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Accessibility Analysis of Urban Green Space: The Case of Erbil City

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Abstract

Urban green areas are open spaces in urban areas that are mainly covered by vegetation. They can be public or private urban green spaces that include parks, community gardens, forests, and nature reserves. Parks are an important component of urban quality of life if they are well designed and accessible. Accessible parks contribute to physical activity among urban residents. Therefore, the objective of the study was to identify the most significant main accessibility factors that discourage the use of public urban green areas, and examine the extent to which they influence the use of green areas in residential areas of the city of Erbil. This study was conducted in 2017 and 2020 to measure the accessibility of green spaces using network analysis with GIS for Erbil city. The present study represents the first known investigation regarding the accessibility of public green spaces within the city of Erbil. The results show that for community parks, 68% of the population has access with a travel time of 5 minutes, 99% of the population has access with a travel time of 10 minutes, and 100% of the population has access with a travel time of 15 minutes. For district parks, 70% of the population had access with 5 minute drive time. With 10-minute drive time, 96% of the population had access and 100% of the population had access with 15-minute drive time. For neighborhood parks, the results show that 43% of the population had access with 5-minute walk and, 71% of the population had access with 10-minute walk. At 15-minute walk time, 80% of Erbil residents had access to neighborhood parks. Mini parks were accessed by 22% of the population with a 5 minute walk and they were accessed by 52% of the population with a 10 minute walk. With a 15 minute walk, mini parks were accessible to 70% of the population.

Keywords:
Erbil, accessibility, urban green area hierarchy, GIS, network analysis

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INTRODUCTION

Urban green areas are places that provide opportunities for people to engage in a variety of sporting and recreational activities. Therefore, public green areas and recreational facilities are important for social and economic health of cities and towns (Sallis et al., 2004). Therefore, there is increasing desire for the creation of organized public green spaces such as public parks and open sports facilities in residential areas like cities. These urban green areas are an essential urban function and land use in the urban development plan. Although a number of such public green areas and recreational facilities were developed in the urban area of Erbil, except for a small number of larger parks and organized facilities, the others are not used for many reasons. The main reasons for the underutilization of urban green spaces include lack of accessibility, lack of attractiveness, unsuitable location and behaviour such as lack of time, and lifestyle and social problems. The success of urban green spaces and open recreation spaces is highly dependent on accessibility (Project for Public Spaces, 2011). Physical accessibility, such as the quality and availability of access, cost of access, time distance, connection to residential areas, and parking and safety, is considered one of the most important characteristics that influences the successful use of these urban green spaces. Similarly, it is argued that visual access variables such as sight distance and visibility of parks influence the use of urban green areas.

Accessibility to urban green areas in a city is generally affected by the degradation of an efficient and sufficient public transportation system, the increase in commercial and related activities that occupy these spaces, the lack of good physical transport facilities such as roads, pedestrian facilities, security, parking, and policies, and the growth of traffic volume, resulting in traffic congestion and increased travel times. Similarly, accessibility to urban green spaces is measured by characteristics such as continuity, proximity, connectivity, walkability, and convenience, as well as pedestrian and vehicular infrastructure and visual accessibility parameters. Thus, it is critical to assess the key factors that influence the accessibility of public green spaces in a city's residential neighbourhoods, and then develop planning and design guidelines to improve accessibility so that urban green areas will be more vibrant and can be used to their fullest potential.

As an attribute of urban land use, green spaces have many functions, such as providing resources and serving as a habitat for life (Solecki and Welchb, 1995). Urban green spaces are areas built as facilities within the city (Bilgili and Gokyer, 2013). They are green spaces that have similar layout and characteristics. Urban green spaces impact traffic flow and emissions, air quality, microclimate, noise, accessibility, economic impacts, and social benefits. These impacts vary from the neighbourhood level to the regional level. The use of various green spaces that serve the entire urban area should be evaluated in urban planning and green space design.

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The adequacy of green space was evaluated by many researchers. It is not correct to evaluate the total area of green space created for recreational purposes in cities by relating it to population size. It is necessary to evaluate the green areas created, or that will be created, based on planning principles and criteria using methods that are consistent with planning principles.

Therefore, the objective of the study was to identify the most significant main accessibility factors that discourage the use of public urban green areas, and examine the extent to which they influence the use of green areas in residential areas of the city of Erbil. Studies indicate that the ratio of road network to pedestrian network (paved paths), the number of access streets to the green areas, and the size of green spaces affect the use of the urban green areas to varying degrees. The questions this study seeks to answer are listed below;

- How accessible are public green areas for different populations within 300 m, 600 m, and 900 m of each other, or 5 minutes, 10 minutes, and 15 minutes by foot for mini-parks and neighbourhood parks, and by car for community parks and district parks?
- In which areas of the city of Erbil do new public green spaces need to be created and accessibility to public green areas need to be improved?

To find answers to these research questions, a two-stage method was applied. First, all green spaces and streets in the city of Erbil were classified, and then the geographic data for the neighbourhoods were linked to demographic data to calculate the population that has access to these green areas.

The study consists of five main parts, after the introduction, the relevant literature review is given, while method, study area and materials used in the study are explained in the next section. The results of the network analysis are given in the results section, which precedes the discussion and conclusion.

LITERATURE REVIEW

Urban Green Areas

Urban green areas are open spaces in urban areas that are mainly covered by vegetation. They can be public or private urban green spaces that include parks, community gardens, forests, and nature reserves. In this study, only public urban green spaces were examined because these public green spaces are free and most of the population do not have access to private green spaces.

Green areas, as a concept, generally refer to a tract of land that is covered wholly or partially with living vegetation, grass or trees and openly accessible by the public free of charge and with ecological, social and economic benefits. Frederick Law Olmsted used the word "park" in his address in 1870 " A Consideration of the Justifying Value of a Public

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Park" to mean a large tract of land set apart by the public for the enjoyment of the rural landscape (Czerniak, 2007). The State Government of Victoria (SGV) defined green space as an area that is publicly owned, protected land, set aside primarily for nature conservation, recreation, public gatherings, and passive outdoor enjoyment (SGV, 2008). The State Government of Victoria determined that public green space (including publicly-owned parks, gardens, squares, waterways, forecourts and green space on universities campuses and schools, nature strips along streets, major sporting areas that are managed by the government) should be offered to the city residents freely. Green spaces usually contain many trees and large areas of grass cover. Their contribution to the environment is important. Urban green spaces improve the quality of the urban environment by regulating urban air temperature and humidity, preventing water pollution and urban air pollution, and maintaining biodiversity (Hirokawa, 2011; Sun et al., 2013; Watmough et al., 2013). Green spaces help store and process storm water, cool air temperature in the urban center, and provide habitats for a rich community of animal, plant, bird, aquatic and microbial species.

