkant (1) Konaxahar (1)	Yarkant (1) Konaxahar (1)

Yengixahar, Kashgar, Yengisar, and Konaxahar have increased their clustering cell class. These four districts, which border each other and are located in the most densely

populated areas in the northwestern part of the study area, also ranked higher in terms of the number of mosques among all districts (Table 1 shows this), and the agglomeration effect of mosques was more significant.

Payzawat consistently had more aggregation units than the other districts during the study period, but the area of high DDE values in the county was concentrated mainly in its southwestern orientation and did not cover all the clustering cells. It can be concluded that the development of mosques in Payzawat was influenced by the agglomeration effect of the neighboring districts of Kashgar and Yengisar, and the agglomeration effect of mosques in neighboring areas of Payzawat was more advantageous. In general, the spatial agglomeration of mosques in the Kashgar region was still influenced by geographical environment and demographic factors, and the agglomeration effect was especially obvious in districts and counties where mosque development had advantages.

5.2.3. Spatial Expansion of the Mosque

The standard deviation ellipse, SDE, can abstractly reflect the geometric characteristics of the distribution of sample points in space. SDE is used to observe the spatial expansion of mosques in the Kashgar region from 1955 to 2004, as shown in Figure 6 and Table 4.
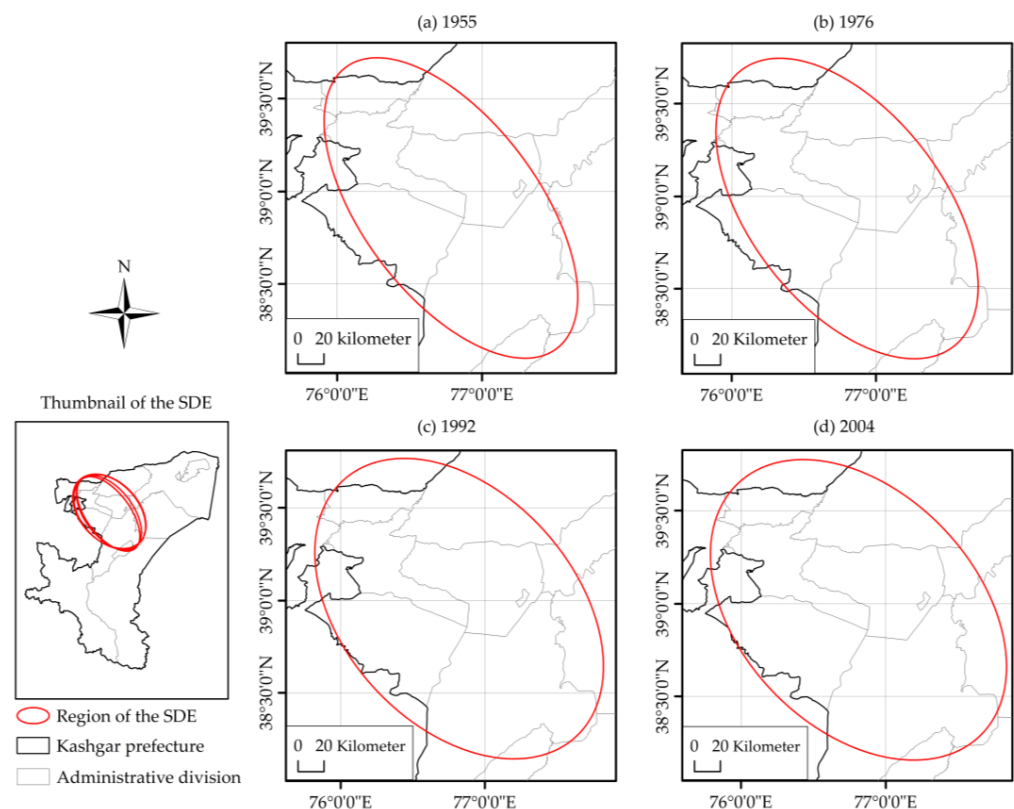

Figure 6. Changes in the SDE of mosque distribution in the Kashgar from 1955 to 2004.

Table 4. SDE data for the spatial distribution of mosques in the Kashgar region from 1955 to 2004.

	1955	1976	1992	2004
Coordinates of center	76.785689° E 38.906773° N	76.799293° E 38.930410° N	76.821778° E 38.951602° N	76.811586° E 38.962799° N
x lengths: σ_x (km)	270.683	268.539	272.384	268.920
y lengths: σ_y (km)	135.632	149.123	179.592	181.376
Area (km^2)	28815.107	31,581.231	37,500.608	38,287.301
Azimuth: θ	131.165°	128.816°	120.532°	118.842°

The area of the SDE continued to increase during the study period, especially during the period from 1976 to 1992. The mosques in the Kashgar region are not only continuously clustered within the SDE, but also grow significantly outside. However, the center coordinates of the SDE did not move significantly during the study period, indicating that the mosques' growth outside the SDE was not sufficient to weaken the intensification of the agglomeration effect in the area near the center point of the SDE.

