Park Accessibility Analysis Based on Location Information and GIS: Take Shanghai Hongkou District As An Example

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Abstract. Spatial accessibility is one of the methods to study the rationality of park design. This paper is taking Hongkou District Park in Shanghai as an example, by using the ARCGis application as analysis tool to analyze that the relation between the location of Park entrance and location of the community, and to calculate the different time cost of people who is under the walking and cycling mode to put forward the distribution of park entrance location which is based on the accessibility of riding and walking.

1. Introduction

Parks and other green environments in a city are public green spaces open to the general public with integrative functions of ecological maintenance, recreation, disaster shelter, etc.[1][2][3]. The public often consider the rationality of the distribution of urban public green spaces in a city based on data collection such as Green Space Ratio of City and/or Green Land Area Per Capita. The application of accessibility analysis in related public green space has led to the emergence of some proper nouns, i.e. in this case, accessibility of public green space. Accessibility, originally proposed and defined by Hansen as the probability of nodes in a transportation network interacting with each other, is now considered to be the ability of people get access to a certain destination[4][5].

At present, most researches on accessibility of parks design accessibility study based on the object of the area of residential zone, and make the proportion of such area the criteria for accessibility evaluation. It wrongly considered as accessible of all the park bounds, which in reality is partially accessible, and as a result is easy to overestimate the accessibility of the park. To replenish the gap like this, this paper enrolled the entrances and exits of residential areas and parks in Hongkou District, shanghai for a point-to-point accessibility test followed by comparative analysis.

“Accessibility” and “Park accessibility” were used as the keywords of searching on CNKI, of which Fig. 1 and 2 showed the metrological and visual analysis results.
Figure 1. Metrological and visual analysis with keyword “accessibility”

Figure 2. Metrological and visual analysis with keyword “park accessibility”

It can be seen that the quantity of papers involving “accessibility” and “GIS accessibility” had a huge growth around 2007, while those involving “park accessibility” increased obviously until 2017 around. Besides, the earliest literature records were ten years later than that of “accessibility”. It suggested more attention were paid to subjects on accessibility in the past two years and the hot discussion has been staying at a high level. Now, GIS-based road network analysis serves as the principal methods for studying in accessibility of urban park. These include buffer analysis, network analysis, gravity model, and cost weighted distance, etc. [6]-[10].

2. Data research

2.1. Data collection

The location information of the entrances and exits of parks and communities in, as well as data of road network of, Hongkou District, Shanghai were required for the research in this paper. During early surveys[11], latitude and longitude information of entrances and exits of those parks were recorded. Park addresses were collected using Python crawler technology in the later data analysis to ensure the accuracy of information before they were converted into latitude and longitude information under different coordinate systems by “Address-GPS coordinate converter”. Community addresses were
captured using Python crawler technology from "58.com", “FangDD”, and “fang.com” websites to increase the accuracy of service data. Road network data of the Hongkou District came from Google Maps in Bigemap's map library. Given the accessibility test was built on walking and cycling, accuracy of road network was at nine-grade.

2.2. Data cleansing and conversion

The optimal Data Cleaning method was determined after geographical information processing with three different methods and comparison to the feasibility in GIS accessibility analysis. On the basis of importing in GIS of location data of communities in Hongkou District, all coordinates of communities were corrected to two decimal places (i.e. hectometre) for proofreading, where non-Hongkou District data were deleted.

![Figure 3](image1.png) Method III for address translation and GPS data processing and verification

![Figure 4](image2.png) Addresses of communities in Hongkou District

The first 45 lines of Hongkou District screened out using the method following served as experimental data. Conformably before each community name it was added with “Hongkou District, Shanghai” before imported in “Address-GPS Coordinate Converter”. From the detection, the derived data and the pickup system were 100% consistent; no consistency between the keyword column and the address column was observed. These were imported into GIS, as shown in Fig. 3. No significant deviation can be seen.

Data of communities in Hongkou District were processed using the Method and imported into GIS, as shown in Fig. 4. All of them fell in the administrative division of Hongkou District without obvious deviation. Method III was considered feasible, reproducible, and mechanically applicable in processing such data.

From the overall importing in GIS and the consistency of translated coordinates with Baidu coordinate pickup system, the conformable addition of “Hongkou District, Shanghai” before each community name produced the most accurate results. No obvious deviation would occur.

| Table 1. Temporal information list |
|-----------------------------------|
| **Walking** | **Bicycles** | **Bicycles** | **e-bicycles** | **e-bicycles** |
| Primary routes | Non-primary routes | Primary routes | Non-primary routes | Primary routes |
| Speed per hour (km/h) | 5 | 15 | 12 | 20 | 15 |
| Time (min) | 12 | 4 | 5 | 3 | 4 |
| No Date(min) | 15 | 3 | 3 | 2.4 | 2.4 |
3. Analysis of accessibility in two traveling modes

3.1. Data importing and preliminary processing
For data processing in GIS, previously obtained geographic location information must be first imported into it and transformed as SHP files. SHP is one of the commonly used file formats for GIS software. It stores a part of geographic data, such as streets, points of interest, and postal code boundaries. From the road network, non-required provincial highway, national highway and other useless data were deleted. Only nine-grade roads, pedestrian paths and other demanded roads should be reserved. For the sake of accessibility test subsequent, in road attribute list the Value field of speed per hour was added according to Table 1. The Values were assigned in accordance with walking or cycling and then saved.

