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A MICRO-LEVEL AN ALYSIS: SPATIAL DISTRIBUTION OF URBAN PARKS AND QUALITY OF LIFE CONCERNS - A CASE STUDY OF GULSHAN TOWN

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ABSTRACT

Urban parks are essential for sustainable urban living, offering spaces that integrate nature with the built environment, while fostering social interaction, physical activity, and emotional well-being. This study examines the spatial distribution and availability of urban parks in Gulshan Town, Karachi, against the backdrop of rapid urbanization and population growth. Employing Geographic Information System (GIS) tools such as ArcGIS 10.8 and Google Earth Engine (GEE), the research maps green space per capita and evaluates it against international standards, including those proposed by the World Health Organization (WHO).

The findings reveal a significant shortage of accessible green spaces relative to the population, alongside notable spatial disparities influenced by socio-economic factors. These results underscore the inequitable allocation of urban parks and their broader implications for residents' quality of life. By offering a detailed analysis of park distribution and accessibility, this study provides critical insights into urban green space planning and recommends for evidence-driven policies to ensure equitable and sustainable urban development.

Keywords: Urban parks, spatial analysis, ArcGIS, proxbilty, accessibility, urban green spaces.

INTRODUCTION

Cities are complex ecosystems that depend on the integration of natural systems, such as urban green spaces, which serve as essential contributors by providing public amenities and supporting both mental and physical recreation, ultimately enhancing urban quality of life (Kendal, D., et. al., 2016). Cities of developing countries with well distributed parks is a worldwide imperative to improve the well-being of both present and forthcoming generations. Urban green spaces assume a pivotal role in delivering cultural ecosystems services within cities.

As urbanization continues to increase, it has become essential to prioritize green spaces within urban design to maintain population health, reduce pollution and quality of life. The environmental, social, and economic benefits of urban green spaces are crucial in achieving sustainable and livable urban environments in cities (Claudiu Cicea and Corina Pîrlogea, 2011; Gozalo et al., 2018; Littke, 2016).

While macro-level research highlights the broad benefits of green spaces, there is a critical gap at the micro level, particularly in assessing how well these spaces meet the needs of local residents. (CBE, Shehri).

The presence of accessible and inviting green spaces is a vital factor in shaping the welfare of urban areas (Unal, et al, 2016), as their proximity to neighborhoods has a key role in increasing quality of living conditions in cities (Ozkan, 2019; Cicea, Pîrlogea, 2011). Proximity to green spaces enhances the quality of life within neighborhoods, as

evidenced in various studies (Ozkan, 2019; Cicea & Pîrlogea, 2011). However, bridging this global understanding with local insights requires standards that help gauge park accessibility and distribution.

In this context, standards provided by organizations like the World Health Organization (WHO) - suggest a minimum of 9 square meters of green space per person within a 300-meter radius—offer an unbiased benchmark for creating equitable, sustainable urban environments (UN-Habitat, 2013; Alam, et. al, 2014; Abdulraheem et. al, 2022). Yet, the availability of parks within a walkable distance is equally critical in maximizing the benefits these spaces offer. Urban green spaces, particularly locality parks, offer urban residents convenient access to nature within their community (Pubaszek, S. 2023). These open areas, featuring trees, grass, playing fields, and playgrounds, serve as primary accessible nature oriented spaces, especially in densely populated areas. This study addresses this gap by analyzing the spatial distribution and tangible availability of park space per person in each Union Council (UC) of Gulshan Town using GIS buffer analysis. This approach helps identify areas where green spaces are insufficient and demonstrates how GIS can be used to analyze spatial distribution and make informed decisions for targeted interventions. By focusing on both the quantity and distribution of green spaces, this research emphasizes the importance of strategic planning to ensure equitable access and availability for all residents.

"The measure of any great civilization is its cities and a measure of city's greatness is to be found in the quality of its public spaces, and its parks and squares"-John Ruskin

What is Urban Green Space?

The meaning of green space in urban areas has been a topic of debate, and there is no agreed-upon definition that applies universally. Each developed country has its own definition of what constitutes urban green spaces, as noted by Byomkesh et. al, (2012).

Urban Green [s] are green space[s] located in urban areas mainly covered by vegetation, which are directly used for active or passive recreation, or indirectly used by virtue of their positive influence on the urban environment, accessible to citizens, serving the diverse needs of citizens and thus enhancing the quality of life in cities or urban regions (URGE, 2004).

The importance of these spaces for promoting sustainable, healthy, and livable urban environments is highlighted by the definitions of urban green space provided by renowned institutions. While the definitions vary slightly in their wording and focus, they share a common understanding of green space in urban areas referring to patches of flora (vegetation) and trees in cities that offer a variety of advantages, including environmental, social, and economic benefits. They all agree that the value of urban green space is in providing opportunities for outdoor recreation, improving water quality and clean air, supporting biodiversity, reducing the urban heat island effect, and contributing to the overall quality of life of urban residents.

The Relevance of Urban Green Space and QoL

With 68% of the world's population expected to live in cities by 2050 (United Nations, 2018), it is imperative that public administrations and urban planners design livable, health-promoting environments with guaranteed access to green spaces (Reyes-Riveros, et. al, 2021).

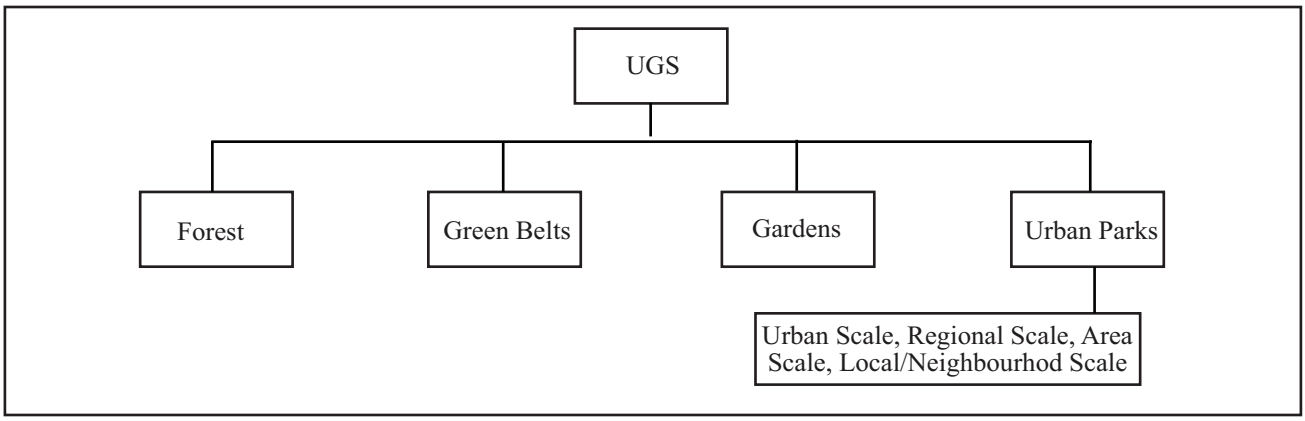

Figure-1: Classification of Urban Green Spaces (Kiani et al. 2014;Depanshi,2019).

Table-1: Definitions of UGS by Renowned Institutes.

