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EVALUATING ACCESSIBILITY OF PUBLIC PARKS THROUGH GIS: A CASE STUDY OF TANDO ALLAHYAR CITY

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ABSTRACT

This paper explores the accessibility of public urban parks within Tando Allahyar city boundaries. Parks are an essential part of urban green infrastructure, have many opportunities for residents' lives. Public park spatial equity is an integral indicator of preservation. Sustainable communities should, therefore, pursue equal access to public services and utilities for all their cohorts. Owing to the unequal spatial allocation of parks, the spatial disparity of citizens' access to parks must be assessed. The research location was split into four zones for better examination. We performed the closest neighbor study, facilities under and over coverage analysis, and network analysis. Using the GIS network analysis tool, this research studied pedestrian connectivity to Tando Allahyar urban parks and their subsequent serviceability. The study showed that the general public park service area found by network analysis was 1415933,61 sq.m, roughly one-third of the service area analyzed by traditional simple buffering approach 3925955 sq.m. The study results will help the researchers and other stakeholders understand using the GIS-based model for accessibility analysis of facilities and amenities within any city's municipality.

INTRODUCTION:

Easily accessible urban green spaces are a crucial aspect of sustainable urban planning. Moreover, urban green spaces promote social interaction and physical activity among inhabitants of urban areas. Therefore urban green spaces should be accessible to regular and optimum UGS use (Kshama Gupta et al., 2016). Urban green spaces (UGS) play a vital role in upgrading living conditions of urban areas through improving air quality, increasing property values and decreasing energy expenditures for cooling (Galeeva et al., 2014), and facilitating persons to recover from the physical and mental stress of daily life (Kshama Gupta et al., 2016). UGS also provides children with a desirable

playground (Amoly et al., 2014). According to Stahle and Alexander (2010), accessibility is one of the main factors promoting the regular use of urban green spaces and improving the health of its users, so all residential areas should have accessible urban green spaces to improve the quality of city life (VanHerzele and Wiedemann, 2003).

More than half of the world lives in urban areas (Oliveira et al., 2014). According to the united nation department of economics and social affairs (2018), it is estimated that the world's urban population can grow up to 68% by 2050. Furthermore, most urban areas in developing countries often face environmental degradation, increased pollution, higher temperatures, and decreased urban green spaces (Kshama Gupta et al., 2016). According to Venn and Niemela, 2004 urban green spaces are parks, gardens, recreational places, green spaces in institutions and industrial areas, greenery in historical places, greenery, and vegetation along the roadside and railway corridors (Kshama Gupta et al., 2016).

In urban planning, it is essential to know the demand of UGS according to area population, and in this way, urban planners can provide high living standards for all populations (Martina Artmann et al., 2017). UGS plays a vital role in sustaining the natural environment of urban areas and also enhancing social interaction. These areas are an essential bridge between man and nature, as they are the leading defenders of the urban natural environment (Chen Jiayu et al., 2015).

The frequent use of urban green space is characterized by its public accessibility (Schipperijn et al., 2010). Moreover, for estimating UGS accessibility for inhabitants of a city, the Geographical Information System (GIS) is a beneficial and powerful tool (Kshama Gupta et al., 2016). Using GIS makes it easy to set the connection and connect the route between different points in the land surface networks. ArcGIS, a GIS tool, allows the facility to find the nearest services' shortest route (Geo Chen v. 2015). It also provides convenience for mapping, analyzing, and creating spatial analysis rules (Kshama Gupta et al., 2016).

Following all these determinations, the report's starting point is that for pedestrian access, public parks must be situated within adequate travel distance. It must have sufficient scale to accommodate current populations. This research aimed to examine Tando Allahyar City's public park facilities' adequacy in terms of accessibility. This study also aims to define Tando Allahyar's views of park serviceability.

Literature review:

Historically it was recognized the importance of public green spaces in urban areas by planners in the 19th century (Isha. k, 2006). Urban green spaces improve city dwellers' living conditions by improving the environment and increasing property values (Galeeva et al., 2014) by providing physical and mental comfort to individuals. UGS also provides children with a desirable playground. Similarly, neighborhood parks and community parks allow people

to participate in multiple activities with their families, and city-level parks and landscapes provide the whole family with weekend recreational opportunities. Urban green spaces are just like a bridge that connects humans and nature because these spaces are the key elements of biodiversity in urban areas. These spaces may be used for urban areas as a comprehensive tool for sustainable development (Gupta,k. et al.,2016). In order to provide a high quality of life to all levels of the population, urban planners must know the demand for UGS from different population groups. First of all, the demand and use of UGS by seniors should be known through an integrative management approach to planning and designing the UGS (Martina A et al. 2017).

