Reality analysis of the state of spatial distribution of green areas using geographic information systems (GIS) – The holy city of Najaf as a case study.

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Abstract. Green areas are an essential component of city planning, as they serve as an outlet for them to spend their free time, in addition to the environmental role that these green areas play in improving the city's climate by purifying the air and beautifying the city. The study's problem is summarized in identifying the appropriateness of the current spatial distribution of green areas in the city of Najaf with the current population densities and the pattern in which green areas are distributed using GIS and knowing the per capita share of those green areas in the city, the research assumes that the inconsistency of spaces between regions Green and residential neighbourhoods need to conform to the standards for the individual share. The research also aims to know the reality of the green areas in the holy city of Najaf using GIS to take advantage of the capabilities provided by the program in the field of entering and analysing information related to its spatial distribution, as well as identifying the pattern in which the green areas are distributed in the city of Najaf, and come up with recommendations and proposals to address the existing imbalance. The research found that more than half of the neighbourhoods in the region do not conform to the standard followed in assessing the individual's share, where the individual's share ranged between (0.4 - 3.9) square meters, and there are neighbourhoods completely devoid of green areas, and this is due to poor planning in those areas. On the neighbourhood link index, the pattern of distribution of these green areas was aggregated to random. As for the Moran coefficient, its value departed from one frequently, indicating a weak spatial and random correlation of green areas. The area reached by the impact area of the green areas reached (5512) hectares, which is equivalent to (83.32%) of the total area of the Holy City of Najaf, and the neighbourhoods near the middle centre and surrounding it are the most intersecting neighbourhoods in the impact area.

1. Introduction

The green areas in the city are considered important and necessary areas, they are considered the lungs of the city and one of the basic things that must be taken into account when planning cities, most of the population use them to entertain and spend leisure time, in addition to the environmental role that these green areas play in improving the city climate through Air purification and beautification of the city, but from the social side, it is a way for the human being to relate to what surrounds him, as well as a means of interaction and social interaction between neighborhood residents and the city. These areas usually arise in shops and residential neighborhoods, as they are considered one of the cheapest and oldest recreational facilities, and they are close to residential units.
In general, green areas are green areas that occupy large areas, which can be planted with a number of different trees, which give them a beautiful view, and usually these green areas are infiltrated by pedestrian paths.

In light of the continuous population increase in all Iraqi cities in general and in the city of Najaf in particular and the continuous demand on the land for housing and other uses, this led to encroachment on those areas and green areas.

Hence our research came to study the current state of the spatial distribution of those green areas in the city of Najaf, and to know the suitability of these areas for the size of the population in the city and to know the pattern in which green spaces are spread and distributed.

2. The study area: City of Najaf

2.1. Location
The holy city of Najaf is astronomically located at longitude (44°17’ – 44°23’) east and latitude (31°58’—32°23’) as in Figure 1. Its western edges are within the eastern edges of the western plateau, but its eastern edges are within The floodplain, bordered to the east by the provinces of Muthanna and Qadisiyah, to the west by the Anbar Province and to the north by Karbala and Babil Governorate and from the south and southwest by the Kingdom of Saudi Arabia, and from the administrative point of view, the city of Najaf represents a center for the province of Najaf, according to the administrative classification currently in force in Iraq, which consists of several Administrative levels [1].

The location of the holy city of Najaf is located at the edge of the Western Desert, which is its extension to the country's borders with Saudi Arabia. On the north and northeast, it will look out over the Valley of Peace cemetery, and will be overlooking the low sea of Najaf from the west. And it is (10 km) from the city of Kufa and rises 70 meters from the sea [2].

![Figure 1. The location of the city of Najaf. [3]](image)

2.2. Surface
The location of the holy city of Najaf is predominantly relatively inconsistent, the surface heights (20-60 m) range from the sea level and these variations in the surface heights have a very important impact
in the urban environment, if the directions and patterns of human urbanization are determined, and their impact extends further than that it will have an effect in determining the type of land use in the city.