Institution	Year	Definition
WHO(Brief for action)	2017	All urban land covered by vegetation of any kind. This covers vegetation on private and public grounds, irrespective of size and function, and can also include small water bodies such as ponds, lakes or streams (“blue spaces”)
WHO (Urban Green Spaces and Health: A Review of Evidence. Geneva)	2016	"Urban green spaces refer to land that is partly or completely covered with grass, trees, shrubs, or other vegetation, and that is open to the public for recreational or other purposes in an urban area."
European Environment Agency (EEA) Urban Sprawl in Europe: The Ignored Challenge. Copenhagen	2011	"Urban green spaces refer to all areas within or adjacent to urban areas, from public parks and gardens to street trees and green roofs, that are covered by vegetation and accessible to the public."
International Union for Conservation of Nature (IUCN) (Nature Based Solution to Address Global Societal Challenges)	2019	Urban green spaces are defined as green areas within urban areas that provide important ecological and social functions, such as habitat for wildlife, carbon sequestration, and opportunities for recreation and education.
The United Nations Development Programme (UNDP) UGS: A Guide for Sustainable Development in Africa. Nairobi	2014	"Urban green spaces are defined as areas of land within urban areas that are dedicated to preserving and enhancing the natural environment, providing opportunities for recreation, and contributing to the overall quality of life of urban residents."
The United States Environmental Protection Agency (EPA)	2020	"Urban green spaces refer to areas of vegetation and other greenery within urbanized areas, such as parks, gardens, green roofs, and street trees. They help to reduce the urban heat island effect, improve air and water quality, and provide social and recreational benefits."
International Federation of Parks and Recreation Administration (IFPRA)	2016	Urban green spaces are areas of land that are dedicated to the enjoyment and benefit of all members of the community. They may include parks, playgrounds, gardens, natural areas, and other green spaces that provide opportunities for active and passive recreation, social interaction, and relaxation.

Urban green spaces (UGS) are critical to addressing the ecological and social challenges posed by rapid urbanization, including urban sprawl, pollution, and biodiversity loss. Often referred to as the "lungs" of cities, they play a vital role in mitigating urban heat islands, improving air quality, conserving biodiversity, and reducing energy usage. Furthermore, their ability to enhance urban resilience by buffering cities against environmental shocks underscores their significance in creating sustainable, livable urban ecosystems. The United Nations emphasizes the importance of accessible green spaces as a core element of the 11th Sustainable Development Goal (SDG 11), which seeks to establish urban areas that are inclusive, safe, resilient, and sustainable. Worldwide, sustainable cities demonstrate a commitment to social and environmental equity by ensuring that all individuals, irrespective of race, age, gender, or religion, have equal access to urban green spaces. This emphasis on inclusivity is fundamental to building urban settings that enhance public health, social connections, and overall well-being (Abdulraheem et al., 2022; Chen, et. al, 2022; United Nations, 2016; Kendal, et. al, 2016). In addition to SDG 11, UGS also contribute to other Sustainable Development Goals, such as promoting health and well-being (SDG 3) and combating land degradation (SDG 15).

Building on this understanding, urban parks, particularly neighborhood parks, play a vital role in enhancing urban sustainability. Situated within residential areas and designed

to be accessible on foot, these parks serve as essential open spaces offering significant social, ecological, and economic benefits. They provide recreational areas, strengthen community bonds, and foster social harmony by encouraging communication among residents. In doing so, neighborhood parks not only support environmental health and livable urban environments but also contribute to a more cohesive and interactive society (Kiani et. al, 2014; Ozkan, 2019).

Connecting Urban Green Spaces to Quality of Life (QoL)

Quality of Life (QoL) is a complex and multi-dimensional concept that reflects the overall well-being of individuals, shaped by various physical, mental, social, and emotional factors. Scholars have offered diverse interpretations of QoL, emphasizing its subjective nature and dependence on individual perceptions (Kiani et. al, 2014; Mensah, et. al, 2016; Gouveia et al., 2019). According to the World Health Organization (WHO), QoL is defined as "an individual's perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards, and concerns" (WHOQOL Group, 1995). This definition highlights the interconnected role of cultural, social, and environmental contexts in shaping individual well-being. Meeberg, (1993) further elaborates on QoL as an "acceptable state of physical, mental, social, and emotional health," emphasizing its deeply personal nature and the need to address diverse aspects of well-being to enhance individuals' quality of life.

This understanding of QoL directly links to the role of green spaces in urban environments. The United Nations underscores the significance of quality of life as a cornerstone of sustainable development, integrating it into the Sustainable Development Goals (SDGs). This global framework addresses interconnected social, economic, and environmental challenges such as poverty, health, education, and ecological sustainability, all of which directly impact QoL. By prioritizing equitable access to basic services, ecological resilience, safety, and opportunities for leisure and cultural engagement, the SDGs aim to foster urban environments that promote well-being and inclusivity for all individuals. Notably, SDG 3 (Good Health and Well-being), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 15 (Life on Land) emphasize the critical role of urban green spaces in enhancing quality of life (United Nations, 2016; Gouveia et al., 2019).

Urban parks and open spaces are crucial for improving the quality of life for all urban residents (WHO, 2017, Hanson, 2017). Urban parks provide sizable natural areas for wandering and admiring, giving people a chance to get away from the hustle and bustle of city life and take a moment for themselves. This aids in lessening feelings of congestion and confined spaces. Parks, gardens, street trees, riversides, and private backyards contribute to physical activity, social events, mental relaxation, and stress relief, all of which are vital for a high quality of life in cities (Kwon et al., 2021).

For guaranteeing individuals' standards of life, cities must have readily available, beautiful green destinations. The interconnection between human habitation, work environments, and the sustainability of urban progress is inherently tied to this phenomenon in cities. This issue has gained significant attention in recent years as it has become an integral factor in ensuring urban life quality (Unal, et. al, 2016; Yang, 2013).

In terms of the specific effects and advantages of green spaces on the quality of civic life, numerous studies have shown that these effects are significant, widely acknowledged, and steadily increasing in documentation. UGS provide opportunities to improve health in urban settings in the following ways:

Physical well-being: This is attained through exercise and access to nature.

Mental well-being: Green areas help people feel better mentally by lowering stress and boosting concentration.

Social well-being: Achieved through involvement, community engagement, and participation (Yang, 2013; Rao, 2021).

Urban parks create cool islands, enhance air circulation, and mitigate the warming effects of impermeable surfaces. Through shading and evapotranspiration, vegetation reduces air temperatures, improves thermal comfort, and lowers energy consumption for cooling (Spangenberg et al., 2008). Research by Chang, et. al, (2007) and highlights the cooling intensity of parks, demonstrating their significant role in moderating urban temperatures and enhancing pedestrian comfort. Additionally, the distribution of green space within neighborhoods is key to lowering Land Surface Temperature (LST), with the cooling effects varying across different green patches (Qi et al., 2024). Urban parks also provide social opportunities and help develop social ties within local communities (Teimouri et. al, 2019; Rakhshandehroo et. al, 2015).

Nature can encourage outdoor recreation, neighborliness, social integration, and crime reduction. According to studies, people who live in areas with greenery and open spaces are more likely to forge better social ties than those who have no access to breathing spaces other than concrete (Duygu and Fatmau, 2014). By fostering positive social interactions and community connections, urban parks play a vital role in enhancing the quality of life for city residents (Mensah, C. A., et. al, 2016). To meet citizens' needs effectively, these green spaces (parks) should be easily accessible and of optimal quality and quantity (Haq, Mohammad 2011).

Availability of Green Space per Person

The World Health Organization (WHO) recommends a standard indicator measure of 9m^2 of UGS per person and an ideal UGS value of 50m^2 per capita, along with a proximity measure of 300m or a 5-minute walk. These standards serve as benchmarks for planning institutions worldwide responsible for green space planning in urban areas. However, the size of UGS varies across different countries, with some countries like Belgium, Germany, and Australia having UGS that are nearly 200m^2, while in Spain, Macedonia, and some southern cities of Italy, the UGS size is around 4m^2. In Turkey, the UGS per person varies between 1 and 9m^2. According to the Siemens Green City report, Singapore is a prime example of effective spatial planning since it successfully combines a dense population with lots of green space (Bagherian, 015). Despite land scarcity issues in some cities, guaranteed adequate amounts of urban green space, the standards method is still a vital component of city planning and policy. (Maryanti et al., 2016).

