# Analysis of indicators of urban land use concentration in the holy city of Najaf

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**Abstract**

*The Holy City of Najaf operates as an urban center of prominent cultural and religious importance and is witnessing rapid urban development. This research deals with a comprehensive analysis of urban land use concentration indicators in the city. The analysis revolves around the city's geographic, economic, social, urban, and human characteristics, in addition to studying the approved urban and basic plans. The paper reviews land uses in the city until 2023 and analyzes them in detail. The research also addresses the concentration in the city center and the determinants of urban development and provides an accurate analysis of land use using advanced planning methods such as standard distance, the nearest neighbor method, and the Simpson index. Based on the results and analysis, understanding land use concentration indicators plays a crucial role in guiding urban development toward a sustainable future. And provide recommendations that contribute to improving the distribution of land uses and preserving the cultural and environmental identity of the city, which is one of the critical future challenges.*

**Keywords:** *Land use, urban concentration, urban sustainability, sustainable development, concentration indicators.*

## 1. Introduction

Urban cities play a crucial role in the advancement of human civilizations, serving as a networked hub for economic, social, and environmental progress. Urban land uses are a manifestation of the essential intersections and synergies among infrastructure, economic endeavors, and social orientations within a society. The city of Najaf holds significant prominence within this particular environment, mostly attributed to its extensive historical background and profound cultural and religious significance. The examination of indicators pertaining to the concentration of urban land use within this metropolis encompasses a comprehensive investigation into the directions of urban growth, as well as the distribution of activities and land uses. This endeavor aids in the creation of a precise depiction of the development pattern and facilitates the identification of future trends. The primary objective of this research article is to investigate and assess the determinants of urban land use concentration in the city of Najaf, and to examine its implications for urban development and the well-being of residents. A variety of methodological and analytical approaches will be employed to comprehensively comprehend these dynamics. The aim is to offer valuable recommendations that enhance existing land uses and steer urban developments towards a sustainable trajectory. The aforementioned analysis is regarded as a crucial component in attaining a harmonious equilibrium between urban expansion and the conservation of the cultural and environmental heritage of the Holy City of Najaf. It serves as a valuable contribution

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towards the formulation of sustainable planning strategies, thereby fostering a more favorable and cohesive trajectory for this remarkable urban center.

## 2. Location and location of the Holy City of Najaf (Location & Site)

The Holy City of Najaf is located between longitudes 42"14'44° - 14"26'44° east, and latitudes 24"56'31° - 36"7'32° north, and with this geographical location it is one of the governorates located to the west. From Iraq, map (1) represents a gateway between two important physiographic regions, the alluvial plain and the western plateau. Thus, it shares the same locational characteristic with the city of Karbala. These cities were known for a wide movement of product exchange between the plain and the desert throughout their history, and it was through them that Bedouin tribes entered Iraq and settled in its countryside and cities.

The Holy City of Najaf is the main center of the Najaf Governorate, extending from the southwest at the Bahr al-Najaf depression to the northwest at the borders of the Karbala Governorate. It is surrounded by cities including Al-Haidariya, Kufa, and Manathira. It is about 160 km from Baghdad, 60 km from Hilla, 78 km from Karbala, and 65 km from Diwaniyah. Place study is important for city planning and environmental analysis. The nucleus of the city rises on a plateau 55 meters above sea level, overlooking southwest over flat lands and barren desert extending to the west. The plateau extends towards the city of Kufa, and the two cities are connected by a vital network of transportation and movement.
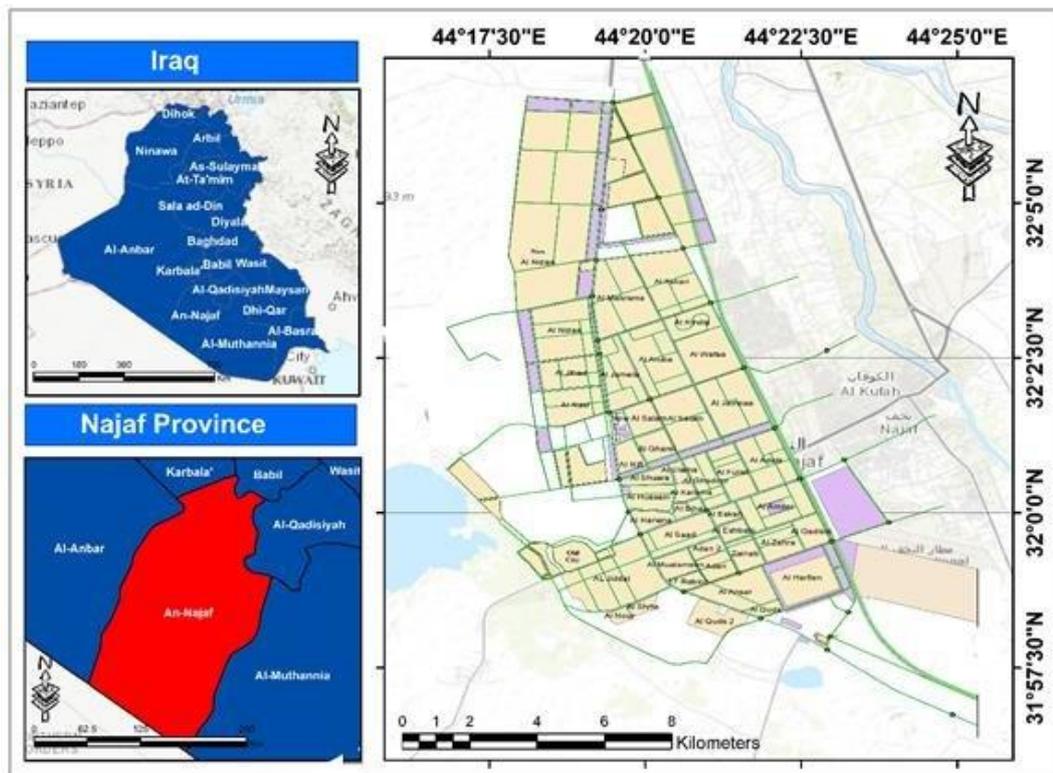


