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Assessing the Accessibility of Swimming Pools in Nanjing by Walking and Cycling Using Baidu Maps

Yifan Dong [1], Bing Zhang [1], Zhenqi Zhou [2] and Zhen Xu [1,*]

[1] College of Landscape Architecture, Nanjing Forestry University, Nanjing 210037, China
[2] Department of Geography, University at Buffalo-SUNY, Buffalo, NY 14261, USA
* Correspondence: xuzhen@njfu.edu.cn

Abstract: Frequent severe heat waves have caused a series of health problems for urban dwellers. Swimming, an exercise that combines both cooling off and moderate to vigorous physical activity (MVPA), is one solution for alleviating the conflict between urban heat problems and public health. Therefore, the distribution and spatial accessibility of swimming pools are worth examining. Using open-source data we scraped from the Baidu Map API (Application Programming Interface), we designed and constructed a grid-based accessibility index. We analyzed pool accessibility in three aspects: distribution of pools, catchment area of pools, and spatial disparities of the accessibility index. The results are as follows. (a) The pools are clustered, dense in the central area, and sparse in the peripheral areas. (b) 53.16% of the residents can access a pool within 5 minutes by cycling, and the number is only 12.03% when they travel on foot. The poor situation is highly improved with the extension of time, these figures are up to 97.62% and 70.71% when the time cost is 15 minutes. The overall circular buffer significantly mismatches the real catchment area of the pools. (c) The spatial disparity in accessibility is significant and shows a sharply decreasing trend outward from the center. (d) Pool accessibility is mainly influenced by the distribution of pools and ground obstacles such as rivers, mountains, and elevated roads. The method used here has high precision and can be used for accessibility assessments of other facilities in the city.

Keywords: accessibility; swimming pools; online map; grids; spatial disparity

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1. Introduction

Urban heat problems, or urban overheating, brought about by frequent and severe heat waves, have become one of the most common climate-related disasters for many cities [1]. This has caused a series of health problems for urban dwellers. First, some studies have pointed out that heat wave events have considerable adverse impacts on morbidity and mortality [2,3], and the risk increases with the intensity and duration of the heat waves [4]. This poses a direct threat to human lives, especially among vulnerable populations like the elderly, children, and people with underlying diseases [3]. Second, some less serious but common symptoms have adverse effects on people's daily life, such as fatigue, heatstroke, and reduced productivity. Last, a more pervasive effect of urban overheating is oppressive outdoor environments that discourage outdoor activities such as football and basketball. Heat confines people indoors, increasing sedentariness and further leading people to sub-health states [5].

A study of heat waves on a global scale has reported that the trends in intensity, frequency, and duration of heat waves have accelerated since the 1950s and will be worse under increased global warming [6]. This will deepen the conflict between urban heat problems and public health. From our point of view, swimming, an exercise that combines both cooling off and moderate to vigorous physical activity (MVPA), is one solution for alleviating this conflict. For one reason, some researchers mentioned in their study [7] that, in some parts of Australia, public aquatic facilities have been identified as valuable in urban resilience to heat waves and climate warming. Public pools are identified as 'cool spots' that provide 'respite for the community during heat waves' alongside other facilities such as libraries and community centers. For another reason, the World Health Organization (WHO) has recommended that to maintain good health, people should engage in at least 150–300 min of MVPA each week. Some researchers have pointed out that individuals with better access to sports facilities are more likely to exercise frequently and have sufficient physical activity [8,9]. Furthermore, the number of swimming pools is positively associated with taking part in sports [10], especially when the sport is swimming. According to some studies, the spatial accessibility of swimming pools has a positive impact on swimming and related aquatic sports [11]. Therefore, the number, distribution, and spatial accessibility of swimming pools have a great impact on the potential for urban residents to exercise under extreme hot weather, but this has never been given sufficient attention.

Previous researchers have used many methods to quantify accessibility. Some studies focusing on accessibility itself have used methods that have their own complete systems with calculations, such as the gravity model [12,13], the two-step floating catchment area method (2SFCA) [14,15], and the space syntax model [16,17]. Some researchers have constructed their own index systems to measure accessibility by using weighted-pixel center-to-facility distance or time [18,19]. Additionally, in some studies of the relationship between facility accessibility and social issues, researchers have used approximate indicators as substitutes for measures of accessibility, such as the kernel density of these facilities [20] or the number of facilities within a home-centered buffer [21]. Nowadays, with the development of big data technology in recent years, more and more researchers have developed new methods of measuring accessibility using mobile-phone tracking data [22,23], social-media data [24], online map API data [25], network analysis [26], and so on. In this study, we also used online map API data to get the times, distances, and navigation routes between pools and the residential buildings around them. Using a novel approach developed by ourselves, we constructed a grid-based accessibility index to visualize the number of pools that can be reached within 5/10/15 mins of each grid square.

Studies of the accessibility itself always focus on some particular types of public services, such as healthcare facilities, sports facilities, parks, or schools [27–30]. Most such studies choose walking and cycling as their travel modes, and some take public transport into consideration [31]. In addition, some studies focus on the relationship between accessibility and certain social issues, for instance, by examining the relationship between accessibility and obesity or physical activity from the perspective of public health [32], or between accessibility and socioeconomic status (SES) from the perspective of social inequality [33]. Most of the above studies mentioned analyzed accessibility at the city or district level with a coarser grain, and a few discussed spatial disparities in accessibility within the study area. Due to spatial heterogeneity, the actual local accessibility of two places with the same overall accessibility level can differ significantly. Therefore, we introduced grids into this study to help us get the isochronous circles and to improve the precision.