Accessibility and access to green spaces

One of the characteristic features of human behaviour is the ambition and ability to move all around the world to exchange merchandise and information over long distances (Hodgart, 1978). Commuting, moving, shopping, gathering, distributing, communicating, and vacationing often take place over some distance. Therefore, accessibility requires special forms of public social behaviour - spatial interaction.

Accessibility is an indicator that reflects the ease with which an intended point or place can be reached from the user's perspective. From the perspective of a product, device, service, or environment, on the other hand, it is defined as the number of users who can use the phenomenon in question. Accessibility analyses are widely used to check the benefits of plans as a planning control tool, to help decision makers to investigate new locations for urban services, to test the benefits of current locations of urban services, to identify thresholds for urban services, and to determine the capacity and service area of urban services such as education, emergency facilities, leisure, industry and shopping, etc. (Kuntay, 1976; Kuntay, 1990). Halden et al. (2000) also emphasized accessibility analyses as practical tools for evaluating the performance of transportation systems. Accessibility results can be used to check if urban services are highly accessible by walking, cycling or public transport etc., to identify critical regions that are out of current service range or to select appropriate sites for new services.

Failure to consider accessibility in the spatial planning and decision processes of a city may result in total barriers to accessing the relevant service for those living in the city and disability in terms of users. In this sense, accessibility is important for decision-makers when selecting locations for new urban facilities (education, health, fire, etc.), it is also

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used to guide planning by determining the capacity and service area of the facilities in question. With network analysis applied for this purpose, it is possible to determine the areas outside the service area for the service in question or to determine the most appropriate location for new urban infrastructure under consideration (Kuntay, 1976; Kemec, 2001).

One of the important issues highlighted in the literature related to public green spaces and public recreation facilities is access, which significantly affects their success. The access to public green areas is related to improved physical and mental health of individuals (Sugiyama et al., 2008; Payne et al., 2005; Potwarka et al., 2008). Green area users are more likely to have good levels of health and physical activity compared with non-users (Deshpande et al., 2005) because there is proof that lack of accessibility of green areas and distance from green areas are inversely related with utilization and physical activity behaviour (Kaczynski et al., 2008).

The significance of green space for urban residents lies in quantity, spatial arrangement, and dispersion across communities or geographical areas, which ultimately govern accessibility. The accessibility of green spaces is frequently determined by factors such as location, proximity, and size, as noted by Zhang et al. (2011). The accessibility of a place is contingent upon its geographical location and the surrounding environment. It is imperative that green spaces designated for public use possess the qualities of being accessible, passable, and visible from a distance. According to Wilbur et al. (2002), the utilization of green space is positively impacted by the presence of local public green space that can be accessed by walking. Conversely, the need to travel to a park may have a negative effect on green space utilization. The utilization of public green spaces is influenced by factors such as geographical location and safety considerations. According to Herzele and Wiedeman's (2003) findings, the most significant factor affecting access and utilization of green spaces is the walking time or distance from one's residence. Proximity to green spaces and ease of access were found to positively impact the frequency of visits and utilization by nearby communities, as noted by Atiqul Haq (2011) and Herzele and Wiedeman (2003). According to research conducted in Helsinki, individuals residing within a 0.50 km radius of green spaces tend to visit them more than four times per week (Neuvonen et al., 2007; Atiqul Haq, 2011). As per the findings of Etzioni (1998), it is recommended that public green spaces should be situated in close proximity to the neighbourhood centre and should not be farther than a five-minute walk for the residents. The concept of accessibility can encompass a wide range of considerations. According to Comber et al. (2008), accessibility in the context of the green space literature refers to the proximity of residential areas to locations providing access to green spaces, measured in terms of walking distance. Green spaces differ in size and characteristics and therefore have different impacts. Some studies indicate that people visit neighbourhood green spaces more

frequently than district or regional green spaces (VDSE, 2002). Neighbourhoods are considered a meaningful territorial element of urban life for many people and a planning ideal in many parts of the world (Lee, 1968; Pacione, 1982; Martin, 1998). A neighbourhood should provide a number of green areas that serve several uses; to ensure all inhabitants have accessible neighbourhood green areas within a specific distance (800 m, 1200 m, or 1600 m, etc.); and to ensure a walking network links the green space to the broader green space network - as the network of green spaces may form the main component of travel through a neighbourhood (Lee, 1968; Pacione, 1982; Martin, 1998).

GIS and Green Space

GIS plays an important role in environmental justice and green space accessibility analysis. GIS and network analysis within it can compute time of travel from one place to another. Studies use network analysis within GIS to explain how different religious groups, ethnic groups, and socio-economic groups access urban green space (Comber et al., 2008). The reason that many studies utilize GIS to carry out environmental justice analysis is because it is only possible to solve different social problems after recognizing the issues. Importance of equal access to green space must be noted by planners, because all inhabitants living in a city deserve to have equal accessibility to public green areas. Studies can raise awareness about utilizing GIS so that scholars can use it to address different kinds of environmental or social issues. This research is the first to utilize GIS network analysis to study the accessibility of public urban green areas, in the city of Erbil. Network analysis within GIS allows landscape architects and urban planners to understand how environmental justice influences cities and to help societies have more equitable accessibility to healthier environments, such as public green spaces. GIS network analysis can be used as a method for architects and urban planners to analyse neighbourhoods in need of renovation.

There are two popular measurement methods that are utilized to study accessibility: network analysis and Euclidean analysis. Urban planners most commonly use the Euclidean technique, referred to as straight-line distance, to measure accessibility (Coutts et al., 2010; Coutts et al., 2013 and Moseley et al., 2013), but the Euclidean technique simplifies the real world because it does not account for obstacles to movement in a city. On other hand, network analysis depends on the actual roads and their related speeds and is much more accurate for an accessibility study (Steadman, 2004). Researchers and urban analysts increasingly focus on the distribution of green spaces in urban environments.

Ann (1991) utilized GIS to measure accessibility as the straight-line distance from open green spaces including rivers, green belts, and water bodies, to residential areas (Ann, 1991). Some research results explained that spaces within a linear distance of 700 m from open areas comprised 98.6% of all areas in the city of Seoul, and so the provision of

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open areas was judged to be more than adequate (Eom et al., 2008 and Eom and Lee, 2009). Gobster (1995) in exploring issues related to access and use of green space and recreation facilities by poor and minorities found that sections of the Chicago River Corridor adjacent to lower-income minority neighbourhoods tended to have lower vegetation quality, poorer maintenance, and low accessibility compared to sections adjacent to higher-income 'white' neighbourhoods. He hypothesized that lower-income minority neighbourhoods may not have access to quality open space environments like those available to upper-income majority neighbourhoods. Talen (1998) used an equity mapping method and a needs-based measure of equity derived from professional green space planning standards and planning policy documents to examine accessibility to green space in Pueblo, Colorado. They found that areas with Hispanic populations had low accessibility. Nicholls (2001) studied distributional equity within a system of public green areas in Bryan County, Texas and accessibility using GIS and the Mann-Whitney U test procedure in SPSS. The results showed that no inequality was present. Lindsay et al. (2001) explored the nature of green ways as public spaces in Indianapolis, Indiana. Their research study used simple GIS analysis of census and proximity as a measure of accessibility and other data to determine equality of accessibility. The results showed that minorities and low-income majorities have unequal accessibility to open spaces. Recently, the Gaussian-based 2SFCA approach was utilized to estimate green space accessibility in Georgia (Dai, 2011) and the results showed that many of the census tracts were beyond walkable distance to the nearest green area.