Map (1). Location of the study area in relation to the city of the Republic of Iraq

## 3. Characteristics of the Holy City of Najaf

Knowing the natural, social and economic characteristics of the area to be studied is important for every urban planner in order to extract indicators that facilitate knowledge of the city's capabilities and determinants and understanding the relationships between

the components of the studied spatial space and thus knowing the city's future directions and functions. The most important of these characteristics are:

3.1 Economic characteristics

The study area is characterized by the fact that it possesses many characteristics related to the economic sectors as a whole, as the city is characterized by the presence of a number of small, medium and large industries spread within the borders of the city and its spatial structure, the number of which is estimated at (2,120) industries, (Najaf Statistics Directorate, 2023), including construction, food, chemical and textile industries. Engineering, wood, and others were mostly concentrated in the city's urban center, benefiting from the available economic savings, employment, the size of demand, and the availability of appropriate infrastructure in the city. As for large industries, there were (20) industries in the city, namely Al-Rehab Mill, Najaf Mill, Al-Amir Mill, Al-Ghari Mill, and Al-Insha'ah. For textiles, ready-made men's clothing, rubber products, thermostone, limestone bricks, Al-Ikhwan Glass, as well as the Najaf oil refinery, the hydrogenation plant, the processing plant, and the extraction plants for raw materials and others, according to the researcher's field surveys and maps of the city's structural plan.

Tourism activity had a comparative advantage for the city because of the impact of these tourism activities on economic, social and urban development and their impact on the movement of trade and the development of markets in the city. Since the city of Najaf Al-Ashraf is distinguished by its religious character, it is a future and open place for tourists, as millions of visitors visit it annually from different regions inside and outside Iraq to perform the visit to the holy shrines on the one hand, and students visit it to study religious sciences in the seminary of Al-Najaf Al-Ashraf, which is considered one of the seminaries. On the other hand, there is great scientific knowledge in the Islamic world, in addition to the presence of the Wadi al-Salam cemetery, the second largest cemetery in the world, in addition to the presence of Najaf Airport.

3.2 Social and urban characteristics

The social characteristics of the city emerge through the exchange and circulation of residents between the various regions of the governorate and the country. These relationships are evident in everyday mobility, where movement occurs for religious, educational, practical and commercial purposes. This continuous movement emphasizes the important role of the city as a multi-use destination and multi-dimensional social interaction. Social relations are represented in the tribal pattern, which produces contrasting relationships and connections between residents. These relationships appear clearly in religious and social events and form the features of social life in the city. As for the urban aspect, we notice from this city that the urban size and form are linked to the human scale. The traditional urban configuration is characterized by harmony and integration of elements, and houses of worship are closely linked to the homes of residents. The urban characteristics are evident through the road network and structural cells, such as houses, markets, schools, and caravanserais, which overlap harmoniously. This urban fabric is characterized by integration and diversity, with details that reflect the cultural and social character of the city. This diversity expresses the convergence of different societal classes within the city and their coexistence in harmony (Al-Nasrawi, 2004, p. 80).