However, the uneven distribution and lack of accessibility to urban green spaces have been considered urban planning problems. Furthermore, in both developed and developing countries, the spatial disparity among the demand and supply of urban green spaces has been increasingly concerned. Access to urban green spaces is a crucial factor in measuring the disparity among the demand and supply of urban green spaces (Xing. Lijun et al., 2018).

Many studies have been done in developed countries on accessibility and evaluation of urban green spaces (Kshama Gupta et al., 2014). However, there is very little information about UGS in developing countries like Asia, Africa, and Latin America. Planners are also using the factor of accessibility to evaluate the availability of public services, i.e., parks, recreational, transportation, and health services at the neighborhood level (Isha. k, 2006).

There is a guideline in accessibility studies to find the nearest facility recommended by the world health organization (WHO). The guideline says that cities should provide a minimum area of 9 sq.m of green space per capita and ensure that every inhabitant of the city should live within 15 minutes of walk to reach an open space (Reyes. M et al. 2014). Furthermore, for estimating UGS accessibility for inhabitants of the city, Geographical Information System is a beneficial tool (Gupta,k. et al.,2016). With the help of GIS distance computation, connectivity and directional relationship between different points in a topographical network can be done quickly. ArcGIS, one of the GIS tools, provides a facility to find the shortest routes and closest facilities (Jiayu Chen. et al. 2015). The modeling for accessibility to green spaces has developed significantly due to the enhancement of geographical information system (GIS) features. In GIS, Euclidean buffer (radius method) and Network Analysis are two standard methods for accessibility analysis. Network analysis is a helpful tool for analyzing water distribution, flow streams, and traffic flows; centers, connections, nodes, and impedance are crucial elements in this analysis.

Materials and Methods

Study Area

For research purposes, Tando Allahyar City (District Tando Allahyar's only urban periphery) is chosen as the Sindh study location. Tando Allahyar is

Sindh's oldest city. It emerged as a tiny town, and the Kalhoro dynasty controlled this area from 1717 to 1783. During this time, several innovations formed the Tando Allahyar as a city. The total area of urban parks in Tando Allahyar city comprises 132680 m^2, which is 1.2 % of the city area. The same scenario is in most of the cities of Pakistan. Throughout the country, the range varies from 1-7% of parks in cities. While this statistic might sound good, large portions of the city's parks are clustered in peripheral areas such that daily viewing opportunities are comparatively limited. Such discrepancy in numbers and accessibility stems mainly from the parks' awkward place. The same problem of uneven allocation of public parks in the study field. Authorities do not have urban public parks, and the amount of public parks available is not adequate. Therefore, current parks cannot accommodate the city's entire population.

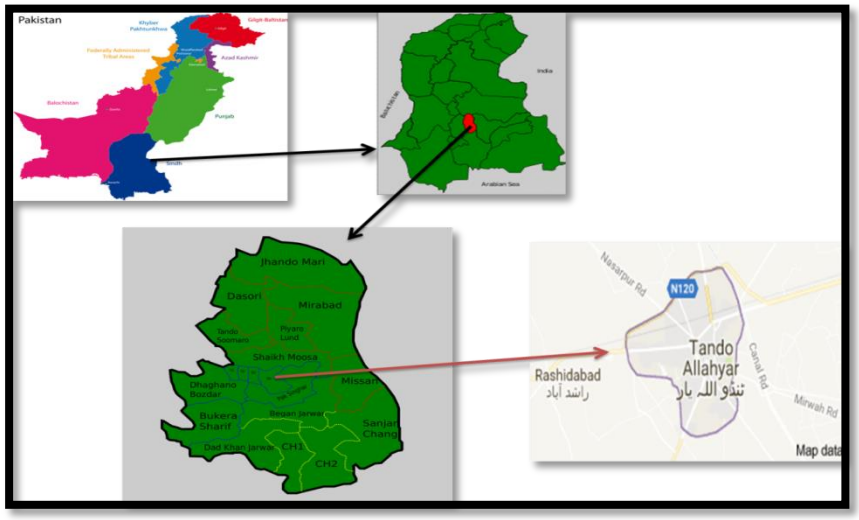

Figure 1: Show the map of the study area

Data Collection

In this study, the primary data sources were detailed site visits and surveys for identifying the different land uses and positions of public parks. The road network data also collected through a primary data source. For road network data, every street and road was visited. As for as the secondary data source is concerned, in this study, Google earth, pro, and USGS earth explorer were used as secondary data sources. Along with this, the interviews were also conducted with stakeholders and experts. The Google earth pro software and USGS earth explorer provided the study area's spatial data in this research. The spatial data included the study area's boundary, and delineation of different land uses within the study area, including streets and roads. Physical surveys and questionnaire surveys were conducted with 65 sample sizes to obtain data on public parks' physical condition in the selected study area, their accessibility to visitors, and their use.