In recent years, due to the international prevalence of COVID-19, the concept of the '15-Minute City' has re-emerged because of its convenience and proximity. Thus, how to assess the accessibility of facilities has been mentioned in some cities' planning texts. For example, Portland and Paris constructed their own indicators to measure the accessibility to a variety of amenities, products and services. [34]. Other cities, such as Melbourne, did not specify how to measure or define the 20 min radius in their planning texts [34]. However, most urban plans in China directly use circular buffers, such as the '15-Minute Community Living Circles Planning Guidelines,' released by the Shanghai government, and the 'Convenient Living Circle within a Quarter' project. It can be seen that, although the circular buffer has gradually phased out in the academic field, in practice, policymakers often ignore the huge error caused by it. Thus, we believe it is still necessary to compare circular buffer and route catchment and highlight the significant mismatches between them. Especially for this study, which takes a Chinese city, Nanjing, as an example. In addition, a study pointed out that walking and cycling for transportation both provide an opportunity to incorporate frequent physical activity into daily living [35], as well as the prevalence of the bike-sharing program in China, which inspired us to take cycling into account during this research.

In general, this study has three goals: (1) mapping the distribution of swimming pools in the city of Nanjing, (2) identifying the 5/10/15-min accessibility boundaries of these swimming pools to pinpoint underserved areas, and (3) discussing the spatial disparities of the pool catchment at the city level. These answered three questions, respectively: Where are the pools? Where are the boundaries of the pool catchment areas? What are the spatial differences in accessibility within the catchment area?

2. Materials and Methods

2.1. Study Area

This study focused on the main city area of Nanjing, which has an area of 308.52 km^2 and a population of around 3.5 million. There are 145 swimming pools in this area. Meanwhile, due to the edge effect, pools located near but outside the boundary also have impacts on the study area. Thus the 17 pools within 3 km outside the main city boundary were also included in the study, for a total of 162 pools.

2.2. Data Processing and Analysis

We used Python to scrape data from the Baidu Map API (Application Programming Interface). We obtained 162 sets of data, matching the number of the pools. Each pool's data set includes one swimming pool POI (Point of Interests), the residential building POIs within 3 km of the pool, and the navigation route data (including walking and cycling routes) between this pool and each of those residential buildings (Table 1). In addition, we introduced two sets of geometric data to support the analysis, which were called 'Base Grid' and 'Residential Building Grid.' The Base Grid is an auxiliary analysis dataset with a side length of 30 m that we created using the Fishnet Tool in ArcGIS. It is big enough to completely cover the main city area. The Residential Building Grid was obtained by intersecting all the residential building POIs in the study area with the Base Grid. We choose 30 m as the side length to match the population raster data [36]. The details of the data processing are as follows (see the flowchart in Figure 1):

Table 1. Indices that are relevant to the walking and cycling routes to the swimming pool.

Name	Description
POI	An abbreviation for Point of Interests. In this study, two kinds of POIS were scraped from the Baidu Maps API; they are swimming pool POIs and residential building POIS. Each POI includes the information about the name, address, latitude, and longitude (both with the coordinate system of WGS84).
Navigation route	A graphic file we scraped from the Baidu Maps API; it shows the shape of the route between the pool and the residential buildings. It includes the information about starting point, ending point, distance, and time costs.
Pool catchment area	The area which is accessible within 5/10/15 min walking or cycling from the swimming pool.
Pool-underserved area	The area which is inaccessible within 5/10/15 min walking or cycling from the swimming pool.
Accessibility index	A grid-based index which is constructed by the author. The value of each grid square represents the number of pools accessible within 5/10/15 min of that square.

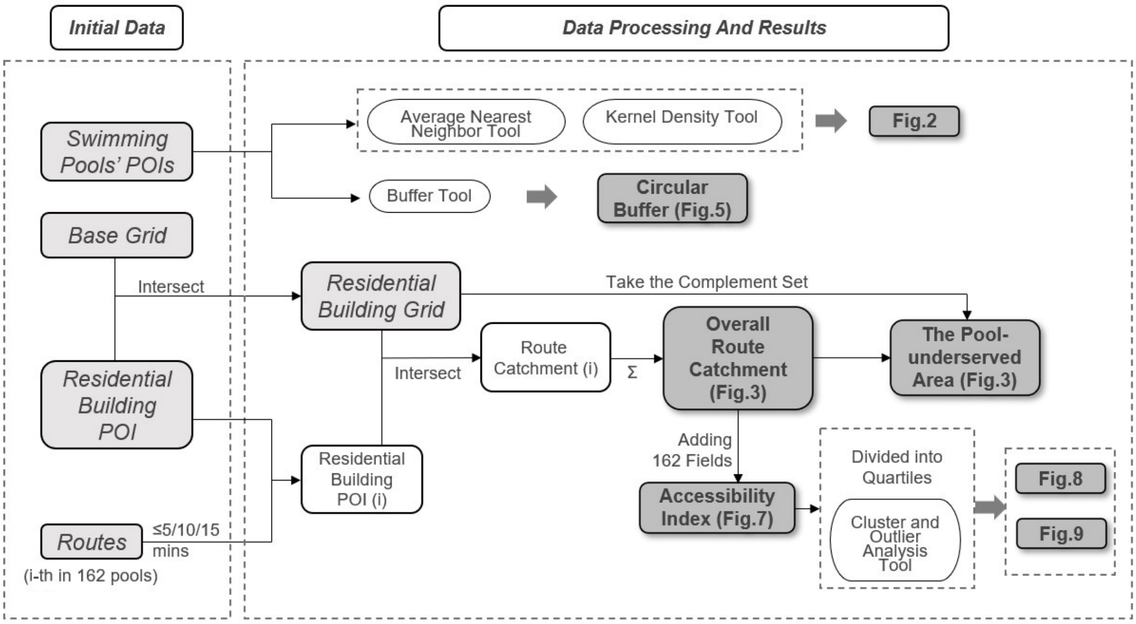


Figure 1. Flowchart of data processing.

(1) Distribution of pools: First, we scraped the POI dataset returned when we searched in the Baidu API with 'swimming pool' and 'fitness room' using Python. Next, we eliminated infant swim stores from that dataset, and manually checked that each of the remaining POIs is open for business and actually had a pool (because some of the fitness rooms have a pool, but they do not put the word 'pool' in their names) by looking up the comment pictures and dialing the telephone number left on the review sites. Then, we calculated the average nearest neighbor ratio (ANN) to identify the spatial point patterns these pools followed, and did the kernel density analysis (Table 2) to map the overall distribution of the pools.

