

MAPPING THE SERVICE AREA AND POPULATION OF URBAN PARKS FOR PARK CITY INITIATIVE: A CASE STUDY OF NANJING

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Introduction

Urban park carries the daily travel and leisure functions, which is the main green activity space in the city. Urban park has more comprehensive functions and values than other type of green spaces. It has ecological restoration, education, science popularization and aesthetic values, which also can improve health effect and social cohesion. After WHO put forward the concept of healthy city, relevant policies have been introduced, which emphasized the fairness of urban park, and defined the direction of urban park system oriented by residents' daily behaviors. walking is the basic way of residents' daily leisure activities, and the planning based on walking equity is an important measure to fully realize green space benefits and equity.

The planning indicator of traditional green space system is only limited to the quantity of green space at the macro level, which lacks the consideration of urban spatial scale and residents' actual travel conditions. Therefore, this article use Baidu Map API crawl actually walk path of Nanjing residents. From the perspective of residents' actual walking path, we can improve the park service area, optimize the layout of the park, promote green fairness and facilitate the implementation of all kinds of benefits to a certain extent.

Method

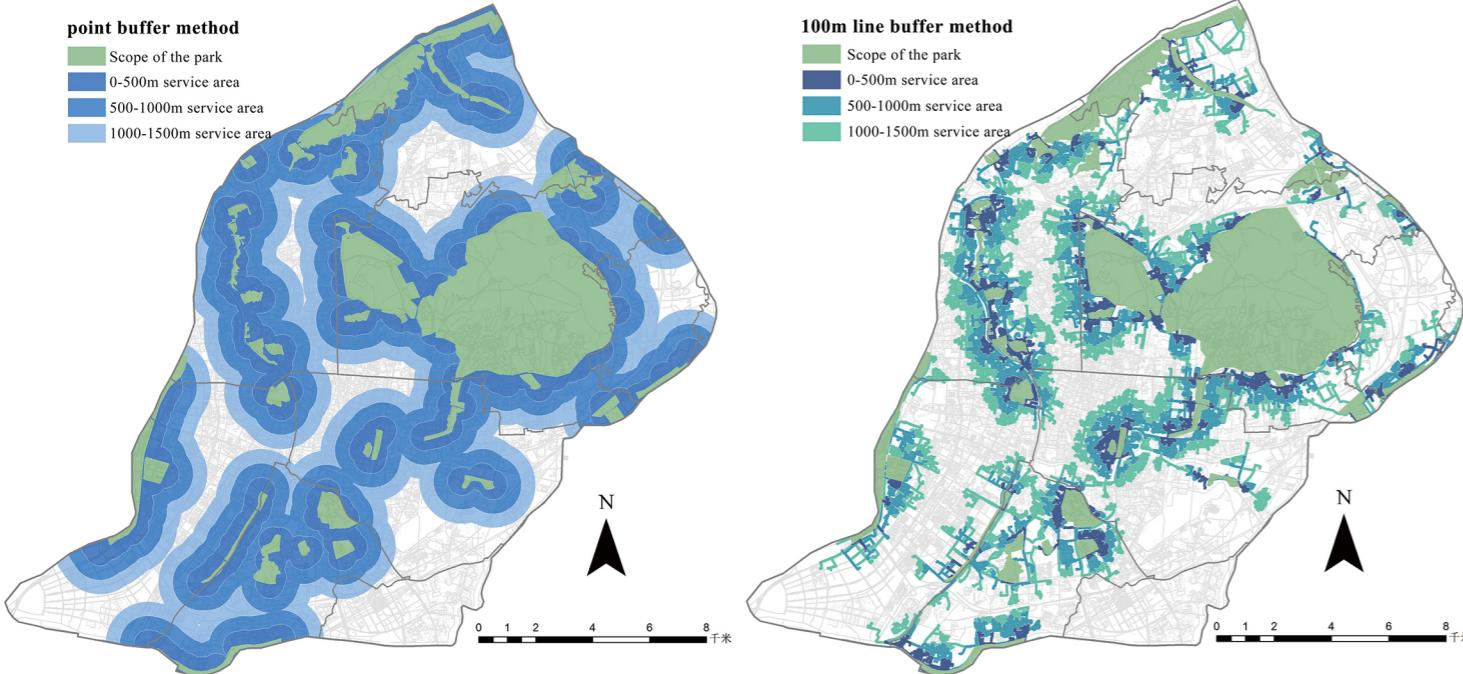
The research object of this paper is 40 urban parks in Nanjing. The entrance of the park is regarded as entering the park. With the help of Baidu Map, Maidu Street View Map and field investigation, 310 entrance points were selected. Using python to crawl the residential POI around urban park and its recommended walking path, as well as the distance and time, etc. Then ArcGIS Point-set Turning tool was used to generate the path and select 362291 walking path data. The specific method is shown in the figure below.