Health outcomes may be influenced by socioeconomic status, environmental quality, and access to health care (Massey, 2004). Low-income communities need the same amenities as affluent communities. Cancer and other diseases are directly linked to the disposal of chemical or toxic wastes. Low quality of life and the environment in these locations contribute to high prevalence of health issues among the local population. Good access to urban green areas can help reduce these health problems, but the high quality of the living environment should not be restricted to high-income groups. Bolin et al. (2005) argued that the historical development of the socio-spatial effect produced unequal and unsafe environmental burdens in low-income and minority communities in Southern Phoenix. Therefore, understanding environmental hazards and the current and historical distribution of different racial groups is necessary to research environmental injustice. In the same way, Bolin et al. (2005) studied how racial categories and companion social relations were constructed by the white majorities to produce a stigmatized area of economic and marginality racial exclusion in South Phoenix at the end of 19th century. Chona et al. (2010) argued that some minority groups don't have good accessibility to green areas and parks in Los Angeles as the city has grown and become increasingly dense. Inner-city minorities and low-income people dwell in poorly-planned neighbourhoods. These areas lack green space and other

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recreational possibilities. Urban green space is in demand because individuals may meet friends, get fresh air, play with children, and interact here. Most research shows that low-income and minority groups have reduced access to these green places.

Several researchers chose network analysis because it has an advantage over the covering approach as it reflects actual travel and avoids all the barriers that make routes inaccessible to pedestrians. Scholars examined environmental justice in the Phoenix urban area and the socio-spatial distribution of different types of facilities in the Phoenix metropolitan area in relation to the demographics of nearby neighbourhoods. They found that ethnicity and social-class are directly related to the distribution of air pollution and immigrants, low-income and Latino inhabitants had higher exposure to pollutants than high income and white residents. Comber et al. (2008) studied green area access for different ethnic and religious groups in Leicester, UK, and they explained that Sikh, Hindu and Indian groups, which are ethnic minorities in Leicester, had limited access to green areas. Comber et al. (2008) utilized network analysis to determine green area access for different religious and ethnic groups in the UK. Boone et al. (2009) found that more African Americans in Baltimore, Maryland had access to green areas within 400 meters walking distance while white people had access to more green spaces in less than 400 meters distance.

Numerous academic studies showed that parks are often distributed in a manner that disproportionately benefits affluent and white populations, thereby creating a significant environmental justice issue with regards to the unequal allocation of green spaces. Although it is impossible to alter an existing neighbourhood, it is important to study where injustice exists and the ways that this injustice can be overcome. Coombes et al. (2010) found that residents living with high accessibility to green areas were more likely to fulfil physical activity recommendations and less likely to be obese or overweight. Coombes suggested that the provision of good access to green space in metropolitan areas may promote physical activity for the population (Coombes et al., 2010). Zhang et al. (2011) explained that developed states in the western and midwestern US had higher neighbourhood green space accessibility, while developing states had lower accessibility (Dai, 2011). More recently, the Gaussian-based 2SFCA approach was utilized to determine green space accessibility in Georgia. The results showed that Georgia still faces the challenge that many of the census tracts are beyond walkable distance to the nearest green area. Bennet et al. (2012) used the network analysis approach to measure the walking distance to the nearest playground and to determine the number of users of playgrounds within the playground's service area.

METHOD, STUDY AREA AND MATERIALS

Method

This study analysed the green spaces in Erbil city and measured the accessibility of green spaces with environmental justice in Erbil city for

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public green spaces. The study examined the accessibility of active green spaces in Erbil city. If all green areas in the city are divided into two categories according to their usability as explained in the diagram (Figure 1), there are two main classes, namely active and passive green areas. In the active green spaces, a total of 264 parks were included in the study. Active green spaces consist of four groups (community parks, district parks, neighbourhood parks, and mini parks) according to the area size and facilities provided. All quarters of Erbil city were selected, and all roads and streets were classified according to speed limitations. All of the datasets were prepared with AutoCAD and then converted to GIS to analyse and calculate time costs to access green spaces, area that encompassed by public green space services and number of residents who access these services, as shown in the diagrams (Figure 2 and Figure 3) (Kemec et al. 2019).

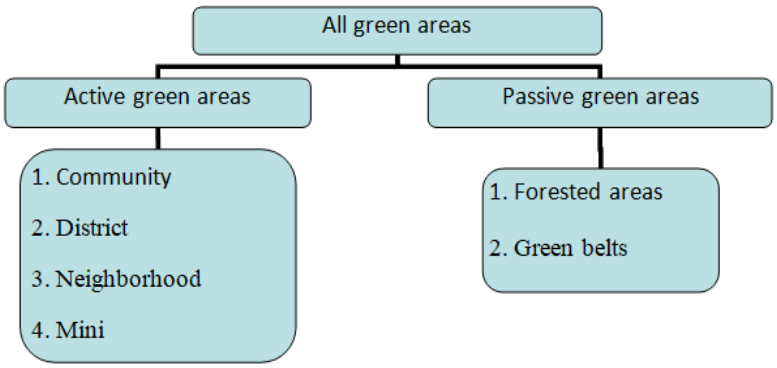

Figure 1. Classification of green space

The green space classes created after classification, taking into account areal size and facilities provided by the park are defined below;

1. Community Parks: Community parks are considered the largest green space in size and are well known amongst all residents. Community green spaces contain all facilities, serve all age groups and provide a wide variety of opportunities to a broad cross section of residents. Ten community parks were included to the study.

2. District Parks: A district park is a mid-sized green area providing space for recreation or sport and facilities. These types of green space serve large groups in the city and are attractive to a range of users. They serve several communities or suburbs and are quite well known for residents living in their catchment. Ten district parks were included to the study.

3. Neighbourhood Parks: Neighbourhood parks serve a small population area, have convenient standard size. The population for this kind of green space is 1 hectare per 1000 people and they usually range in size from 0.5 hectare to 4 hectare. These parks provide facilities for a range of age groups. Neighbourhood parks are considered one of the most significant features of the green space system. They are deemed one of the major elements in neighbourhood design and their essential role is provision of recreational space for surrounding neighbourhoods.