Table 2. Analysis tools that are involved in this study.

Name	Description
Kernel Density Analysis	Calculating the density of point or line elements in their surrounding neighborhoods.
Average Nearest Neighbor Analysis	This measures the distance between each feature centroid and its nearest neighbor's centroid and then averages all these nearest-neighbor distances. If the average nearest neighbor ratio (ANN) is less than 1, the pattern exhibits clustering. If the index is greater than 1, the trend is toward dispersion. The ANN is given as $ANN = \frac{\overline{D}_O}{\overline{D}_E}$, where $\overline{D}_O$ is the observed mean distance between each feature and its nearest neighbor, and $\overline{D}_E$ is the expected mean distance for the features [37].
Cluster and Outlier Analysis (Anselin Local Moran's I)	Given a set of weighted features, one can identify statistically significant hot spots, cold spots, and spatial outliers using the Anselin Local Moran's I statistic. As the final result, HH indicates that high-value elements are clustered together, meaning the accessibility of the area is relatively high; LL indicates that low-value elements are clustered together and the accessibility of the area is lower. There are also two types of outliers, HL and LH. HL indicates high-value elements that are surrounded by low-value elements, and LH indicates low-value elements that are surrounded by high-value elements. The rest of the area is not statistically significant (NS), meaning there is no significant trend of clustering of either high-value or low-value elements in this area.

(2) Pool catchment areas: Two types of catchment areas (Table 1) were delineated in this study. For catchment areas based on route ('route catchments'), taking one pool as an example, we first picked out the residential building POIs accessible within 5/10/15 min using route data. Then intersected those with the Residential Building

Grid to get a new grid called the route catchment of the pool. For the circular buffers, following the same method used in most planning texts and some studies, we obtained a circle with the pool as the center and 5/10/15 minutes' travel as the radius using the Buffer Tool in ArcGIS.

(3) Accessibility index (Table 1): First, we created a new field for each route catchment obtained in step 2 and assigned it the value of 1. Then, using the Union Tool, we integrated all 162 catchments into one shapefile to map out the overall route catchment of the pools. Finally, we added the 162 fields together and got the accessibility index.

(4) The pool-underserved area (Table 1): The relative complement set of the overall route catchment in the Residential Building Grid is the pool-underserved area.

(5) Analysis of the internal disparities of the accessibility index: First, we divided the accessibility index into quartiles by value. Then, we counted the number of grid squares in each quartile and calculated them as percentages. This would help us gain an overview of the distribution of the accessibility index. Then, we explored the spatial disparity of the accessibility index statistically, using the Cluster and Outlier Analysis Tool (Table 2), to reveal inequalities in pool distribution at a further level.

3. Results

3.1. Where Are the Pools?

The three basic types of spatial point patterns are clustered, random, and dispersed. After the average nearest neighbor analysis (Table 2), the results show that ANN is about 0.80, the p-value is less than 0.01, and the z-value is about −4.89, indicating that the pools are cluster-distributed in the main city area.

We then performed the kernel density analysis to map the overall distribution of the pools. After many trials and comparisons, the search radius was set to 1000 m (which is approximately a 15-min walk). As Figure 2 shows, there is a trend of density in the central area and sparseness in the peripheral areas. There is also a multi-core distribution. The main center is located at Xinjiekou, followed by Hunan Road, Fuzimiao, and Olympic Sports Center. We found that the first three of those are all located in commercial centers with convenient transportation, probably because pool owners want to rely on large flows of people to increase turnover.