In this study, the concept of urban park accessibility indicator refers to the efficiency of the park based on its location. The service scope of the park is analyzed, including service area ratio, service population ratio, per capita green space area and service pressure at the park entrance; According to the analysis of the walking path, including the number of paths, the number of residential points, the PDR(path directness ratio).

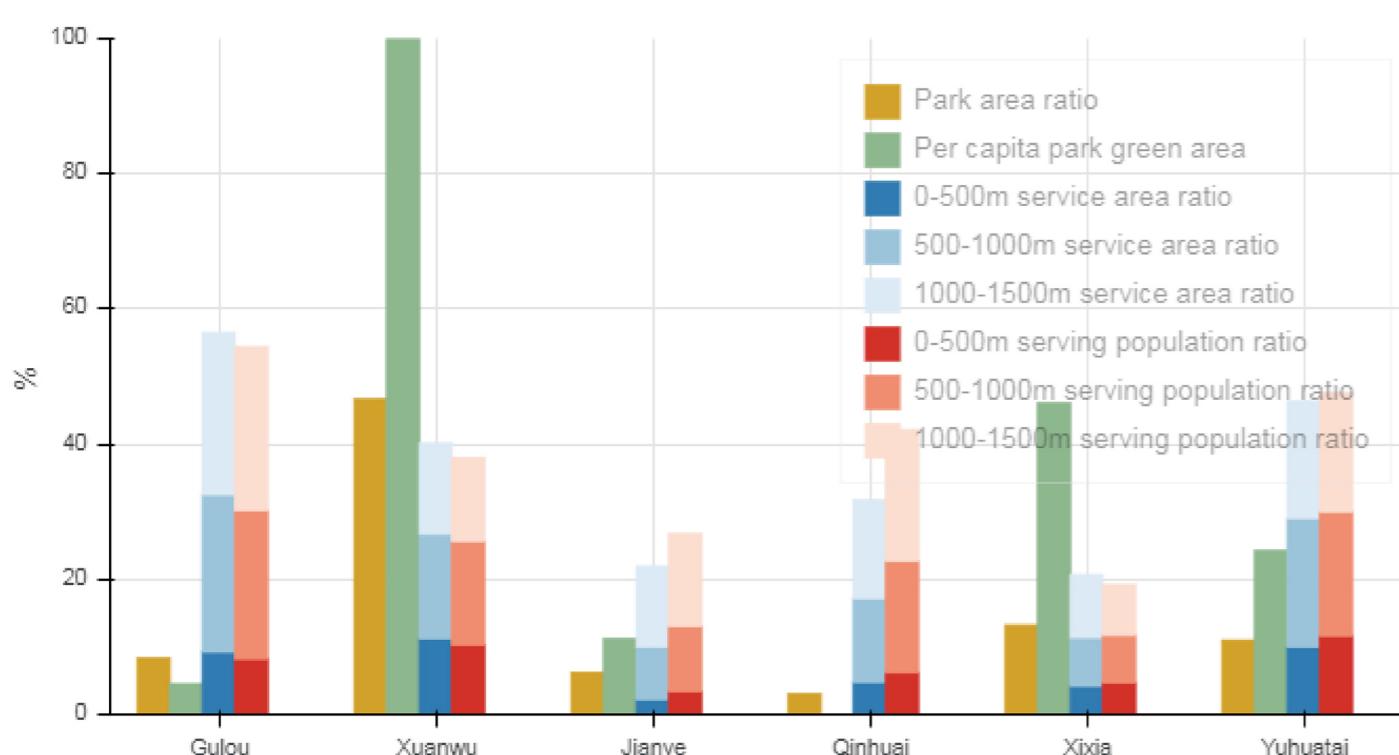
Results

Analysis at district level:



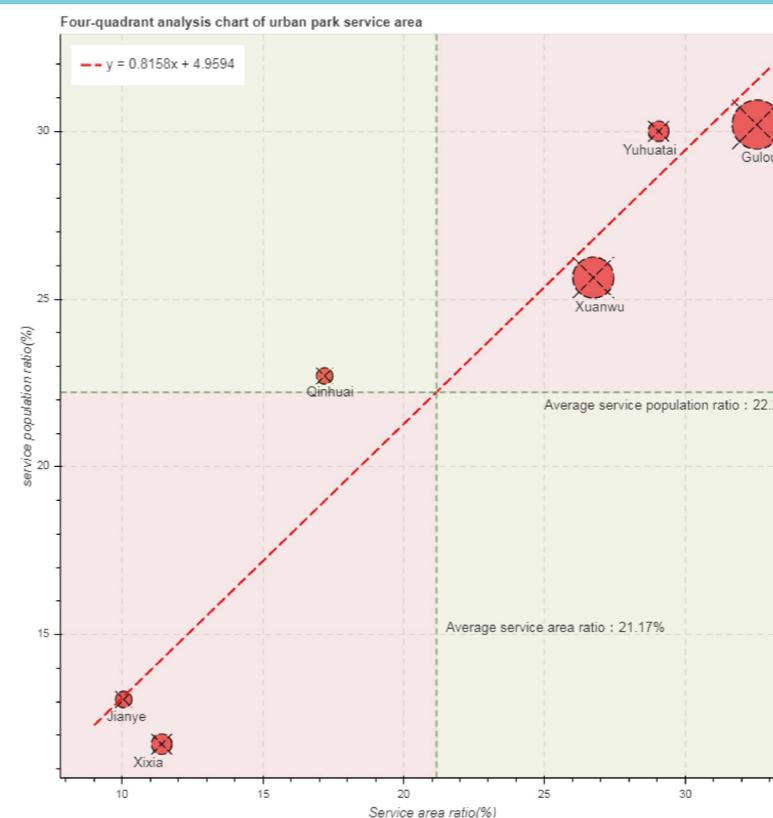
Using simple point buffer method measured the service area within 500m, 1000m and 1500m from the park. The service area excluding the park was 59.72km², 137.64km² and 199.33km², accounting for 23.32%, 53.75% and 77.84% of the total area of the Nanjing (308.52km²), which was quite sufficient. However, in reality, the road is difficult to maintain a straight line all the time, so actually walking to the park takes more distance and time.

According to the 100m line buffer method, the service area excluding parks are 16.10km², 49.71km² and 85.95 within the walking range of 500m, 1000m and 1500m, accounting for 6.29%, 19.41% and 33.57% of the total area of the Nanjing. This result is less than half of the point buffer method, because the point buffer method contains area that residents cannot reach.



In this study, the per capita park green area was standardized, and the service area ratio and service population ratio were compared with the park area ratio and per capita park green area. Service area ratio and service population ratio have similar trends, but different from park area ratio and per capita park green area. These results can be viewed as differences between traditional indicators and service indicators that take into account the surrounding population based on the spatial location of the park.

For example, the ratio of park area and per capita park green area in Gulou district is far smaller than in Xuanwu district. However, within 1000m and 1500m, the ratio of service area in Gulou district is 5.81% and 16.39% higher than in Xuanwu district. The ratio of service population is 4.56% and 16.36% higher than that in Xuanwu district, which is the highest in all districts. Combined with the urban form, it can be concluded that there are two reasons. In the one hand, the total area of parks in Gulou district is small, but the number of parks is the highest. In the other hand, Xuanwu Lake park is located in Xuanwu district, a considerable part of its service area serves the Gulou district. Although Qinhuai district has the lowest park area ratio and per capita park green area, and has only 4 urban parks, its service area ratio and service population ratio are in the middle, which means that the park location and distribution is more important than the size of the park.



