Quantitative analysis and comparative study of four cities green pattern in API system on the background of big data

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Abstract. Beijing, London, Paris, New York are typical cities in the world, so comparative study of four cities green pattern is very important to find out gap and advantage and to learn from each other. The paper will provide basis and new ideas for development of metropolises in China. On the background of big data, API (Application Programming Interface) system can provide extensive and accurate basic data to study urban green pattern in different geographical environment in domestic and foreign. On the basis of this, Average nearest neighbor tool, Kernel density tool and Standard Ellipse tool in ArcGIS platform can process and summarize data and realize quantitative analysis of green pattern. The paper summarized uniqueness of four cities green pattern and reasons of formation on basis of numerical comparison.

1. Introduction

On the background of big data quickly developed, Urban planning, landscape architecture, architecture design and other expertise fields have been affected. It's obvious that the number of papers research about smart city and digital landscape is increasing. From 2010 to 2016, the papers which published in core journals used the "smart city" as key words were more than 200 and the "digital landscape" were more than 100. [1] The application of big data was not only used to theory research, but also was concerned by engineering practice of landscape architecture, and the combination of science and aesthetics is more and more important. [1] API system is an effective tool for various industries in the background of big data.

API is not a new word, and the full name for API is "Application Programming Interface" which means some pre-defined functions. API provided ability for applications and developers to access a group of feature sets based on a software or hardware without accessing source or understanding details of internal working mechanism. API system more used in the Internet field [2]. At the third annual meeting of the Beijing City Lab(BCL), Dr. Li Dong firstly explored the possible application of the API system in the urban research and introduced multiple typical cases of API urban analysis. This is the first time for putting forward this concept in urban planning and landscape architecture.

The study in this paper obtained real-time data for specialization relied on API system, and compared typical characteristics and quantitative analysis of green space pattern in the four urban (Beijing, London, Paris, New York). Four cities are typical world-class cities. So horizontal comparative studies can survey the existing problems and gaps of urban green space construction from a new perspective in China. It's helpful to learn and reference from each other.

2. Introduction to Development of Green Space Pattern in Four Cities

Beijing is the latest starting systematic construction of green space in four cities. 1840~1949, the concept of “Western park” passed into Beijing, so the Qing government firstly put forward the idea of "park". 1950s, Beijing began to large-scale construction for urban green space and comprehensive parks. In this stage, urban green space system already had a complete concept. 1960s, the urban plan creatively put forward the layout form of “scattered, grouped”, and there were pieces of green land between the groups. 1970s, park area in Beijing appeared negatively grow. At the end of the 1980s, the policy that contiguous pieces into a group and combination with point, line and area green space was applied in urban green space system layout. To this stage, Beijing had built interconnected and criss-cross system network which has point, line, area, ring, gallery and wedge green space. [3][4][5]

London is the earliest starting construction of green space in four cities. The parks with entertainment functions appeared in the 1820s in London. In 1843s, the construction of Birkenhead Park in England marked the birth of the first urban park in the world. Since then, England began to construct a large number of urban parks throughout the country. 1850s, regent park group which formed in near Regency area had begun to have rudiment of park system and profoundly affected the structural development of urban space in London. 1860s~1890s, the government promulgated the capital city law, and citizen started to protect common lands to have long-term preservation for the green space which had landscape and historical value. 1900s~1930s, open space system was established, and green belt surrounded London urban area as a ring. In 1940s, Albercrombie, Patrick and other person promoted the idea of ring green belt and proposed park system planning program for the Greater London area. In 1970s, London began to construct "green chain". From the 1990s to the present, <Green Strategy Report> had proposed a series of overlay networks, each of them had different attributes, So green network had been basically constructed in London. [6][7][8][9]

