

**Analysis of Walking Accessibility of Community Park in Duhok City**  
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**Abstract**

Research studies show that urban green spaces promote physical activity, the health of urban residents, and psychological well-being. Taking the community park in Duhok city as the research object, the spatial service area in terms of accessibility of to the Community Park under the mode of pedestrian transportation is analyzed by using the network analysis service area function of the geographic information system (GIS). The results show that under the walking mode in the research area, Parks are concentrated in the north and south of the city, but community parks are few in disadvantaged neighborhoods. In addition, there is a significant disparity between the number of community parks and the number of communities. Only 11 communities have walking access to a community park, whereas roughly 31 neighborhoods could not access. However, the network study results show that there is no pedestrian access to Azadi Park because it is positioned in the center of the roads. Finally, because of the community park's undesirable location, overall accessibility is poor, and space accessibility is low. The distribution of parks does not correspond to accessibility requirements. Furthermore, as the number of people increases, the present urban park green space cannot fulfill the demands of all urban residents. The findings of the study suggest that GIS network analysis might be used to improve the spatial design and layout of community parks in Duhok city to be more sustainable.

**Keywords :** Duhok city; Community Park; Green spaces; GIS; green infrastructure; accessibility

## التحليل المكاني لإمكانية الوصول سيرا الي الحدائق العامة في مدينة دهوك

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### الخلاصة

تظهر الدراسات والبحوث العلمية أن وجود المساحات الخضراء الحضرية في المدن تعزّز من النشاط البدني للأفراد ، وصحة سكان الحضر ، والشعور بالراحة النفسية . من هذا المنطلق تم التطرّق خلال هذه الدراسة إلى حالة الحدائق العامة في مدينة دهوك كموضوع للبحث ، حيث تم تحليل منطقة الخدمة المكانية للحديقة العامة من حيث إمكانية الوصول إليها سيرا على الاقدام وذلك باستعمال (وظيفة منطقة خدمة التحليل الشبكي) في نظم المعلومات الجغرافية (GIS). أظهرت الدراسة أنه في حالة استعمال وضعية المشي للوصول إلى المساحات الخضراء ضمن منطقة البحث ، تبين أنه تتوفر هذه الحدائق بشكل منطقي نوعا ما في الوجهة الشمالية والوجهة الجنوبية لمدينة ، في حين تقل هذه الكثافة في وجهة الشرقية الغربية .

بالإضافة إلى ذلك ، هناك تفاوت كبير بين عدد الحدائق العامة وعدد الاحياء السكنية ، إذ تبين أنه من بين 31 حيا سكنيا في المنطقة المعنية يمكن للأفراد من 11 حي سكني فقط الوصول سيرا على الأقدام إلى حديقة عامة ، علاوة على ذلك تظهر نتائج تحليل الشبكة باستعمال نظام GIS أنه لا يوجد وصول للمشاة إلى حديقة آزادي التي هي إحدى الحدائق العامة والاكثر من بين حدائق المدينة لأنها تقع في وسط شبكة من طرق المواصلات الغير القابل لاجتياز . أخيرا ، بسبب الموقع غير المرغوب فيه للحدائق العامة في مدينة دهوك ، فإن إمكانية الوصول إليها باستعمال وضعية المشي بشكل عام تكون ضعيفة وعليه فإن الوصول إلى المساحة الخضراء تكون بدرجة منخفضة ، ويتبين من ذلك أنه لا يوجد هنالك توافق بين توزيع المتنزهات العامة في المدينة وبين إمكانية الوصول إليها سيرا نظرا لسوء توزيعها المكاني وعدم اتباع المعايير المكاني . علاوة على ذلك ، مع زيادة عدد الأفراد لا تستطيع المساحات الخضراء الحالية للحديقة الحضرية تلبية متطلبات جميع سكان الحضر.

من الجدير بالذكر أن نتائج الدراسة تشير إلى إمكانية استعمال وظيفة التحليل الشبكي في نظم المعلومات الجغرافية لتحسين التصميم المكاني وتخطيط الحدائق العامة في مدينة دهوك بطريقة مستدامة .

**الكلمات المفتاحية :** مدينة دهوك؛ الحديقة العامة ؛ المساحات الخضراء ؛ نظم المعلومات الجغرافية ؛ البنية التحتية

### 1. Introduction :

The green spaces have been defined by (Kuta et al., 2014) as “an area within an urban environment which is dedicated to nature”. The green spaces could not only improve the people life but also provide a place to people for picnics lawns, hiking trails, serene environment for human use as well for relaxation (Willis and Osman, 2005). The psychological benefit another improvement that provide by the green space along with urban environment quality improvement for the residents (Kuta et al., 2014). Green space in cities is an important component of urban modernization and green infrastructure. It not only offers inhabitants a wonderful soft environment, but it also serves to protect the environment, improve the ecology, cleanse the water body, and block noise. At the same time, it has the functions of enhancing city-style, preventing and mitigating catastrophes, storing water, and flood management, furthermore, the park's green space provides a location for residents to engage in leisure and entertainment activities. Also serves as a gathering place (Wolch et al., 2014). The accessibility to services and goods is a difficult notion that pervades territorial issues completely, it is related to the individual ability to participate in activities and travel to various locations in an environment (Thériault, 2005). Nowadays the regulations of current cities accessibility and systematic application have been improved in cities system, in many cases, our cities are not fully accessible (Andújar-Montoya, 2016). Either permanently or temporarily people with disabilities, are still some places that are not accessible to them, and their daily problems are full of indifference and obstacles (Jouffe, 2010). The accessibility level of cities public spaces has an impact on the standard of living of citizens and their possibilities limits social integration and enhancing relationships (Clarke et al., 2008). The best walking accessibility and enough supply of cities parks are critical for the mental and physical well-being of people that live inside cities, especially for the people who lives in a megacity (Liang, 2017). The accessibility of public parks is a key method for assessing their overall service. The difficult degree of overcoming space resistance in the process of inhabitants getting to the park from their place of residence is characterized by the accessibility of an urban park. It can objectively represent the logic of the spatial