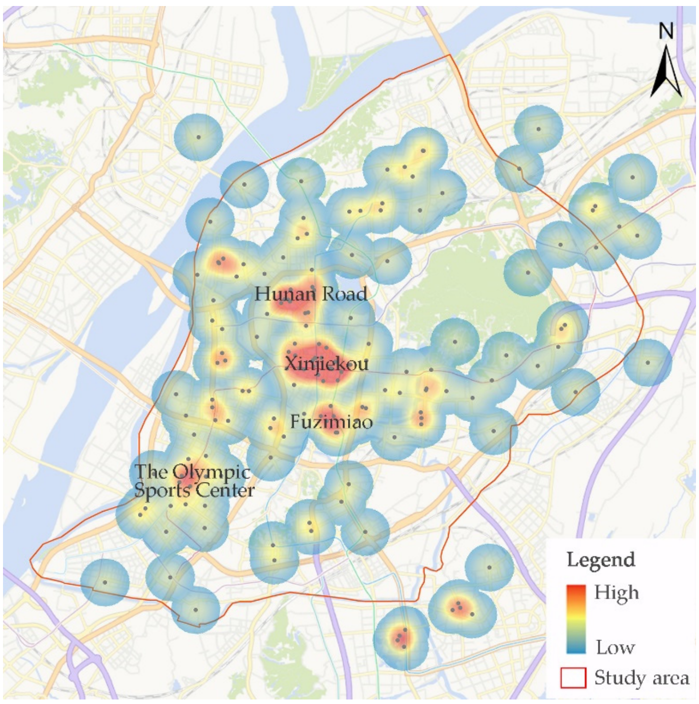
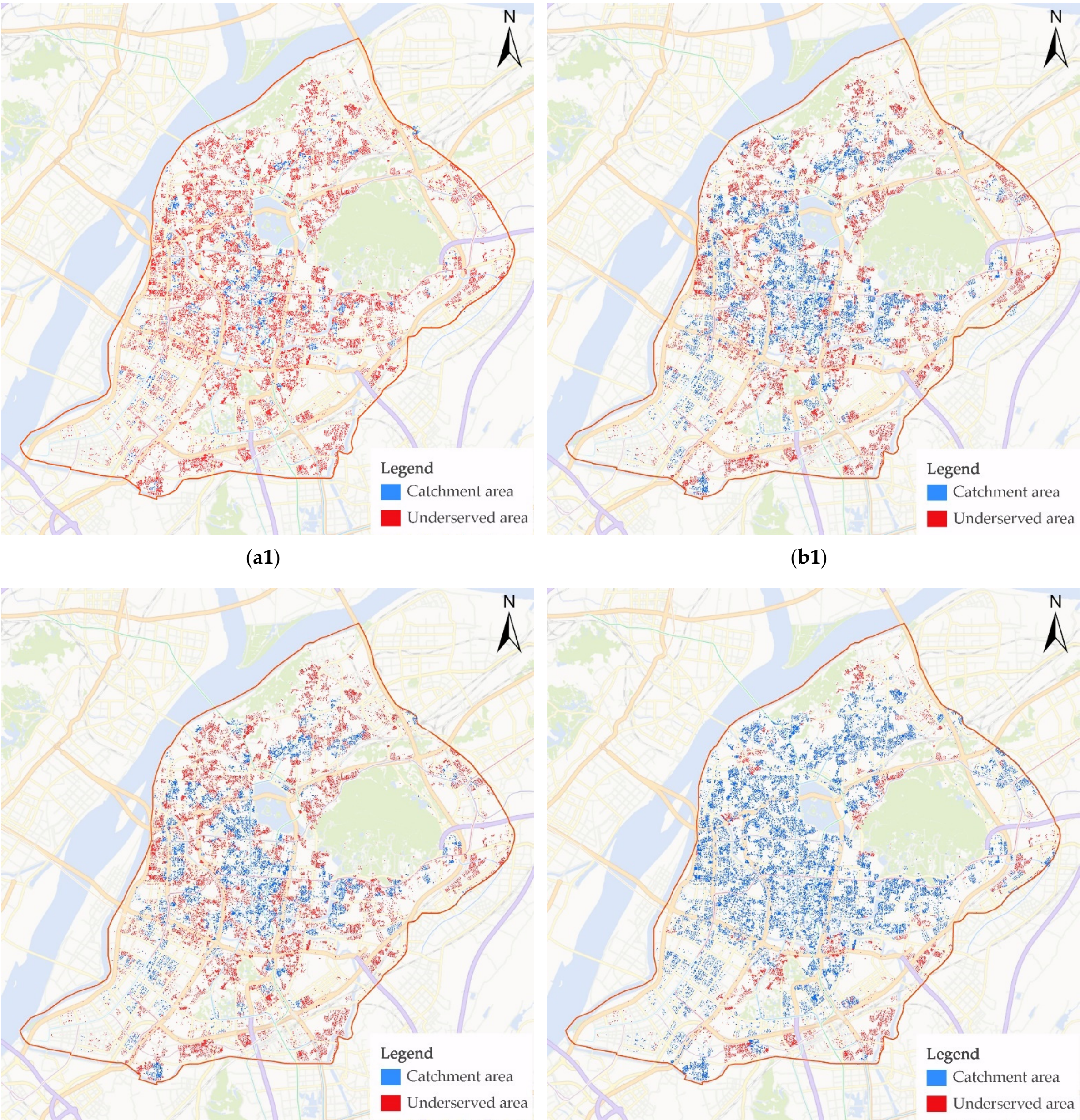


Figure 2. Kernel density analysis of the swimming pools.

3.2. Where Are the Pool Catchment Boundaries?

3.2.1. Route Catchment and the Underserved Area

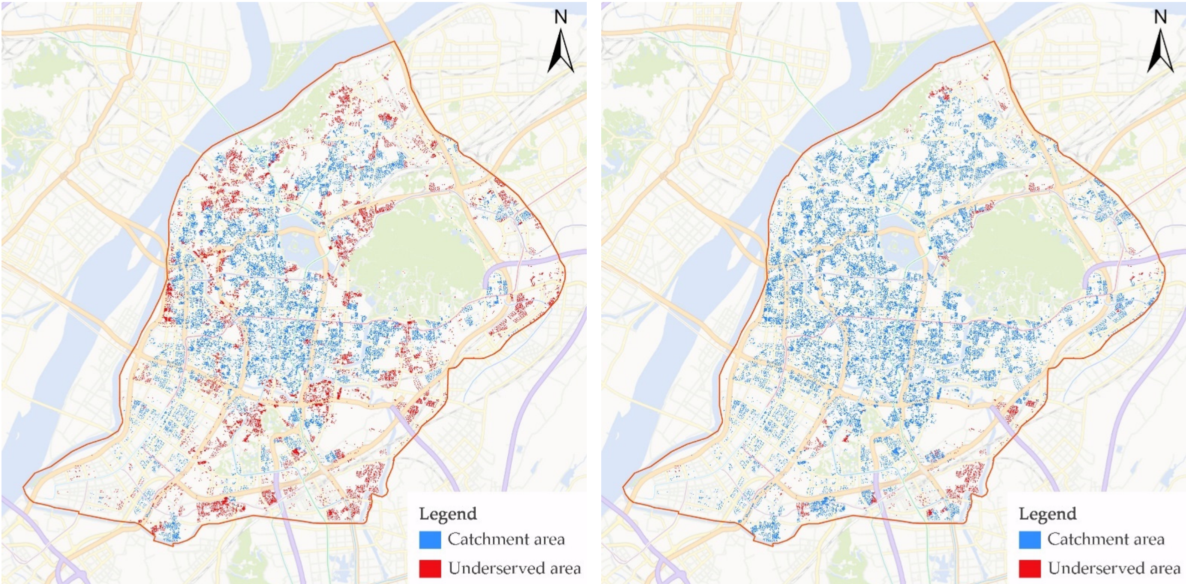
Figure 3 shows the overall route catchment and the accessibility index for walking and cycling with three different time costs, which are 5 min, 10 min, and 15 min. Figure 4 shows the percentages of each catchment area with different travel modes to the Residential Building Grid; area and population were both calculated. We found that 53.16% of the residents can access a pool within 5 min by cycling, and the number is only 12.03% when they travel on foot. This poor situation is largely improved if the time cost is 10 min. About 89.92% of the residents can access a pool by cycling, and 42.01% when traveling on foot. When the time cost is 15 min, these figures are up to 97.62% and 70.71%. In addition, we noticed that the underserved areas are more likely to be in less commercially developed areas at the edges of the main city, or in areas with obvious ground obstacles, such as the foot of the mountains and the riverside.