The province of Najaf, in general, is part of the western plateau and the sedimentary plain, and its slope is from the southwest, which is 420 meters above sea level, and towards the northeast, it takes the surface to drop to 10 meters above sea level, and that is at the low of the Najaf sea as shown in Figure 2, the highest height within this slope is represented by the historical nucleus, which reaches a height of (55 m) and then takes the slope to the south towards the Jadidat area, reaching a height of (49 m) above sea level, while the height to the north of the historical nucleus is (50 m). On the sea level represented by Wadi Al Salam Cemetery, the western side is connected to the Najaf Sea with a sharp and sudden slope, and the surface takes a slope from (55-35 AD) down to the end of the boundaries of the base plan (Kari Saada) from the east and toward Karbala Governorate from the north. According to the foregoing and what is currently the city, the area expansion of the city will be in two directions, the first on the northern axis (Najaf - Karbala) and the other southeast (Najaf - Diwaniyah) [4].

2.3. Climate

The climate is one of the important factors affecting the various activities of the city. The city of Najaf is distinguished as being located within the desert climate region, and its climate is characterized by the presence of two seasons (the summer season) which is hot and dry, and its beginning will be from April to the end of October, so the temperature has reached more The months are a rise in temperature, which is the month of July, about (36.3) A.D., and another season (the winter season) which is relatively cold and humid, and extends from November to the end of March, and the lowest temperature was January, when it reached a degree The temperature is about (10.3) m, and the high daily and annual thermal range for the city of Najaf is due to the astronomical site occupied by the city, it is located to the south of the northern temperate region, which led to the length of summer and high temperatures [5].

3. The study area: the city of Najaf

The study area is the same as the rest of the districts and areas of the Najaf governorate, which have witnessed significant population growth during recent years, given the region’s progress and the availability of various services in it as it represents the center of the province as this increase is due to high fertility rates and social factors such as early marriage, so all these and other reasons helped To increase the population of the city of Najaf. Through table 1 and Figure 2 the population of the Holy City of Najaf in 2020 was 685709, which is equivalent to (46%) of the total population of the province of Najaf, which is (1488092), which is the highest of the proportions found in Table 2, This is due to the reasons mentioned above.

As for the neighborhoods of the holy city of Najaf, the population percentages were varied, as the military district occupied the highest percentage in terms of population, it reached (10.47%) of the total population of the city of Najaf, and then came the fourth new after it with a population of (9.62%), then the military district with a percentage (6.74%) Then the percentages will gradually be taken down to the lowest percentage of the population that was in the Health District, which is (0.12%), as in Table 2.

| The administrative unit      | Population | %  |
|------------------------------|------------|----|
| Najaf District Center        | 685709     | 46 |
| Al-Haidariya Township        | 87990      | 6  |
| Alshabaka Township           | 12         | 0  |
| Kufa District Center         | 255269     | 17 |
| Al-eabbasia Township         | 110043     | 7  |
Table 2. Distribution the number and the relative population of the neighborhoods of the city of Najaf.