Furthermore, the data collected from the municipality was used to complement this material. Continuous digital imaging was used to document the physical state of parks and perform park use surveys. Facilities and problems on traffic

network systems in and around public parks in the selected areas, parking access near public parks, the quality and availability of pedestrian access, the public transit system serving the selected areas, and the local land use were all examined the physical surveys.

Data Analysis

The collected data through field visits and physical surveys were analyzed in ArcGIS and SPSS. In ArcGIS for accessibility analysis, Network analysis and buffer analysis were used to analysis of accessibility parks. Furthermore, collected data from residents about their perception were analyzed in SPPS and presented in simple frequency distribution analysis. The service area of public parks under this method was generated so that each park's entrance points were considered the facility to start the journey. From that point in all directions, service areas 800m and 300m for the city parks were calculated using the buffer and network analysis. In this way, GIS calculated the service area from starting point to all directions by following the street network.

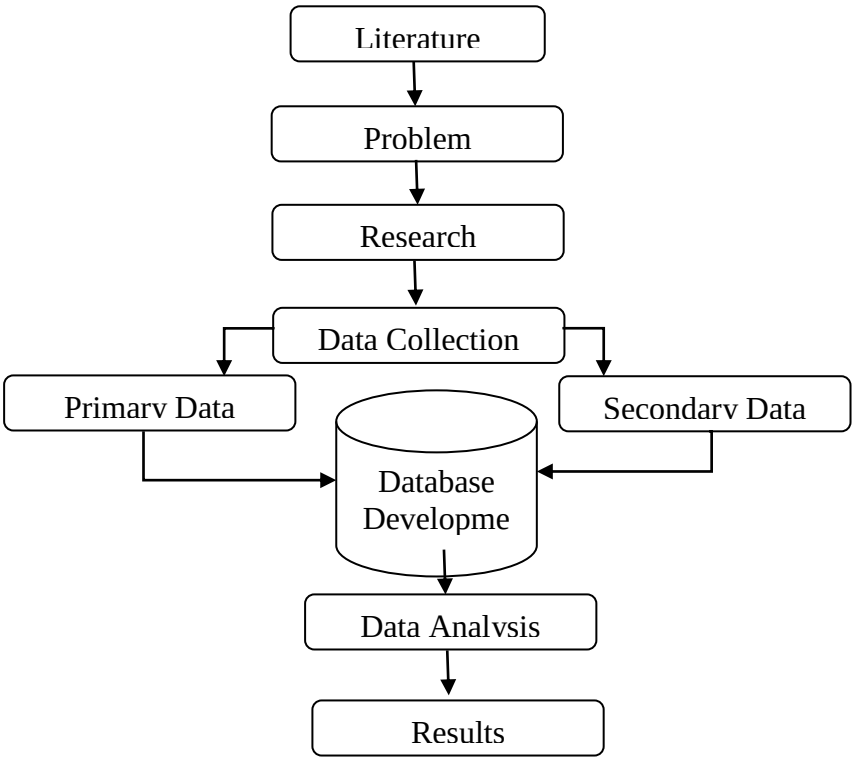

Figure 2: Research Process Flow Chart

Results and Discussion

Perception of inhabitants towards accessibility of Parks

The perception of residents was identified in the study area through a questionnaire survey. In this survey, 64.2% of male respondents participated, and only 35.8% were female participants, which can be seen in table 1