3.3 Human characteristics: Human characteristics are more important in terms of their impact on urban development because the population is the basis for the process of growth and expansion through increasing the size of the population and its expansion in directions:

First: Population growth: From Table (1) it is clear that there is an increase in the population census for the period (1987-2023), as the population will increase from (309,010) people in the year 1987 to (776,458) people in the year 2023 due to the

increase in population growth, as the number reached The population according to the 1987 census was (309,010) people, while the population in 1997 reached (381,468) people, with a population increase of (72,458) people and a growth rate of (2.3%), while the population in the 2010 census reached (560,198) people. With a population increase over the previous census (178,730) people and a growth rate of (3.6%), as for the population estimate for the year 2018, the population reached (709,642) people, that is, an increase over the previous census of (149,444) people with a growth rate of (3.3%). As for the number The population for the year 2023 reached (776,458) people, an increase over the previous census (66,816) people, with a growth rate of (1.9%), as in Figure (1).

Table (1): Population and Population Growth Rate of Najaf City for the Period (1987-2023)

| Year | Population | Overpopulation | [3]% Population growth rate |
|---|---|---|---|
| 1987 | 309010 | 120501 | 6.4 |
| 1997 | 381468 | 72458 | 2.3 |
| 2010 | 560198 | 178730 | 3.6 |
| 2018 | 709642 | 149444 | 3.3 |
| 2023 | 776458 | 66816 | 1.9 |

Source: The researcher worked based on the data of the Republic of Iraq, the Ministry of Planning, the Central Bureau of Statistics, the results of the Najaf Governorate census for the year (1997, 1987, 2010) and population estimates for the year (2018, 2023).

The population of the city of Najaf in 2023 reached (776,458) people, and as a result of the creation of Al-Radawiyah district in 2018, there was a need to subtract the population of Al-Radawiyah from the year (2018) so that the population becomes (669,780) people in the holy city of Najaf, and then estimate the population for the year (2023). To reach (776,458)(*) people. Thus, the population in 2030 will reach (954,945) people, that is, an increase over the previous census of (178,487) people, with a growth rate of (3%). As for the population in 2040, it will reach (1,283,366) people, an increase of The previous census was (328,421) people, with a growth rate of (3%), and in the year (2050) the population will reach (1,724,736) people, an increase over the previous census of (441,370) people.

Second: Population Distribution:

What is meant by distribution is to determine the areas of population presence for the purpose of knowing the areas of presence and then knowing the degree of their pressure on the land. The population is distributed within the urban environment in a heterogeneous manner due to the pattern of distribution of the population of cities and neighborhoods according to their functions such as commercial, residential and industrial. Thus, the pattern of land use attracts the population according to its characteristics. And the function of the land it occupies, and thus the density varies between neighborhoods and regions of the city (Al-Ajili, 2010, p. 223), and through the data of the Najaf Statistics Directorate 2023, it is clear that the northern sector ranked first in the total population, as it reached (499,777) people, with a concentration rate of (64.37%) ) of the city's total population, with its highest population concentration in the Askari neighborhood at a rate of (6.90%), and the lowest population concentration in the Sultan Complex at a rate of (0.02%). As for the southern sector, it ranked second. The total

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(*) The population growth rate was extracted using the following equation where $r = \left( n\sqrt{\dfrac{pt}{po}} - 1 \right) \times 100$ r = growth rate, n = number of years, pt = oldest census, po = most recent census.

population reached (183,105) people, with a concentration rate of (23.58%) of the city's total population, and its highest population concentration is in the Al-Ansar neighborhood at a rate of (7.53%), and its lowest population concentration is in Jerusalem residential apartments at a rate of (0.17%). As for the new and new construction sector, it ranked third, as the total number of residents reached (76,290) people, with a concentration rate of (9.83%) of the city's total population. The highest population concentration is in El Jadida IV, at a rate of (4.07%), and its lowest population concentration is in El Jadida II, at a rate of (0.86%). As for the old city sector, it ranked fourth. Finally, the total population reached (17,286) people, with a concentration of (2.23%) of the city's total population. The highest population concentration is in the locality of Al-Huwaish, with a percentage of (0.72%), while its lowest population concentration is in the locality of Al-Amarah, with a percentage of (0.43%).

3.4 Study of the city's latest master plan (2008-2030) (Al-Najaf city Master plans):

The English company Lewin Davis prepared this plan in cooperation with consultants from the architectural designer company. The general vision of the basic plan was directed towards making the city of Najaf one of the most prominent cities in Iraq, due to its prominent religious and Islamic role. Emphasis was also placed on its role as a center for education and religious studies, in addition to its importance as a receiving destination for visitors and providing various services to them and its residents.