| Neighborhoods               | Population | %   | Neighborhoods               | Population | %   |
|-----------------------------|------------|-----|-----------------------------|------------|-----|
| Alhanana                    | 5429       | 0.65| al'amir                     | 25482      | 3.04|
| ALHussein                   | 15830      | 1.89| Alsaed                      | 10554      | 1.26|
| Alkarama                    | 6790       | 0.81| Al 'iiskan                  | 3487       | 0.42|
| Alsiha                      | 965        | 0.12| Alaishtirakiu               | 3365       | 0.40|
| Aleulama' / Alshueara' ,    | 14644      | 1.75| Almuthanaa / 14timuz        | 6585       | 0.79|
| Alfaris                     |            |     |                             |            |     |
| Alghadir                    | 9989       | 1.19| Almuealimin / al'imam almahdi | 8219       | 0.98|
| Aljamiea                    | 10680      | 1.27| Alhura ' zaynab            | 10225      | 1.22|
| Aljameia                    | 23099      | 2.75| Alnafa                      | 8036       | 0.96|
| Aleuruba                    | 52217      | 6.23| Althawra                    | 9978       | 1.19|
| Alghuri                     | 7698       | 0.92| alshurta                    | 4980       | 0.59|
| Alnsr                       | 44771      | 5.34| alzuhara'                   | 21437      | 2.56|
| Almukarama                  | 45711      | 5.45| al'ansar                    | 87850      | 10.47|
| Aleaskari                   | 56562      | 6.47| alqadisia                   | 20762      | 2.48|
| Almilad                     | 21448      | 2.56| alquds 1                    | 1413       | 0.17|
| Alwafa'                     | 16222      | 1.93| alquds 2                    | 2827       | 0.34|
| Alsalam                     | 33957      | 4.05| The old city               | 20502      | 2.44|
| Aleadala                    | 23953      | 2.86| Aljadidat 1                 | 15557      | 1.85|
| Alfurat                     | 11018      | 1.31| Aljadidat 2                 | 8095       | 0.97|
| Al'atibba'                  | 7169       | 0.85| Aljadidat 3                 | 44823      | 5.34|
| 'Abi talab                  | 7602       | 0.91| Aljadidat 4                 | 80691      | 9.62|
| Alnida'                     | 8864       | 1.06| Alshawafie                  | 19201      | 2.29|
| Total                       | 838684     | 100%|                             |            |     |

Source: authors and [6]
4. Spatial distribution of green areas

4.1. Green areas
Green areas are defined as areas that grow with a number of tall and large trees, which gives a natural beauty to cities and residential neighborhoods and is penetrated by a number of walkways and paths that residents use to walk and spend time picnicking, it is considered one of the old facilities for recreation as it is inexpensive and close to the population [7].
It is also known as the land that is cultivated and the predominant feature is entertainment, and the major part of that land is covered with greenery, trees and other plants, and it is characterized by being free from any of the land uses and enjoys fresh air [8].

4.2. The importance of green areas
The importance of green areas emerges as having an effect on the psychological side of the human being. They are areas that are far from the noise, and are distinguished by their natural ingredients and human activities, so they have a prominent impact on the ability of the person to focus and be creative. There is a link between the mental and psychological sides.
It has effects from an economic point of view as it contributes to providing job opportunities for the population through what it provides of prudent activities in it, and this leads in the end to strengthen the economic aspect of the city in which these green areas and states in general.
In addition to its environmental importance, it will have a major role in the treatment of noise pollution, as it works as a buffer against winds carrying dust and dust in the event that it is used in the form of strips of green belts. Also, its presence in the form of voids between housing units and buildings will have a role in changing the local climate through the fact that these voids allow air currents and sunlight to reach the residential units.
The same applies to the social aspect, as it works as areas for meeting and interaction between the residents who use these areas. [9]

4.3. Green areas are listed according to their spatial distribution
Green areas must be distributed spatially and at different levels of the city so that residents can reach those areas easily, and they are graded in the city depending on the size, degree of specialization, and level of service, and in proportion to the population and their needs and according to the grades recommended by the plan (Symonds), it is at the following levels, Figure 3: [10]

1- Building Garden: A garden that is specific to the residential unit or building, and serves only its users recreationally, while the visual benefit serves the entire area, and it has no minimum.

2- Green areas at the locality level: its area starts from 2500 square meters and is no more than 400 meters from the housing unit, and it is available in front of all age groups without any restrictions or fees, and it works as a place for children to play safely and with a green view of the housing units.

3- Green areas at the neighborhood level: It will also be a safe place for children to play, suitable for walking, sporting activities, entertainment and relaxation, and its area starts from 50,000 square meters and its distance from residential units does not exceed 1000 meters.

4- Green areas at the city level: It works as a natural area that separates the population from the urban area of the city and its area starts from 250,000 square meters, available to all age groups for appropriate fees.