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These types of green areas should be located at the centre of the neighbourhood, have a service area of about 800 meters, convenient and safe pedestrian access and range in size from over 0.25 hectare up to 5 hectares. The study encompasses a total of 189 neighbourhood parks.

4. Mini Parks: Local green areas are small green spaces for use by a very small population. These green areas normally serve a population between 500 to 1000 people, usually include a playground for children or have aesthetic purposes. In relation to size, they are generally less than 0.25 hectare. A total of 55 mini parks were included in the study.

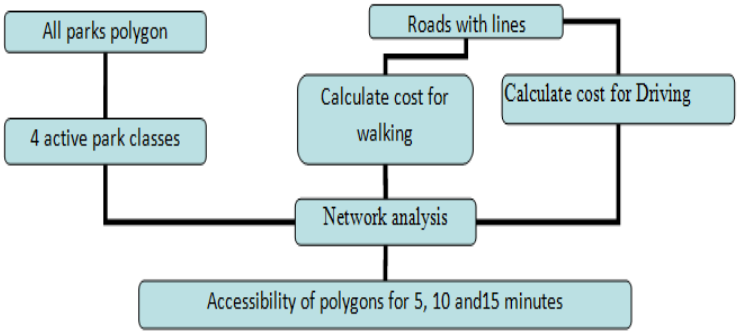

Figure 2. Methods for analysing with the GIS Network analysis tool

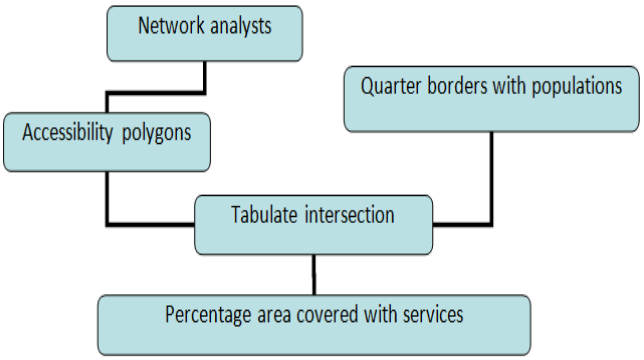

Figure 3. Methods of calculating area and population covered by services.

Study area

This research was carried out in the city of Erbil (Figure 4), which has a population of almost 1,000,000 people. Because Erbil gets very hot in the summer, there must be enough green space. Green spaces should be freely accessible to inhabitants, and residents should have easy access to public green spaces. Erbil has a lot of urban green space. All public green space evaluated in this study were chosen with the input of Erbil Municipality and the Green Space Directorate. A comprehensive accessibility study should incorporate multiple criteria to effectively gauge and comprehend the significance and practical value of accessibility to green areas. These criteria may include:

1. Availability of datasets that are required and accessible for the study area to allow focus on matters related to

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mapping, measuring and analysis of green space accessibility.

2. The study area must have a high level of accessibility to allow verification and workable field-based observations when necessary.
3. The study area should be a significant metropolitan area with green space provision and development to allow the assessment of space and time changes in relationships between demand and availability of urban green space.

Due to the factors mentioned above, the city of Erbil was chosen as the location for the research project since it is desirable to conduct concentrated research about the availability of green space.

Erbil city is located in the north of Iraq with latitude: 36°11'33.25" N and longitude: 44°0'38.23" E and elevation above sea level of 429.00 m. The climate of Erbil City is dry and semi-arid climate according to the Köppen-Geiger climate classification (steppe BSh and Mediterranean Csa). It is cold and damp in winter and hot and dry in summer, with short autumn and spring seasons compared to winter and summer. In winter, this locale is affected by Mediterranean cyclones that move east to northeast over the area. Arabian Sea winds move northward passing over the Arabian Gulf carrying significant moisture causing high precipitation in the region. In summer, the region is impacted by tropical high pressure belts and Mediterranean anticyclones. The sub-tropical high pressure centres that move from west to northeast and north pass over the Middle Eastern landmass carrying sand to the region. The highest daily temperature may reach 50 ^{o}C in hot summer periods, while the lowest daily temperature can drop to 0 ^{o}C in cold winters. Therefore, it is necessary to provide green spaces in Erbil city in terms with significant numbers and features for inhabitants because of the higher amount of hot days within a year.

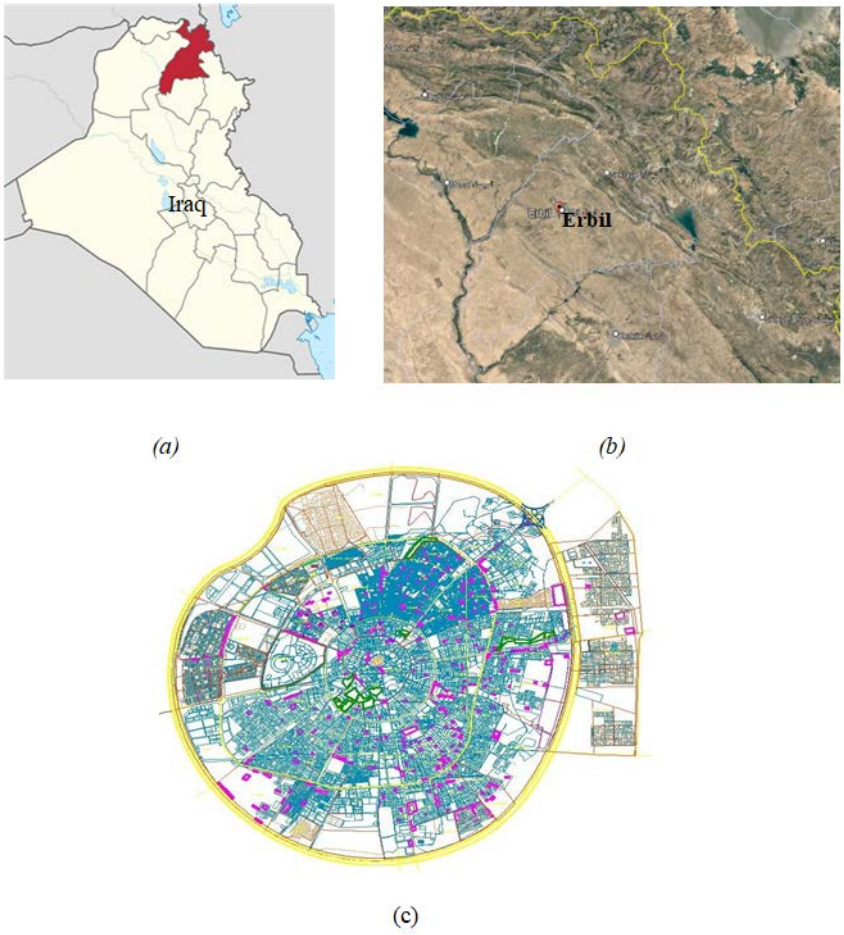

Figure 4. Location of the study area (a) in Iraq, (b) Erbil city and near surroundings (Google Earth), (c) Erbil city center (source: U.S. Agency for International Development (USAID)

