Research on the Spatial-temporal Changes and Driving Forces of City Green Space in Kunming

Zhuoya Zhang¹,², Linjiao Zhi², Junjie Yang²,*

¹Faculty of Environmental Science and Engineering, Kunming University of Science and Technology, Kunming, China
²Faculty of Geography and Ecotourism, Southwest Forestry University, Kunming, China

*Corresponding author e-mail: 27024601@qq.com

Abstract. To explore the spatial and temporal changes and driving forces of city green space in Kunming since 1950, and provide a reference for future city green space development planning. Through consulting a large number of documents, Kunming statistical yearbook and field investigation, the geospatial analysis method and comparative analysis method were used to analyze the spatial and temporal changes of the park green space above 5hm² in the downtown area of Kunming, and its driving force was analyzed by qualitative analysis method. The results shows that (1) There are four development stages in the construction of city green space in the downtown of Kunming. (2) The city green space in Kunming city center > 5hm² ranks in order as Chenggong District, Panlong District, Xishan District, Wuhua District, Guandu District. (3) There are four trends in the spatial distribution of city green space. (4) The driving force mainly includes geographical factors, economic factors, population factors, transportation factors, and policy factors. After the comprehensive effect of various aspects, the current city green space distribution pattern in Kunming is formed.

1. Introduction
City Green Space is a concrete form of city forestry, a reduction organization of city ecosystem, an important part of national greening, and a part of the overall planning and construction of modern cities. The population of modern cities has increased dramatically, and the pollution of air, water, solid waste, noise and soil has also intensified, destroying the living environment and ecological balance, and also causing serious harm to the health, production and life of city residents. The purpose of building city green space is to create a reasonable and pleasant city green space system, which is an important part of human settlement environment and one of the factors that have the greatest impact on the city ecological environment [1, 2]. City green space emphasizes the coordination and unity of people and the environment, embodies the concept of sustainable city development, is the main component of city ecologicalization, is also the main form of city landscape form, and is the charm of a city. Since the 1980s, China's city green space construction has made great achievements.

There are many concepts of city green space. For example, Alan defined a garden serving the public in the city, including a garden funded by the government, owned by the public, and serving the public, and privately constructed to serve the public or a garden open to the public [3]. Maruekkke H. considered
it as a natural return in industrial cities [4]. Olmsted believes that it is a fully functional city open green space [5]. The current foreign research on city green space mainly includes the following aspects: city green space planning and design research, city green space landscape pattern and ecological effect evaluation and analysis, city green space and recreation space spatial layout research, city green space comprehensive evaluation research, city green space accessibility research and other aspects[6]. Taking the main city area of Kunming as an example, Li et al. discussed how to introduce the concept of network city into the city green space system to form a green space network pattern, and proposed an extended linear land use model [7]. Zhu et al. based on Kunming population data and park data, applied spatial analysis methods such as GIS spatial interpolation and overlay analysis to study the emergency refuge capacity of city green space in Kunming [8]. Wu et al. studied the current situation of road green space in Kunming City through a comparative analysis of the width of green belts and plant collocation in different road sections in Kunming City [9]. Du et al. used the theory and methods of landscape pattern and selected corresponding landscape pattern index to analyze and study the characteristics of city green space landscape pattern in the main city area of Wuhua District, Kunming [10].

Kunming is an important city in southwest China and a national garden city, with a coverage rate of 50.5% [11]. Previous studies have focused more on landscape pattern characteristics [10], current status of city forests [9], and functional roles [8, 12], while on Kunming’s city forests. There are few studies on the spatial and temporal changes and driving forces of green space. Therefore, this paper takes the green space≥ 5hm$^2$ in the downtown area of Kunming as the research object to study the dynamic changes of the time and space of city green space in Kunming since 1950. This paper combines ArcGIS to analyze the spatio-temporal dynamic changes of city green space in Kunming, and further studies the driving force of spatio-temporal changes of city green space, which provides a reference for future city green space development planning.

