

## **WALKING ACCESSIBILITY OF URBAN GREEN SPACES IN COMPACT CITIES: A CASE STUDY OF BAHAWALPUR**

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**ABSTRACT:** Adequate supply of urban green spaces and ease to access these spaces is essential for the sustainable livelihood in modern day cities. Promoting use of urban green spaces is not only beneficial for the physical and mental wellbeing of the citizens but also offer broad social benefits. Service area from residential areas to publically accessible green spaces was measured through network analyst tool in ArcGIS. A statistical analysis of green spaces and visitors was conducted to analyze the distribution and equity or inequity in green spaces provided to the communities. Park service area, walkability time and supply vary in different parts of city. Majority of good service areas are located in and around central part of the city. Action are needed to redress the access of public to this important health resource and motivate people to use these resources more often.

**KEYWORDS:** Walkability, Impedance, Network analysis, Sustainable Cities

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### **INTRODUCTION**

Presence of green spaces in urban areas is considered as a valuable component of urban fabric (Corbane et al., 2020). These natural and semi-natural vegetation consist of roadside plantations, lawns, domestic gardens, parks, green roofs, forests (Gan, Deng, Zheng, Hong, & Wang, 2014). These spaces provide a wide array of ecosystem services for urban environment and population. The contrast between prominent built up areas and green spaces is an indicator for sustainable management of cities (Corbane, et al., 2020).

Provision of accessible green spaces is very important for the livability of the cities due to number of ecosystem services it provide to the environment and citizens both. Presence of good green spaces doesnot fulfil the criteria of sustainable development goals until its accessibility is not made sure, citizens should be encouraged to use and visit nearby parks for wellbeing of urban societies (Wang, Brown, & Liu, 2015). United Nations Sustainable Development Goals 2030 also focus on the improvement of green spaces in cities 'by 2030 provide universal access to safe, inclusive and accessible green and public spaces'(UN, 2015). Green space is considered one of the environmental factor to improve community health (Jia et al., 2021)

Accessibility to public facilities is necessary condition for development of resilient cities. It is a very commonly used notion. Accessibility is defined as how fast and far one can go to reach a destination (Unal, Uslu, & Cilek, 2016) or the degree of connection from a specific location to all other regions (Tsou, Hung, & Chang, 2005) quantitative expression of the ability of

residents to reach a service facility (Chen, 2014)but it is a very broad and flexible term (Gould, 1969). This concept has changed the notion of local governance of public facilities, as accessibility has been used in different field such as health care services (Guagliardo, 2004; Luo & Wang, 2003), daycare facilities (Fransen, Neutens, De Maeyer, & Deruyter, 2015), shopping centers (Liu & Zhu, 2004), public amenities (Hewko, 2001; Talen & Anselin, 1998), safe drinking water (Lewis, Siyambango, & Lendelvo, 2018), neighbourhood green spaces(Kong, Yin, & Nakagoshi, 2007; Nicholls, 2001). Any facility or service lose its worth and impact if not accessible to public. Different methods and techniques are used to measure and quantify accessibility. Sustainable cities should take into account a convenience distance from green space specially in core areas (Hammer, Coughlin, & Horn IV, 1974). To rationalize the equity in green space supply it is necessary to identify the shortage areas and the reason of this lacking. Network analysis is a useful tool in analyzing network flows like water distribution, stream flows and traffic flows (Unal, et al., 2016) and is also used in many studies to determine the accessibility of urban green space.