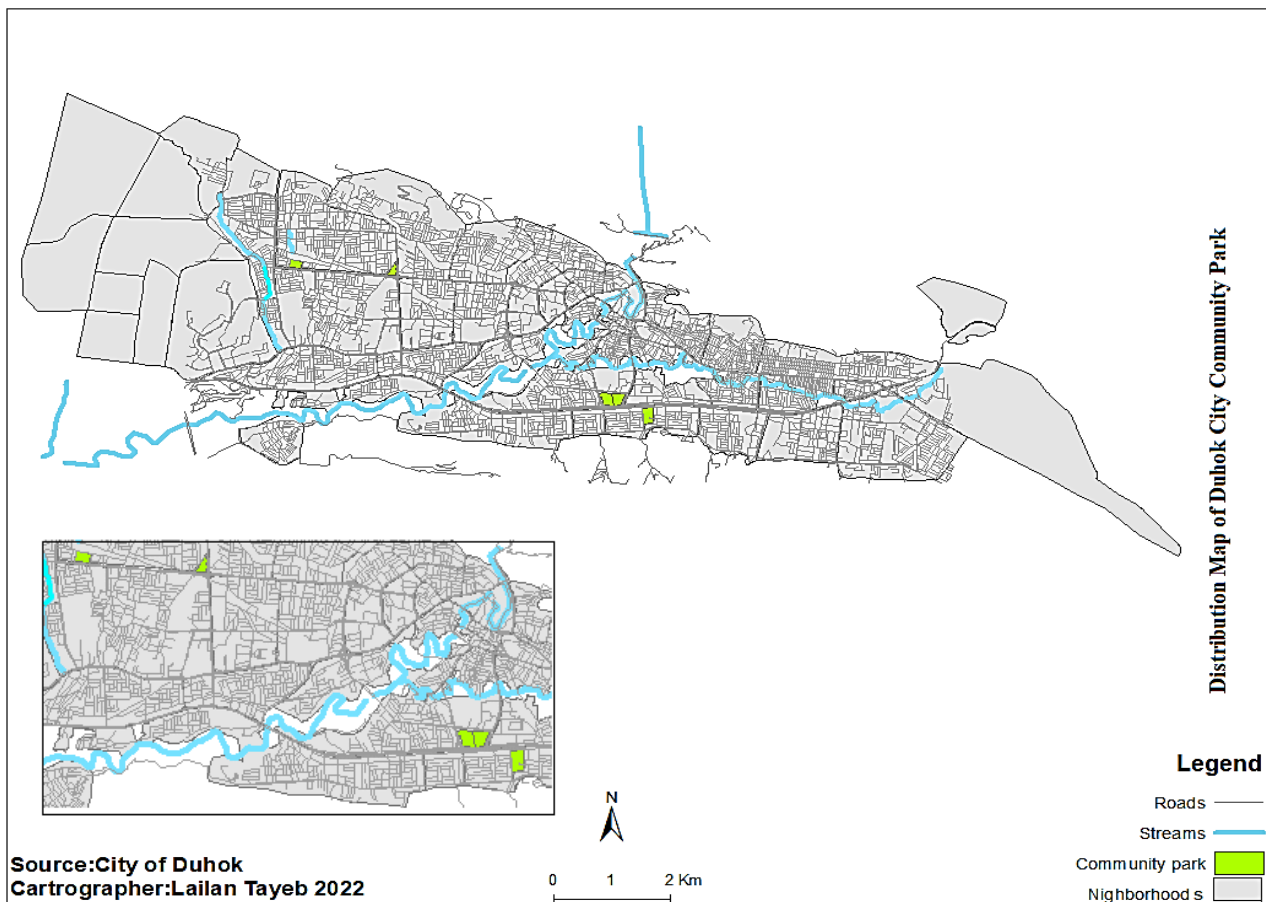
arrangement of open green space, and it is an essential indicator to evaluate whether inhabitants can enjoy urban green space equitably and easily. It is influenced by time, distance, cost, and other considerations (Jabbari et al., 2021). GIS has been shown to be a valuable tool for determining park accessibility. The modeling of accessibility to green spaces has advanced significantly in recent years as a result of improved GIS features, notably the development of GIS modules such as the ArcGIS Network Analyst Tool (Nicholls 2001). The development of Duhok City has begun on a dramatic scale since 1990 (Mustafa et al., 2012). The method is quite clumsy. Due to financial restrictions and a lack of scientific information. The development process faces the problem of a diminished overall distribution of green open space as well as an inappropriate regional arrangement (Hajani, 2019). As a result, network analysis will be applied in this paper to examine the sufficiency of community park services in the Duhok district in terms of accessibility, and spatial distribution. Climate change and the Corona epidemic necessitate reconsidering the usage of automobiles and improving green space within cities. On the other hand, traffic congestion, high fuel expenses, and a lack of time for recreation outside of the city are all key aspects to consider while looking for walkable recreation areas. Thus, the aim of this study is to investigate the adequacy of community park services in Duhok city in terms of accessibility (walkability) and spatial distribution by using GIS grid analysis function, the issues occurred in the green space (urban park) accessibility under three different distance modes of walking 600m, 800m and 1000m are analyzed.

## **Methodology**

### **1.1. Study Area**

The city of Duhok is the center of the Duhok Governorate and one of the most important tourist destinations. It is located at latitudes 36° 50'00" and 36° 54'40"N, and longitudes 42° 52'00" and 43° 04'44"E. The city of Duhok is located on a flat plain about 430-450 m above sea level (Mahdi et al., 2018). Duhok lies between Irano-Anatolian and Mediterranean region (Youssef et al, 2015). According to the (Peel et al. 2007) Köppen-Geiger climate system classification Duhok city is classified as a semi-arid region. With

regard to the conditions of weather (Temperature and Rainfall) within starting and ending



season of precipitation in the city, the mean annual temperature is around 26.7 °C for 2021 - 2022. It is between two mountain ranges, Chandokha in the south and Sibi in the north, and covered roughly 10715 km<sup>2</sup>s. There are two rivers passing through the city; the first one is called the Duhok River, whilst the second one is smaller and seasonal called Heshkarow River. Both rivers meet up in the southwest of the city (Mustafa et al., 2012). The rural-urban migration and refugee repatriation have resulted in massive population growth over the last two decades. It increased from 982,340 in 2019 to 1,034,112 in 2021 (Natali, 2013).