2. Materials and Methods

2.1. Study area
Kunming is the capital of Yunnan Province. It is located in the Central Yunnan Basin in the Yunnan-Guizhou Plateau and is surrounded by mountains on three sides in the central city area. The average altitude is 1891m, which belongs to the sub-tropical-plateau mountain monsoon climate at low latitudes in the north. The climate is warm, with typical temperate climate characteristics, the city temperature is generally between 0-29°C [13]. Kunming is located in the watershed of the Jinsha River, Nanpan River, and Red River. It is controlled by the entire Yunnan Plateau uplift movement and the transversal vein from the northwest and the North Umong Mountains. The terrain is high in the north and low in the south, and gradually decreases from north to south in a staircase [14]. The city area of this research center is Wuhua District, Panlong District, Guandu District, Xishan District, and Chenggong New District. The administrative division of each stage is based on the actual scope of 2017.

2.2. Methods
In this study, ArcGIS software was used to analyze the temporal and spatial changes of the green space in the main city area of Kunming. In this study, the city area of downtown Kunming was taken as the research scope, and the park green space above 5hm$^2$ was taken as the research object. By consulting the statistical yearbooks of Kunming, the tourist maps of Kunming, online materials and field surveys, a total of 54 central city green spaces were collected. Among them, there are 8 in Wuhua District, 13 in Panlong District, 12 in Xishan District, 7 in Guandu District, and 14 in Chenggong District (Table 1). It can be seen from Table 1 that in 1950, there were only 7 park green spaces above 5 hectares in downtown Kunming. By 1978, there were an increase of 2 parks, in 1999, 34 in 2009, and 54 in 2017.

The geospatial analysis method is an important method in this study. The statistically good data is grouped according to time nodes, and ArcGIS software is used to mark the spatial distribution of city green space at various stages in the form of points.
Table 1. Quantity of city green space in various districts of Kunming

| Year | Panlong District | Wuhua District | Xishan District | Guandu District | Chenggong District | Total |
|------|-----------------|----------------|----------------|----------------|--------------------|-------|
| 1950 | 4               | 2              | 1              | 0              | 0                  | 7     |
| 1978 | 4               | 3              | 2              | 0              | 0                  | 9     |
| 1999 | 6               | 4              | 6              | 1              | 1                  | 18    |
| 2009 | 10              | 8              | 10             | 3              | 3                  | 34    |
| 2017 | 13              | 8              | 12             | 7              | 14                 | 54    |

3. Results

3.1. Spatial-temporal changes of city green space in Kunming

Using ArcGIS software, 5 maps of Kunming city green space distribution in each period were drawn (Figure 1). From the perspective of time lapse, before 1950, there were only 7 city green spaces in Kunming's downtown area> 5hm². From 2010 to 2017, there will be an increase of 20, a total of 54. It can be seen that Kunming's city green space foundation is weak before the founding of the People's Republic of China. During the period after the founding of the People's Republic of China and before the reform and opening up, there was little investment in city green space construction. After the reform and opening up in 1978, Kunming's city green space grew faster and faster. Especially after 2010, city green space has shown a rapid growth trend.

Figure 1. Spatial changes of city green space in Kunming
From the perspective of administrative location, Panlong District has been the administrative region with the largest number of city greenbelts before 1978. After 1979, Xishan District developed rapidly. The construction of Guandu District and Chenggong District started late, and the construction of city green space began only after 2000. However, since 2010, Chenggong District has become the administrative district with the largest amount of city greenbelt construction in the downtown area of Kunming in the past 8 years. The ranking of city green space in Kunming city center> 5hm² is in order of Chenggong New District, Panlong District, Xishan District, Wuhua District, and Guandu District, with 14, 13, 12, 8 and 7.

There are four trends in the development of city green space in Kunming. One is to develop along the lake around Dianchi Lake, and take advantage of the wetland of Dianchi Lake to build a large number of wetland ecological parks. The second is to develop along the Panlong River that flows through the city area, and use the rich water resources brought by the river to build city green spaces. The third is to develop into mountainous areas and around city areas, and use natural resources to build a large number of parks. Fourth, the construction of large city green spaces in the central Guandu District and the eastern part of the Xishan District has been lagging behind (Figure 2).