This graph, taking 1000m as the walking interval, made a scatter map with service area ratio as the x-coordinate and service population ratio as the y-coordinate, where the size of points is the number of parks. The average service area ratio and average service population ratio were used to divide the graph into four quadrants.

The first quadrant, including Gulou district, Yuhuatai district and Xuanwu district, represents a better spatial distribution of the park. Among them, the spatial distribution of the park in Gulou district was the best. Qinhuai district is located in the second quadrant. The third quadrant is Jianye district and Qixia district, whose service area ratio and service population ratio are far less than the average, which means the spatial distribution of the park is poor, and the accessibility of the park needs to be solved urgently.

Analysis at park level:

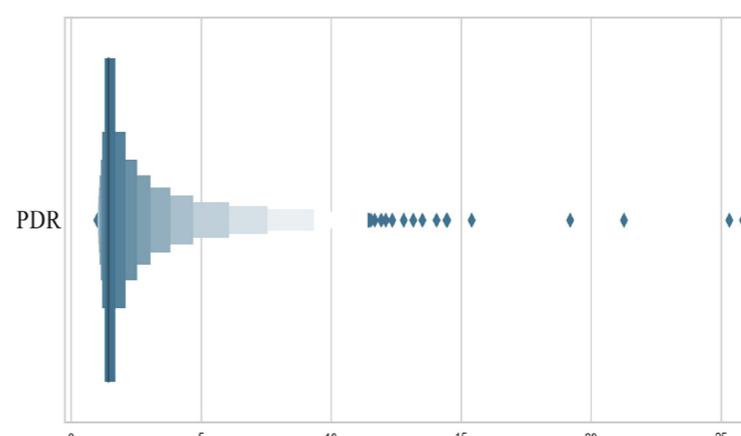
Among the 40 parks, 6 parks were selected, named Xuanwu park, Zhongshanling park, Shitoucheng park, Mochouhu park, Bailuzhou park and Yuhuatai park. These 6 parks were taken as samples to analyze the service capacity of the park within the service range of 1000m walking distance.

Park	Park area (ha)	Entrances	Residential points	Service area (ha)	Service population(10,000)	Entrance service index
Xuanwu Park	508.28	20	1038	509.81	12.07	0.60
Zhongshanling Park	2741.75	33	1430	647.87	8.35	0.25
Shitoucheng Park	16.29	9	987	314.15	8.21	0.91
Mochouhu Park	46.20	4	581	185.91	7.37	1.84
Bailuzhou Park	10.56	6	762	222.52	8.47	1.41
Yuhuatai Park	110.76	6	442	183.16	3.42	0.57

The area of Zhongshan park is much larger than other parks, serving the largest number of residential points, 1,432, and the largest service area, 647.87 hectares. However, in terms of the number of people served, Xuanwu park serves 37,200 more people than Zhongshan park. The area of Yuhuatai park is also relatively large, but it has the least number of residential points (442 points) and the smallest park service area (183.16 hectares). The possible reason is that Zhongshan park and Yuhuatai park are scenic areas, which means that there are few living spots around them, and they serve more foreign tourists than local residents.

The ratio of the service population to the number of park entrances, i.e. the average number of 10,000 people served by each entrance, was calculated to determine the entrance service index. As can be seen, each entrance can serve about 9700 people on average. The entrance service index of Mochouhu park and Bailuzhou park is too large, which is 1.84 and 1.41, the entrance is 4 and 6. This situation indicates that the average service pressure of each entrance is too high, and more entrances can be set to reduce the existing service pressure. The entrance service index of Zhongshanling park is the smallest, 0.25. The possible reason is that Zhongshanling park mainly serves foreign tourists, but the population of foreign tourists is not taken into account in this paper, which leads to the low index of the entrance service.

The ratio of path distance to Euclidean distance (greater than or equal to 1) between the park entrance and residential points reflects the degree of path directness ratio (PDR). When the block size is pleasant and the permeability of the road network is high, the PDR is relatively low.