(**a1**) (**b1**)

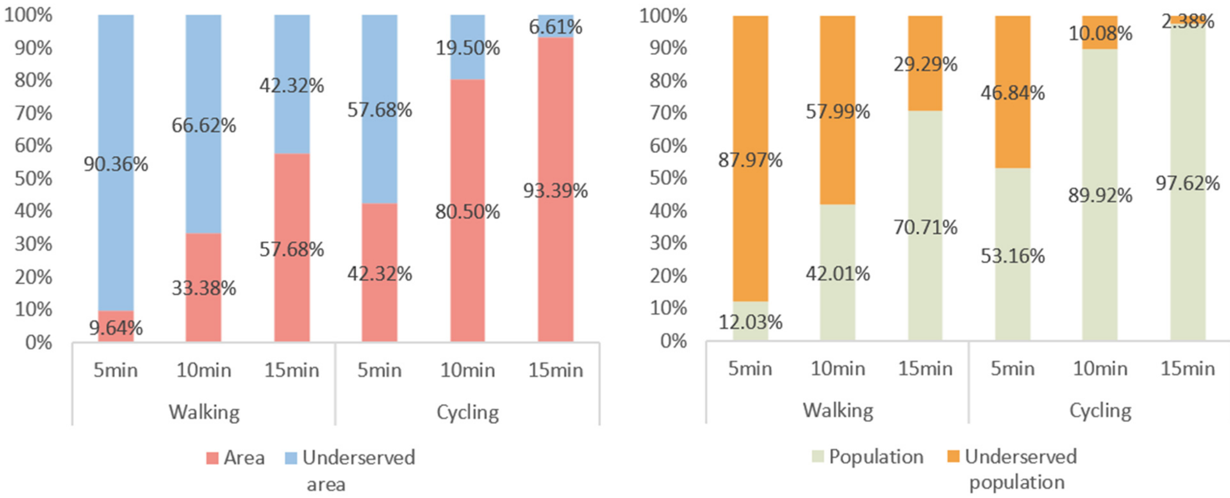
(**a2**) (**b2**)

Figure 3. *Cont.*



(a3) (b3)

Figure 3. The overall route catchment and underserved area (**a1**–**a3**) walking; (**b1**–**b3**) cycling and (**a1**,**b1**) 5 min; (**a2**,**b2**) 10 min; (**a3**,**b3**) 15 min.



(**a**) (**b**)

Figure 4. The percentages of each kind of route catchment to the Residential Building Grid (**a**) area; (**b**) population.

3.2.2. Differences between Route Catchment Area and Circular Buffers

Figure 5 shows the catchment area which is generated using the method of the circular buffer. To unify our measurement standards, we calculated the percentage of the grid squares covered by the circular buffer to the Residential Building Grid and its corresponding populations (Figure 6). The results show that the Residential Building Grid is well-covered by the circular buffer. Even when traveling on foot, there are still 38.71% of residents that can reach a pool within 5 min. If traveling by bike for 15 min, this figure is up to 99.89%. By comparing Figures 4 and 6, it can be seen that the circular buffer's area and population are 1–3 times as large as the overall route catchments in this study. The shorter the travel time, the larger the multiple. This means that the overall circular buffer at the city level significantly mismatches the real catchment areas of the facilities, as the route catchment is very close to the real travel situation.

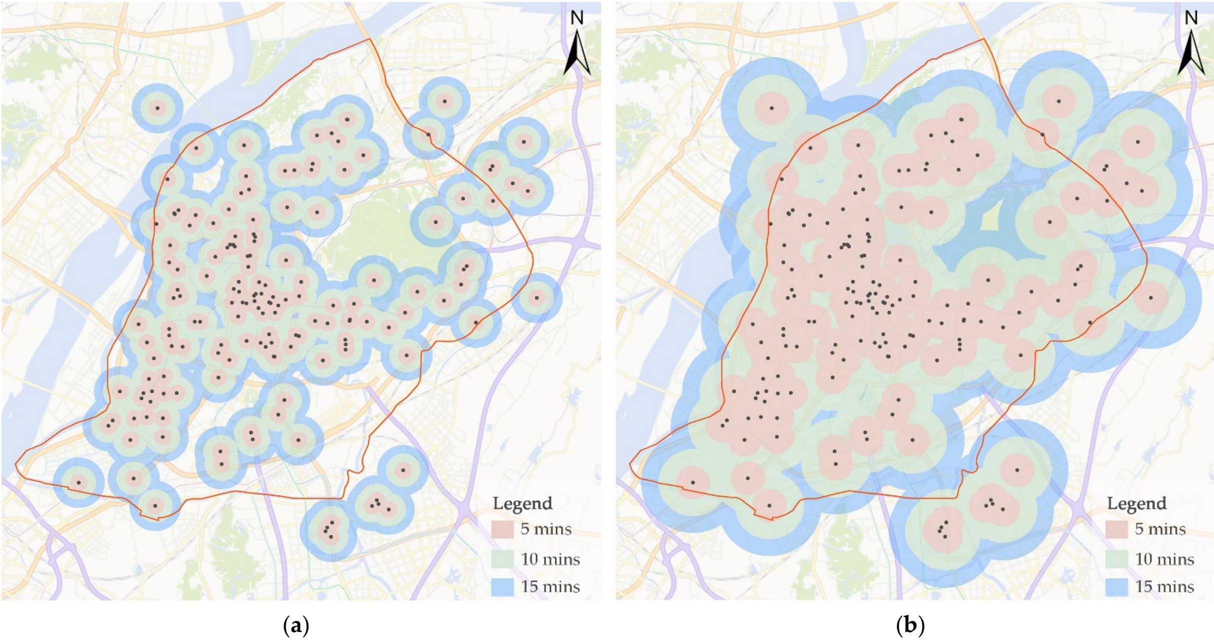


Figure 5. Circular buffers (**a**) walking; (**b**) cycling.