5- Areas of regional, national, or international service: These are parks of special quality, such as zoos or whatever is used in international tourism (Versailles Gardens, Disneyland ... etc).

Figure 3. Green areas (city, neighborhood, residential neighborhood) are included. [11]

5. Planning standards for the availability of green areas
Green areas are more present in the city than the appearance. Green areas have environmental effects. They work to reduce air pollution and make it breathable, as well as reduce audio and visual pollution, and other social and psychological benefits that make it one of the services that must be provided in the city.

What makes it necessary for the planner to take care of these areas and provide them with adequate areas to achieve an environmental and urban level appropriate for the city in general, and to be
distributed spatially in a manner that serves all levels of spatial and planning units in the city. The quantities of green areas in cities are significantly different from one location to another, and this is due to the difference in conditions between cities, whether these conditions are natural or physical, economic and social, so it is difficult to set and define general standards for all green areas in cities, and the planning standards themselves differ. Some of them devote an area that represents the share of the individual, family or housing unit from the green areas, or relative to the area of the city, or criteria that concern the environmental aspect.

5.1. *Per capita green areas*

In general, each individual of the population is assigned a specific area of green areas and the percentage of this area will be different from one country to another and from one city to another depending on the capabilities of the country and the availability of land and water resources, and the per capita share of green areas in any city should not be less than 3-4 square meters of its total area in general, and in Table 3, we find a difference about the per capita share of green areas in developed and developing countries [12]. The researcher will rely on the Saudi standard because it is not a very large standard as in the standards of developed countries so that this leads to consumption in the area at the expense of other uses and is not small to the extent that leads to depriving the individual of obtaining the service, in addition to the Kingdom of Saudi Arabia being a climate approach to Iraq And socio-economic aspects, as shown in Table 3 to verify the extent to which the criteria for per capita green areas in the holy city of Najaf are matched.

| Table 3. Per capita green areas in developed and developing countries.[13] |
|---------------------------------------------------------------|
| Developed countries | Developing countries |
| City               | Per capita green areas / m² | City               | Per capita green areas / m² |
| Rome               | 23.5                        | Cairo              | 1.5                        |
| Brussels           | 29.5                        | Damascus           | 0.7                        |
| Copenhagen         | 35                          | Saudi              | 5                          |
| Glasgow            | 55.6                        | Dubai              | 13.18                      |
| Vienna             | 124.6                       | Manama             | 2.5                        |

*Figure 4. Comparing per capita green areas between developing and developed countries. (Source: authors and [13])*
5.2. The percentage of green areas in the city
It is a simple and understandable indicator, but what is taken is that it may be misleading when there are high population or building densities and high building heights. Usually, the minimum level ranges between (10-20%) of the city’s area. In Germany, the value of this indicator ranges between (40-50%) in most German cities [14].

5.3. Environmental performance of green areas
Those interested in environmental performance use other criteria that are applied to green areas, and those who are interested in the benefit of the green area rather than its area, prefer trees with a huge green mass even if the area they occupy is small, then most of them view the tree as equivalent to a green horizontal area similar to the flat area exposed to light from its leaves, and some of the criteria are more complicated, as it looks at the oxygen and carbohydrates produced by these green areas and considers this a standard for their environmental performance, as the planners focus on the horizontal area of the green areas, and one of the planning standards used in the field of environmental performance is the number of trees per person or The number of trees per vehicle (3-5 trees can compensate for pollution caused by one vehicle) or calculate green areas by translating the types and sizes of trees in an equivalent area [15].

6. The numerical and spatial distribution of green areas
The number of green areas in the holy city of Najaf reached (64) according to the data of the Directorate of Najaf Municipality - the city’s organization division, distributed among the 42 neighborhoods, and from the data of Figure 5 and Table 4 shows the following:

1- Of the total of (42) residential neighborhoods, these green areas are located in (28) of them, which is equivalent to (66.66%), while (14) residential neighborhoods suffer from the absence of green areas and they constitute the ratio (33.33%).