Material

As is common in GIS applications, it was envisaged that the data collection phase would take the majority of the time in the study, comprising 80-85% of the time. The data obtained for the study (Table 1) included;

- Green space locations; in point data format, green space location data should have a distance that can be articulated to the transportation network used for accessibility analysis. In other words, the transportation network data should be obtained for an area wide enough to cover all green space points
- Transport network; roadways to be included in the analysis in vector format with in line detail, hierarchical and average velocity data were entered into the attribute table
- Quarter borders and population data; used to find the access status in each neighbourhood in terms of population

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Table 1. Data used in this study

No.	Datasets	Purpose of dataset	Sources of dataset
1.	Green space locations	To determine the green area	Directorate of Green Areas
2.	Road network	To calculate distance and time to access green spaces	Erbil City Municipality
3.	Quarter borders	Combine with population data	Erbil City Municipality
4.	Population	To calculate population	KRG Statistics Office

Data processing stages

1. Green space locations: The study covers the accessibility of active green spaces in the city of Erbil. Therefore, passive green areas were excluded from the scope of the study. Green space boundaries were acquired in CAD format. This data was first transferred to the GIS environment and converted to point detail in order to be used as input for network analysis. There were 264 green spaces in the study area, classified in to two categories as active green areas and passive green areas. Active green space included 10 community parks, 10 district park, 189 neighbourhood parks and 55 mini parks.

2. Road network: Another input for network analysis is road network data. For the analysis, the required impedance information was created by seconds required to traverse the relevant road segment. To calculate the impedance input, which constitutes the next step in the method, the path data must be created in a hierarchical manner. The road network data used in the study comprised road hierarchy information created by expert definition. Road network data must be hierarchical. Considering academic studies and Erbil's road conditions, the average speed for each road segment was incorporated into the created road network data. The average speed values were as follows; intercity roads 70 km/h, degree I urban roads 50 km/h, degree II urban roads 30 km/h and degree III urban roads 15 km/h.

Calculation of impedance (cost): Costs must be calculated. These costs can be stated in a variety of measures, including time, money, and land. The time required to pass each line segment is used as cost in this analysis. The mathematical logic of the method on which network analysis is based is the determination of input time determined in seconds to be spent on each road segment (the cost of traveling the road segment is calculated by the length of the related road segment and the average speed observed on the related road segment) and finally reaches the point where it is '0'. As a result of the analysis, service areas were created by combining the end points of road segments where the input time reaches zero.

After hierarchical classification of the road network, average speeds determined in 'kilometers/hour' were then converted to 'meters/second'. The length of each road segment was calculated in meters in the GIS environment and entered into the road network data. By dividing the calculated road segment lengths in meters by the

average speeds in meters/second, the time required to traverse each road segment was obtained in 'seconds'.

3. and 4. Quarter borders and population: Quarter borders and population of these quarters were used for the evaluation of accessibility analysis results. The quarter border layer in CAD format was converted to the GIS environment. Then tabular population data was integrated with the quarter border layer by using the joint tool in the equipped software.

RESULTS

Accessibility analysis results for public urban green space in different quarters of Erbil city are given below (according to park type);

1. Community Parks: There were 10 community parks with accessibility measured by GIS network analysis for 5, 10 and 15 minutes of driving. The results show that for 5 minutes driving, 68% of the population have access to green space and 32% of population don't have access to green areas. For 10 minutes of driving, there was accessibility for 99% of population and 1% of population don't have access to green areas. For 15 minutes driving, there was accessibility for 100% of population to public community parks (Figure 5).

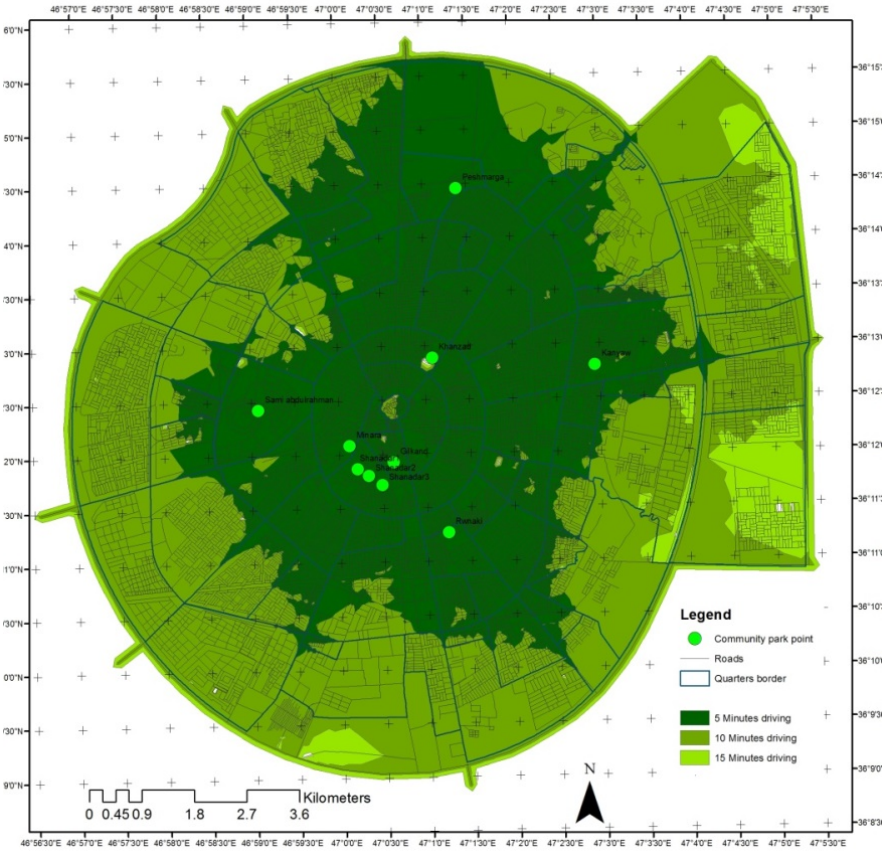

Figure 5. Community Park accessibility with 5, 10 and 15 minutes driving

2. District Parks: There are 10 district parks with accessibility measured by GIS network analysis for 5, 10 and 15 minutes for driving. The results show that for 5 minutes driving, 70% of Erbil city population had access and 30% of population don't have easy access to district

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parks. For 10 minutes driving, there was accessibility for 96% of Erbil residents to district parks. For 15 minutes driving, there was 100% accessibility to district parks (Figure 6).