Paris had begun to construct a series of green gardens as early as the 17th century, Jardin des Tuileries was the first public garden for citizen. At the 18th century, the city had formed an axis around Louvre area and built a series of urban squares. From the end of the 18th to the beginning of the 19th, Seine river had been renovated and the city axis extended. 1850~1870s, landscape construction in the city started from the road to green space layout which combined point line and area. 1880~1930s, the government firstly proposed the urban plan to limit the vicious expansion and beautify the city. 1930~1960s, the layout of green space system in Paris was reticulation. 1970~1990s, city parks construction upsurge appeared and the circular green belt was constructed. At the beginning of the 21th century, the ring green belt had become an important part of ecological environment construction in Paris and green space construction in suburban had been concerned. Finally, the city established a green network with integration of urban and rural area. [6] [10] [11]

The grid layout form in New York Manhattan was officially established in 1811. 1830~1850s, the city opened up green space in high density of the city. The earliest park plan was Central Park in New York in 1858 which completed construction in 1873. 1860~1880s，New York began to gradually form a structure in which park roads connected city parks. 1880~1920s, under the scale of regional planning, the construction of park roads connected public green space in the city and the suburbs. The United States held the World Expo in 1893 and "City landscaping movement" began from then. New York began to construct the first park avenue in 1908, since then the park avenue in New York City had reached more than 40. 1930~1970s, a city park system had formed through interconnecting multiple city parks and the city gradually formed green system skeleton in a larger area. 1970~2000s, construction of greenway system passed through the city and formed large-scale green space system connection. To 2011, the section in New York city of East Coast Greenway system had been completed 62%. [12] [13] [14]

3. Summarization and Quantitative Analysis of Basic Data of Green Space Pattern in Four Cities

3.1. Refinement and Induction of Basic Data of Green Space Pattern

Because of geographical differences of four cities (Beijing, London, Paris, New York), the process of access to data required multiple data sources via API system, and then integrated these basic data. The

main data source of green space in London, Paris and New York was Open Street Map system. The map images and vector data are authorized with good open data and highly detailed data. The green pattern data in Beijing was obtained from National Geographic Information Center and Baidu map, Public Comment map and other sites. The basic data obtained by the above method had characteristics of large amount of information, high repeatability and different classification, so it was necessary to refine basic data to get all kinds of data that green pattern analysis required. The Information points of basic data was complicated. Data processing relied on ArcGIS software platform needed to delete irrelevant information and merge and refine the required data. Eventually, this process obtained the information of municipal boundaries, road network which included trunk roads and railways and land use which included park, forest, water and built-up area.

The main way through the API data interface to obtain multiple data source information were Baidu map information, OSM system information and public comment information and programming operations relied on PYTHON programming language. Then the data was translated into geographic information data and stored in the ArcGIS platform. Finally, urban parks, forest, water, railways, roads and other basic information in four cities were refined through the data processing and arranging.

3.2. Study on Distribution Density and Scale Distribution of Urban Park pattern in Four Cities

The municipal boundaries scale of four cities were quite different, so the paper choose built-up area in four city centers as the object referred to population density of main built-up area in the comparative analysis of urban park pattern. The study area in Beijing was six city districts in which area was 1368km^2 and the population density was 8560 per/km^2; The study area in London was the Greater London in which area was 1572km^2 and the population density was 5197per/km^2; The study area in Paris was the Central city and three provinces in suburbs in which area was 762km^2 and the population density was 8163per/km^2; The study area in New York was five districts in New York City in which area was 790km^2 and the population density was 10595per/km^2. [15] [16] [17] [18]

The paper used average center tool to calculate the center of parks which meant calculating the center data based on the x, y of all points in facade elements of urban park in ArcGIS software platform in order to get all the park center point data. Using Nearest Neighbor Analysis tool to process urban park distribution data in four cities, the results showed that the “P” value (significance level) approached “0” which meant that the probability of random process generated by urban park pattern in four cities was extremely low and the paper could reject null hypothesis. On the basis of the above analysis, Nearest Neighbor Analysis ratio (the average observation divided by the expected average distance) of urban park pattern in four cities was less than 1, which meant the probability of being a random distribution mode was less than 1% and all of the urban park pattern belonged to aggregation pattern mode with high degree of aggregation (Figure 1).