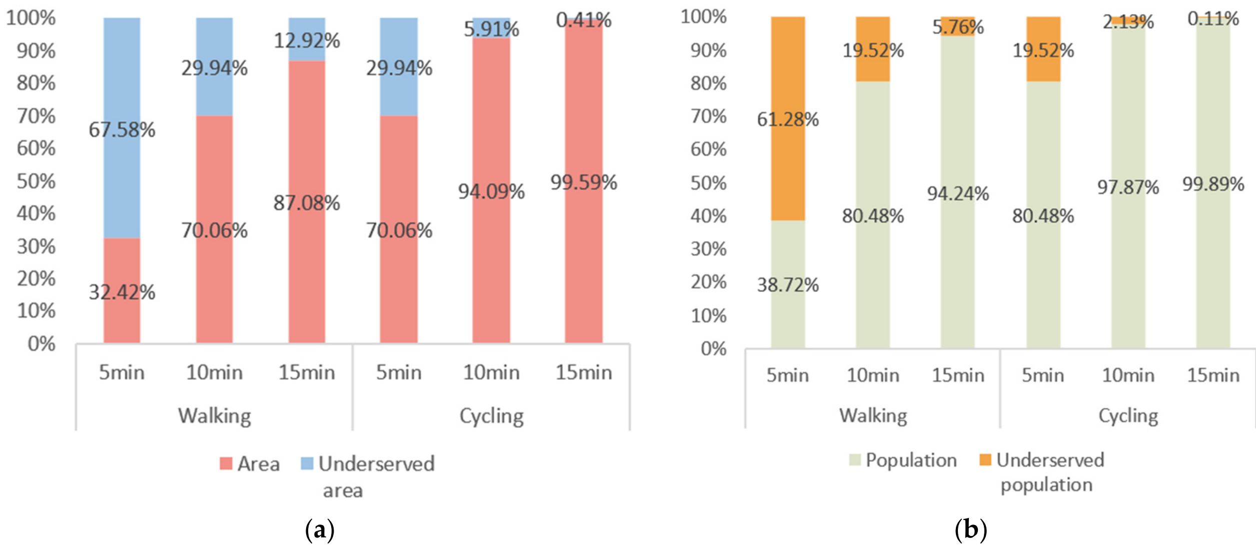


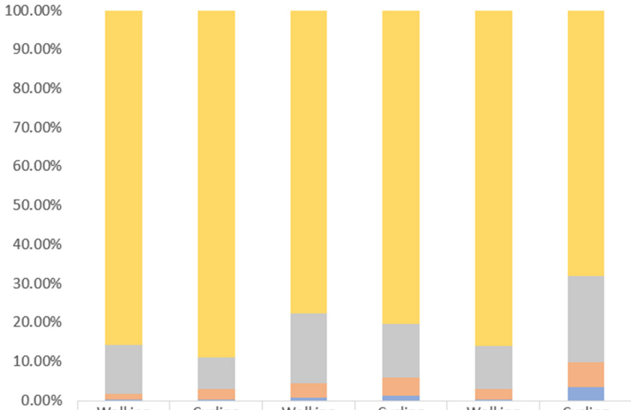
Figure 6. The percentages of each kind of circular buffer to the Residential Building Grid (**a**) area; (**b**) population.

3.3. What Are the Spatial Differences in Accessibility?

3.3.1. The Accessibility Index

We calculated and mapped the accessibility index (Figure 7) using the method described above. The maximum value of the walking accessibility indexes are 4 (5 min), 6 (10 min), and 13 (15 min), and the corresponding cycling accessibility indexes are 10 (5 min), 21 (10 min), and 28 (15 min). All of them are located near Xinjiekou. This is similar to the result of the kernel density analysis above. We also found that the accessibility indexes showed a sharply decreasing trend outward, with Xinjiekou as the main center. We quartered the accessibility indexes by their value and calculated the percentages of each part (Figure 8). For all situations, the top quartile, with larger values of the accessibility index, accounts for a very small percentage. Correspondingly, the bottom quartile accounts for a very large percentage. This reveals that the spatial disparity in pool accessibility in Nanjing is significant.

Figure 7. The accessibility index (**a1**–**a3**) walking; (**b1**–**b3**) cycling and (**a1**,**b1**) 5 min; (**a2**,**b2**) 10 min; (**a3**,**b3**) 15 min.

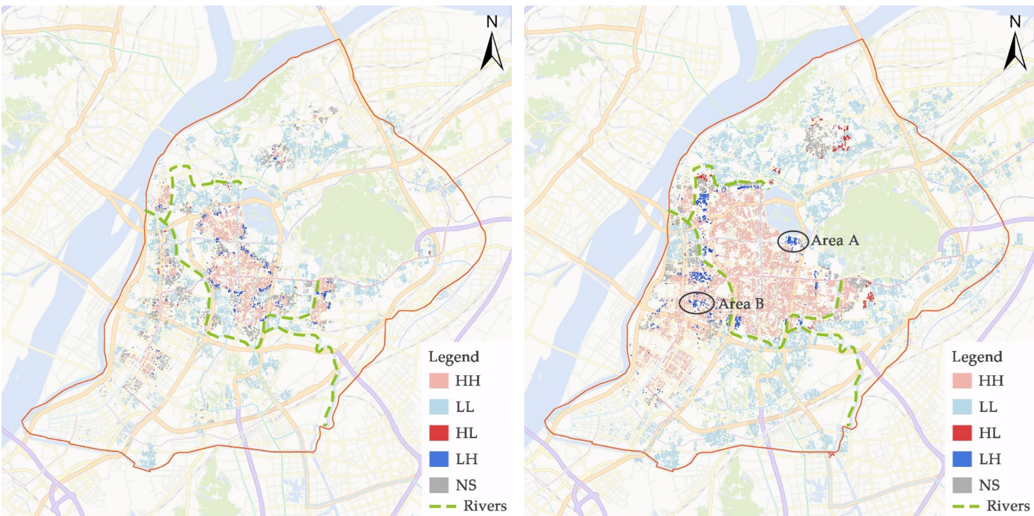


	Walking	Cycling	Walking	Cycling	Walking	Cycling
	5mins		10mins		15mins	
Q4	85.71%	88.78%	77.68%	80.25%	85.83%	68.03%
Q3	12.50%	8.13%	17.79%	13.79%	11.08%	22.05%
Q2	1.56%	2.76%	3.80%	4.59%	2.71%	6.44%
Q1	0.23%	0.33%	0.73%	1.37%	0.38%	3.48%

Figure 8. The percentages of the accessibility indexes after quartering.