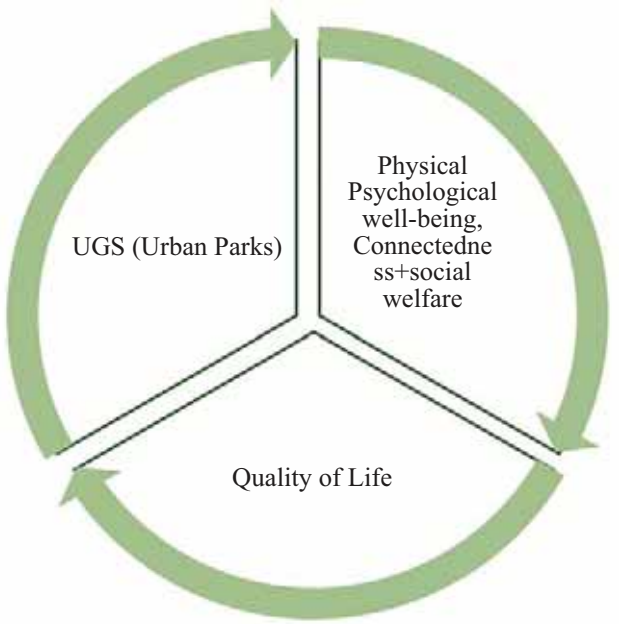

Figure-2: Conceptualized Relationship Between Urban Parks and Quality of Life (Kitheka et al., 2018).

People in densely populated cities who lack access to private gardens frequently rely on local parks for green space. High population density, on the other hand, can result in less green space per person (Rayman, J. S., and Goodies, M., 2020)

Table-2: The Implementation of Urban Green Space Standards in Various Cities.

S. No.	Cities	Size (hectares)	Population	M^2/Person
1.	Greater London	4	1000 Residents	40
2.	Edinburgh	2.9	1000 Residents	29
3.	Cambridge	4.6	1000 Residents	46
4.	Washington	3.8	1000 Residents	38
5.	Minneapolis	2	1000 Residents	20
6.	Los Angeles	4.85	1000 Residents	48.5
7.	Kansas City	3.64	1000 Residents	36.4
8.	Bristol	1.0	1000 Residents	10
9.	India	0.8	1000 Residents	8
10.	Pakistan	0.52	1000 Residents	5.2

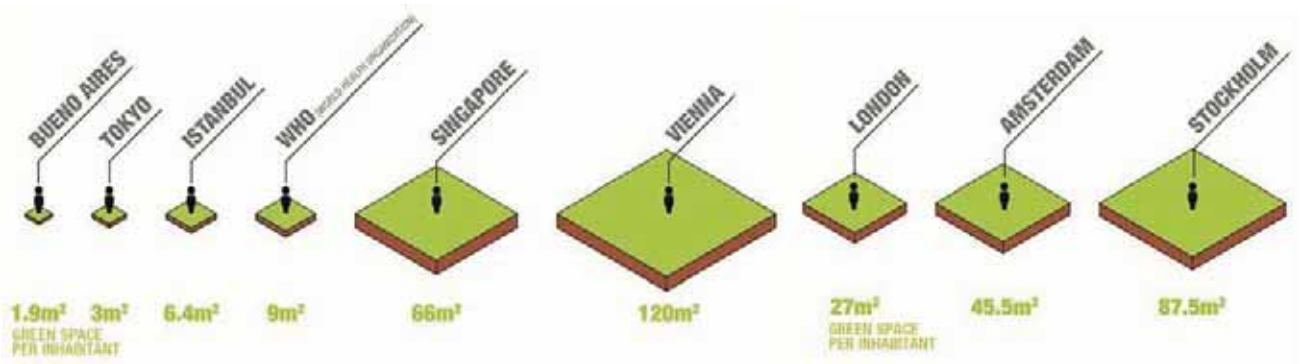

Figure-3: Showing Green Space per Inhabitant in Cities Around the World (Bagherian, 2015).

so, every city should endeavor to provide an abundance of urban green space that goes beyond what is the basically required for improved citizen quality of life.

LOCAL CONTEXT

The City Karachi

Karachi, Pakistan's largest metropolis and the third-largest city globally (Zia, et. al, 2022), serves as the nation's economic and cultural hub. According to the 2017 Population Census, the city has a population exceeding 15 million, accounting for one-third of Sindh's population and one-fifth of Pakistan's urban population (World Bank, 2018). Unofficial sources suggest the actual population may be significantly higher. With a population density of 4,543 individuals per square kilometer over 3,527 square kilometers, Karachi faces immense challenges in urban sustainability.

Rapid population growth, coupled with unregulated commercial development, has significantly contributed to the loss of green spaces in Karachi, which now account for only 4% of the city's built-up area (Ah and Soh, 2020). Weak urban planning policies and the prioritization of construction over environmental preservation have further exacerbated this trend. Karachi's green infrastructure has undergone a significant decline, with research by the Karachi Urban Lab revealing a 40% reduction in the city's intermediate green cover over the 22-year period leading up to 2021. This trend reflects the rapid urban expansion and insufficient prioritization of green spaces, exacerbating environmental challenges such as urban heat islands, biodiversity loss, and deteriorating air quality (Mazhar, Abbas and Zain, 2024).

The environmental management of urban parks has been identified as a potential strategy to enhance livability and mitigate the adverse effects of diminishing green spaces in densely populated areas (Syed S., et. al, 2024). The COVID-19 pandemic underscored the critical role of accessible green spaces in supporting public well-being and enabling social distancing during public health emergencies.

While Karachi is estimated to host between 1,100 and 1,600 parks, discrepancies in official data hinder comprehensive planning. The Government of Pakistan's 2000 report and studies by Qureshi S., et. al, (2010) and Schetke S., et. al, (2016) identified approximately 1,230 nature spaces, including formal and informal parks. However, these numbers remain insufficient to meet the needs of a growing population (Khan G., 2019).

Study Area: Gulshan Town, District East

Gulshan Town, located in District East of Karachi, spans 55 square kilometers and has a population of 1.55 million, distributed across 15 Union Councils (Figure 4). It is one of Karachi's largest towns, characterized by mixed land use, including residential, commercial, and industrial zones, along with relatively higher green space coverage compared to other towns (KSDP, 2020). Notable parks include Aziz Bhatti Park, Safari Park, and Bagh-e-Karachi.

Urban growth in Gulshan Town reached 70% between 2005 and 2017, driven by rapid urbanization and population increases. This has intensified spatial disparities in green space availability and accessibility. The town's geographic coordinates are N 24° 55.244' E 67° 5.2897'. Gulshan Town, like many areas of Karachi, faces challenges related to green space availability. While relatively higher green space coverage exists compared to other towns, the increasing population density and urban sprawl highlight potential disparities in access and allocation. (Kiani et al., 2014; abdulraheem, et. al, 2022; Pouya, and Aghlmand, 2022).