Table 1: Frequency and Percentage of Gender

Gender	Percentage (%)
Male	64.2
Female	35.8
Total	100.0

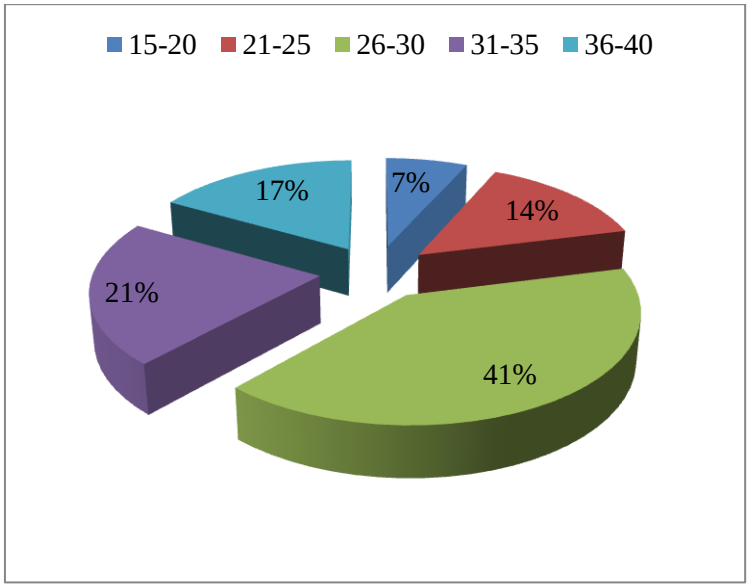

Figure 3: Frequency and Percentage of Gender

The frequency and age ratio of the respondents are shown in Figure 3. The age of respondents is based on the age of young people 15 and over. Regarding the pie chart, with a proportion of 27.5 percent, most respondents are between the ages of 26-30 years. Meanwhile, 25.6% of participants are between the ages of 26 and 30. At 22.5 percent, the respondents were between 31 and 35 years old. Participants increased by 17.6 percent from 36 to 40 years old. Finally, from 15 to 20 years of age, only 6.8 percent of respondents participated in this research.

The income levels of the respondents are shown in Table 4 and Figure 6. The income of respondents is based on the average income of people. Regarding the pie map, with a proportion of 49 percent, most respondents are between the income level of 20000-30000 rupees.

General Facilities

The question regarding the facilities at the parks of the study area was asked from the respondents. Figure 4 illustrates the results of collected data from the residents regarding the general facilities in the parks of Tando Allahyar. The results elaborate that there is a high need for a canteen under the general facilities category in the study area's public parks.

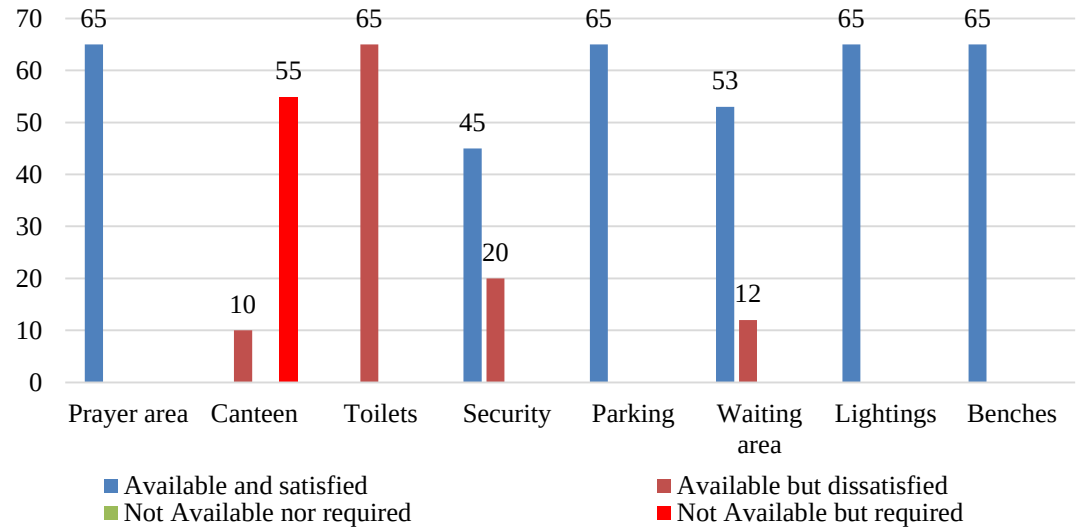

Figure 4: General facilities at Public Parks

Park Appearance

The park appearance question was asked from the respondents, and the results are presented in figure 5. The results demonstrate that the condition of parks in the study area is in the worst condition, and all the appearance factors are not available and required at its best the lake and pond, which is not required at the parks of the study area, the factors for this question selected as trees, greenery, fountains, lake, and monuments.