During the study period, the distribution of SDE from the northwest-southeast direction underwent a counterclockwise rotation, and the rotation angle tended to decrease. The x (long axis of the ellipse) lengths did not change significantly. However, the y (short axis of the ellipse) lengths, especially from 1976 to 1992, have increased significantly and the shape of SDE gradually became rounded. Combined with the analysis in the previous subsections, the increase in the number of mosques in the eastern and northeastern districts of the SDE, such as Maralbexi and Payzawat, has led to an outward expansion of the mosque agglomeration effect, resulting in a change in the geometry of the SDE, i.e., the spatial expansion of mosques has had a diffusion effect, but the diffusion effect has not had a significant impact on the agglomeration of mosques in several districts and counties in the northwestern part of the Kashgar region. Accordingly, it can be inferred that the center point of SDE will still not change much after 2004, but the area will continue to change, and the rotation angle will continue to decrease. Mosques will continue to expand in the eastern and northeastern parts of the study region, and the agglomeration effect will continue to increase in the northwestern part. The absolute difference of mosque development in the region will further expand and the relative difference will continue to decrease.

5.3. Causes of the Evolution of the Spatial Distribution of Mosques in the Kashgar Region

The natural conditions of regions can be an important factor influencing the early process of origin and spread of religion. The population of the Kashgar region has mostly been distributed since ancient times in geographic areas with gentle terrain, freshwater resources, and in non-desert areas, which tend to form relatively developed urban settlements as the population gathers. The emergence of settlements provided the missionary infrastructure for the early development of Islam in this region.

Around the tenth century A.D., the rulers of the Kara-Khan Dynasty were influenced by their western neighbor, the Samanid Dynasty, and embraced Islam. The rulers represented the upper echelons of the religious hierarchy, and Islam became the official faith of the Kara-Khan Dynasty. During this period, Islam spread spatially with geographic carriers such as commercial roads and cities. After the division of the Kara-Khan Dynasty, the Eastern Kara-Khan Dynasty took ancient Kashgar, the northwestern part of the Kashgar region studied in this paper, as its economic, political, and cultural center. Although deeply inland, ancient Kashgar was relatively rich in river resources and gently sloping, and its location at the natural boundary between East Asia and Central Asia, as well as its relatively dense population, gave rise to many settlements and cities (Zilolakhon and Akhmadjonov 2022). The establishment of mosques completed the social and religious functions of these settlements and cities. Similarly, in the Yarkand Khanate area (near the river on the west side of present-day Makit), the gentle terrain and the presence of the river made it easier for the population to gather and Islam to flourish there. In the analysis of the previous study, the spatial layout of the mosque also favors areas with gentle terrain, freshwater resources, and in non-desert areas. Therefore, it can be argued that natural features and population are the two basic causes of the spatial distribution of mosques in the Kashgar region.

In the period studied in this paper, between 1955 and 2004, social factors were an important reason for the evolution of the spatial pattern of mosques in the Kashgar region. The Uyghur autonomy system was introduced in Xinjiang in 1955, with the Chinese government declaring that it would fully guarantee the customs and religious beliefs of minority groups. In 1958, Xinjiang completed its democratic reform and socialist transformation and carried out a reform of its religious system focusing on the elimination of religious feudal privileges and exploitation and the prohibition of illegal activities by religious people.

During this period, some mosques in the Kashgar region were spontaneously demolished by the masses, some collapsed naturally, and some were collectively occupied or demolished during the communalization period (Cao and Youze 2006). However, at this time the government did not restrict the legal religious activities in the mosque, and some less developed areas still build a number of new mosques to meet the normal religious needs of the masses.

During the "Cultural Revolution", from 1966 to 1976, the Chinese government's religious policy guidelines were undermined and a large number of mosques were occupied as revolutionary places for ideological propaganda (Li 2014). People in some districts and counties of the Kashgar region were banned from conducting religious activities in religious places. At this stage, although there was a demand for mosques among the faithful, fewer new mosques were built due to the political environment. Around 1976, with the end of the "Cultural Revolution," the Chinese government's religious policy was restored and implemented. A large number of mosques in the Kashgar region were approved to be restored and newly built. During this period, the management of the mosques that were occupied and demolished during the "Cultural Revolution" was returned to the faithful. After this, religious activities and the management of mosques in the Kashgar region developed normally.

Since 1978, mainland China has been implementing a policy of reform and opening up. Due to the relaxation of the national economy's restrictions on the means of production as well as material and equipment, and the proximity to the border, the social production in the Kashgar region was further liberated and a large number of businessmen emerged. After 1980, the number of mosques in the Kashgar region expanded dramatically, financed by a few businessmen and mostly by compulsory distribution to the faithful. Most of the businessmen financed the construction of mosques in their hometowns, and most of the "first rich people" came from several districts and counties in the northwest of the Kashgar region. This period is also the most significant change in the spatial pattern of mosques from 1995 to 2004. Although the number of mosques has grown and Islamic activities have developed well, it is clear that it has increased the financial burden on the faithful (Xie and Du 2013).