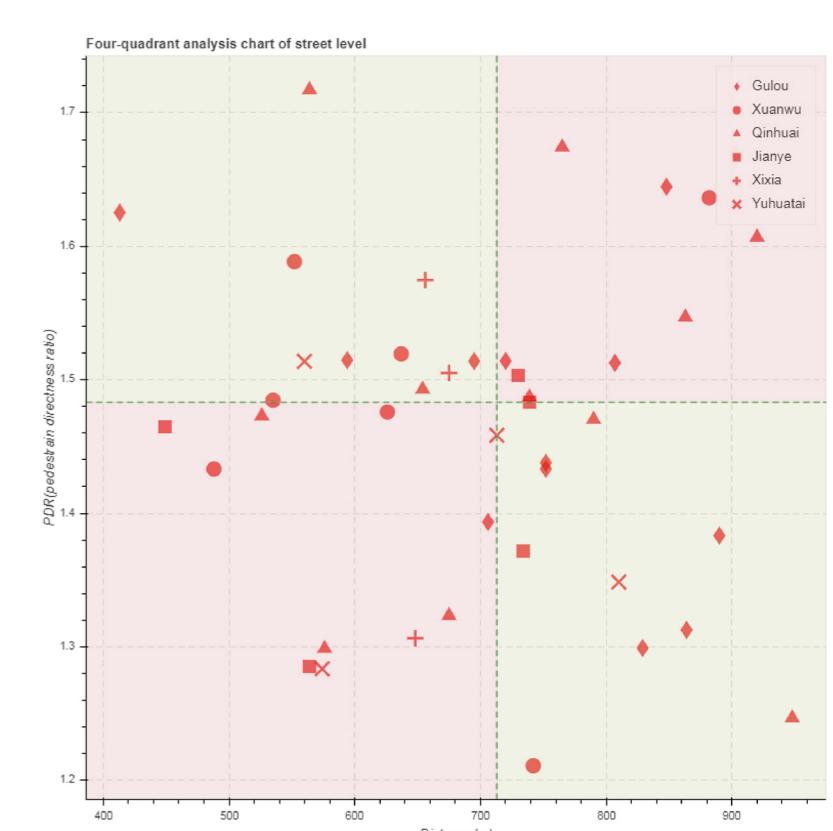


Analysis at street level:

It is assumed that residents will choose the nearest entrance to enter the park, selecting 14,624 residential points for analysis with 1000m as the walking interval. The PDR and distance were used to measure the convenience of residents to the park. The lower the PDR, the shorter the distance, and the easier it was for residents to walk to the park.

Street as a unit, indicates the residential point of its area. The scatter graph was made with distance as the x-coordinate and PDR as the y-coordinate, then the graph was divided into four quadrants with median PDR 1.48 and median distance 713.

As can be seen from the figure, Most of the streets in the Gulou district are concentrated in the first quadrant, which means that the residents in the Gulou district are far away from the park. Most streets in Xuanwu district are gathered in the second quadrant, which means that the walking distance is short, but the road is winding. The reason may be that Xuanwu district has a large number of the city walls, and parks are distributed around them, which causes high PDR. Streets in Qixia district are located in the second and third quadrants, indicating that residents in this district are close to the park.



Discussion

When measured by path distance, it can be seen that the position the path can reach are significantly smaller than the spatial position, and significantly smaller than the range of service area based on Euclidean distance which is still used in some planning norms and studies. On the whole, the well-covered areas of the urban park can be roughly summarized as the riverside areas around the city wall, Zijin mountain, Hexi, the southern part of the city and the northern part beside riverside. Most of them are waterfront space. In the areas with high population density, the urban park is still in short supply.

The Gulou district and Xuanwu district is the best. Although there are few green spaces of Gulou district, the area and population served by it are large due to its proximity to Xuanwu and other areas which has more urban parks. Regardless of whether different path distance threshold or different measurement methods (area or population) are adopted, the urban park service scope of Gulou district and Xuanwu district is the best, while Jianye and Qixia are the worst. Xuanwu district contributes a lot to the surrounding district.

From the point of park, because the quantity of entrances and distribution, population density and the surrounding urban form, location and environment, the service area and population may have big difference, even different entrance to the park in this aspect also exists obvious difference. Relying on Euclidean distance was no difference in the buffer. Combining a more accurate population density with a realistic path can provide more refined service area and population number.