2- The largest number of green areas is found in the neighborhoods (Al Milad, Al Amir, Al Mukarramah) by (5, 5, 7), respectively, and they constitute (26.56%) of the number of green areas in the study area.

3- The neighborhoods (University, Al-Mukarramah, Al-Salam) occupy the highest areas of the green areas. The total of the green areas in the three neighborhoods reached (959411 m²) and they constitute (35.38%) of the total area of the green areas in the neighborhoods of the study area.

| Neighborhoods | The number of green areas | Green area / m² | Neighborhoods | The number of green areas | Green area / m² |
|---------------|---------------------------|----------------|---------------|---------------------------|----------------|
| Alhanana      | 1                         | 9831           | al'amir       | 5                         | 187998         |
| ALHussein     | 1                         | 25826          | Alsaeed       | 3                         | 54654          |
| Alkarama      | 1                         | 10458          | Al 'iiskan    | 1                         | 92636          |
| Alsiha        | 0                         | 0              | Alaishtirakii | 0                         | 0              |
| Aleulama' /  | 0                         | 0              | Almuthanna /  | 3                         | 20524          |
| Alsheura' ,   |                           |                | 14timuz       |                           |                |
| Alfaris       |                           |                |               |                           |                |
| Alghadir      | 2                         | 36586          | Almualalim /  | 2                         | 126886         |
|                |                           |                | al'imam almahdi |                           |                |
| Aljameia      | 4                         | 369574         | Alhura' zaynab | 2                         | 65451          |
| Aljameia      | 2                         | 147939         | Alnaf        | 1                         | 6692           |
| Aleuruba      | 0                         | 0              | Althawra     | 0                         | 0              |
7. Spatial efficiency of the spatial distribution of green areas

The spatial distribution of phenomena is the final fruit of spatial relationships, and identifying them by knowing the reality in which these phenomena are distributed using some measures that determine the characteristics of the phenomenon distribution and its spatial directions in terms of grouping and dispersion around a certain value [17], and given the GIS offers high skills and capabilities in the field of analysis and interpretation, some statistical indicators have been used in the research, such as the influence range, the mean and mean center, the standard distance, the direction of distribution, and the closest neighbor in analyzing the efficiency of spatial distributions for the use of educational land within the Jadidat area.

Figure 5. Surveying the green areas in Najaf city. (Source: authors). Figure 6. Numerical distribution of green areas in the city of Najaf. (Source: authors)
7.1. *Per capita green areas*

Through table 5 we note that most of the neighborhoods in the Holy City of Najaf do not conform to the standard 5 square meters per capita green areas according to the Saudi standard, with the exception of neighborhoods (Aljamiea, Aljameia, Alghuri, Almukarama, Almilad, Alsalam, Al'atibba', al'amir, Alsaed, Al 'iiskan, Almuealimin, Alhura ' zaynab) where the individual share in them ranged between (5.2 - 34.6) square meters, while the other neighborhoods did not match the standard and the individual's share of green areas ranged between (0.4 - 3.9) square meters, while the neighborhoods that do not exist There are green areas where they were excluded from Table 5 and the absence of green areas in the neighborhoods is due to poor planning.