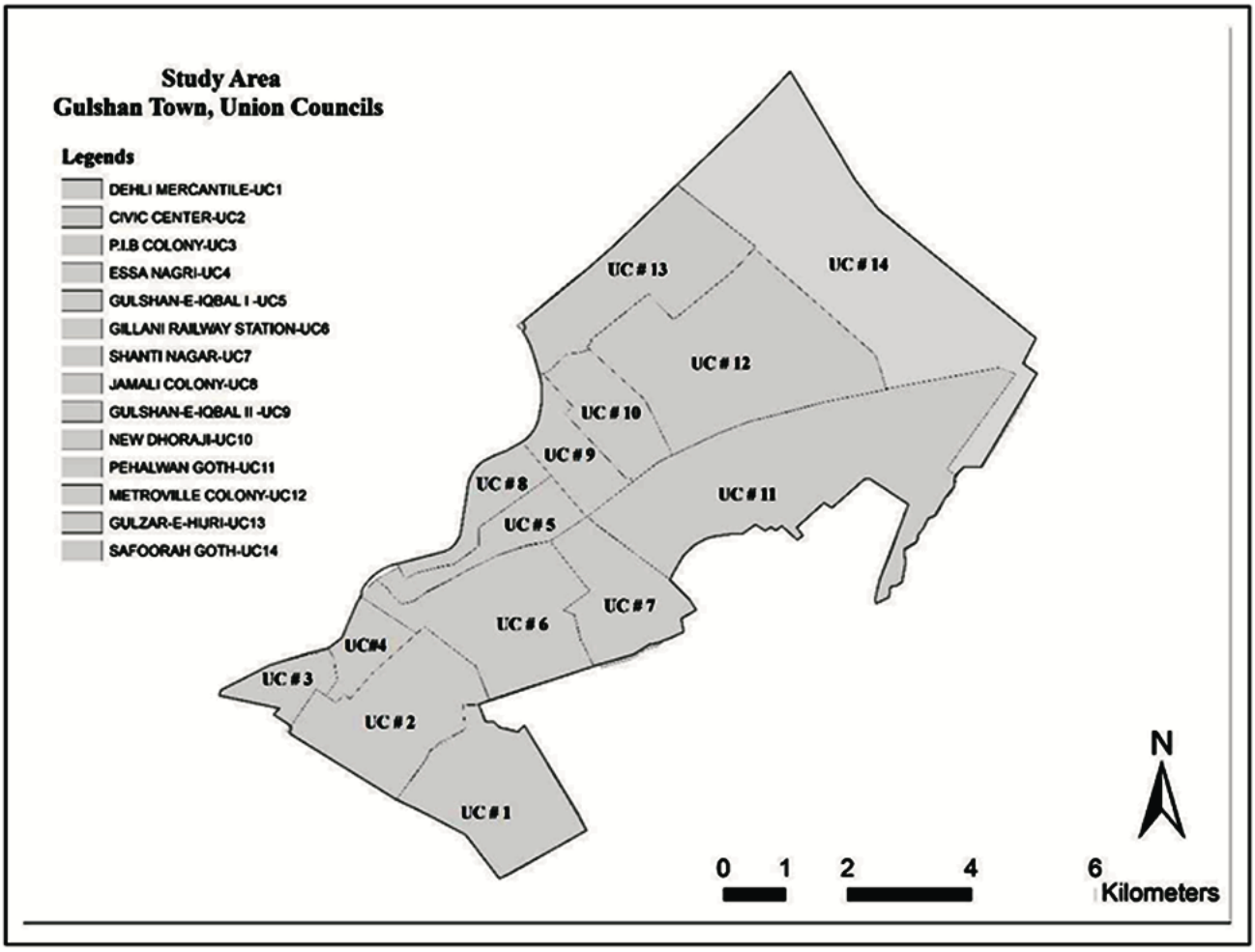

Figure-4: Showing the Union Councils of Gulshan Town.

RESEARCHMETHOD

To define the extent of the study area, the population per neighborhood based on the census data of 2017, as well as micro-scale data about neighborhoods like boundaries (Almohamad, et. al, 2018) of the Union council, list of public parks of all hierarchic levels (City parks, neighborhood parks and pocket parks) were collected from the relevant departments responsible for the management of green areas in Karachi, namely District Municipal Corporation (DMC) East, Karachi Development Authority (KDA), and Karachi Municipal Corporation (KMC). These departments were approached to obtain comprehensive and reliable information pertaining to the study. The subsequent phase entails scrutinizing satellite imagery to pinpoint green spaces within the urban terrain that could potentially be absent from the existing data files. The research employed Geographic Information System (GIS) with a buffer zone approach and Google Earth Engine (GEE) as the main tools for formalizing the secondary data for primary research of urban parks distribution pattern and their availability. Utilizing satellite imagery from Google Earth Engine, GIS tools and techniques were employed to map the overall public parks in Gulshan Town listed or not listed. The mapping process aims to identify the overall pattern of green space distribution and assess the equitable allocation of these spaces throughout Gulshan Town. International guidelines suggest an average of 30 m² of green space per resident, with a range of 15-50 square meters, while the United Nations recommends 20-25 square meters per capita (Kiani, et. al, 2014). The World Health Organization (WHO) recommends 9 m² of urban green space (UGS) per individual, with a target of 50m^2 (Abdulraheem, et. al, 2022; Pouya, and Aghlmand, 2022). These standards were used as benchmarks for evaluating green space availability and allocation in Gulshan Town, providing guidelines for urban planning and promoting the well-being of residents.

Table-3: Population Density and Green Space Availability Analysis.

UC #	Name	UC Population	Population Density (km2)	Total Area Parks (m2)	Green Space Per Capita (m2)
UC12	Dehli Merchantile	110818	27704.5	38805	0.35
UC18	Civic Center	144606	36151.5	52122	0.36
UC19	PIB Colony	85835	85835	0	0
UC20	Essa Nagri	132729	132729	0	0
UC21	Gushan-e-Iqbal I	94892	47466	31853	0.33
UC22	Gilani Railway Station	131408	32852	52054	0.39
UC23	Shanti Nagar	99555	33185	33401.5	0.33
UC24	Jamali Colony	110,639	110639	13844	0.12
UC25	Gushan-e-Iqbal II	97020	97020	18299	0.18
UC26	New Dhoraji	36490	18245	37477	1.02
UC27	Pehlwan Goth	132717	13271.7	374264	2.8
UC28	Metrovil Colony	148849	21264.1	11056	0.07
UC29	Gulzar-e-Hijri	95959	23989.8	31810	0.33
UC30	Safora Goth	96911	8810	86605	0.89

