Research on the Key Problems of Leisure Service Radius of Urban Green Space

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Abstract. In this paper, the methods and means of accessibility computing are discussed. In particular, about 135 relatively homogeneous temporal units accessible to Tianhe Park are established according to the rules. Based on GIS, the central point is calculated, and the road density, population density of each unit can be calculated. Thereafter, the related data sets are established. With the doors for access points and the basis of the real road systems, the road distance, time distance, landscape attractiveness, etc. are calculated, and their correlation analysis are performed. The results indicate that the establishment of park gate is reasonable, its influence range can cover the surrounding area, and has its own characteristics, and regardless of the bus distance or car distance, they show a general distribution of the ring, but buses show strong regional differences.

1. Connotation of Service Radius for Urban Green Space

Urban green space is the important part of urban natural environment, and plays a very important role in maintaining urban ecological balance, mending the quality of urban ecological environment, and improving the urban landscape and biodiversity. In general, urban green space has a variety of functions such as leisure, disaster reduction, ecological environment services, etc., and leisure is definitely what the residents care mostly. Its quantity, area, and pattern affect the quality of urban environment and the development of residents' recreation activities directly. The most direct performance of it, in fact, can be attributed to the size of the service radius of urban park green. It does not exist in accordance with urban planning, but is mainly affected by the resistance of residents when they visit green spaces which can be represented by the distance by foot to the green space. If the differences of spatial distribution of resistance are not considered, the direct distance between two points in plane is the shortest and with the minimum cost of arrival. The reachability measurement from a single source exhibits concentric distribution.

Actually, because of the heterogeneity of urban landscape and different road direction, the resistance distribution often varies, such as distance, time, cost, and so on. Urban resistance affects the radius of the leisure and recreation and also disaster reduction services in urban park green spaces, and cause the changing of service radius in a curve distribution way. It changes the selection of green space recreation for urban residents in some cities with high resistance. In these areas, the service
radius decreases due to the constraints. While in the zones with low resistance, the service radius is relatively bigger, and is beneficial to the leisure and recreation for the urban residents.

The population density, the landscape quality of urban green space and the resistance factors for coming to green spaces affect the utilization of urban green space in certain degree. In general, the green landscape quality and road accessibility are positively correlated with the service radius of green space. The real urban park green space service radius is usually irregularly shaped. The service radius of green land is the best manifestation of the fairness and equality of green land. It reflects the capacity and degree of radiation provided by the green land.

2. Significance of Research on Service Radius of Urban Greenland

Plan the green space scientifically. The green space service radius is generally determined by the compiling unit according to the area and nature of the park, and currently are lack of unified scientific standard. The comprehensive parks with large area, located in the new district always tend to develop a bigger service radius for green space. However, the park's service radius is often constrained by the road system, transport, etc. actually. Urban green space resource allocation and planning based on urban green space service radius can be considered as relatively fair in terms of spatial distribution, for it can figure out which service areas in the green space layout are duplicated and which areas are vacant. Therefore, a comprehensive analysis of service radius of urban green space can rationally and efficiently make a plan for urban green space according to local conditions.

Improve the utilization. After determining the service area of green space, the residents’ minimum cost of reaching the green space can be used to rationally plan the green space so as to expand the service radius, to avoid the waste of green space resource, to optimize the landscape pattern, and to improve its utilization. So the leisure service function of urban green space can be maximized.

Play its service functions. Among the functions of green space such as leisure service, environment improving, etc., leisure service can represent the people-oriented thinking mostly. With the gradual awakening of urban residents’ ecological awareness, the demand to enter the green space with the quickest and lowest cost way is more and more urgent. However, the general plan only focuses on the construction of green space quality, ignoring the residents' participation and accessibility to the green space, which may result in lack of its service functions.

Therefore, no matter it is for urban green space or for some type of green space, the research on service radius will be helpful to rationally plan the urban green space, avoid the waste of green space resource, improve its utilization and play multiple roles in its services.

3. General Research Methods for Urban Green Space Service Radius

Buffer analysis. It is mainly based on point or surface, using service distance as the radius to make multiple buffer analysis. It often used in the project planning process due to its ease of use and intuitive presentation. However, this method replaces the actual road distance with the shortest distance and replaces the actual green space entry point with the center point or the boundary, thereby actually expanding the service range. Hence it can only be used in the pre-analysis or approximate assessment.

Landscape gravity method. More and more studies show that the population density, road density and travel costs of residential areas affect the use of green space. So the landscape gravity method is used widely. However, this method emphasizes more about the attractiveness of the green landscape as a kind of attraction center to residents, and the regions gravitated heavily by green areas are not necessarily within the service radius of smaller green areas.

Road system approach. It calculates the spatial coverage of green space based on the selection of a transport system which overcomes the urban landscape differences obstruct that residents may encounter in their journey to green space (Nicholls, 2001). It usually takes into account many factors such as intersections, footbridges, underpasses and crosswalks (K. Oh, Jong S.; C.F. Liu, 2010), and can truly reflect the scope of green space services (B. Li, 2008). The shortage of this method, however,
is that it needs a large amount of data to be processed, which poses difficulty in work and is not suitable for large-scale research.

Here is an example illustrated in Fig.1. Suppose that the shortest distances between locations of A, B and the doors of city park (e.g., O1, O2) are equal, i.e., \( SAO1 = SBO2 \). If we choose the method of shortest time cost of cars, and get \( TAO1 = TBO2 \), but if the public transportation system of A is developed, then we probably have \( GA \geq GB \), even though \( TAO1 \) is a little bigger than \( TBO2 \), the advantage of location A is still very prominent, and most people will choose the public transport rationally.