Influence of different factors can be observed to the access of green spaces such as street layout, traffic, residence location, green space distribution, level of attraction of parks etc. (Cutts, Darby, Boone, & Brewis, 2009; Harnik & Simms, 2004; Kaczynski, Potwarka, & Saelens, 2008; Liang, Chen, & Zhang, 2017)Yin in Shanghai and Coombes in Bristol used minimum distance method(Coombes, Jones, & Hillsdon, 2010; Yin, Kong, & Zong, 2008). Nicholas used simple buffer analysis for the purpose to measure accessibility of parks in

Texas(Nicholls, 2001). Zhu adopted cost weighted distance method to measure accessibility of forest in cit(Zhu, 2011).Some studies use simple walking distance as the shortest distance to the park (Comber, Brunsdon, & Green, 2008; Oh & Jeong, 2007). (Hillsdon, Panter, Foster, & Jones, 2006) use gravity model to determine access to nearest park. (Lwin & Murayama, 2011) use a web based calculator to calculate ecofriendly access to parks. Some studies use statistical analysis to measure accessibility (Reyes, Páez, & Morency, 2014). Authors used a GIS based walking time accessibility focusing on actual route walkability from starting point to entrance of the green space.

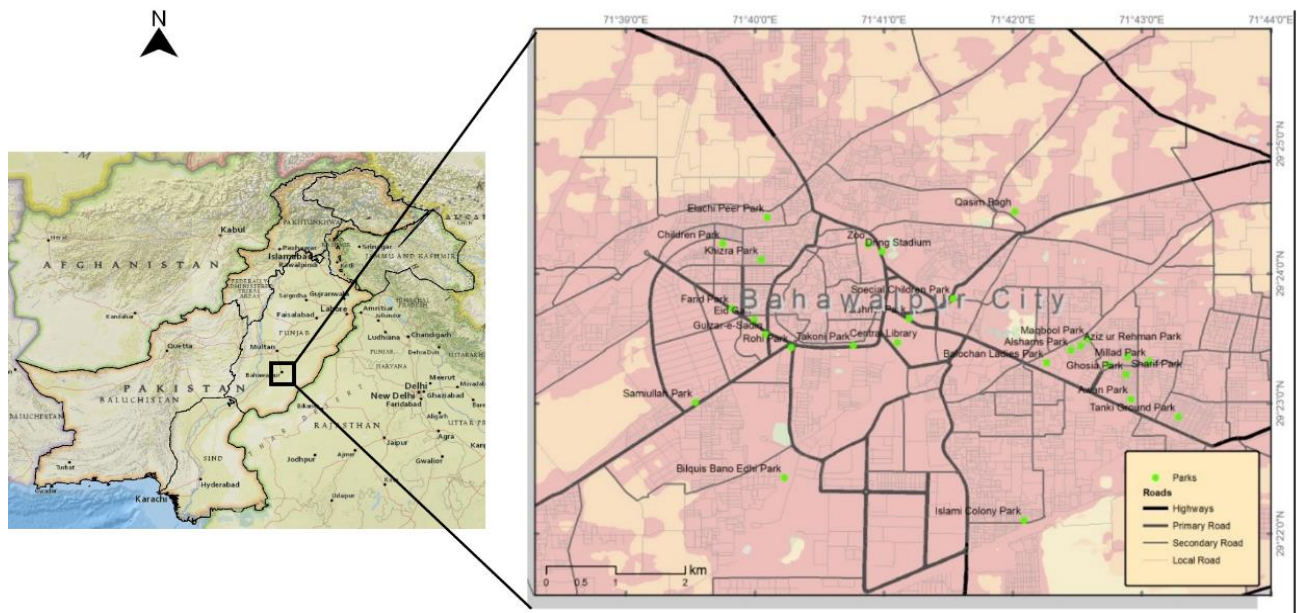
Like most of the developing countries Pakistan is facing challenges due to the rapid urban population growth in last decade of 20<sup>th</sup> century. Bahawalpur is one of the cities that are facing high population growth rate and increasing urbanization that has accelerated the

demand of civic services including provision of open and green spaces and placed an abundant pressure on government institutions (Nazir & Bukhari, 2022). The biggest challenge faced by municipal authorities and other institutions is due to poor management and lack of funds

## MATERIALS AND METHODS

The city of Bahawalpur is densely populated city of Pakistan, covers an area of 246 sq. km. (24600 hectares) approximately. Its registered population according to Census 2017 is 762744 persons (Pakistan, 2017). There are 21 administrative union councils in the city, out of which 18 are urban and 3 are rural. Only urban union councils were surveyed for the present study.