3.3.2. Spatial Disparities of the Accessibility Index

We chose the 15 min catchment area as an example to do the cluster and outlier analysis because its data volume is large enough. In addition, a study indicated that, after sensitivity analysis, the association between swimming and accessibility of swimming pool was strongest when it was measured within about 1 km (approximately a 15-min walk) from the residence [11]. Figure 9 shows that when people travel by foot, the areas with higher accessibility to pools also have a multi-core trend. This is similar to the result of the kernel density analysis above. They are mainly located in five places: Xinjiekou, Hunan Road, Fuzimiao, Olympic Center, and the east side of Yueya Lake. At the same time, because the travel radius increases greatly for cycling, the size of the area with higher accessibility is also increased. It then includes the area between the Zhongyang Gate in the north, the Zhonghua Gate in the south, the Waiqinhuai River in the west, and the Hucheng River in the east, together with the Olympic Center. The LH outliers are mostly around the boundary between high- and low-value areas in both the walking and cycling situations, but some are located inside the high-value areas for cycling.



(a) (b)

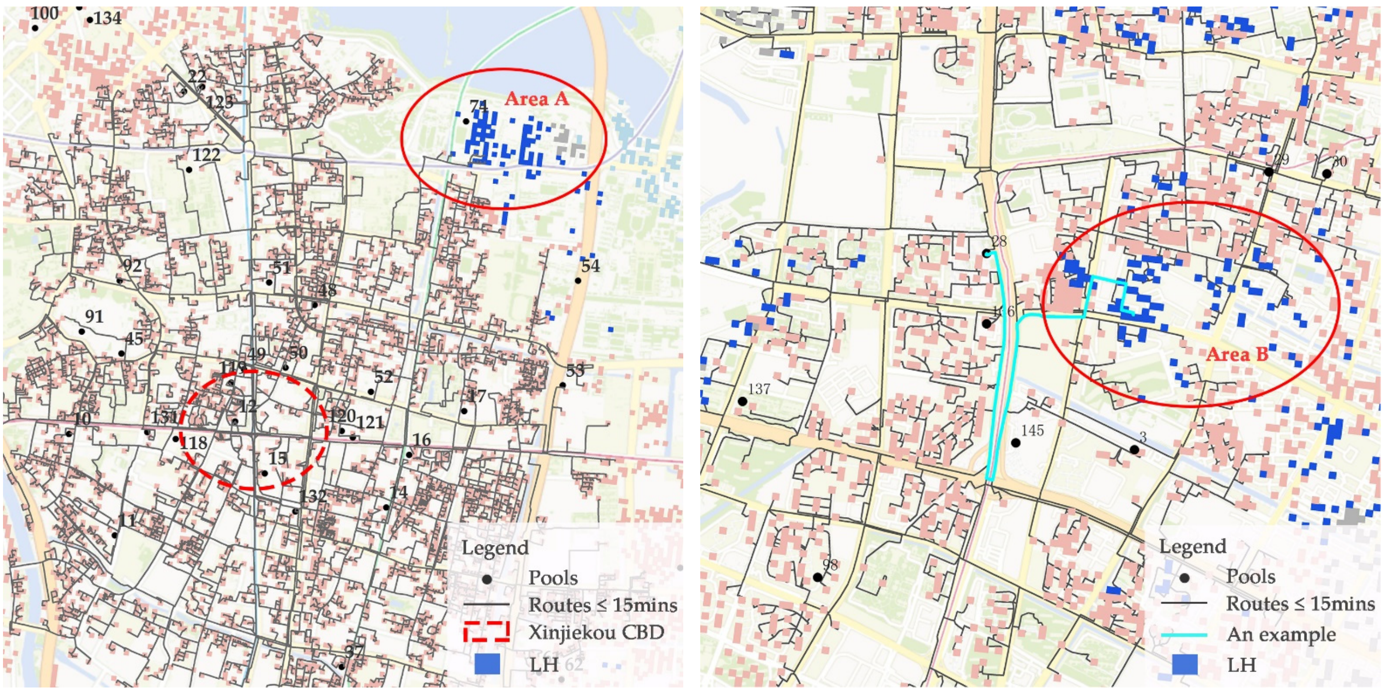
Figure 9. Results of the cluster and outlier analysis for (**a**) walking; (**b**) cycling. Areas A and B are two places with LH outliers but no significant ground obstacles around them, more discussion can be seen in Section 4.1.

4. Discussion

4.1. Reasons for the Spatial Disparity in the Accessibility Index

LH outliers are themselves low values but are surrounded by high values. The catchment of a pool is a continuous area; it never jumps over an area for no reason. This means that there must be some reason these LH outlier elements are inaccessible to certain pools that the surrounding elements have access to. Therefore, we treat the LH outliers as a window to look for internal causes that influence pool accessibility.

We checked the lists of pools accessible from these outliers and compared them with their surrounding elements, then summarized two factors in the inner differences of the accessibility index. First, the differences are largely influenced by the spatial distribution and density of the swimming pools. For example, the accessibility index of the outliers in area A (Figure 9b) is only around 5–6, but the high-value elements surrounding them are generally around 10. We compared the pool lists and the original navigation route data associated with the outliers and the high-value elements, and we found that area A was located just outside the boundary of the 15-min cycling catchment of Xinjiekou—the most densely distributed area of pools. Thus, the accessibility index sharply decreased in area A, resulting in outliers (see Figure 10a for more details). Most of the outliers on the boundary between high- and low-value areas in Figure 9a also occur for this reason. Second, the accessibility index is easily influenced by ground obstacles such as rivers, mountains, gated parks and schools, and elevated roads that cannot be crossed directly. These obstacles extend travel distances and reduce traffic efficiency, leading to a decrease in the accessibility index. For example, due to the elevated road on the west side of area B (Figure 9b), the residents cannot cross the street directly, resulting in a sharply reduced accessibility index (see Figure 10b for more details). We checked the other LH outliers in Figure 9b and found that most of them had the same cause, though the actual ground obstacles were moats, lakes, old city walls, gated parks, and so on.