3.2. Accessibility test in walking mode

3.2.1. Accessibility test. The data of road network after processed is rasterized, since the information of the road is much too fine, the pixel accuracy is adjusted to be $10^{-4}$. The rasterized data is re-classified according to Table 2. With the cost-distance tool, the park entrance as the source data and the reclassified rasterized data as the cost data, the cost distance from each pixel to the nearest source in the Hongkou area is analyzed. The time domain after analysis is re-divided according to Table 2.

| Walking time(min) | Level          |
|------------------|---------------|
| >10              | Level I       |
| 10-15            | Level II      |
| 15-20            | Level III     |
| 20-30            | Level IV      |
| 30-60            | Level V       |
| 60<              | Level VI      |

3.2.2. Test result. Beautify the analytical drawing and export the map as shown in Figure 5. From Table 2, it can be seen that the accessibility of Quyang and Pinggong Park is lower, while the accessibility of Jiangwan Park, Ace Children Park and Huoshan Park is higher. Besides, it can be seen that the park is densely distributed and the district distribution is also denser.

3.3 Accessibility test in riding mode

3.3.1. Bicycle-based accessibility test. The bicycle-based accessibility is also analyzed with the walking method. The time domain after analysis is divided according to Table 3.

| Riding time (min) | Level |
|------------------|-------|
| >10              | Level I |
| 10-20            | Level II |
| 20-30            | Level III |
| 30-45            | Level IV |
| 45-60            | Level V |
| 60<              | Level VI |

The diagram is exported as shown in Figure 6. Combining the results with Table 3, it can be seen that the accessibility of Liangcheng Park and Kunshan Park is lower, and the accessibility of Jiangwan Park, Peace Park and Lu Xun Park Park is higher under the condition of bicycle. It can be assumed primarily that the accessibility of the large-scale parks is higher in the bicycle-based model.
3.3.2. **E-bicycle Accessibility Test.** Analyze the accessibility of e-bicycles with same method. It is exported as shown in Figure 7. In combination with Table 3, it can be seen that the accessibility of Liangcheng Park and Kunshan Park is lower, and that of Ace Children Park, Peace Park and Lu Xun Park is higher under the condition of bicycles. It is found that the coincidence rate of the accessible result for e-bicycles and bicycles is higher.

3.3.3. **Comparison of Two Riding Models.** It can be seen from Figure 6 and 7, in the same time domain, the coverage of e-bicycles increases more significantly compared to bicycles, but there is no significant change in the accessibility of parks.

![Figure 5. Walking Accessibility Test](image1)
![Figure 6. Riding Accessibility Test (Bicycle)](image2)
![Figure 7. Riding Accessibility Test (e-bicycles)](image3)

3.4 **Comparison with walking and riding**
It can be seen from Figures 5, 6, and 7, that at the same time domain, there is a significant increase in the accessibility of the park compared to that of walking. Accessibility of park also changes, and that of the smaller parks is higher.

4. **Conclusion**
Based on different travel modes, the accessibility of Hongkou Park in Shanghai is analyzed in this paper and the following conclusion is drawn:

Under the walking mode, the comfort accessibility of park is smaller. Smaller parks with only one or two entrances, such as River Bay Park, Ace Children Park and Huoshan Park, have the higher accessibility. Large parks with large entrances and exits, such as peace park, has less accessibility. It can be seen that in this travel mode, the relevance of the park’s entrance and exit and community is not higher.

In the riding mode, the range of park's comfort increase significantly. In this case, large parks with more entrances, such as Peace Park and Lu Xun Park, have higher accessibility, while smaller parks have slightly lower accessibility. It can be seen that in the riding mode, multiple entrances and exits enables relatively improve the park's accessibility range.

In order to further improve the quality of urban residents’ life, the independent road system can be established for larger range of riding accessibility which enhances the safety and convenience for urban residents accessible to the park green space in a short time. According to the distribution density of residential region, the number of the park’s entrance and exit can be increased or deduced, which
can shorten the time for residents to reach the park and improve the accessibility of the park.

**Acknowledgments**

Project Research Team of Intelligence Sustainable Package Design Support by Shanghai Summit Discipline in Design; Foundation item: Chenguang Plan (13CG74) sponsor; Shanghai Style Fashion Design &Value Creation Collaborative Innovation Center Support by Shanghai Summit Discipline in Design (DB18212).

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