3.2. Analysis of the driving force of the spatial and temporal changes of city green space in Kunming

3.2.1. Geographical factors. The downtown area of Kunming is located in the central Yunnan Basin. The main city is located on a dam. The terrain is not gentle. There are some hills scattered from the centre to the periphery. Kunming's development of city green space can be described as unique natural conditions. Through field investigation, it was found that Kunming has built a large number of city green spaces in the surrounding mountain and along the Dianchi Lake. These green spaces are mostly forest parks and wetland parks. The development of forest parks and wetland parks has become a major trend for Kunming to develop city green spaces. Forest parks and wetland parks have won the love of the general public for their beautiful natural ecological landscape and good ecological effects, and have become the first choice for weekends and holidays.

3.2.2. Traffic factors. City green space shows a trend of developing from the inside out. More and more city green spaces are located in places with sparse city population, low development intensity and good natural ecological environment. However, city green space is for citizens, and it must be convenient for citizens to travel, which requires strong transportation system support. The city green space built on the edge of the city must have convenient transportation. Kunming is one of the most important
transportation hubs in western China. As of the end of 2015, the roads above 15m in the downtown area of Kunming reached 1,577km, and the road network density reached 4.4km/km². Kunming, as the highway transportation centre in Yunnan, has well-developed transportation in Kunming. At the end of 2015, the number of motor vehicles in the city was 2,150,700[13]. Kunming's public transportation system is at the national leading level. Kunming Rail Transit is in a period of rapid development. At present, rail transit has been implemented in the east, west, south, north, and middle of the city, and the five districts of the main city can be reached.

3.2.3. Economic factors. In the administrative area, there are 2 large dense areas. One is Wuhua District and Panlong District, and the other is Chenggong District, and this reflects the shift of the focus of city green space construction in the administrative area. This development trend of city green space in the downtown area of Kunming is very similar to the economic development trend of Kunming City and even Yunnan Province and the whole country. Before the reform and opening up, the economy was relatively backward, and the government did not have sufficient funds to build the park. After the reform and opening up, the national economic form has improved. As the capital of Yunnan Province, Kunming has developed rapidly. In the 21st century, the economy has developed rapidly. While developing the economy, the government has paid more and more attention to the city environment and the quality of life of residents. The popularity of real estate has also given the park more and more attention.

3.2.4. Demographic factors. Kunming's downtown area had a population of 1.09 million in 1974, 1.5 million in 1988, 1.73 million in 1998, 2.99 million in 2008, and 3.58 million in 2017 [15]. With the population growth, Kunming's city green space has also increased accordingly. After 1998, Kunming's population has increased significantly, and Kunming's city green space has also developed rapidly after entering the 21st century. As a service target of city green space, city green space must meet people's needs. Therefore, the population factor is also one of the driving forces for the development of city green space in downtown Kunming.

3.2.5. Policy factors. City green space belongs to municipal facilities, and it needs policy support from the initial site selection, approval to construction and operation, and must be constructed in strict accordance with relevant government documents. Therefore, the local government's investment in city construction and various decisions play a key role in the development of green space. Kunming proposed the goal of creating a "National Garden City" in 1996. After 14 years of unremitting efforts, Kunming was awarded the title of "National Garden City" by the Ministry of Housing and City-Rural Development in 2010. In 2014, the work of Kunming City to create a national ecological garden city started. In 2017, Kunming began to fully launch the creation of a national ecological garden city. In these processes, the Kunming Municipal Government has invested a lot of money, which has also driven the rapid development of Kunming's city green space.

4. Conclusion

There are four development stages in Kunming city green space construction, 1950-1978 is a period of development stagnation, 1979-1999 is a period of initial development, 2000-2009 is a period of rapid development, and 2010-2017 is a period of rapid development.