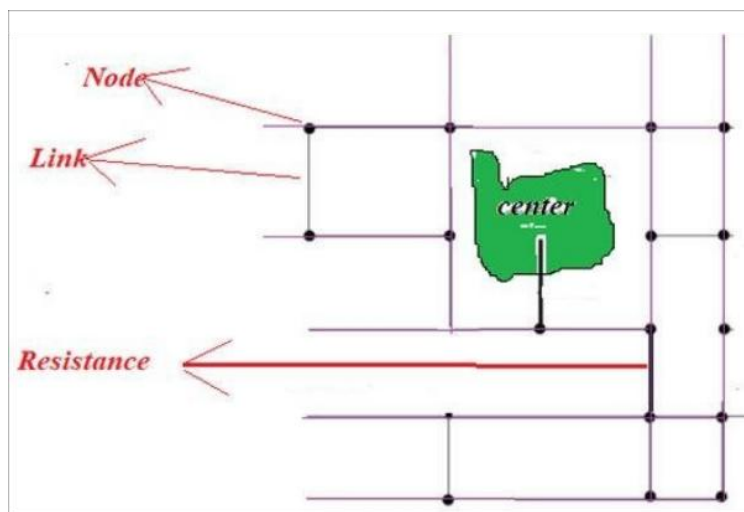
**Figure 1: Distribution Map of Duhok City Community Park**

This demographic movement has resulted in the city's unexpected change from its southern, western, and eastern outskirts. As a result, the city has a large and diverse number of ethnic minorities and socio-economic groups on the other side. So it is facing congested roads, which is limiting access to the recreation area. Duhok is characterized

by a relevant shortage of public green spaces and services, especially community parks. Currently, the number of community parks is about four parks with an area of 0.191546 km<sup>2</sup> covering only 12 neighborhoods with 19.2708km<sup>2</sup> (see Fig 1). Residents are now looking for recreation spaces close to their houses. Because it is secure, inexpensive, and simple to access and return back home.

## 1.2. Network Analysis Method

A geographic network is a reticular arrangement made up of several lines and spots. This linear network carries network resources. The basic parts of a network are linear entities and the places at which these linear entities cross, often known as links or network lines and nodes. A full network consists of the center, link, node, and resistance (see Fig 2), with the center serving as the primary study object. The node is the crossroads in this



study, the chain is the traffic path from residences to the park, the center is the entry and exit of each park, and the resistance is the speed and node delay of different traffic modes.

**Figure 2: Elements of Network**

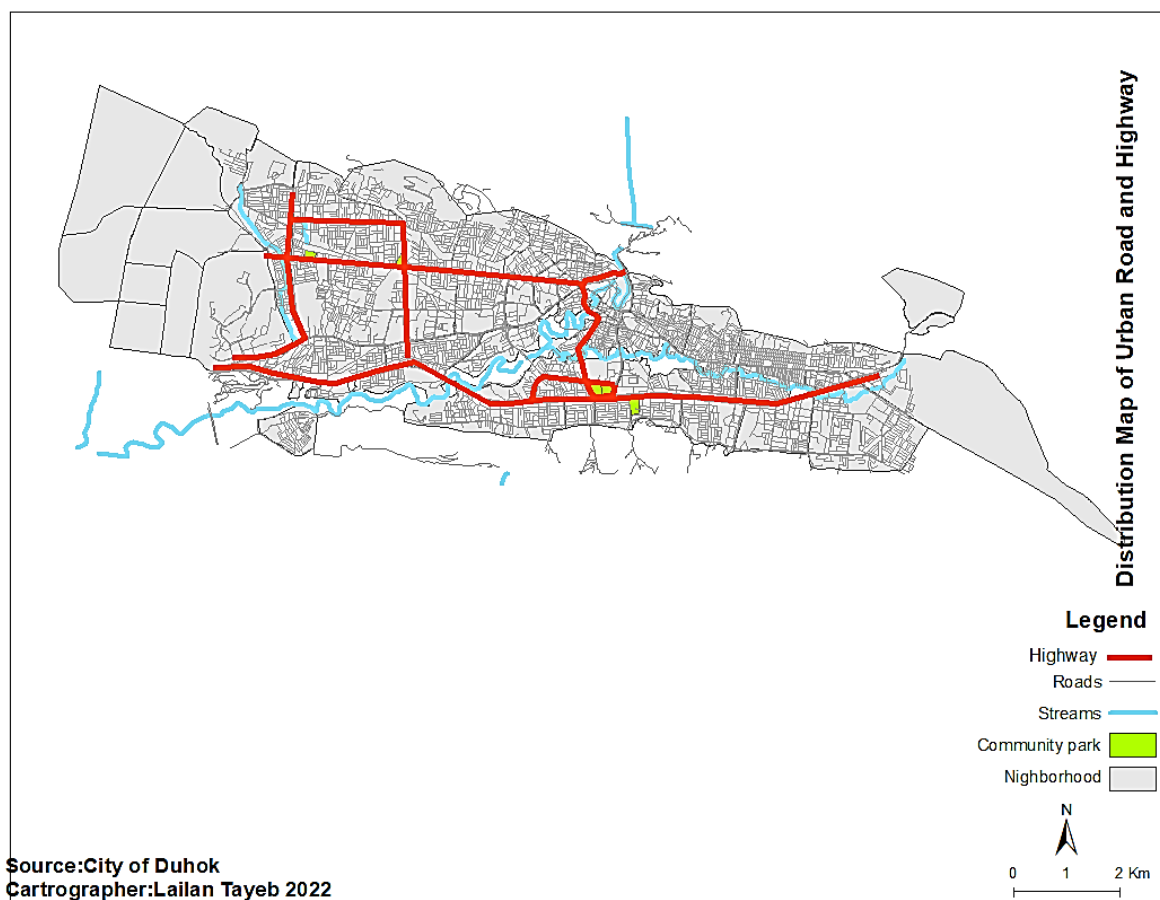
## 1.3. Data Source

The data used in the paper was gathered from the Duhok City Council. Three fields were added to the community park attribute tables. As it was important for the analysis. To know the area of the community park, the area for each community park was converted from meter square to km square. However, the information obtained from the

government body was neither comprehensive nor complete for the entire study area. So the analysis was carried out based on the available data.