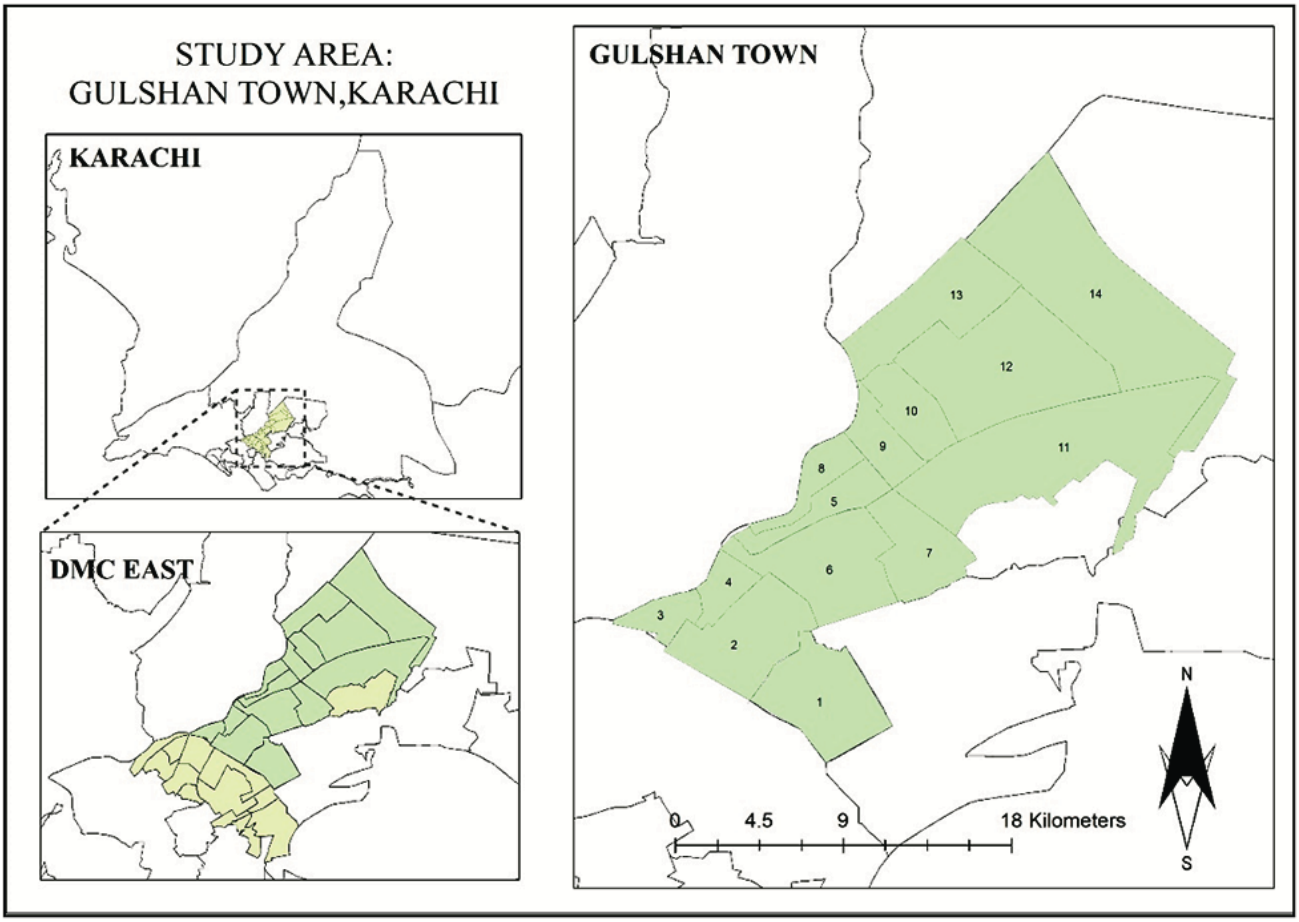

Figure-5: Study Area Map, Gulshan Town in DMC East, Karachi.

The mapping process was carried out on ArcGIS 10.8 to assess the availability of greenery per resident in Gulshan Town. Primary research included several key steps: the acquisition of urban parks data, which included park location, size, and type within each Union Council (UC) of the town. This mapping data was used to calculate the total green space area in each UC. Using the 2017 census population data (DMC East, PBS 2017), the amount of green space per inhabitant was calculated by dividing each UC's total park area by its corresponding population. Furthermore, a detailed analysis was conducted using ArcGIS person for each UC and compares with the minimum standard set by WHO for green space per capita. This comprehensive analysis provided detailed insights into the distribution, inequality, and accessibility of green spaces across different socio-economic strata and building typologies within Gulshan Town. The details of population and green space availability are in table-3.

RESULTS AND ANALYSIS

Mapping of Parks

The mapping of urban parks in Gulshan Town reveals a total of 165 parks, indicating a generally adequate coverage of urban green spaces distributed unevenly across its Union Councils (UCs), as shown in Fig. 6. However, significant patches within almost every UC are devoid of park provision. Safoorah Goth, located on the peri-urban fringe of Gulshan Town, stands out with the highest concentration of parks, hosting 43 green spaces. This UC predominantly consists of gated societies with more planned layouts, contributing to better park provision.

In contrast, UCs situated closer to the core city center, such as Jamali Colony and Gulshan-e-Iqbal-II, exhibit markedly lower park provision. Jamali Colony, despite having the highest population density, contains only two parks, one of

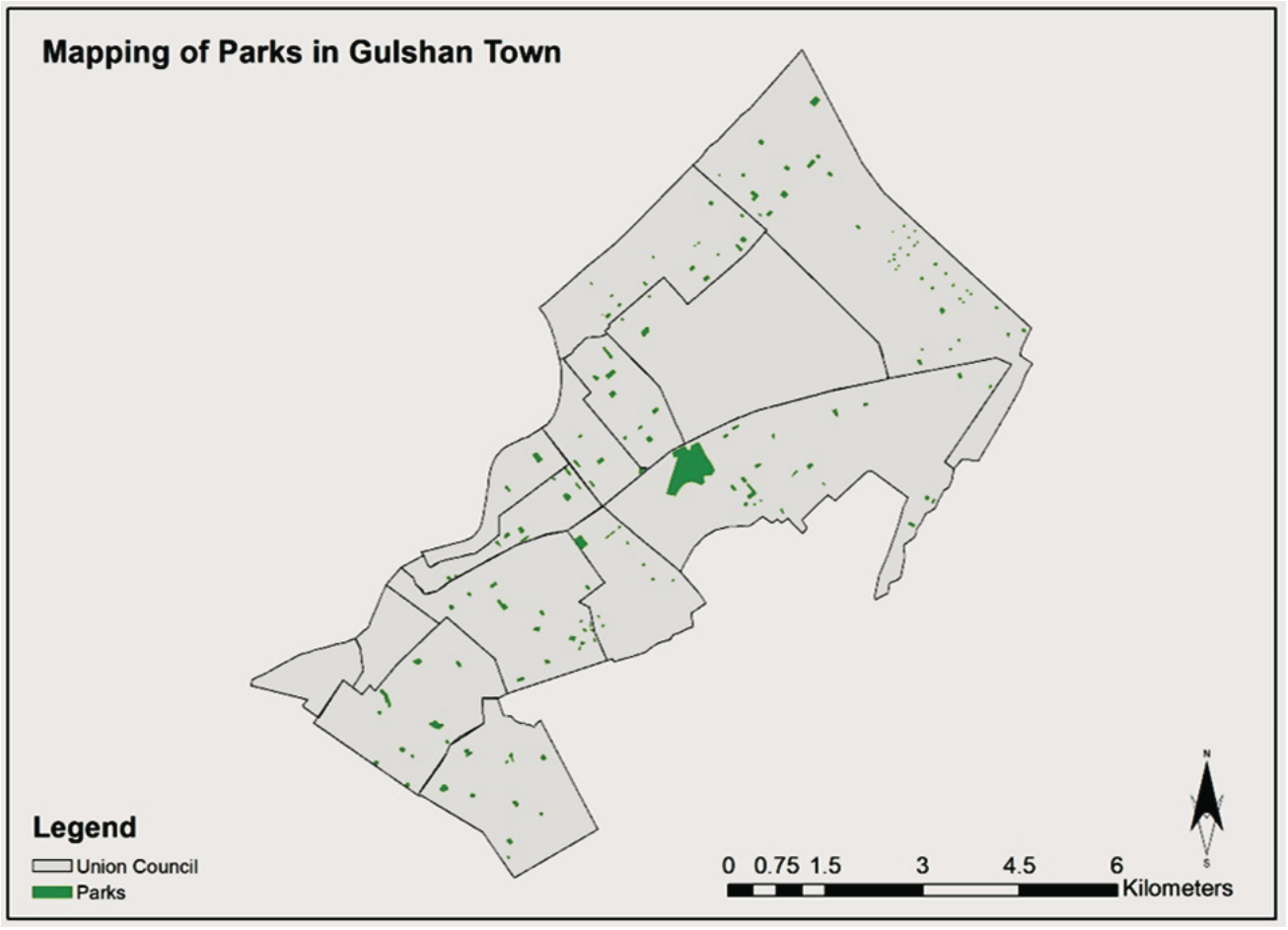

Figure-6: Mapping of All the Parks in Gulshan Town, Karachi.

which is inaccessible to local residents. Pehlwan Goth, with 23 parks, appears well-served but is an outlier due to the inclusion of the city-level Safari Park. If the exceptional case of Pehlwan Goth is excluded, its situation mirrors that of other densely populated UCs, which have limited availability of urban parks within walking distance.

Moreover, UCs like Essa Nagri and PIB Colony are particularly underserved, with no parks present at all. This observation further highlights a stark spatial imbalance in the availability of urban parks relative to population density across different UCs in Gulshan Town.