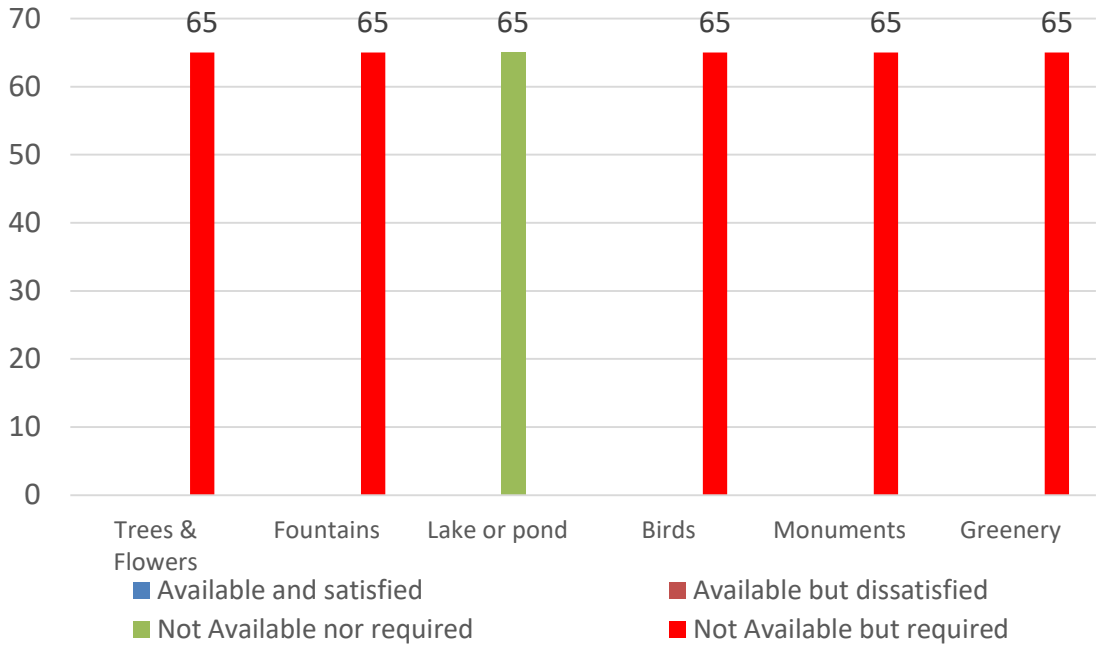

Figure 5: Park appearance at Public Parks

Availability of Passive facilities

The question regarding the passive activities was asked from the questionnaire survey respondents; the collected data results are presented in figure 6. The results illustrate that the study area parks do not match the standards and lack inactive facilities. Furthermore, results depict that the sitting and relaxing facilities are most demanding in the study area's public parks.

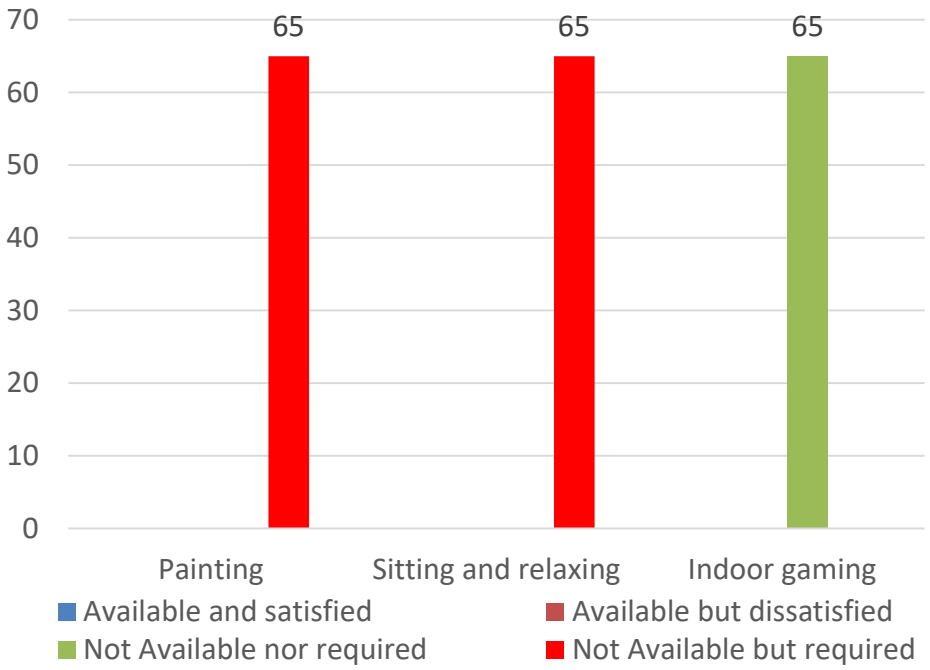

Figure 6: Passive facilities at Public Parks

.Availability of Active facilities

The availability of active facilities in the public parks of the study area is missing. The collected data analysis identified it through a questionnaire survey depicting that all the active facilities are available and required a priority basis. The required active facilities are a gymnasium, jogging track, swimming, and cycling; these facilities are the key for health exercises once their availability in the study area's public parks. The results can be seen in figure 7.