In the late 1980s, the government concluded that illegal religious activities existed in Xinjiang and that it was more vulnerable to the influence of separatist forces outside China. Therefore, in 1990, the Xinjiang government issued a new management policy for mosques in various areas. At this stage, the relevant authorities believed that the religious sites owned by southern Xinjiang at that time could fully meet the needs of the religious masses in terms of policy religious life, and that the new construction of mosques would be managed restrictively. After the 1990s, the Xinjiang government stipulated that, in principle, no new mosques would be built. However, new settlements and herdsmen settlements without mosques can build new mosques after strict approval procedures. The excessive number of mosques was considered a sign of religious fanaticism. The increase in illegal religious activities resulting from religious fanaticism was one of the dangerous factors affecting social stability in Xinjiang. Therefore, the relevant authorities required the mosques in the Kashgar region to be equipped with legal persons. The database used for this study shows that all of the people serving as legal persons in the mosques were Uyghurs and there were no Han Chinese. From this perspective, religious affairs in the Kashgar do implement the policy of minority autonomy.

In 1992, Deng Xiaoping's Southern Talk reaffirmed the importance of the market economy in China's reform and opening-up process. Due to its special geographical location, the Kashgar region had relatively frequent economic exchanges with the outside of China and the living standard of the people had been rising in the process of reform and opening up. The urban areas of the districts and counties in the Kashgar region were constantly expanding, with more and more new settlements, and the existing mosques did not meet the needs of the faithful. With the financial support of the faithful, new mosques were built, and while not as many as in the 1980s, the number was still relatively significant.

It is worth noting that, in conjunction with the previous analysis, even though new mosques were being built, the number of new mosques was still relatively small compared to the number of mosques already built. Therefore, the spatial distribution pattern of mosques in the Kashgar region from 1992 to 2004 was not much changed. In addition, Tumxuk has been sparsely distributed due to the implementation of the Xinjiang Production and Construction Corps management system, and the incompatibility of Islamic beliefs with the ideology of the local administration.

In general, the spatially changing characteristics of mosques in the Kashgar region from 1955 to 2004 are basically closely related to the historical evolution of the region from the time periods selected for this study (1955, 1978, 1992, and 2004). Geographical conditions and population laid down the basic characteristics of the distribution of mosques in the region. After the founding of People's Republic of China, changes in social factors such as productivity, religious management system, and administrative system are the reasons for the changes in the spatial distribution characteristics of mosques in the Kashgar region.

6. Conclusions and Discussion

This study examines the spatial and temporal evolution of the spatial distribution pattern of mosques in the Kashgar region of Xinjiang, China, from 1955 to 2004, based on data from the Digital Map of Religions in China, using mathematical statistical methods and spatial analysis, and explores the causes. The results of the study show that there was a significant increase in the number of mosques during the study period. The agglomeration effect of mosques in the region was greater than the diffusion effect, and the growth of mosques was more significant in agglomeration areas than in non-agglomeration areas. In the Kashgar region, the absolute difference in the development of mosques across districts and counties continued to expand, and the agglomeration effect had a tendency to increase. The number of mosques in non-agglomerated areas also increased during the study period, and the relative differences in regional development tended to decrease. The spatial distribution of mosques showed spatial autocorrelation and tended to be clustered. The districts and counties in the northwestern part of the Kashgar region, such as Yengixahar, Kashgar, and Konaxahar, were the areas with the most pronounced mosque aggregation effect. In addition, concentrations were also seen in Yarkant, Poskam and other districts and counties.

The period from 1976 to 1992 was the most obvious period of change in the pattern of mosque concentration and distribution in the Kashgar region. Later in the study period, new areas of agglomeration emerged in Maralbexi in the northeastern part, and in Makit in the central part of the region. Overall, the clustering of mosques in the study area was found mostly in areas with gentle topography, rivers and dense population. Geographical conditions were the basic factors affecting the distribution of mosques in the Kashgar region, and demographic factors also played a key role in the construction and development of mosques. During the study period, social factors were an important reason for the evolution of the spatial pattern of mosques. Under the current social system in China, factors such as the increase of productivity, administrative system, religious management policies, and historical background have greater impact on the evolution of the spatial distribution pattern of mosques. The effects of these factors on the development of Islam in the Kashgar region cannot be ignored.

This study has implications for understanding the development of Islam in the Kashgar region and the spatial evolution of mosques in the region since the founding of the People's Republic of China. However, limited by the data sources of the first economic census of China, the digital map of Chinese religions on which this study is based cannot fully reflect the whole picture of mosque development in the study region, and can only briefly explore the development of mosques in the region from a spatial perspective. Firstly, the first economic census only recorded the year of origin of religious sites, and it was not possible to identify and confirm whether some mosques belonged to those that were destroyed during the "Cultural Revolution" and other historical events but were subsequently restored. Since

the information on religious affairs in the Kashgar region during the Cultural Revolution is insufficient and difficult to obtain, the role of special historical events in the development of mosques in the Kashgar region remains to be explored. Secondly, mosques in the region are differentiated by size, but since the first economic census did not count the size of religious places this study does not explore the spatial heterogeneity of mosques in depth. Therefore, studies related to the development of mosques in the Kashgar region still need to be further developed.

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