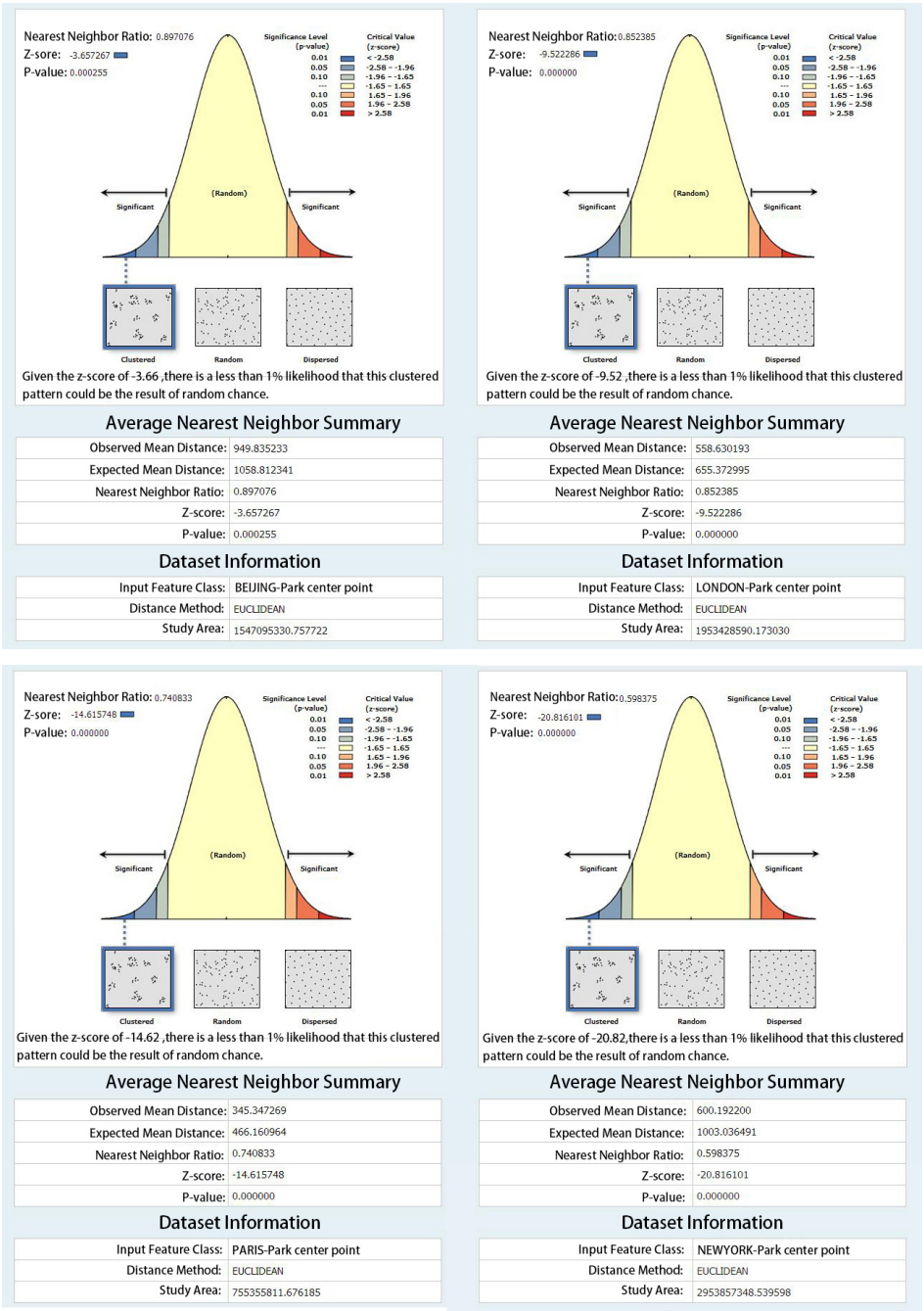

Figure 1. Nearest Neighborhood Analysis of Urban Park pattern in four cities

In the aggregation of urban park pattern in four cities, the lower average nearest neighbor ratio was, the higher spatial aggregation degree was, and the ratio in Beijing, London, Paris, New York were respectively 0.897, 0.852, 0.741, 0.598. Comparison of the ratio in four cities showed that New York City Park pattern had higher degree of aggregation than the other three cities and followed by Paris. The degree of aggregation of urban park pattern in London and Beijing were similar.

The paper got urban park quantity density distribution map using kernel density analysis tool in ArcGIS with setting the search radius to 1500m. The highest density area in Paris was the central city and Hauts-de-Seine in west, and there was lower park density outside urban area in Paris referred to data analysis of urban parks quantity. The urban park pattern in Paris showed an obvious tendency that

diffusion was reduced from the center to the periphery. The area that higher density distribution of urban park in Beijing was very scattered. Unlike Paris, urban park pattern in Beijing didn't show obvious centrality. But the density of distribution in northwest suburb was obviously lower. The urban park density distribution in London was relatively