**Table 5. Individual share of the green areas in the city of Najaf.**

| Neighborhoods         | Population size | Population percentage% | Area of green areas / m² | Per capita standard / m² | Actual per capita | Match / Not match |
|-----------------------|-----------------|-------------------------|--------------------------|--------------------------|-------------------|------------------|
| alhanana              | 5429            | 1%                      | 9831                     | 5                        | 1.8               | Not match         |
| alhusayn              | 15830           | 3%                      | 25826                    | 5                        | 1.6               | Not match         |
| alkarama              | 6790            | 1%                      | 10458                    | 5                        | 1.5               | Not match         |
| alghadir              | 9989            | 2%                      | 36586                    | 5                        | 3.7               | Not match         |
| aljamiea              | 10680           | 2%                      | 369574                   | 5                        | 34.6              | Match             |
| aljameia              | 23099           | 4%                      | 147939                   | 5                        | 6.4               | Match             |
| alghuri               | 7698            | 1%                      | 196807                   | 5                        | 25.6              | Match             |
| alnasr                | 44771           | 8%                      | 173117                   | 5                        | 3.9               | Not match         |
| almukarama            | 45711           | 8%                      | 273656                   | 5                        | 6.0               | Match             |
| aleaskari             | 56562           | 10%                     | 54698                    | 5                        | 1.0               | Not match         |
| almilad               | 21448           | 4%                      | 194652                   | 5                        | 9.1               | Match             |
| alwafa'               | 16222           | 3%                      | 62643                    | 5                        | 3.9               | Not match         |
| alsalam               | 33957           | 6%                      | 316181                   | 5                        | 9.3               | Match             |
| aleadala              | 23953           | 4%                      | 25309                    | 5                        | 1.1               | Not match         |
| alfurat               | 11018           | 2%                      | 35114                    | 5                        | 3.2               | Not match         |
| al'atibba'            | 7169            | 1%                      | 94273                    | 5                        | 13.2              | Match             |
| al'amir               | 25482           | 5%                      | 187998                   | 5                        | 7.4               | Match             |
| alsaed                | 10554           | 2%                      | 54654                    | 5                        | 5.2               | Match             |
| al'isikan             | 3487            | 1%                      | 92636                    | 5                        | 26.6              | Match             |
| almuthanana            | 6585            | 1%                      | 20524                    | 5                        | 3.1               | Not match         |
| 14timuz               |                 |                         |                          |                          |                   |                  |
| almelmyn/ al'imam     | 8219            | 1%                      | 126886                   | 5                        | 15.4              | Match             |
| almahdi               |                 |                         |                          |                          |                   |                  |
| alhura' zaynab        | 10225           | 2%                      | 65451                    | 5                        | 6.4               | Match             |
| alnaft                | 8036            | 1%                      | 6692                     | 5                        | 0.8               | Not match         |
| alshurta              | 4980            | 1%                      | 12845                    | 5                        | 2.6               | Not match         |
When studying the spatial distributions of some phenomena, the scheme is concerned with determining intermediate locations that represent spatial gravity centers or the main attraction points of these distributions, and they use the central tendency measures used in analyzing point phenomena [18]. On determining the values of the aggregate distance or the center of gravity of the spatial distribution [19], either the median center, which indicates the most central location among the group of other locations of the geographical phenomenon to be measured, and includes the heart for its spatial distribution and depends in its determination on the values of the aggregate distance that separates these sites that achieve the lowest values. [20] Through them, we can determine the pattern of spatial centering of the green areas in the study area, as well as the direction of the tendency of those areas towards grouping or dispersion, and that the location of the two measured dimensions from each other means the apparent tendency to disperse and spread and vice versa.

**Figure 7. Spatial Center feature**

**Figure 8. Spatial Mean center**

When applying the two scales to the study area and as in Figure 9, it is clear that the mean center of the distribution of green areas in the city of Najaf is located at the bottom of the Salam neighborhood, at the intersection point of the arithmetic mean for the values of the horizontal coordinate (X) (437749.163898) and the arithmetic mean of the vertical coordinate (Y (3543174.419662). As for the mediator, who can define any of the green areas that mediate the number of projected green areas, he notes that the mediator is located in the Karama neighborhood, which is an affirmation that there is a concentration in the distribution of green areas, as it is located at a distance of (751 meters) which is not far from comparison the total area of the holy city of Najaf, which is (6615) hectares, southwest of the center, given that the centrality of the green areas is not consistent with the population.
7.3. Standard Distance

The standard distance corresponds to the spatial analysis of the standard deviation index that is used in the analysis of non-spatial data, as it is an indicator for measuring the extent to which the phenomena are spaced or concentrated spatially and is often expressed by using the value of the standard distance and drawing it in a circle called the standard circle and through which we can know the extent The focus or spread of the spatial dimension of the phenomenon, and the center of the standard circle is the location of the coordinates (the middle center). The greater the value of the standard distance and the greater the size of the standard circle, this indicates an increase in the spread and spatial dispersion of the distribution of the phenomena of the phenomenon, and the opposite is also true as in Figure 10 [21].