#### 1.4. Build a Network Data

The network dataset was built with the network data tool option and its properties in Arc Catalogs. Create a network data collection based on a well-screened image fusion path. Add the shape file of the highway, (see Fig 3) shows the net road, highway, and park location.



**Figure 3: Distribution Map of Urban Road and Highway**

To create a network data collection, specify network data set properties and set connectivity by using the resistance value. The study will be based on the Iraq green open space accessibility index (urban housing standards manual, 2010). The distance accessing the community park green space is 400 meters, 600 meters, 800 meters 1000 (crossing with collector streets allowed), which are graded by good, intermediate, and poor, very

poor respectively. Further, it corresponds with criteria for determining accessibility in a certain amount of time (Urban housing standards manual,2010) as shown in table 1.

Table 1: Accessibility Walking Iraq Criteria Of Community Park

| Accessibility   |              | Rate         |
|-----------------|--------------|--------------|
| Distance /meter | Time/minutes |              |
| 0-400           | 10 min       | Good         |
| 0-600m          | 15 min       | Intermediate |
| 0-800m          | 20 min       | Poor         |
| 0_1000          | 30 min       | Very poor    |

(Urban housing standards manual,2010).

## 1.5. Network Building Procedures

### A- Topology

- The first steps will fix the error by making a topology in the Catalog pane, right-clicking the feature dataset to which you want to add a topology, and clicking New > Create Topology.
- Then add rule network road > must not overlap, should not intersect >ok, topology data set will be set and the error will be exhibition.
- Display the topology toolbar by clicking Customize > Toolbars > Topology. If the Topology Toolbar is greyed out, you have to turn on Editing mode by clicking Editor > Start Editing.



Figure4: Topology

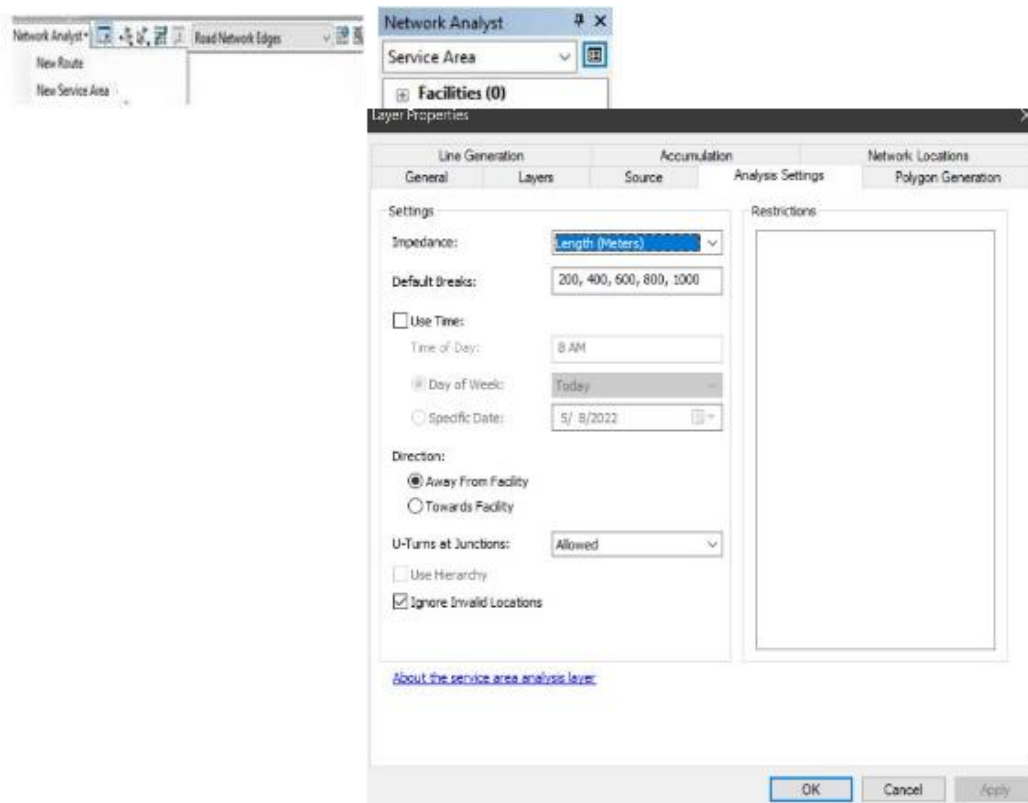
B- Check geometry data management>input feature= Duhok roads>output

tables>save >ok Note: The highway roads on the Duhok map did not have the same speeds as real so we have to choose the table of contained > started edited and change the value or make a new shapefile and table attributes

C- Creating network >Service Areas in ArcGIS Network Analyst.

- ☐ Arc catalog> new folder >copy the files = collector roads, highway, parks, streams to one file
- ☐ Selected roads>new network>put the criteria for the mode of travel >walk>next>ok
- ☐ Selected service area in network analysis>ok
- ☐ Selected facilities > load location >parks >ok
- ☐ Selected line restriction >load location >highway >ok
- ☐ Selected service area properties>put criteria for our model  
“dependent on Iraqi accessibility to community park “ as in table1

Give fundamental field attributes required by the road network. Set network connectivity, specify network data set attributes, and set resistance value to build a network data set.



**Figure 5: Layer Properties**

Finally, we click on solve



**Figure 6: Network solve step**

For future scenario “1” Buffer>input = HashkaRwa stream >liner =50meters>ok.