Moderate park availability is observed in UCs like Gulzar-e-Hijri and Gillani Railway, each with 16 parks. Conversely, Metroville UC presents a unique scenario; despite having significant green spaces within academic institutions and employee societies, these areas are largely restricted and inaccessible to the general public. This exclusion diminishes their role as public urban parks and mirrors the conditions of underserved UCs.

To assess park accessibility, a 300-meter buffer zone analysis was conducted using GIS to evaluate the coverage of parks within a walkable distance, as recommended by WHO guidelines (Fig 7). The analysis revealed that even UCs with higher park counts, such as Safoorah Goth and Gulzar-e-Hijri, fail to achieve complete coverage, leaving significant portions of the population without accessible green spaces. This inadequacy is particularly pronounced in UCs like Jamali Colony, Essa Nagri, PIB Colony, and Shanti Nagar, where the buffer zone analysis reveals significant areas lacking any accessible parks. Shanti Nagar, with its mixed socio-economic levels, showcases the challenge of providing sufficient public green spaces for all residents, particularly in neighborhoods with low socio-economic status and high population density. Similarly, in Essa Nagri and PIB Colony, neighborhoods with high population density and lower socio-economic status suffer from inadequate park availability and access.

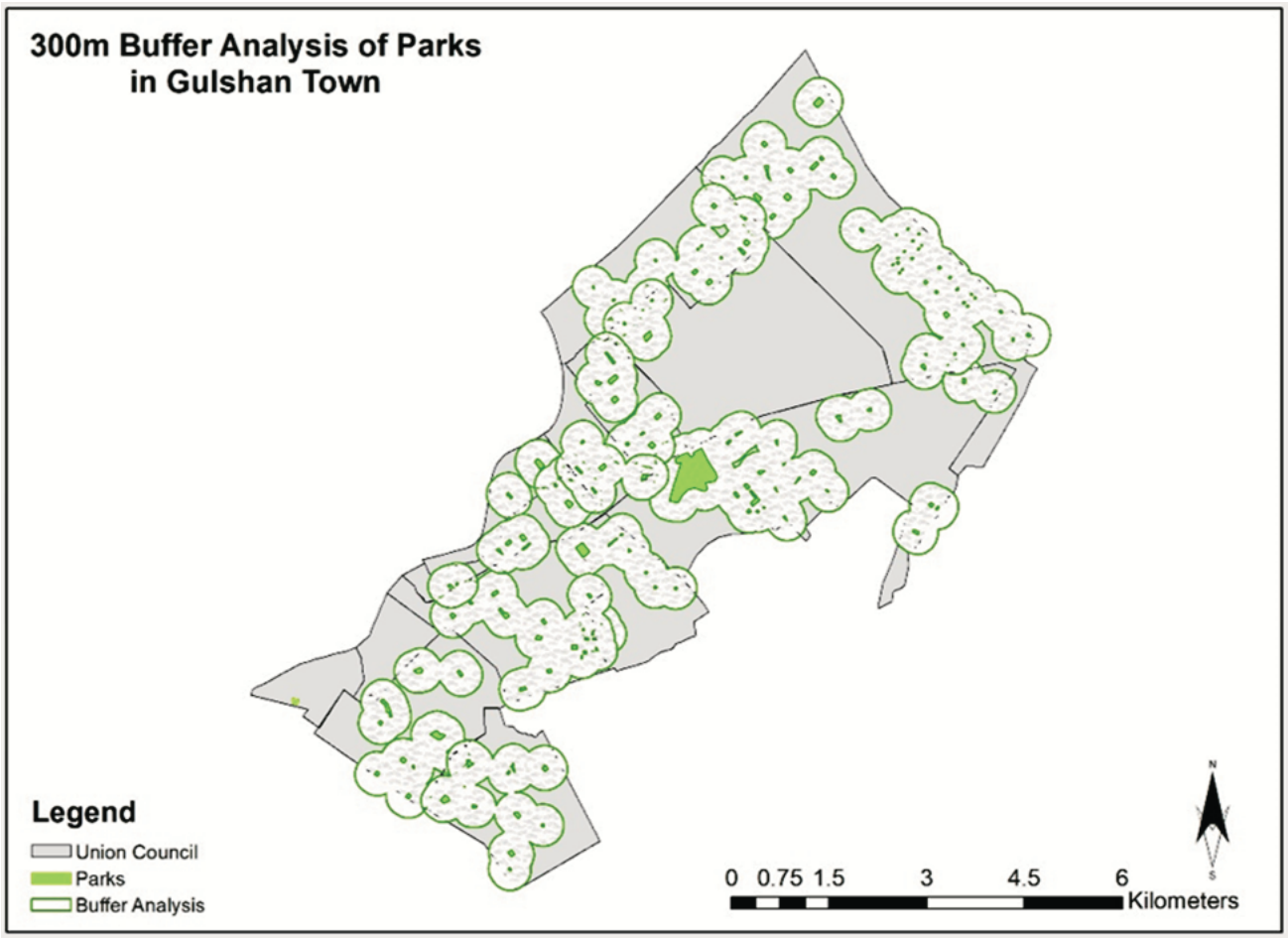

Figure-7: Urban Parks (UGS) 300m Buffer Zone Analysis of Gulshan Town.

The spatial analysis highlights a clear divide in park distribution between the peri-urban and core city UCs, with the latter exhibiting denser populations but comparatively fewer and less accessible parks. These findings underscore the urgent need for planning interventions to improve park accessibility and equity across all UCs of Gulshan Town.

Population Density and Urban Parks

The insights from Figure 8 proved valuable in examining the correlation between population density and the availability of green spaces. The figure distinctly illustrated that regions with higher population density tended to have fewer to zero green spaces compared to those with low or medium population density. Furthermore, Fig. 8 revealed that areas characterized by high population density and limited green spaces were predominantly those encompassing primarily consisted of informal settlements or communities with low to average socioeconomic status.

These regions have been prioritized for urbanization, resulting in insufficient park maintenance and inadequate establishment of new parks. Consequently, this has generated an imbalance in the availability of urban parks.

Union councils like Dehli Marcantile, Civic Center, and New Dhoraji, characterized by moderate population densities, Additionally, they are moderate to affluent socioeconomic and are well-planned areas have relatively more parks compared to other areas, also their accessibility coverage is notably superior (Figure-7).

Despite the large park areas in UCs like Pehalwan Goth and Safoorah Goth, their distribution does not align with population density and urban accessibility needs. Mixed socio-economic neighborhoods like Shanti Nagar, along with low socio-economic areas, face challenges in ensuring equitable access to parks, particularly for lower-income residents who rely more on public spaces for recreation and well-being. This highlights the failure of authorities to