Figure 1: Location of study area



The study focused on Bahawalpur’s publicly accessible green spaces. Park data was obtained from the office of Park and Horticulture Authority (PHA) Bahawalpur. There are 29 publicly accessible green spaces identified in Bahawalpur City ranging from district parks to neighbourhood parks. Parks and Horticulture Authority (PHA) and Cantonment Board Bahawalpur (CBB) are two organizations that are responsible for Bahawalpur’s parks.

With exception to the park data, the data used in this study is taken from different sources including satellite image, district boundary map, street map, park map and other related government sources. After a field validation of the data obtained from images and maps, it was used in ArcMap(10.4 esri) for further analysis. A measure for service area and service population was done

using spatial analyst tool keeping 5 minutes walking time interval. Images were then edited and processed to create walkable road network with nodes and barriers was produced to be used in network analysis. For the calculation of the accessibility, a model built in ArcGIS ModelBuilder. The model has several geoprocessing steps that aim to analyze the walkability of a park using GIS.

## RESULTS AND DISCUSSION

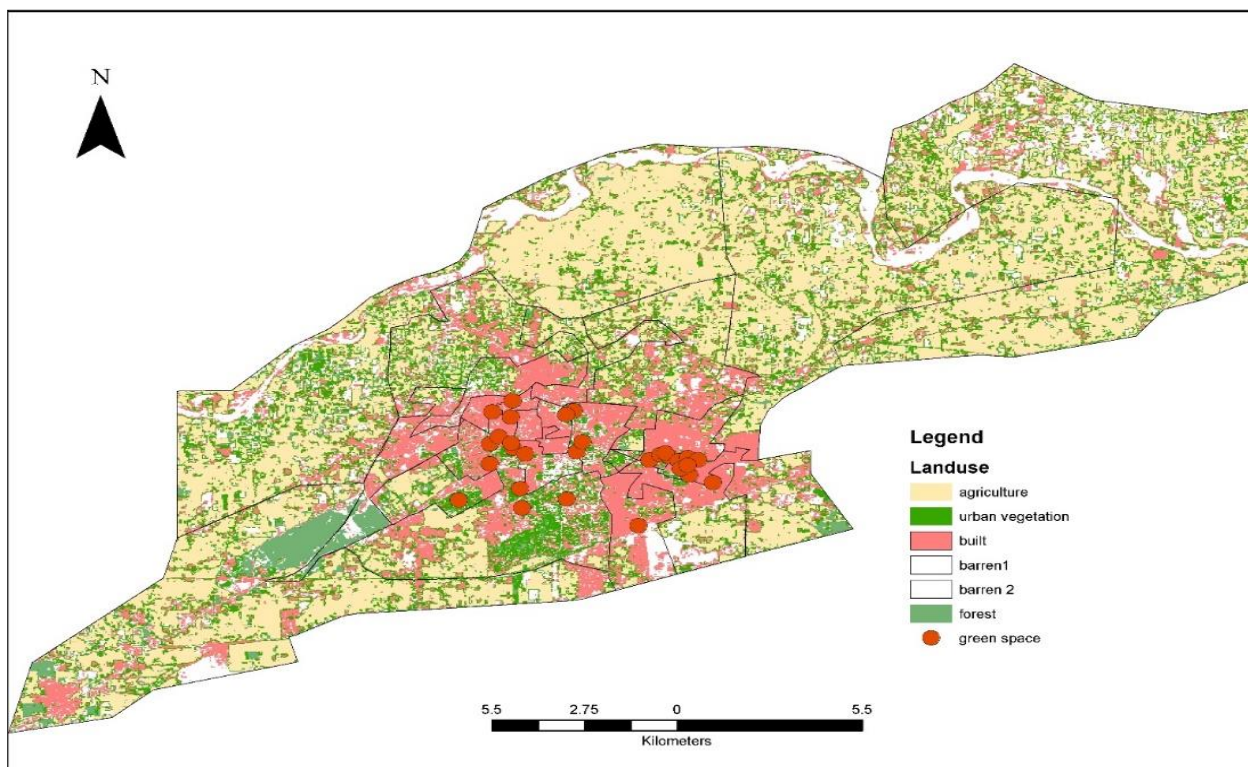
The study was conducted for 29 publicly accessible green spaces that were determined by survey studies in Bahawalpur.