Before 1978, the administrative district with the largest amount of city green space was Panlong District. After 1979, the development of the Xishan District has been rapid, and the Wuhua District has grown steadily. The construction of the Guandu District and Chenggong New District started late. After 2010, Chenggong District developed the fastest. As of 2017, the city green space ownership in Kunming's downtown area> 5hm² ranked in the order of Chenggong New District, Panlong District, Xishan District, Wuhua District, Guandu District.

From the geographical space, there are four trends in the spatial distribution of city green space. One is the development along the lake around Dianchi Lake. The second is to develop along the Panlong River flowing through the city area. The third is the development of mountains and around the city.
Fourth, the construction of large city green spaces in central Guandu District and eastern Xishan District has been lagging behind.

Kunming is located in the southwestern border of the motherland. It is a well-known "Spring City" at home and abroad. It has won the titles of "China's International Image Best City", "China's Excellent Tourism City", "National Garden City" and "China's Best Ecological Livable City". The achievement of these honors is closely related to the development of Kunming city green space construction.

In this study, due to the difficulty in obtaining data, only green areas with an area $> 5\, \text{hm}^2$ were involved in city green areas. In this study, the spatial and temporal changes of city green space only discuss the changes in quantity and space, and do not involve changes in the area of city green space. In future research, this aspect of the study will be strengthened.

Acknowledgments

This work was financially supported by the 2017 Yunnan Provincial Department of Education Science Research Foundation Project (Grant 2017ZZX210).

References

[1] Zhuo Lihuan. Application Guide for Urban Landscape Plants [M]. Beijing: China Forestry Press, 2002.
[2] Xu Feng. Design and Construction of Urban Garden and Green Space [M]. Beijing: Chemical Industry Press, 2002.
[3] Alan T. Creat City Parks[M]. London: Spon Press, 2001.
[4] Marielle H. Jardins et Parcs Contemporains France[M]. Paris: Telleri, 1995.
[5] Phaidon P. The Garden Book[M]. London: Phaidon Press, 2000.
[6] Wang Nuying, Sun Mingzhe, Wang Hui, et al. Research on the characteristics of space-time development and influencing factors of urban parks in Beijing[J]. Journal of Capital Normal University (Natural Science Edition), 2015, 36(2).
[7] Li Lu, Li Liping, Guo Fang. Research on the construction of urban green space function network based on the network city form. Take the urban green space system in the main urban area of Kunming as an example [J]. Forestry Investigation and Planning, 2014 (1): 130-133.
[8] Zhu Yong, Zhang Li, Zhang Ying, et al. Investigation and Research on Emergency Refuge Ability of Park Greenland in Kunming City [J]. Journal of Southwest Agriculture, 2010(1):192-196.
[9] Wu Liang, Dong Cao, Tan Xiumei, et al. Diversity of garden plants in road green space in Kunming City [J]. Northern Horticulture, 2011(24):110-114.
[10] Du Songcui, Wei Kaizun. Spatial analysis of urban green space landscape characteristics in Wuhua District of Kunming City [J]. Anhui Agricultural Sciences, 2011, 39(25): 15550-15553.
[11] Kunming Forestry Bureau. http://lyj.km.gov.cn/c/2017-09-05/2049914.shtml.2019-09-05.
[12] Li Lu, Li Liping, Guo Fang. Research on the construction of urban green space function network based on the network city form. Take the urban green space system in the main urban area of Kunming as an example [J]. Forestry Investigation and Planning, 2014 (1): 130-133.
[13] Liu Xin. The climate of "Spring City" Kun next year with extremely small temperature difference is rare in the world [J/OL]. City Scenery Network, 2013-02-19.
[14] Li Hailin. GIS-based spatial and temporal evolution and driving force of Kunming main city construction land expansion [D]. Kunming: Yunnan University of Finance and Economics, 2012.
[15] Kunming Municipal People's Government. Kunming National Economic and Social Development Statistical Bulletin 2015. Kunming Municipal People's Government Network. 2019-07-21.