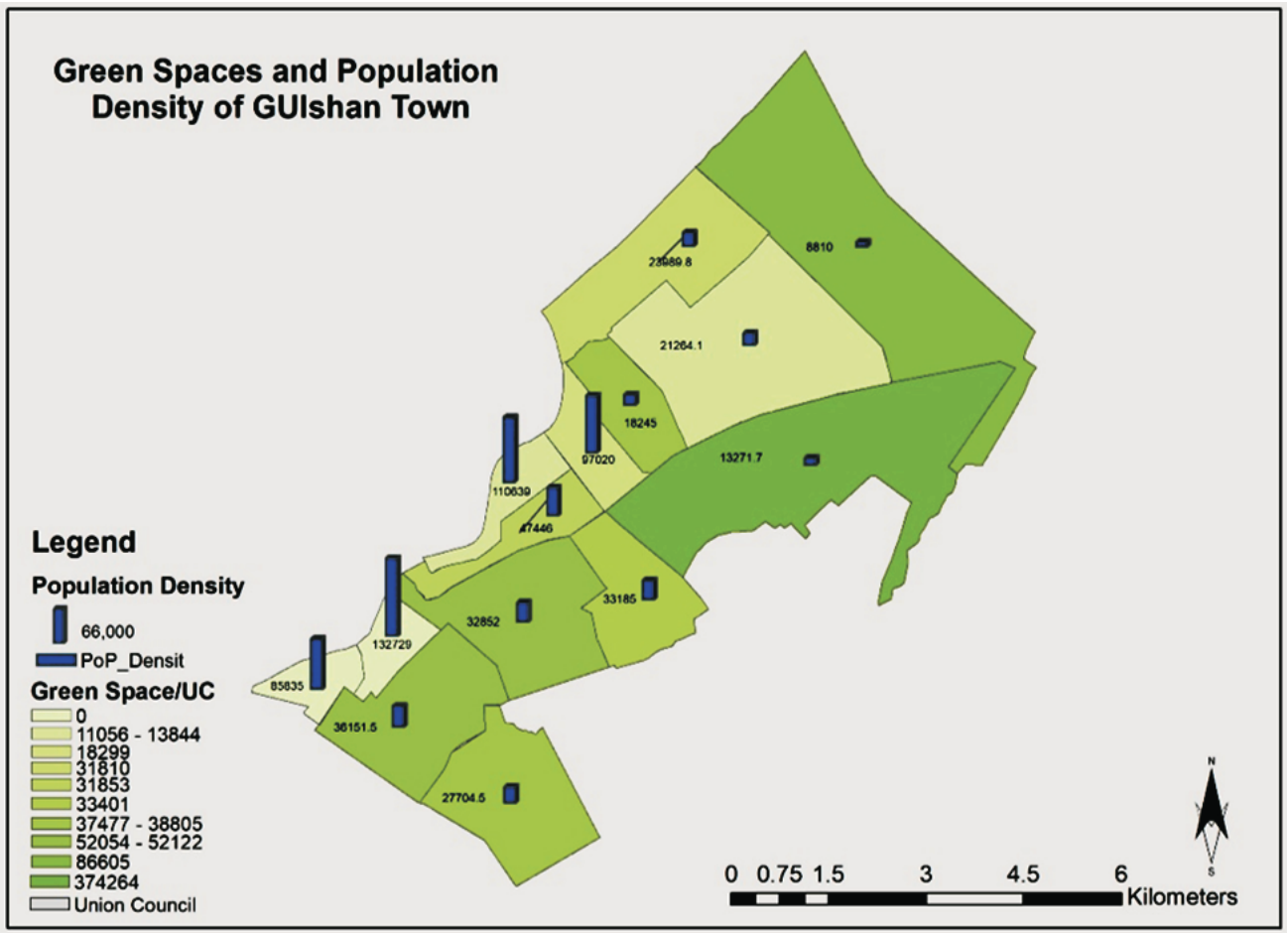

Figure-8: Green Space Availability and Population Density in Gulshan Town.

provide equal access to green spaces for all residents, as recommended by the World Health Organization (Abdulraheem, 2022).

Urban Parks Availability per Person

Gulshan Town, amidst a rapid population surge as per the 2017 Census, exhibits notable discrepancies in green space allocation among its Union Councils (UCs). The average allocation is 0.4 m² per person, falling short of the recommended minimum.

As detailed in Table 3, our analysis assesses adherence to the World Health Organization's (WHO) recommended standard of 9m² per individual for green space within Gulshan Town. The findings reveal a pervasive inadequacy across all UCs, none of which meet the WHO benchmark. This insufficiency is exacerbated by high population density and the lack of parks that fulfill WHO standards. The allocation of green space varies significantly across UCs. Pehlwan Goth stands out with 2.6 m² per person, largely due to Safari Park, while PIB Colony and Essa Nagri have no designated green space. New Dhoraji provides 1.02 m² per person, surpassing the average but still falling short of the WHO standard. Notably, New Dhoraji achieves 90% coverage in terms of population density and accessibility, although its parks are still insufficient in quantity. Safora Goth, located on the urban periphery, features numerous private builder communities and gated societies with substantial green space, yet these provisions do not meet the population's needs or established standards.

Figure 10 illustrates the distribution of parks per person through symbology in ArcGIS. Additionally, presents a multiple bar chart comparing the current green space in the study sites with the WHO's standard of 9m² per capita. The analysis indicates that the existing green spaces are insufficient to meet the needs of the population for an enhanced quality of life.

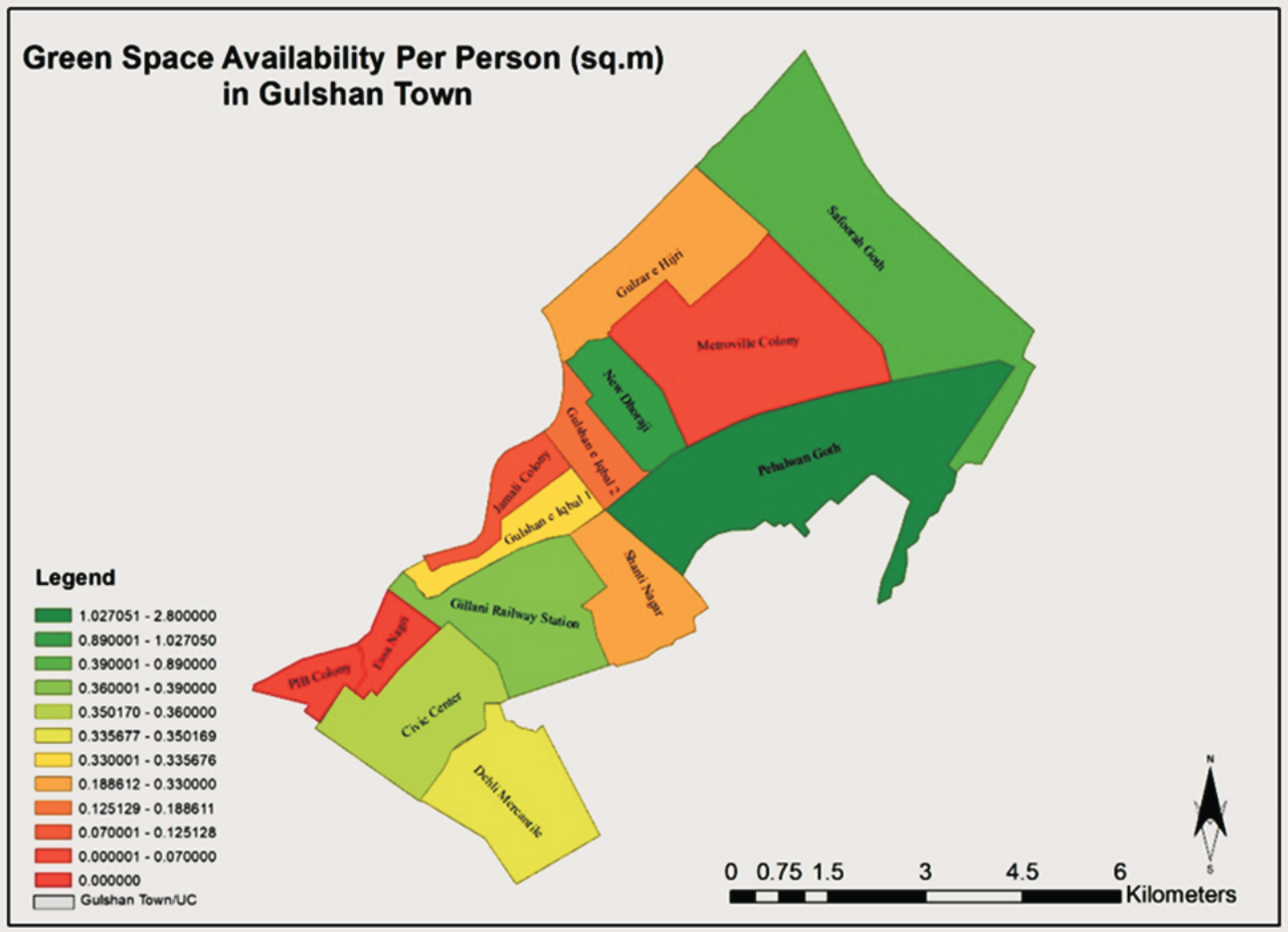

Figure-9: Availability of Green Space per Person in Each UC in Gulshan Town.