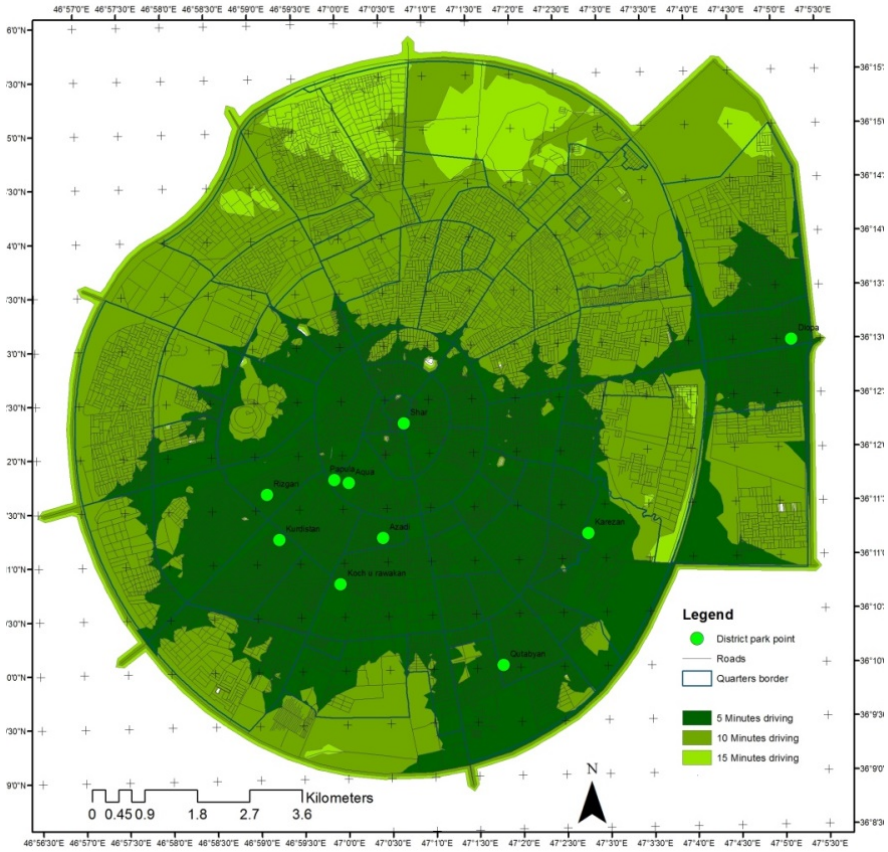

Figure 6. District park accessibility with 5, 10 and 15 minutes driving

3. Neighbourhood Parks: There were 189 neighbourhood parks with accessibility measured by GIS network analysis for 5, 10 and 15 minutes walking. The results show that for 5 minutes walking, 43% of Erbil city population have access and 57% of population don't have easy access to neighbourhood parks. For 10 minutes walking, there was accessibility for 71% of Erbil residents to district parks. For 15 minutes walking, 80% of Erbil city residents have accessibility to neighbourhood parks (Figure 7).

4. Mini Parks: There were 55 mini parks in Erbil city with areas less than 2000 m2 and accessibility measured by GIS network analysis for 5, 10 and 15 minutes walking. The results show that for 5 minutes walking, 22% of Erbil city population have accessibility and 78% of the population don't have easy access to mini parks. For 10 minutes walking, there was accessibility for 52% of Erbil residents to mini parks. For 15 minutes walking, 70% of Erbil city residents have accessibility to mini parks (Figure 8).

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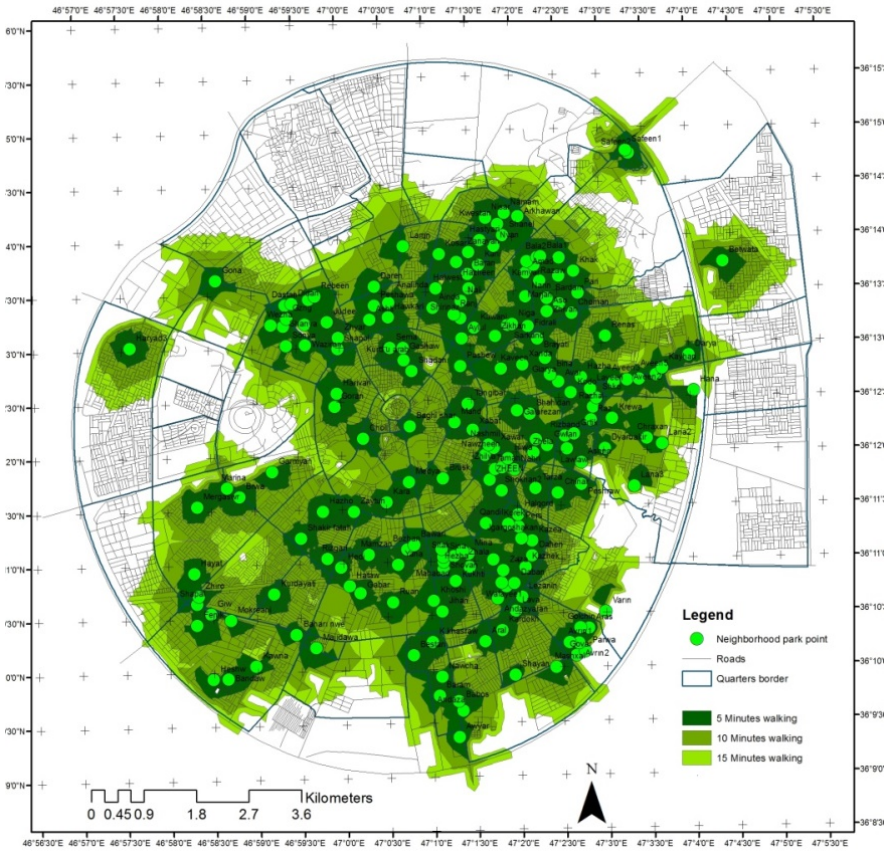

Figure 7. Accessibility of neighbourhood parks with 5, 10 and 15 minutes walking

DISCUSSION AND CONCLUSION

The aim of this research conducted in Erbil, Iraq was to evaluate the overall state of public green space and assess their accessibility within the city. Additionally, the study sought to ascertain the costs associated with accessing these green spaces, compare the accessibility of public green spaces in Erbil with global benchmarks, and identify areas within the city that require additional parks. There are many green spaces in Erbil city which were classified into active and passive types according to their daily use by people. The present study specifically focused on the active types, as they are deemed to be the most significant component of public green spaces within the metropolitan area. Additionally, the roads were categorized into four distinct groups based on their average speed limits.