Figure 2 shows that the distribution of publicly accessible green spaces are sparse and mostly in the

central part of the city. Which are mostly old towns or areas which are surrounding walled city laid back in 1970s approximately. These areas are in the mature stage of development while the new areas or peripheral areas are still under development process. This inequity in park distribution often results in overuse of the park with better accessibility and the parks with lesser accessibility got wasted in terms of resources and service.

A total of 83.3 hectares of area is covered by publically open green spaces. These are the areas which visitor can visit without any liability. These are different type of spaces with different services. A network analysis based on the walkability time was conducted on

the identified open green spaces. Distance from a park is an important measure. How far is a green space from your residence, office or block? Is the distance less enough to walk alone or with a child or an elderly? These are the question which are often asked. But there is no standard distance or time to identify the measure. Many countries and cities have set their own standards according to their level of development, culture and goals. When urban green spaces are considered accessible when meet the high demands of population density in terms of distribution, services and convenience (Unal, et al., 2016).



**Figure 2: Spatial distribution of green spaces in study area**

Figure 3 shows the results of network analysis based walkability time where the minimum time to reach park is 5 minutes going upto 30 minutes. As part of the urban lifestyle people usually visit green spaces and parks from their homes. Therefore urban green space walking accessibility from residential communities to a park (c to p) and road junction to a park (j to p) is analyzed in this process. Overall result show the calculations and mapped service area within in a walking distance time using network analyst tool in ArcGIS.

Table 1 shows the relationship between impedance (walk time in minutes) and the area and population served by the parks. The results indicate that parks within a 0-5 minute walk time serve the smallest area (5 sq. km) and population (2%), while parks within a