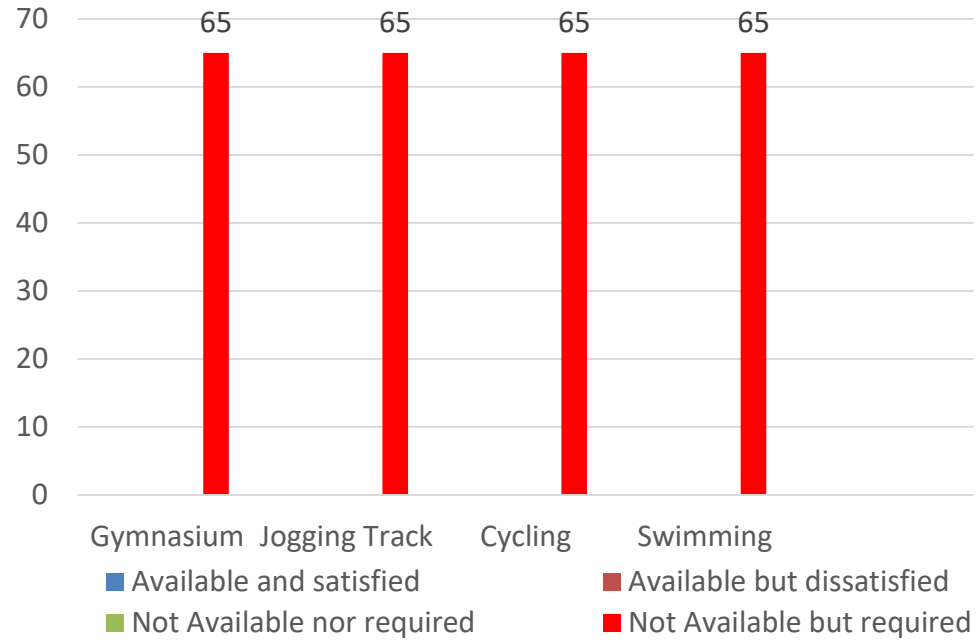

Figure 7: Active facilities at Public Parks

Accessibility of Public Parks through GIS

There are different land uses available in the study area, all common to every Pakistan city almost. Residential, Commercial, and Agricultural lands are dominant in the study area. Out of these land uses except residential land use, the dominant land use is Agricultural land use (unfortunately, it is converting to buildup). Then comes residential land use and then vacant lands. The mixed land use is also there, such as residential cum commercial and commercial cum residential.

The residential land use or built-up area comprises 51%, Agricultural land use comprises 39%, and Vacant land comprises 6.5% of the whole study area. The detailed land use/land cover map of the urban boundary of city Tando Allahyar is shown in figure 8. Furthermore, the study area is divided into four areas by the research team to assess the availability and