## 2. Results And Discussion

The walking accessibility-distribution map of the community park in Duhok City within different distances of 400, 600, 800, and 1000 meters (as shown in Figure4) is derived by the calculation of the ArcGIS service area. First and foremost, the findings showed that community parks are only in the northern and southern districts. Also only 11 neighborhoods have access to the community park by walking while nearly 31 neighborhoods lack community parks. Moreover, the results show that the accessibility to

the community open green spaces according to the study distances are varies from 400m to 1000m due to some problem in site establishing according to the spatial planning criteria in term of high ways and the interior corridors that connect the people to the park in term of access, because of that, it can be seen clearly that the accessibility to the parks are very low. Azadi Park which is the biggest park (0.085192) km<sup>2</sup> is obviously are non-due to having high ways surrounding the park which create unsafe conditions to the community. Additionally, Azadi and Barzani parks are too close to each other. Moreover, Tahsin Taha Park, and Dilshad park , overlap in zone of 1000m of the service area. Thus the distribution of both parks are not valid. Tahsin Taha park is the smallest of the parks (0.022953) km<sup>2</sup> because it is surrounded by a highway from the east and south, but its accessibility service area in zones 400,600,800m are 123.027, 221.978, 356.618m<sup>2</sup>Consequently. As is the case with Tahsin Taha Park, Dilshad park with (0.029969) km<sup>2</sup>'s similarly bounded by a highway extending from south to west. Only Mustafa Barzani park which is about (0.053432) km<sup>2</sup> remains among the parks that are restricted by the roadway on one side resulting in the greatest accessibility service area as

shown in table 2.

**Table 2: Accessibility Service area Zones of Community Park**

| Parks           | Area km <sup>2</sup> | Accessibility area zone square meter |         |         |         |
|-----------------|----------------------|--------------------------------------|---------|---------|---------|
|                 |                      | 400m                                 | 600 m   | 800 m   | 1000 m  |
| Mustafa Barzani | 0.022953             | 129,527                              | 291,433 | 505,849 | 714,386 |
| Tahsin Taha     | 0.029969             | 123,027                              | 221,978 | 356,618 | 467,363 |
| Dilshad Saeed   | 0.053432             | 155,465                              | 284,720 | 436,525 | 611,578 |
| Azadi           | 0.085192             | -                                    | -       | -       | -       |

Establishing public parks without a city's planning criteria, namely social, environmental, and economic requirements, results in inefficient parks, a waste of money, and higher expenses for municipal management.

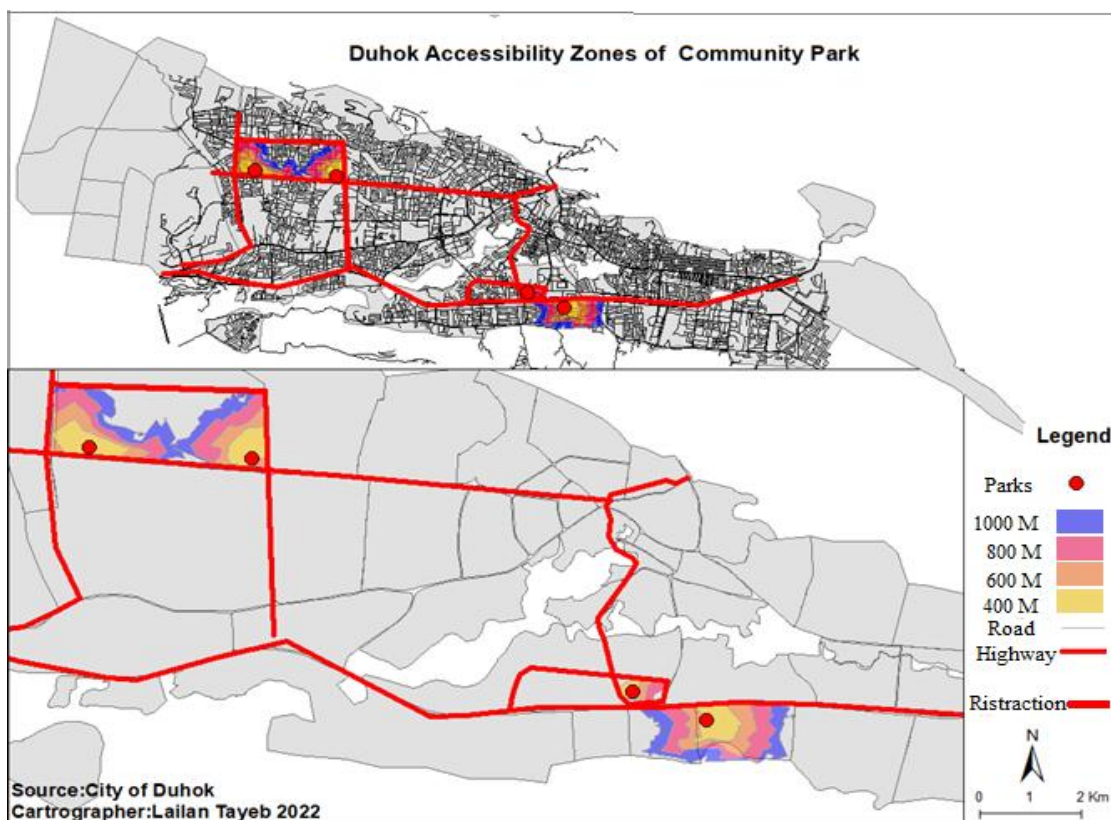
As long as the parks are near to roads, there is a considerable risk of traffic accidents, raising the city's health-care costs. The gases and heat released by automobiles damage the plant cover, which is the main factor in these parks, raising management expenses and impacting the public health of people who visit the park, because children, elderly, and women comprise the majority of park visitors, Chow et al (2016).

Accordingly, it is not enough to have parks without people having access to them with safe and ease within accessible distance. They should be distributed according to the spatial parameters to avoid a situation where they will all be located in one place or a lack of access location. as Liu et al., (2011) noted that the community prefers to access the safe open green spaces, hence the access to the convenient and safe open green spaces is tending to be environmental factor important that promote health effort and physical activity. Community parks provide space for sport and other types of recreation because it's larger than other types of green open spaces. So people feel comfortable in the community park. In addition, If the community feels the safety of the park the demand on getting enjoyment and recreation would increase, and the demand for parks in becoming higher in order to access the quiet environment or clean air, as well as to obtain recreation, aesthetic and enjoyment (Liu et al., 2011).