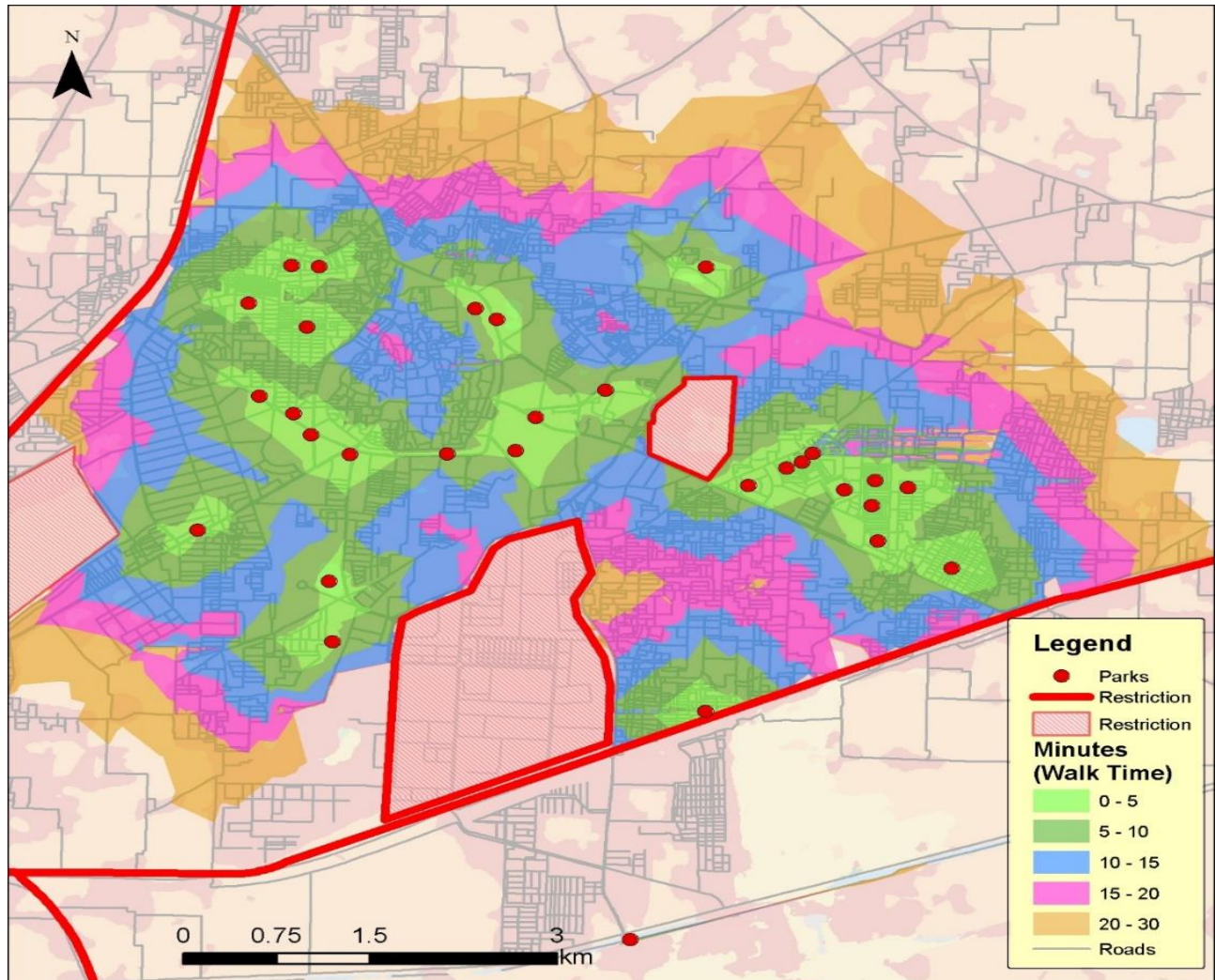
10-15 minute walk time serve the largest population (4% of the total city population). Walk time access to parks greater than 30 minutes is considered as the unserved population from parks. 83% of population is deprived of parks. The number of served population is only 130,245 out of 762,111 that is only the 17% of the total population of the city. The service area analysis map highlights the importance of proximity in park accessibility and emphasizes the need for more parks in areas with longer walk times. Tracks working as barriers, and prohibited areas are also shown in the figure3. According to studies a 10 minutes walking distance is consider as half a mile or 800 meters in route (O'Sullivan & Morrall, 1996 ). Furthermore a model was used to analyze and categories the accessibility of green space using a buffer of 1



kilometer. The model's purpose is to analyze the walkability of a park by calculating the distance and cost of reaching the park from neighboring parcels. The model output is a polygon feature class that shows areas of high and low walkability around the park.

The model's steps involve using ArcGIS's built-in tools for geoprocessing as Euclidean distance, cost

distance, reclassify, and dissolve. These tools are used to perform operations on raster and vector data, such as converting raster data to polygon features, selecting features by location, and dissolving polygons. The model's input data include a roads dataset, a parcels dataset, and a park feature class. The model assumes that the input data is projected in a suitable coordinate system.