balanced. The density of urban parks in London inner city and the surrounding districts was slightly higher. The urban park density distribution in New York City showed aggregated trend, and the highest density area was located in the Manhattan district, as well as Queens district, west in Brooklyn district bordered on Manhattan. The urban park density in peripheral area in New York city was obviously lower and the density decreased gradually from Manhattan to north, east and south three directions of peripheral area. (Figure 2)

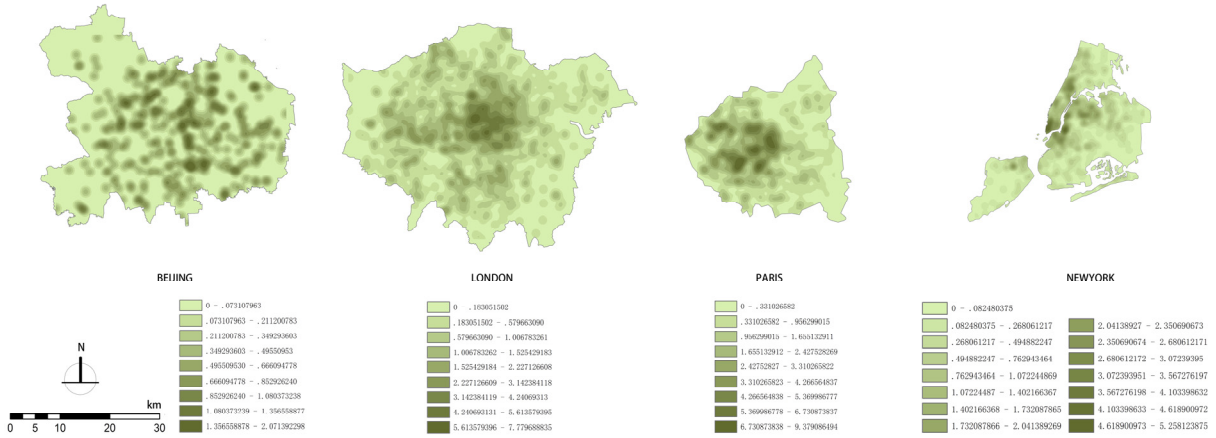

Figure 2. Density Distribution Map of Urban Park Quantity in four cities

The paper combined with urban park quantity density distribution and park scale distribution trend that considered area weight and calculated the distribution trend of park scale using Standard Deviational Ellipse method in ArcGIS. The distribution trend of urban park in Beijing was (E-W) East-West; The distribution trend of urban park in London was (EN-WS) Northeast – Southwest; It was relatively weak in Paris, but the aggregated degree of urban park scale distribution was clearly the highest in the three cities and especially in the central city. Urban park scale distribution trend in New York city conformed to urban form with North-South distribution and the density was the smallest in Staten Island (Figure 3).