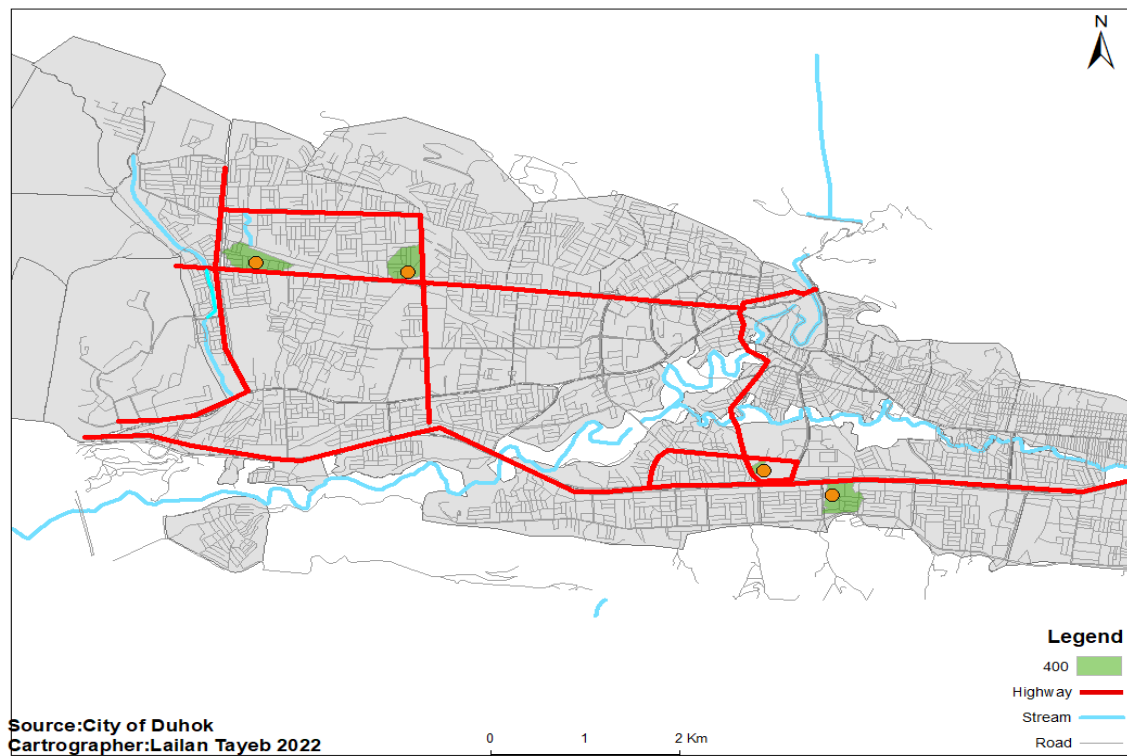
The result was in contradict with the accessibility walking Iraq criteria of community park which mentioned that the distance between 0-1000 is very poor, while It

can be seen from the study findings showed that the walking accessibility of Azadi park in Duhok city is extremely poor see(Fig8), Ken and Osman (2005) highlighted that the more attractive and accessible the parks, the more will be used by the people in a wide range. Urban and regional planners are consequently encouraged to utilize GIS base network analysis in order to satisfy standards and identify areas that increase access in the green spaces. Planner can save time and effort by employing GIS network analysis, on the other hand, offers a lot of power.

It may be used to examine the existing condition and provide the best option for enhancing accessibility using various types of criteria, as well as to identify the appropriate allocation for other parks, and gathering areas, and calculate distances.



**Figure 7: Duhok Accessibility zones of community parks.**



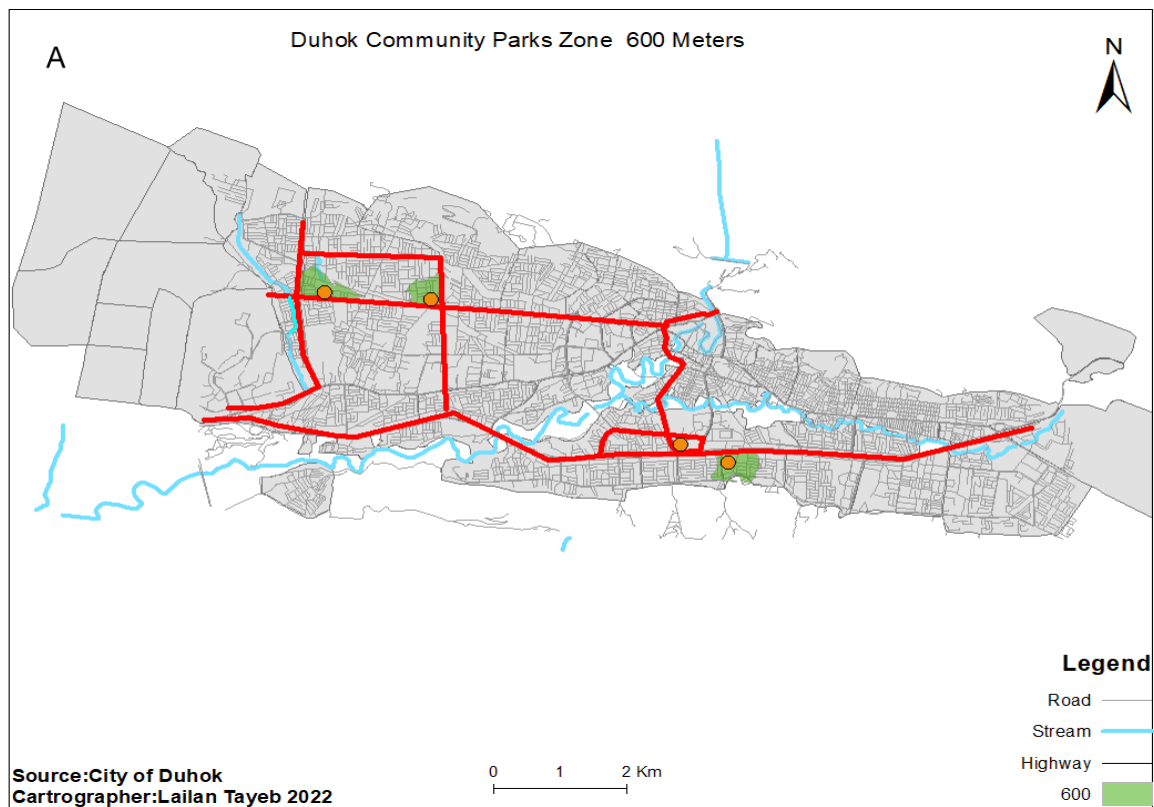
**Figure 8: Duhok Accessibility zone 400m community parks.**