To date, there is no extant research about the accessibility of green spaces in Erbil city, which would enable a comprehensive evaluation of the overall state of public green space. The present study represents the first known investigation regarding the accessibility of public green spaces within the city of Erbil. The network analysis tool in environmental GIS was used to determine time cost access to public green spaces divided into groups of small parks and large parks. Small parks include neighbourhood parks and mini parks with time cost calculated for walking distances of 300 m, 600 m and 900 m; meaning 5 minutes, 10 minutes and 15 minutes. Results for neighbourhood park access show 43% of the population had access with 5 minutes walking;

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71% of the population had accessibility in 10 minutes; and 80% of the population had access with 15 minutes walking. Access to mini parks with 5 minutes walking was available for 22% of the population; it encompassed 52% of residents with 10 minutes walking; and 70% of population had access with 15 minutes walking. For access to large parks, access to community parks and district parks was calculated for 5 minutes, 10 minutes and 15 minutes driving. For community parks, with 5 minutes driving 68% of population had access; with 10 minutes driving 99% of residents had access; and with 15 minutes driving 100% of the population had access. Network analysis for district parks found that with 5 minutes driving, 70% of residents had access; for 10 minutes driving 96% of the population had access; and for 15 minutes driving 100% of residents of Erbil city had access.

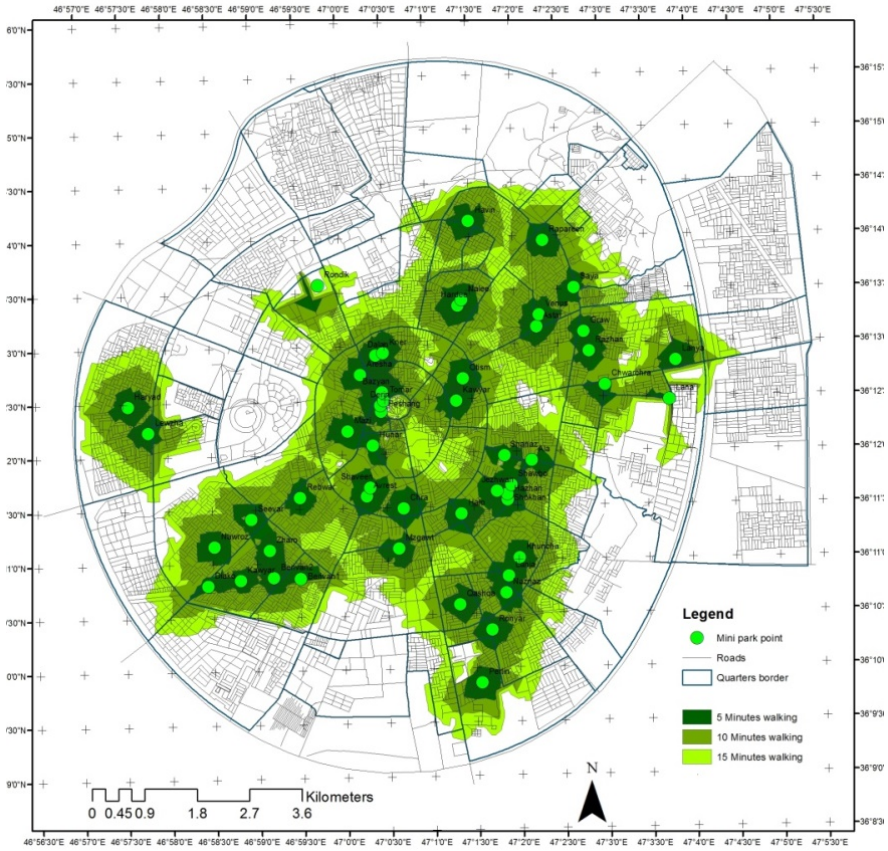

Figure 8. Accessibility to mini parks with 5, 10 and 15 minutes walking

Analysis possibilities offered by GIS software are important for the detection and/or modelling of spatial processes operating in a city. However, there are serious problems with spatial data to enable this type of analysis in the city of Erbil. These problems can be listed as lack of data, temporal and spatial extent of the data found, and problems related to timeliness and access. Additional challenges encountered in this investigation included the arduous task of procuring datasets from governmental entities due to security apprehensions, which impeded the accessibility of said datasets. All datasets utilized in this study are primary data that were manually generated. In terms of future research directions, it is recommended that further investigations be conducted

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about critical urban facilities and services such as health, fire fighting, and police stations. Additionally, incorporating real-time speed data in accessibility analyses may enhance the precision of the findings.

Within the scope of publications, the position-based service levels of the parks in the city were evaluated. However, in future studies, it will be possible to make an ecological network-based assessment of the green areas that provide input to the study with the data used, as in Cetin (2015). In this context, in addition to the presentation of green infrastructure as a service with an equitable approach, visual, recreational and aesthetic concerns, evaluation of the adequacy of green spaces as an ecological function and the status and potential of creating an ecological network will be the main criteria.

This study exhibits a dynamic nature, as it pertains to fluctuations in both the quality and quantity of green space. Furthermore, alterations to road networks may potentially impact the accessibility outcomes; thereby necessitating the need for updated data in future analyses.

REFERENCES

Ann,T.M. (1991): A study on the method of measuring accessibility to urban open spaces. - Landscape Architect, 18(4): 17-28.

Atiqul, Haq., Shah, M.D. (2011): Urban green spaces and an integrative approach to sustainable environment. - Journal of Environmental Protection, 2: 601-608. doi:10.4236/jep.2011.25069 (http://www.scirp.org/journal/jep).

Bennet, S., Yiannakoulias, N., Williams, A. and Kitchen, P. (2012): Playground Accessibility and Neighbourhood Social İnteraction Among Parents. - Social Indicators Research 108: 199-213.

Bilgili, B.C., Gokyer, E. (2013): Urban green space system planning. - Published by InTech. DOI: 10.5772/45877.http://www.intechopen.com/books/landscape-planning/urban-green-space-system-planning

Boone, C., Buckley, G., Morgan, G. and Sister C. (2009): Parks and People: An Environmental Justice İnquiry in Baltimore, Maryland. - Annals of the Association of American Geographers 99(4): 767-787.

Cetin, M., (2015): Using GIS analysis to assess urban green space in terms of accessibility: case study in Kutahya, International Journal of Sustainable Development & World Ecology, 22:5, 420-424, DOI: 10.1080/13504509.2015.1061066

Chona, S., Wolch, J., Wilson, J. (2010): Got green? addressing environmental justice in park provision. - Geo Journal, 75(3): 229-248.

Comber, A., Brunsdon, C. and 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: 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 and Medicine, 70(6): 816-822.

Coutts, C., Horner, M. and Chapin T. (2010): Using GIS to model the effects of green space accessibility on mortality in Florida. - Geocarto İnternational 25(6): 471

DOI: 10.15320/ICONARP.2023.231

Coutts, C., Chapin, T., Horner, M. and Taylor, C. (2013): County-Level Effects of Green Space Access on Physical Activity. - Journal of Physical Activity and Health10(2): 232-240.