(**a**) (**b**)

Figure 10. Details for (**a**) area A; (**b**) area B. The numbers beside the black dots are the pool number.4.2. Reflections on Environmental Equity.

In this study, we calculated the accessibility index of pools using online map data. We found significant spatial disparities in accessibility within the study area. As mentioned in some related studies, these differences in accessibility results in environmental inequality [38,39]. However, when we put it into the context of real life, we realized that the actual spatial disparity in accessibility may be even greater. Because the survival of swimming pools is very vulnerable to factors such as management and market competition, a low accessibility index may be unstable in the future, leading to still lower accessibility and greater environmental inequality.

In addition, we found that if we only focused on the catchment-area boundaries at a two-dimensional level without paying any attention to inner spatial differences, we would ignore deeper underlying problems of environmental inequality. For example, if we considered only Figure 5 when assessing accessibility, we might conclude that accessibility is good because the catchment area covers almost the whole city, especially for cycling. However, after the later analysis, we knew that unstable low values account for a very high percentage of the accessibility index. That is to say, the accessibility is not as good as the previous hypothesis implied. This suggests we should think about the matter from more perspectives, such as intensity, stability, and even equity, when focusing on accessibility issues in urban infrastructure, and not only on facilities like swimming pools.

To alleviate environmental inequality, we made two recommendations corresponding to the two reasons given in the previous section. First, compensatory measures could be taken through government or social forces to adjust the trend of pool distribution, which is currently almost entirely determined by free-market competition. For example, building new public pools in underserved areas and areas with low accessibility indexes but high population, or providing pool operators in these areas with policy assistance such as financial incentives or business training. Second, the impact of the ground obstacles could be reduced to improve traffic efficiency. For example, reducing ground obstacles due to human intervention, such as by opening some gated parks or college campuses or adding underpasses that can be used both for walking and cycling.

Furthermore, we divided the cycling accessibility index (15 min) by the walking accessibility index (15 min) using the Raster Calculator Tool in ArcGIS. The result showed that the maximum multiple was 27 for a single grid, and the average multiple after weighting based on the number of grids was 4.63. Similar results were found in a study of walking and cycling accessibility in Scotland. The researchers calculated that the number of facilities accessible by a 10-min ride was about ten times as great as that by walking. This gives cycling residents a greater chance of compensating for the limitations of their immediate surroundings [40]. Therefore, the significance of a robust, active travel system dominated by walking and cycling, also known as non-motorized transportation, comes to the fore. Especially given the prevalence of electric bicycles in China, the development of active travel systems would bring greater health benefits and alleviate environmental inequities.

4.2. Advantages and Limitations of the Method

First, the basis for the analysis in this study is the concept of an 'accessibility index.' The greatest advantage of this index is that it is intuitive, as the value of a grid square directly represents the number of pools that can be reached. It is also easy to understand even for non-specialists and policymakers, which makes it easier to apply to related studies and urban planning.

The second advantage of this study is the use of online maps. In some previous studies, researchers considered the road network when calculating distance, but most of them chose the method of network analysis [26]. In this study, we scraped route navigation data from online maps in batches using Python and then used these data to delineate the catchment areas. This approach makes it easier and faster to obtain the data and saves a lot of time over modeling the road network in ArcGIS. In addition, the route navigation data greatly improved the precision of our study, as they are closer to residents' real travel choices than the network analysis. They can also clearly show the routes residents take to the target pool, which plays a key role in looking for reasons for the spatial disparities in the accessibility index.

The third advantage is the introduction of the girds; it not only improved the precision of this study, but also solved the problem Geurs [41] mentioned in his research that the opportunity points adjacent to the origin point and those just within the catchment area lack differentiation. Several previous studies in the field of accessibility have also introduced the grids [18,19,42]. They all heavily rely on the spatial relationships between grids when calculating the accessibility, such as calculating the distance between two grid centroids and using it as one of the indexes of accessibility. However, in this study, we use the grid as a method of normalization and use it to rasterize the isochronous circles generated from the online navigation data, thereby highlighting the accessibility differences within the catchment area. The high accuracy of the 30 m edge length grid also makes it easier to pinpoint the specific streets or ground features on the map that causes such spatial differences.

Although the use of online maps was a great advantage for us, it also brings some limitations. First, the online maps simulate residents' travel choices entirely from the perspective of the objective environment, without taking subjective human choices into account, so there might be slight differences from real travel routes. Second, we ignored the temporal factor. Different times of the day or different seasons can lead to different travel options and time costs.

5. Conclusions

The results of this paper show that the accessibility of pools in Nanjing is poor when the time cost is low (5 min), but this improves significantly as the time cost increases, with 97.62% of residents being able to access at least one pool within 15 min by cycling. This means that it is feasible to take swimming pools as a kind of cool spot to cope with heat wave attacks. The market penetration of air conditioning in urban areas in China was already up to 124% in 2016 [43], and people can easily enjoy the cool breeze of air conditioning at home during heat waves. However, over-reliance on home air conditioning increases the burden on the environment and makes extreme hot weather occur more frequently. Providing cool spots is not only an environmentally friendly way to cope with heat waves, but also safeguards the health and well-being of low-income urban populations. This requires the involvement of government organizations.

In this study, we attempted to assess the accessibility of swimming pools in the main urban area of Nanjing in three dimensions: distribution of pools, catchment areas of pools, and spatial disparities in pool accessibility. We used pool accessibility as an entry point to reveal environmental inequalities in cities. However, what we focused on was more about the supply side. This could easily lead us to average equity without noticing the residents' actual demands for pools, and we also ignored the environmental capacity of the pools. Therefore, our future studies will focus on citywide information integration to explore actual demand patterns for swimming pools. Discussing the accessibility together with the demands will enable us to have a comprehensive perspective on environmental equality and health equality.

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