### **3. Conclusion And Recommendation**

In this paper, the accessibility of urban park green space in Duhok City is analyzed based on walking mode. Although the city of Duhok has a linear shape from east to west, but parks are only found in the northern and southern districts. While East and West Park is lacking and basically has no community Park coverage as shown in the distribution map of Duhok city community park (Fig1) most of the location of the community parks is discriminatory. Also, there is a big gap between the number of community parks and the number of neighborhoods. Only 11 neighborhoods have access to the community park by walking while nearly 31 neighborhoods lack community parks. Yet it can be seen from the network analysis results that there is no access to Azadi park by walking because it is located in the middle of the highways.

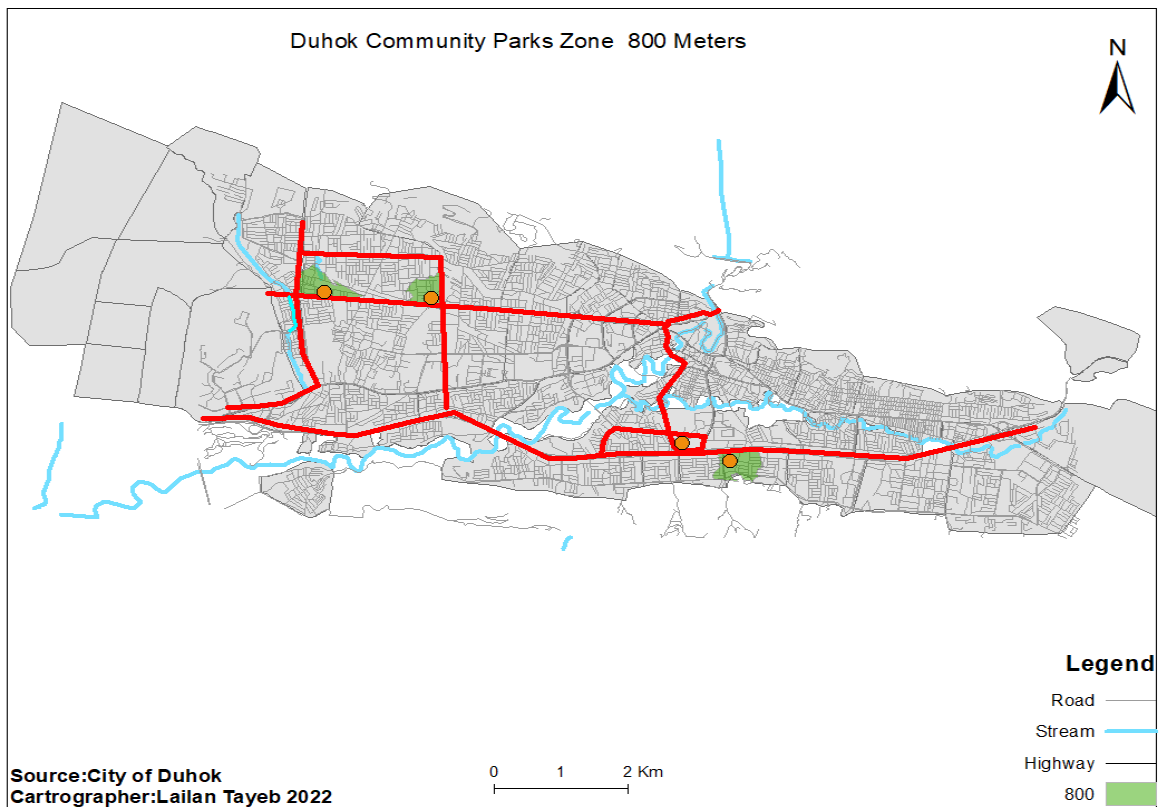
Finally, due to the inconvenient location of the community park overall accessibility is poor, and the accessibility of space is not good as shown in accessibility zones of community parks Duhok city, 2022: A, B, C, The distribution of parks is not following criteria in terms of accessibility. Moreover, with the increase in the number of

residents, traffic accidents, long working hours, high fuel prices, and the scarcity of transportation modes, the current urban park green space cannot meet the needs of the whole urban residents. The study results found out that the choice of location is very important for example the Azadi Park represents the largest park, but its location among roads with a speed exceeding 60 km led to the loss of its visitors on the contrary Tahsin Taha is highly accessible because it is surrounded by one highway from the south side. The time and effort have been saved by employing GIS network analysis. GIS network analysis, on the other hand, offers a lot of power. It may be used to examine the existing condition and provide the best option for enhancing accessibility using various types of criteria, as well as to identify the appropriate allocation for other parks, and gathering areas, and to calculate distances.