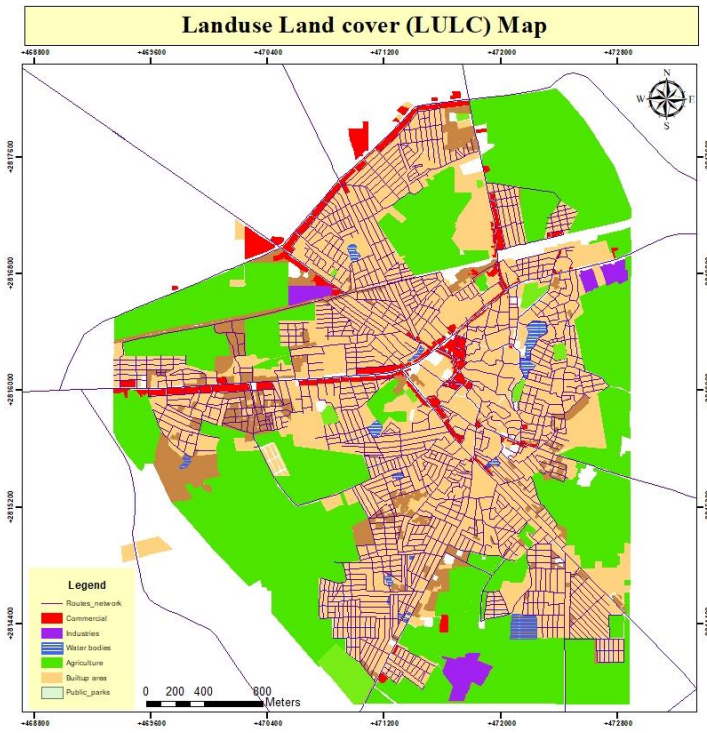

Figure 8: Detailed Land Use map of Study Area

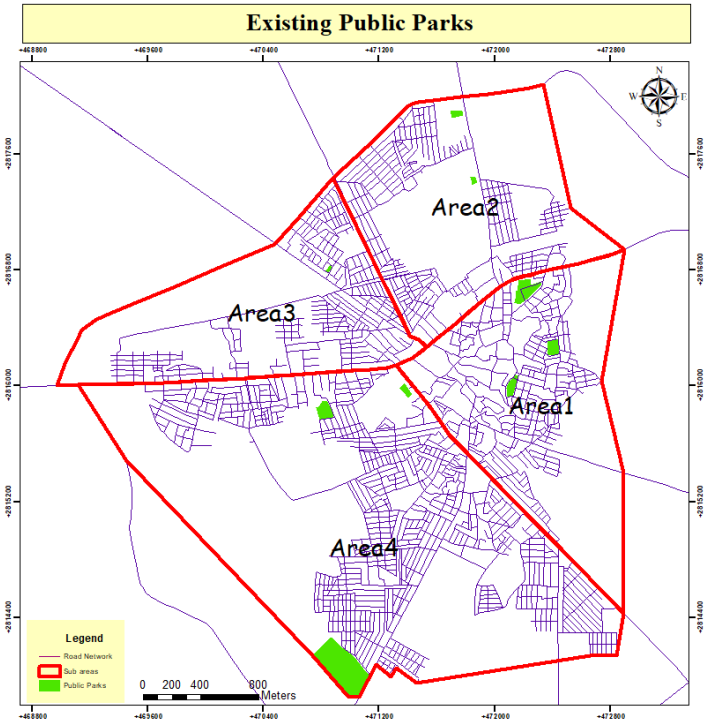

Figure 9: Location map of existing public parks w.r.t Sub-study area

Service area analysis

Comparison between simple buffering and network analyses of the service area of Public Parks in Tando Allahyar City.

The simple buffering approach was used to calculate service areas within an 800 m linear distance from parks (Fig. 10). The service area is 3925955 square meters or 35% of the total study area. In Tando Allahyar, the number and locations of urban parks are deemed adequate. However, when it comes to pedestrian accessibility, roads are far from straight. As a result, more time is spent getting to the parks than if linear routes were available and could be used.

The network analysis tool was used to evaluate public parks' service areas, including Community parks, natural parks, and other parks (Fig. 11). The City park's service area, measured using the NAM equation, is 1415933.61 sq.m. This represents 12% of the study area, and the buffering approach with a 300 m threshold was used to estimate approximately half of the service area. These findings can be interpreted as a disparity in thresholds. However, whether or not to include the inaccessible areas in the measured coverage areas decided by simple buffering and network analysis is the most critical issue. While pedestrian road networks define access routes in network analysis, the simple buffering approach involves areas inaccessible in practice.

CONCLUSIONS

Cities are places where many people and activities locate close together. Social events, leisure activities, and stress reduction are all possible in public parks. In urban areas, public parks and open spaces serve several purposes. This study focused on assessing the accessibility to green spaces in Tando Allahyar city, which comprises the only urban periphery due to shortage of time and spatial data size.

According to studies, some factors, such as safety and the availability of active and passive facilities, are causing people to stop using public parks. However, study findings may help concerned authorities and stakeholders create standards and understanding. They may provide planners with valuable resources to optimize the delivery of parks and green spaces and shift towards a sustainable climate that is safe and balanced.

Besides, this study used GIS analysis to determine the degree of serviceability of urban parks using the equity principle, with the evaluation process focusing on park distribution. The fundamental problems were the number of visitors to urban parks and the amount of land they serve. GIS network analyses were used to determine the distribution of urban parks in population density in suburban areas, land usage, and construction density. The following outcomes were achieved: First, using the simple buffering technique, network analysis covered roughly half of the parks' service area. This is because actual pedestrian travel routes are indirect and therefore cover a smaller area.

Second, unlike statistical indices that have been historically used, the urban

park service indices, i.e. service area ratio, service population ratio, and service floor area ratio, were especially useful in assessing public parks' distribution and the volume of patronage due to accessibility.