![Figure 9. The mean center and center feature of the green areas in the city of Najaf. (Source: authors)](image)

![Figure 10. Shows the standard distance.](image)
The percentage of the number of green areas within the normative circle whose standard radius is (3112.60) meters (60%), whose area has reached (3043.52) hectares, Table 6 and Figure 11, and it constituted (46%) of the area’s area of (6615) Hectares, and this shows that the pattern of distribution of green areas within the standard distance is a pattern with an elevated concentration around the spatial center.

Table 6. The standard distance to the green areas in the city of Najaf.

| Standard distance / meter | Area of the circle / hectare | The ratio of the area of the area | The ratio of the number of green areas within a department to the total ironing of green areas |
|--------------------------|-------------------------------|----------------------------------|--------------------------------------------------------------------------------|
| 3112.60                  | 3043.52                       | 46                               | 60                                                                             |

Source: authors

Figure 11. The standard distance to the green areas in the city of Najaf. (Source: authors)

7.4. Nearest Neighbor
This indicator is used in spatial distributions to measure the dispersion of distribution points around each other, and to measure the distance between each node and the closest adjacent node to it in order to know the pattern of spatial distribution, and thus extract the true distance between the distribution node [22].

Table 7. Main and sub-Nearest Neighbor patterns.

| The main pattern | The value of the nearest neighbor coefficient | Sub-pattern | The value of the nearest neighbor coefficient |
|------------------|---------------------------------------------|-------------|---------------------------------------------|
| Collective       | Less than 1                                 | Convergent convergent approx from randomly | Greater than 0 - 0.5 |
| Random           | 1                                           | Random      | ---------- |

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Through Figure 12, the nearest neighbor chart that shows the type of spatial distribution of the green areas in the city of Najaf, which number (64) green area distributed over the neighborhoods of the city, the value of 7.4. The nearest neighbor reached (0.96) and this value according to Table 7, which shows the main and sub-nearest neighbor patterns. The main distribution pattern for green areas is a collective pattern, while the sub-pattern is convergent approx from randomly, and the main reason for this is due to the occurrence of most of these green areas in the neighborhoods in a region that represents the heart of the city because of its oldness, and the lack of surrounding neighborhoods to green areas due to the recent establishment.

7.5. Directional Distribution
This scale determines the direction in which the phenomena are distributed in the spatial space by drawing an ellipse shape that embodies the direction of distribution for most of the phenomena under study and is also known as the (standard ellipse shape of dispersion) and the center of this shape is completely applicable to the main center, so through the axis of the largest we can know The value and direction of the distribution of spatial phenomena. As in Figure 13, the use of this indicator in determining the direction of the spatial distribution of the point phenomenon within the area of the region is an important topic in geography to determine the distribution axes of the phenomenon and benefit from it for future planning procedures [23].

Figure 12. The nearest neighbor to the green areas in the city of Najaf. (Source: authors)
Figure 13. Directional Distribution

Through Table 8 and Figure 14, it is clear that the direction of the distribution of green areas is northwest towards the southeast, and the value of rotation of the figure reached (157.93) degrees in the north direction, and an encircled ellipse shape (51%) of the green areas means that most of the green areas are located in this The direction inside the city, knowing that the growth of the city of Najaf is north and south, meaning that the distribution is in line with the city's growth trends.