**Figure 3: Walkability time network analysis of selected green spaces in study area**

**Table 1: Result of service area and served population**

Walking Time (mins)	Served Area (sq. km.)	Served Population
0-5	5	15184
5-10	10	30839
10-15	11	33386
15-20	7	21577
20-30	9	29259
More than 30	204	631866

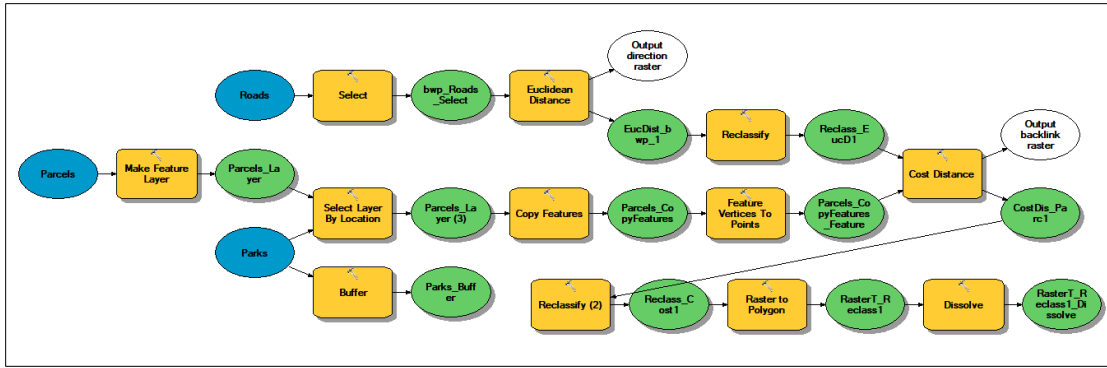


Figure 4: Green space accessibility access model

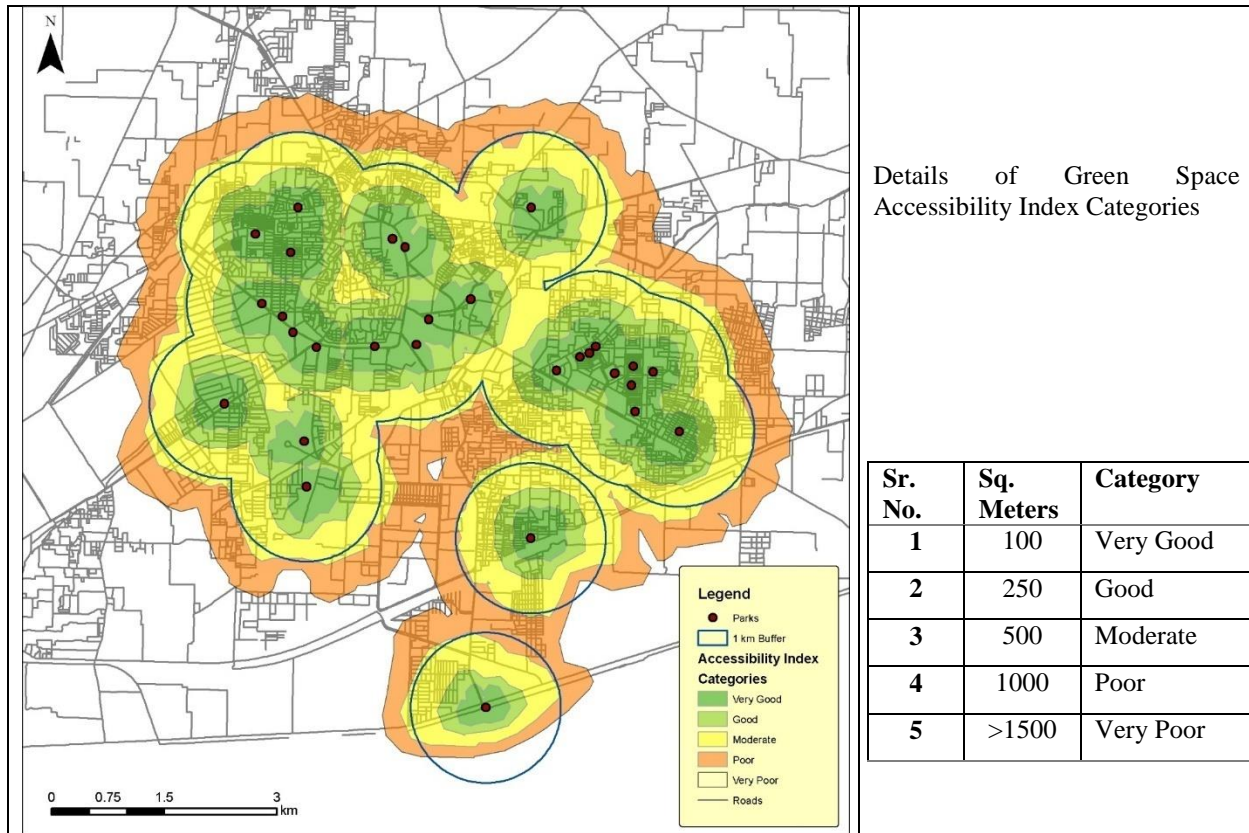


Figure 5: Green space accessibility index

Figure 4 presents the ranges and categories of the accessibility index. The index consist of 5 levels of accessibility including very poor, poor, moderate, good and very good.

As illustrated in Fig. 4, it can be observed that the areas with very poor and poor accessibility lie in the periphery of the study area while moderate and good accessible areas are the central area of the city. In other words, bus stops located in the central area of the city have high accessible values, the accessibility values decrease as the distance from city center increases. This is mainly because of the fact that

the number of green spaces in the city outskirts are less in number, are scattered and widely spaced.

**Conclusion:** It was found that most of the green spaces were located in built up and residential areas hence most of the service areas also lie in the same. Accessible service area is very low due to the sparse green spaces. Meanwhile a new urban master planned is needed based on the current studies that has a balance between residential, working and recreation space.