Czerniak, J. (2007): Large Parks. - Princeton Architectual Press, New York.

Dai, D. (2011): Racial/ethnic and socioeconomic disparities in urban green space accessibility: Where to intervene?. - Landscape and Urban Planning, 102(4): 234-244.

Deshpande, A. D., Baker, E. A., Lovegreen, S. L., Brownson, R. C. (2005): Environmental correlates of physical activity among individuals with diabetes in the rural Midwest. - Diabetes Care, 28: 1012-1018.

Eom, S., Cho, C., Choi, Y. (2008): The study of estimating total greenspace on the seoul metropolitan by the location-allocation model. - The Korea Spatial Planning Review, 56(3): 61-78.

Eom, S., Lee, S. (2009): Application of the Urban Green Assessment Model For The Korean Newtowns. - International Conference on Computational Science and Its Applications, Seoul.

Etzioni, A. (1998): The Essential Communitarian Reader, Rowman and Littlefield. - Lanham.

Gobster, P. H. (1995): Perception and Use of a Metropolitan Greenway System For Recreation. - University of Massachusetts, Boston.

Halden, Derek., Mcguigan, David., Nisbet, Andrew., Mckinnon, Alan., (2000): Guidance On Accessibility Measuring Techniques And Their Application, Scottish Executive Central Research Unit, http://www.scotland.gov.uk/cru/kd01/blue/guidance.pdf

Herzele, V., Wiedeman, T. (2003): A monitoring tool for the provision for accessible and attractive green spaces. - Landscape and Urban Planning, 63(2): 109-126. doi:10.1016/S0169-2046(02)00192-5.

Hirokawa, K. H. (2011): Sustainability and the urban forest: An ecosystem services perspective. - Natural Resources Journal, 51(2): 233-259.

Hodgart, R. L., (1978): Optimizing access to public services: A review of problems, models and methods of locating central facilities. - Progress in Human Geography, 2(1): 17-48.

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: 1451-1456.

Kemec, S. (2001): Accessibility with its conceptual and theoretical dimensions (Unpublished graduation thesis). - Gazi University, Faculty of Engineering and Architecture, Department of City and Regional Planning, Ankara, Turkey.

Kemec S., E., K., Karahan, Y., Mert, (2019): Spatial Accessibility Analysis of Emergency Health Units: The Case of Van City, Van Yuzuncu Yil University Journal of the Institute of Science and Technology, Volume 24, Number 1, 30-40

Kuntay, O. (1976): Physical accessibility and attraction as planning control tools. - Journal of the Urbanism Institute, 33-47.

Kuntay, O., (1990): Erişilebilirlik Kesin Bir Öncelik. - Planlama Dergisi, Journal Of The Chamber Of City Planners, 90/1-2, 7

Lee, T. (1968): Urban neighborhood as a socio-spatial schema. - Human Relationships, 21(3): 241-267.

Lindsey, G., Maraj, M., Kuan, S. (2001): Access, equity and urban greenways: An

exploratory investigation. - Professional Geographer, 53(3): 332-346.

Martin, D. (1998): Automatic neighborhood identification from population surfaces. - Computer, Environment and Urban Systems, 22(2): 107-120.

Massey, R. (2004): Environmental Justice: Income, Race, and Health. - Medford: Global Development end environment institute, Tufts University.

Moseley, D., Marzano, M., Chetcuti, J., Watts, K. (2013): Green networks for people: Application of a functional approach to support the planning and management of greenspace. - Landscape and Urban Planning, 116: 1-12.

Neuvonen, M., Sievanen, T., Susan T., Terhi, K. (2007): Access to green areas and the frequency of visits: a case study in helsinki. - Elsevier: Urban Forestry and Urban Greening, 6(4): 235-247.

Nicholls, S., Shafer, C. S. (1999): Measuring The Accessibility and Equity of Public Parks: A Case Study Using GIS. - Thesis. Texas A and M university, Texas.

Pacione, M., (1982): Neighborhoods and public service boundaries in the city: A geographical analysis. - Geoforum, 13(3): 237-244.

Payne, L., Orsega-Smith, E., Roy, M., Godbey, G. (2005): Local park use and personal health among older adults: an exploratory study. - Journal of Park and Recreation Administration, 23: 1-20.

Potwarka, L. R., Kaczynski, A. T., Flack, A. L. (2008): Places to play: association of park space and facilities with healthy weight status among children. - Journal of Community Health, 33: 344-350.

Project for Public Spaces (2013): No Title. What Makes a Successful Place? - Retrieved September 07, 2022, from https://www.pps.org/reference/grplacefeat

Sallis, J. F., Frank, L. D., Saelens, B. E., Kraft, M. K. (2004): Active transportation and physical activity: opportunities for collaboration on transportation and public health research. - Transportation Research Part A: Policy and Practice, 38(4): 249-268. doi:10.1016/j.tra.2003.11.003.

SGV (2008): Melbourne 2030: Planning Update-Melbourne @ 5 Million. - State government of victoria, Melbourne.

Solecki, D.W., Welch, M.C. (1995): Urban parks: Green spaces or green walls? - Landscape and Urban Planning. 32: 93-106.

Steadman, P. (2004): Guest editorial: Developments in space syntax. - Environment and Planning B: Planning and Design, 31: 483-486.

Sugiyama, T., Leslie, E., Giles-Corti, B., Owen, N. (2008): Associations of neighbour- hood greenness with physical and mental health: do walking, social coherence and local social interaction explain the relationships? - Journal of Epidemiology and Community Health, 62-69.

Sun, R., Chen, A., Li, F., Wang, D., Xu, Z., Chen, L. (2013): Guidelines and evaluation indicators of urban ecological landscape construction. - Acta Ecologica Sinica, 33(8): 2322-2329.

Talen, E. (1998): Visualizing fairness: Equity maps for planners. - Journal of the American Planning Association, 64(1): 22-38.

VDSE (2002): Melbourne 2030 Planning For Sustainable Growth. - Victorian department of sustainability and environment.

Watmough, G.R., Atkinson, P. M., Hutton, C.W. (2013): Exploring the links between census and environment using remotely sensed satellite sensor imagery. - Journal of Land Use Science, 8(3): 284-303.

Wilbur, J., Chandler, P., Dancy, B., Choi, J., Plonczynski, D. (2002):

DOI: 10.15320/ICONARP.2023.231

Environmental, policy, and cultural factors related to physical activity in urban. - African– American women. Women and Health, 36: 17-28.

Zhang, X., Lu, H., Holt, J. B. (2011): Modeling spatial accessibility to parks: A national study. - International Journal of Health Geographics, 10(31): 1-25.

Resume

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