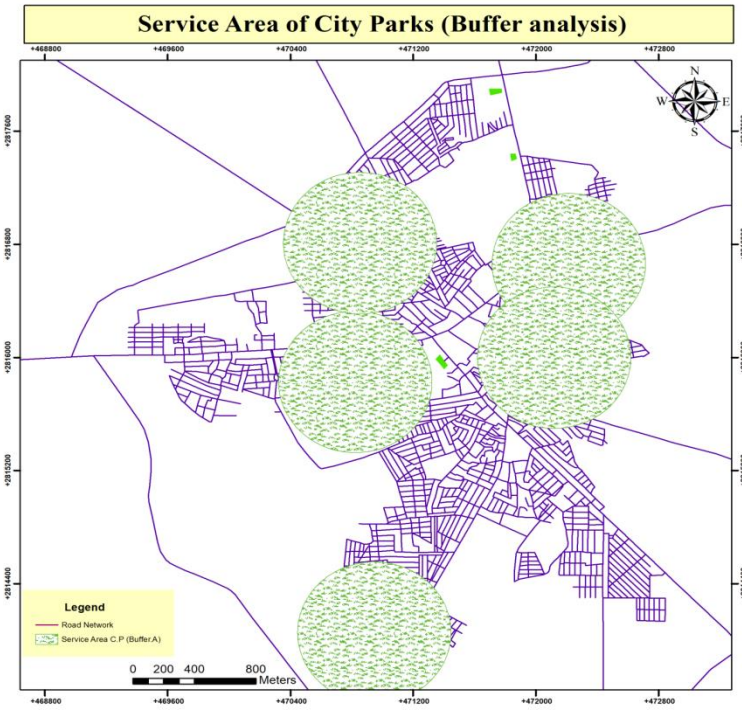

Figure 10: Service area of City parks (Euclidean method)

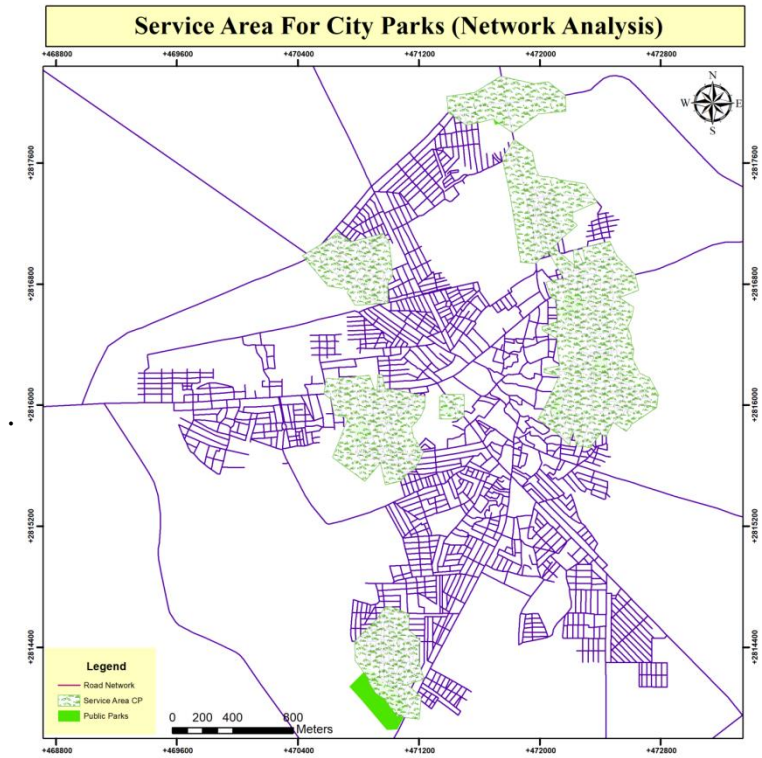

Figure 11: Service area of Neighborhood parks (NAM method)

RECOMMENDATIONS

As it was found that people are willing to use public parks, but due to some factors, they are not using public parks, so it is suggested that any public authority should understand that access to essential public services is a fundamental right for every human being. A planner should always try to promote growth and settlement patterns that prioritize increasing access between humans, their places of work, and the services they require. Precisely following recommendations are generated;

Ensure public parks are reasonably proximate to residential locations with particular attention to population segments with less mobility.

Provide footpath amenities such as shade and lighting to encourage walking and cycling.

Provide opportunities to develop and sustain an inclusive community culture.

Organize programs and events that capture residents' shared interests in activities.

Spatial equity of public services distribution is analyzed and incorporated into public decision-making.

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