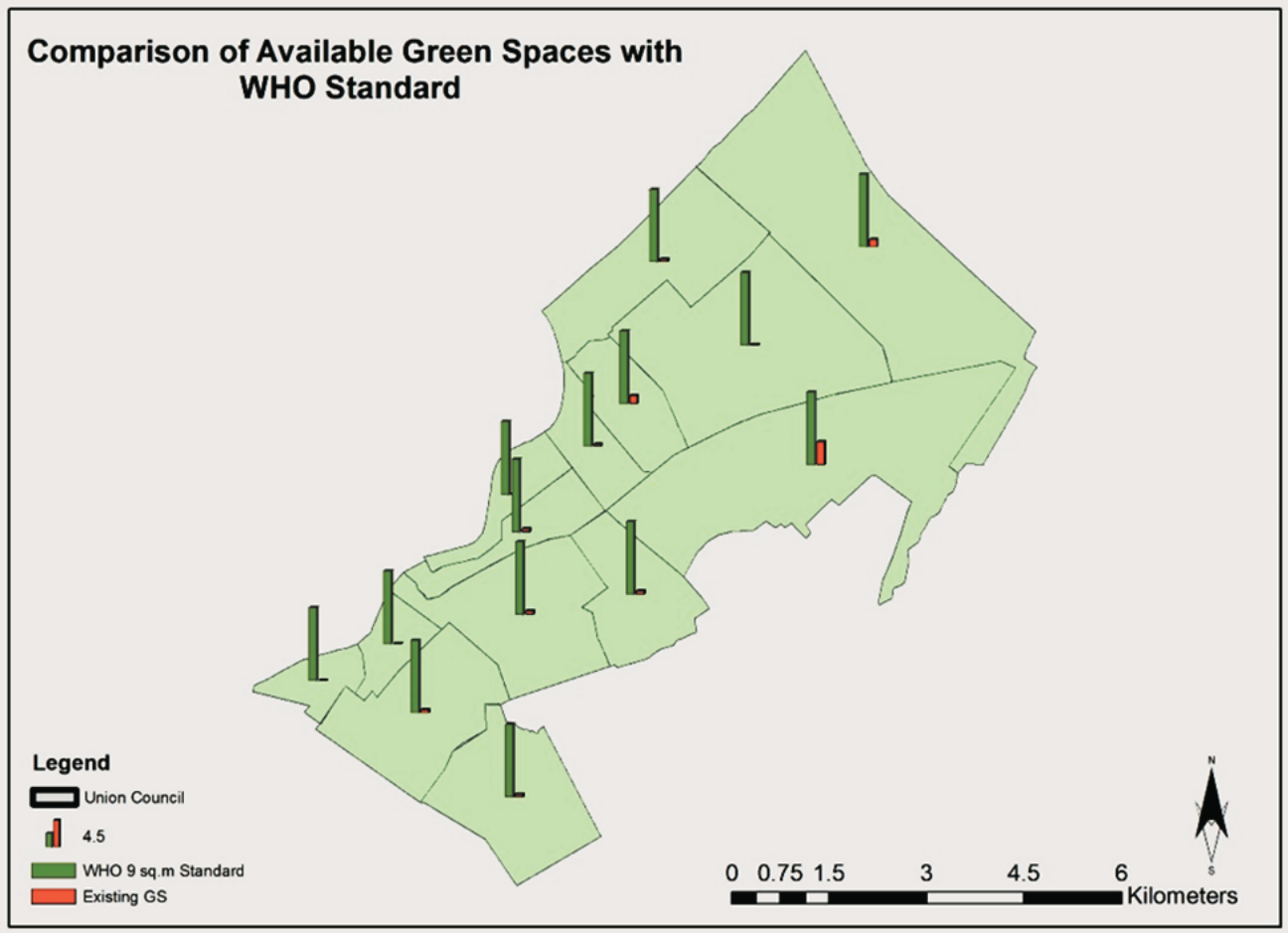

Figure-10: Comparison Between Available Green Space and WHO Standards per Person.

DISCUSSION

The analysis of Gulshan Town's green spaces demonstrates a pronounced disparity in their distribution and accessibility, reflecting broader global and regional trends. Globally, green space inequalities are especially pronounced in the Global South, where the Gini coefficient for green space distribution is 0.47 compared to 0.27 in the Global North, and green space exposure is only one-third that of the North (Chen et al., 2022). This trend resonates within Karachi, where towns like Gulshan face significant shortfalls in green space availability, particularly in informal settlements and densely populated areas.

At the city level, comparative studies in Pakistan reinforce these findings. For example, only 1.89% of the total urban area in Peshawar (209.89 ha) is covered by parks, with five zones completely lacking parks, two of which are in the city center (Sultan, et. al, 2023). Similarly, in Lahore's Gulberg Town, only one union council met the WHO standard of 9 sq. meters of green space per person, leaving most areas underserved (Alam, et. al, 2014). In Karachi, Shah Faisal Town saw a marginal increase in green spaces (9,826.8 yd² between 2004 and 2009), but population growth of 48% since 1998 and encroachments diluted this improvement (Burke, et. al, 2012). These examples highlight the compounded effects of urban expansion and uneven spatial planning, issues that are clearly mirrored in Gulshan Town.

The GIS mapping and spatial analysis conducted for Gulshan Town revealed an acute shortfall in green space provision, with per capita availability falling far below the WHO-recommended standard of 9 sq. meters per person. This deficit is most pronounced in informal neighborhoods, where unchecked population growth, urban densification, and land encroachments have severely restricted residents' access to green spaces.

Unlike city-level studies that generalize green space distribution, this research provides a detailed micro-level examination, identifying disparities at the neighborhood level within Gulshan Town. This localized perspective is critical for urban planners and policymakers, offering targeted insights into underserved areas that require immediate attention. These findings stress the need for equitable planning interventions to prioritize green space allocation in high-density and marginalized areas, fostering both social and spatial equity.

Limitations

This study primarily focuses on spatial distribution, with quality assessment of parks remaining a potential area for future exploration. Population data was drawn from the latest available census, which may not fully capture current dynamics. While the accessibility analysis used buffer zones, which provide preliminary insights, future studies could explore network analysis for a more nuanced approach. Despite these limitations, the study offers significant contributions to understanding green space equity at a neighborhood level.

CONCLUSION / RECOMMENDATIONS

This study provides a spatial analysis of urban parks in Gulshan Town, identifying critical deficits in their availability when adjusted for population density. While the buffer analysis indicates that spatial coverage might appear adequate, high-density neighborhoods, particularly in two Union Councils where no urban parks exist, face a significant lack of green areas per capita. These findings highlight the inequities in the distribution and accessibility of urban parks, emphasizing the need for targeted interventions to address these gaps.

The research also underscores the limitations of current urban planning approaches that often rely on generic benchmarks and fail to account for localized population density and community-specific needs. Through GIS-based mapping, this study offers granular insights into disparities, providing a foundation for policymakers to enhance the equitable distribution of urban parks, improve social well-being, and ensure compliance with population-based green space standards.

To close the existing gaps, urban park planning should shift towards evidence-based strategies that emphasize both the quality and accessibility of parks, alongside their quantity. Future research could extend this work by incorporating evaluations of park quality and advanced metrics of accessibility, furthering the understanding of urban park equity and strengthening efforts to create inclusive and sustainable urban environments.

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