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## REFERENCES

- Chen, Q. X. W., L.;Yang,W. (2014). Evaluate the accessibility of urban park based on travel distance, in case of leqing city. *Journal of Zhejiang University*, 3, 348-352.
- Comber, A., Brunsdon, C., & Green, E. (2008). Using a GIS-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups. *Landscape and urban planning*, 86(1), 103-114.
- Coombes, E., Jones, A. P., & Hillsdon, M. (2010). The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social science & medicine*, 70(6), 816-822.
- Corbane, C., Martino, P., Panagiotis, P., Aneta, F. J., Michele, M., Sergio, F., . . . Thomas, K. (2020). The grey-green divide: multi-temporal analysis of greenness across 10,000 urban centres derived from the Global Human Settlement Layer (GHSL). *International Journal of Digital Earth*, 13(1), 101-118. doi: 10.1080/17538947.2018.1530311
- Cutts, B. B., Darby, K. J., Boone, C. G., & Brewis, A. (2009). City structure, obesity, and environmental justice: An integrated analysis of physical and social barriers to walkable streets and park access. *Social science & medicine*, 69(9), 1314-1322.
- Fransen, K., Neutens, T., De Maeyer, P., & Deruyter, G. (2015). A commuter-based two-step floating catchment area method for measuring spatial accessibility of daycare centers. *Health & place*, 32, 65-73.
- Gan, M., Deng, J., Zheng, X., Hong, Y., & Wang, K. (2014). Monitoring urban greenness dynamics using multiple endmember spectral mixture analysis. *PloS one*, 9(11), e112202.
- Gould, P. R. (1969). Spatial Diffusion, Resource Paper No. 4.
- Guagliardo, M. F. (2004). Spatial accessibility of primary care: concepts, methods and challenges. *International journal of health geographics*, 3(1), 1-13.
- Hammer, T. R., Coughlin, R. E., & Horn IV, E. T. (1974). The effect of a large urban park on real estate value. *Journal of the American Institute of Planners*, 40(4), 274-277.
- Harnik, P., & Simms, J. (2004). Parks: How far is too far. *Planning*, 70(11), 8-11.
- Hewko, J. N. (2001). Spatial equity in the urban environment: assessing neighbourhood accessibility to public amenities.
- Hillsdon, M., Panter, J., Foster, C., & Jones, A. (2006). The relationship between access and quality of urban green space with population physical activity. *Public health*, 120(12), 1127-1132.
- Jia, P., Cao, X., Yang, H., Dai, S., He, P., Huang, G., . . . Wang, Y. (2021). Green space access in the neighbourhood and childhood obesity. *Obesity reviews*, 22, e13100.
- Kaczynski, A. T., Potwarka, L. R., & Saelens, B. E. (2008). Association of park size, distance, and features with physical activity in neighborhood parks. *American journal of public health*, 98(8), 1451-1456.
- Kong, F., Yin, H., & Nakagoshi, N. (2007). Using GIS and landscape metrics in the hedonic price modeling of the amenity value of urban green space: A case study in Jinan City, China. *Landscape and urban planning*, 79(3-4), 240-252.