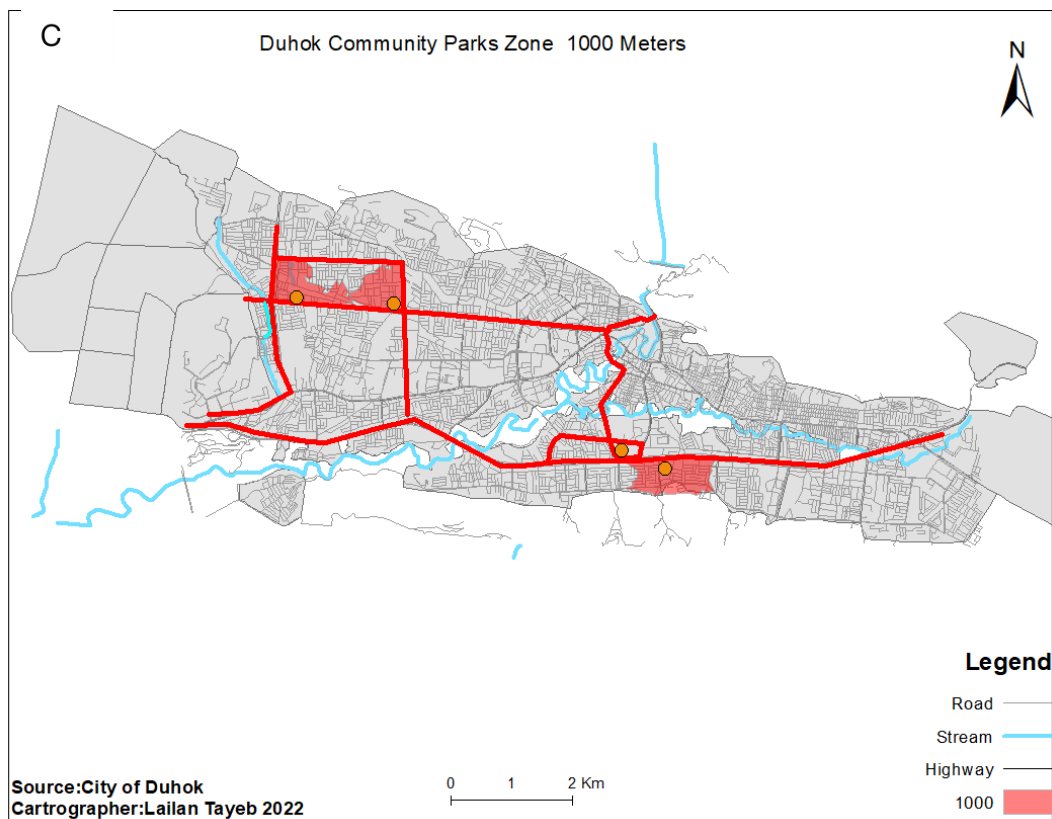
**Figure A: Duhok Accessibility Zone 600m community parks**

B



B

**Figure B: Duhok Accessibility Zone 800 m community park**

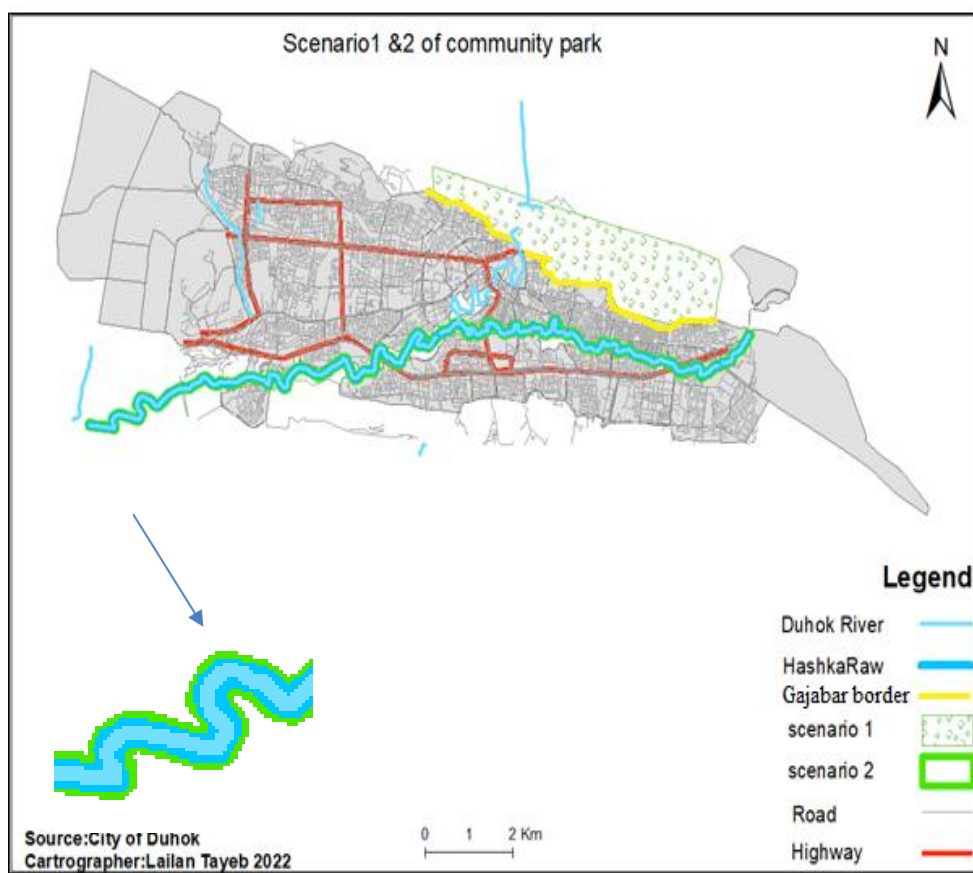


**Figure C: Duhok Accessibility Zone 1000 m Community park**

It is clear that there are many cause of the lack of accessibility to green open space in Duhok city . firstly, bad distribution and by focusing in two area north and south. Secondly bad location in the determined area close to high way from different side. Thirdly, lack of information's and neglecting urban development criteria. So to overcome the current park shortage in Duhok city, the green infrastructure offices must rely on modern methodology to assess the current situation of green spaces.

Additionally, there are two scenarios for establishing a community park as shown in (Fig 9)

- Semi-natural Community Park up Gajabar area.
- Along Hashka Raw stream because the area around Hashka Raw belongs to the government.



**Figure 9: Scenario 1&2 of community parks.**

Developing different community park maps and patterns and finding gaps and suitable places to improve green infrastructure in Duhok, and making land use maps could be the best techniques to solve the lack of green spaces in Duhok. Determining the roads leading to those spaces and determining the best, safest, and shortest routes to them, or finding other routes to those spaces and linking green open space paths to be more accessible all that can be easily done through network analysis.

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