![Figure 1. Different traffic tools gravitational field sketch map](image)

4. Key Issues of Research on Urban Green Space Service Radius

The following questions as listed below should be considered much in the research of accessibility:

1. It cannot be stipulated that a piece of green space serves only a specific area, nor can the public's use of green space be deduced from the amount of park space per capita. Urban green space coverage can only serve as an intuitive statistical index. Urban green space service radius cannot truly reflect the situation of residents into the green space. It is just a possible service space for green space.

2. The process of entering green space and its obstacles should be truly reflected on the basis of the urban road network maximally. The perfection of traffic facilities and the spatial location of green space are the important factors of green space accessibility.

3. Heterogeneity of urban landscapes should be considered due to the obvious differences in urban landscapes of different types. And there are obvious differences in the population carrying capacity for different types of land use (T.G. Zhou, 2004). So the landscape attractiveness of urban green space to different population densities is somewhat a new research direction. In general, the larger the population concentration area is, the greater the aggregation error is, and the lower the reachability accuracy is (C.F. Liu, 2010). If the data accuracy is improved, this problem can be solved well by using less aggregated population data (S.L. Handy, 1997; J Hawk, 2002).

Combined with the scale and census data of urban topographic maps, H.W. Yin, et al. proposed to choose the size of housing and residential area in the study of accessibility of urban green space in China (H.W. Yin, 2006). But for general method, it is difficult to obtain the data for high data accuracy. Different types of land use have different degrees of land use, while changes in land use level have a positive correlation with population changes (X.L. Wang, 2000). T.G. Zhou, D.Z. Goo (2004) proposed a method of calculating population density after removing green space, water bodies, roads and so on from the entire land structure. Redistributing the population within each sub-district office in conjunction with the actual type of land use to reflect the characteristics of its distribution more reasonably has become a consensus. Therefore, it can be tried to establish a simple set of population density distribution based on the street census data and appropriate surveys based on the type of land use.
Figure 2. The reach way of city green space

(4). Getting to the city park boundary does not mean entering the park. Actually, only the park gate can be used as the park's entry point (as illustrated by Fig. 2). AC is the shortest distance from point A to the park wall, AO is the distance from point A to the park's geometric center, and AB is the closest distance from point A to the park gate. Most of the current research use the geometric center of the park to represent the park, while actually, the entering into the park from point A should follow the preset way AEB. Obviously, the research on park accessibility should be based on park gates and the actual road network.

(5). There are many ways to enter the park, buses, cars, bicycles should be considered, while the direction of crossing through resistance should be taken into account much more. That is, along the direction of the road and perpendicular to the direction of the road can make different resistance effects. So pedestrian bridges, underground passage should be considered as the resistance for crossing, and the city's one-way and double-way line for car traffic should also be considered.

5. Conclusion
Increasing the landscape quality of these carriers such as urban park can increase the attractiveness of the green spaces, and can increase service radius. Rational transformation of ordinary parks to improve the effectiveness of disaster prevention and refuge can be realized by adding necessary disaster prevention and reduction functions into common parks according to the actual requirement. The plant community structure should be rationally allocated and the greatest benefits of disaster prevention and reduction of urban green space should also be brought into full play. From the aspect of landscape ecology, in order to improve the effectiveness of disaster prevention of urban green space, large-scale plaque green spaces such as existing comprehensive parks, scenic spots or civic squares can be utilized. The research on green spaces of urban parks involves multiple disciplines, people with different professional backgrounds are needed, and new thinking, new methods from various viewpoints should be introduced continually, which cannot be done at one stroke. Due to the limited time, condition, and incomplete information, we did some exploratory studies on the service functions of urban park green spaces for residents, so there are still some shortcomings including: the choice of factors is not completely, making the research system still not perfect; in the aspect of ecosystem’s services functions of urban park green space, only the content of carbon and oxygen balance are analyzed, the research of cooling and noise reduction and air purification is still lacking. The investigation of the leisure and recreation of park green space does not take into account the cultural background, social and economic conditions of residents, etc. and the analysis on disaster relief services function is incomplete. The questions mentioned above are crucial to be solved and needed to be paid more and more attention.
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References
[1] S. Nicholls, Measuring the accessibility and equity of public parks: a case study using GIS, Managing Leisure. 6(4): 201-219 (2001).
[2] K. Oh and S. Jeong, Assessing the spatial distribution of urban parks using GIS, Landscape and Urban Planning. 82(1/2): 25-32 (2007).
[3] C.F. Liu, X.M. Li, D. Han, The reachability of urban park-methods and key problems, Journal of Ecology. 30(19): 5381-5390 (2010).
[4] B. Li, Y. Song, K.J. Yu, Evaluation Method of Reachability Index in Green Space Planning of Urban Park, Journal of Peking University. 44(4): 618-624 (2008).
[5] T.G. Zhou, D.Z. Guo, Study on Gravitational Field of Urban Greenland Landscape based on GIS—Illustrated as Ningbo City, Journal of Ecology. 24(6):1157-1163 (2004).
[6] H.W. Yin, F.H. Kong, Y.G. Zong. Evaluation on Reachability and Fairness of urban green space, Journal of Ecology. 28(7):3375-3383 (2008).
[7] X.L. Wang. Analysis on Demographic factors in land use / land cover change, Resource Science. 22(3):39-43 (2000).