- Lewis, E. W., Siyambango, N., & Lendelvo, S. (2018). Assessment of accessibility of safe drinking water: a case study of the Goreangab informal settlement, Windhoek, Namibia. *Water Practice & Technology*, 13(4), 871-878.
- Liang, H., Chen, D., & Zhang, Q. (2017). Walking accessibility of urban parks in a compact megacity. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning*, 170(2), 59-71.
- Liu, S., & Zhu, X. (2004). An integrated GIS approach to accessibility analysis. *Transactions in GIS*, 8(1), 45-62.
- Luo, W., & Wang, F. (2003). Measures of spatial accessibility to health care in a GIS environment: synthesis and a case study in the Chicago region. *Environment and planning B: planning and design*, 30(6), 865-884.
- Lwin, K. K., & Murayama, Y. (2011). Modelling of urban green space walkability: Eco-friendly walk score calculator. *Computers, Environment and urban systems*, 35(5), 408-420.
- Nazir, A., & Bukhari, S. M. H. (2022). Safe Drinking Water and Local Governments: A Study of Bahawalpur Metropolitan Corporation (2000-21). *Journal of Development and Social Sciences*, 3(2), 709-720.
- Nicholls, S. (2001). Measuring the accessibility and equity of public parks: A case study using GIS. *Managing leisure*, 6(4), 201-219.
- O'Sullivan, S., & Morrall, J. (1996). Walking Distances to and from Light-Rail Transit Stations. *Transportation Research Record*, 1538(1), 19-26. doi: 10.1177/0361198196153800103
- Oh, K., & Jeong, S. (2007). Assessing the spatial distribution of urban parks using GIS. *Landscape and urban planning*, 82(1-2), 25-32.
- Pakistan, G. o. (2017). 6th Population & Housing Census 2017, from

- <https://www.pbs.gov.pk/content/final-results-census-2017>
- Reyes, M., Páez, A., & Morency, C. (2014). Walking accessibility to urban parks by children: A case study of Montreal. *Landscape and urban planning, 125*, 38-47.
- Talen, E., & Anselin, L. (1998). Assessing spatial equity: an evaluation of measures of accessibility to public playgrounds. *Environment and planning A, 30*(4), 595-613.
- Tsou, K.-W., Hung, Y.-T., & Chang, Y.-L. (2005). An accessibility-based integrated measure of relative spatial equity in urban public facilities. *Cities, 22*(6), 424-435.
- UN. (2015). Transforming our world : the 2030 Agenda for Sustainable Development.
- Unal, M., Uslu, C., & Cilek, A. (2016). GIS-based accessibility analysis for neighbourhood parks: the case of Cukurova district. *Journal of Digital Landscape Architecture, 1*, 46-56.
- Wang, D., Brown, G., & Liu, Y. (2015). The physical and non-physical factors that influence perceived access to urban parks. *Landscape and urban planning, 133*, 53-66.
- Yin, H., Kong, F., & Zong, Y. (2008). Evaluation of the accessibility and equity of urban green space. *Acta Ecol. Sin, 7*, 3375-3383.
- Zhu, Y. J. W., C.; Jia, B.Q.; Su, J. . (2011). GIS-based analysis of urban forest accessibility in Guangzhou City. *Acta Ecol. Sin., 8*, 2290-2300.