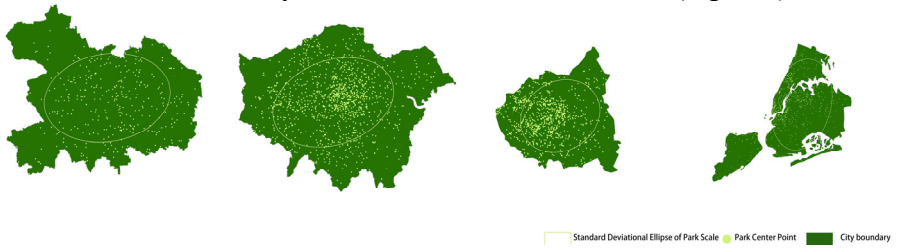

Figure 3. Urban Park Scale Distribution Trend in four cities

3.3. Comparison of Green Pattern in Core Area in Four Cities

Selecting core area in four cities as research object: Beijing Second Ring area, London north-bank area, Paris central city, and Manhattan in New York city (Figure 7). This part of study mainly analyzed the relevant data of public green space that had the greatest impact on citizen's use in the core area. The public green space included a variety of parks, zoos, botanical gardens, cemeteries and gardens, avenue and square green constructed for recreation and didn't include general plant on street and avenue and the green space not open to public.

From the distribution characteristics of public green space quantity in the core area in four cities. The density of southeastern area in Beijing Second Ring area was obviously high, but the alley residential

area in north area was lack of public green space; The plots that had higher public green distribution density was the northwest of London north-bank area while the north area was relatively small. The density distribution of public green space in Paris central city was more balanced than other cities. The density in several districts in the north was relatively small. Bois de Vincennes and Bois de Boulogne were on both sides of east and west like ears. Public green space was mainly distributed in north and south ends in Manhattan. While the number of public green space in central area in Manhattan was small, but the public space scale in the area held an absolute advantage because of "New York Central Park".

In the analysis on characteristics of public green pattern in the core area in four cities, large-scale royal gardens, historical parks, urban parks had a greater impact and controlled the overall pattern of green distribution to a certain extent. Small-scale public green space was widely distributed, but inevitably there were some typical areas where had a problem of crowded land and lack of public green space in the development of the core area in cities.

4. The Development of Application of Big Date Connected to API System in the Industry

(1) In the study of green pattern in four cities, the API system as a medium provided a large amount of valid data to researcher with characteristics of wide range of data sources and high accuracy, and it could change graphic analysis into digital analysis which was more rational. In particular, the rapid and extensive connectivity of API provided a strong guarantee for the comparative study, so as to realize the horizontal comparison of urban green pattern in different geographical locations and environment.

(2) Big data in API system was complicated and provided very good basic data for the study. This meant that the data had diversity and relevance and it was undeniable to provide new ideas and research methods for future development in the industry. The ability of data process which meant how to add value to the data and used effectively was more important in massive data analysis. Big data and information didn't bring change but also challenge.

(3) Newer real-time data in API system had some deviation to a certain degree. This was directly related to Internet attributes and was influenced by regionalism and community attributes. [19] In the one hand these deviations needed to be circumvented and processed through software platform, in the other hand in order to increase accuracy requiring researchers to combine professional thinking and make more efficient use of data resources in the research process.

5. Conclusion

Horizontal comparison of green pattern in four cities provided a new perspective to examine present situation of urban green space in China. Even the green pattern in four cities could be quantified in data and compare with each other, the reason for the difference was gradual evolution in thousands years in cities. The analysis and comparison of big data was only the basic work of green pattern study, and could provide the basic reference for future construction of the city. But green pattern was far more than this content, and it connected with city's history, planning policy, economic development, natural environment and so on. The characteristics of each city determined its style, and some one will not change in thousands of years, some one are rapidly changing. Big data platform will provide us with opportunities and challenges.

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