Table 8. The direction of distribution of green areas in the city of Najaf.

| The values of the axes of the distribution direction | The value of rotation | The ratio of the number of green areas within the ellipse |
|-----------------------------------------------------|----------------------|--------------------------------------------------------|
| Values (X) meters                                   | Values (Y) meters    | Direction of distribution                             |
| 1623.69                                             | 4091.48              | Northwest                                             | 51 |

Source: authors

Figure 14. The direction of the distribution to the green areas in the city of Najaf. (Source: authors)
7.6. Global Moran's I

The Moran coefficient is a statistical analysis tool based mainly on the linear regression model, which is a measure used to know the degree of spatial correlation between the vocabulary of the phenomenon within the study area and is also known as the index of similarity or contact and the basis of its idea is due to the law of geography (converging things have a greater relationship than spaced objects). If the value of the spatial correlation index is close to one, this means that there is a strong spatial correlation if the value is far from one, this means that the weak relationship and spatial correlation [24], Figure 15.

![Figure 15. Global Moran's I](image)

Through Figure 16, which shows the Moran coefficient of spatial correlation of green areas in the holy city of Najaf, we notice that the value of Moran coefficient (0.072) is very far from one, indicating weak spatial correlation and randomness of green areas.

![Figure 16. Global Moran’s I to the green areas in the city of Najaf. (Source: authors)](image)

7.7. Buffer

One of the metrics commonly used in various studies provided by GIS is determined the effect of each phenomenon (point, linear, spatial) on its surroundings. In the geography of services, it is defined in
the areas of impact and the scope of impact are the spatial limits that service covers for the residents in it for the purpose of obtaining the service, so the program creates circles around the green areas within the neighborhoods according to the planning criteria established [25], which is (800) meters as defined by the Iraqi Ministry of Construction and Housing, The distance people can walk from their place of residence to those green areas.

Figure 17. Demonstrates the idea of Buffers

Through Figure 17, we note that there is a large overlap between buffer of the green areas in the City of Najaf according to the distance of arrival (800) m, which indicates that there is a misuse of green areas distribution over the city's neighborhoods, so we notice that there are neighborhoods that reach the impact area For more than one green area, while there are neighborhoods such as the fourth new, the alrahma district, and aljadidat 2, deprived of service in the green areas. The area reached by the impact area of the green areas reached (5512) hectares, which is equivalent to (83.32%) of the total area of the City of Najaf, and the neighborhoods near the main center and surrounding it are the most intersecting neighborhoods in the impact area.

Figure 18. The buffer to the green areas in the city of Najaf. (Source: authors)
8. Conclusions
1- The research concluded that the spatial distribution pattern of green areas in the city of Najaf is a grouped pattern that approximates to random.
2- The choice of green area sites depended on the presence of vacant spaces and on the possibilities and conditions available away from the standards and considerations per capita, as well as on-site considerations such as those related to the access distance.
3- Districts that do not conform to the standard per capita share (5 square meters), in which the per capita share of the green areas ranged between (0.4 - 3.9) square meters.
4- The direction of distribution of the green areas is northwest towards the southeast, and the turnover value of the figure is (157.93) degrees to the north, and an enclosed oval shape (51%) of the green areas, meaning that most of the green areas fall in this direction within the city, note that growth The city of Najaf is north and south, meaning that the distribution is in line with the city's growth trends.
5- The area of the area reached by the impact area of the green areas reached (5512) hectares, which is equivalent to (83.32%) of the total area of the Holy City of Najaf, and the remaining percentage are neighborhoods not served by the green areas, and the neighborhoods near the middle center and surrounding it are the most neighborhoods Intersection in the effect range.

9. Recommendations
1- Using the expertise of academics and specialists in the field of developing development plans to reduce the failure of these services and other services to meet the planning standards.
2- Establishing a database for green areas and benefiting from the GIS, as it provides many facilities in the field of entering, processing, analyzing, storing, and reviewing the results, in addition to the savings it provides in the effort, time and costs.
3- When signing green areas, they must be signed depending on planning and surveying standards in neighborhoods that lack this service.
4- Implementing the laws and procedures necessary to limit abuses on green areas throughout the city.
5- Taking into consideration the future population size when allocating areas for green areas in the basic plans to reduce pressure on those areas and reduce their efficiency due to population growth.

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