Among the objectives of this basic plan was to eliminate the housing shortage in the holy city of Najaf, improve the level of well-being, and promote economic diversification. A balance was achieved between the needs of visitors and residents, and the development and protection of the religious, historical and cultural heritage, as well as the preservation of the natural and urban environment and heritage buildings in the city. Development efforts were directed towards appropriate areas, especially the residential, cultural and sports areas in the south and north, and partly towards the west of the city. . Emphasis was also placed on developing an environmentally friendly transportation system that makes it easy to access facilities and services for both visitors and residents. It is noteworthy that the development was directed towards the city's road network to ensure easy access for residents and the provision of comfortable and efficient services. Map (2) shows the fourth plan of the city. This plan divided the proposed development stages into four stages, as follows: (Report of the delivery plan for expanding the city, 2009, pp. 12-19).

1- The first stage: It was proposed to use several strategies to develop the Holy City of Najaf, including (urban filling, densification, cohesion, and developing residential areas towards the northwest, developing the new Al-Salam area with a capacity of about (2000-3000) residential units with 3-5 floors and horizontal floors.
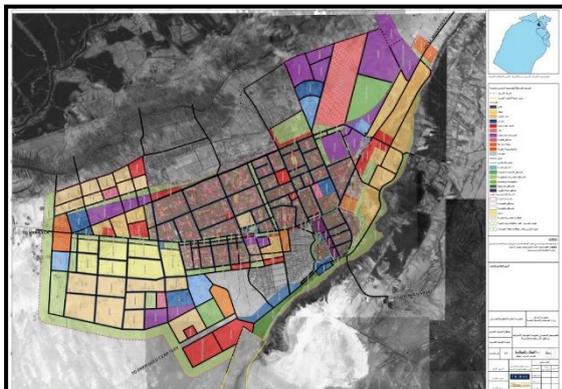


Map (2): The fourth basic plan (2008-2030) for the city of Najaf

Source: Ministry of Municipalities and Public Works, Directorate General of Urban Planning, Llewellyn Davis Young LDY, Architectural Designer for Engineering Consultants ADEC, Final Report on Foundation Design Phase 4, 2008.

2- The second phase: It included developing residential use towards the north, developing the northwestern direction, and allocating sites from the northern region to serve the residential areas scheduled to be expanded in this direction.

3- The third phase: It included several proposals for the development of the south and north of Manathira Road, through residential expansion in four stages in the south of Manathira Road, with an area of (62) hectares, to accommodate (15,000) housing units, and provide housing for a limit of (90,000) people, and residential expansion north of Manathira Road. Al-Manathira. Providing (4,500) housing units, providing housing for approximately (27,000) people.

4- The fourth stage: It included the final stage of the residential expansion plan, represented by (residential expansion in the northeast of the city), which is evident through the allocation of a site with an area of (527) hectares, which provides (13,000) housing units and housing for (78,000) people, and residential expansion in the north. The western part of the city with an area of (295) hectares, which provides approximately (7,300) housing units and housing for (44,000) people. It can be noted that the percentages of land use are according to the fourth basic plan (2008-2030) in the holy city of Najaf, as in Table (4), Map (2). ).

Table (2). Land Use Ratios for Najaf City by Fourth Basic Plan (2008-2030)

| Land uses | Rate % |
|---|---|
| Residential | 58 |
| Commercial areas and urban center | 11.1 |
| Industrial Zones | 5.1 |
| Religious and cultural areas | 9.1 |
| Roads, parking lots, green and open spaces | 16.7 |
| Total | 100% |

Source: Lewin Davies Yang, Final Report of Foundation Design Phase IV, 2008.

3.5 Land uses for the city of Najaf until 2023:

Land uses are the main pillar in the formation of the urban structure of the city, because it provides many services and jobs to its residents and surrounding areas (Al-Hiti, 1986, p. 51).The uses of land in the city of Najaf vary through the area it occupies, where the area of the basic plan (15965.86) hectares and the total area of land uses (9276.79) hectares after removing the area of expansion areas and the area of the cemetery, the airport and the green belt as in Table (3), and it is clear that residential use is predominant and dominant among the rest of the other uses where it occupied a large area of the city amounted to (3808.61) hectares, as it constituted (41.06%) of the total other uses and then followed by the rest of the uses according to for its areas of the total area.

Table (3): Area and percentage of land use in the city of Najaf for the year 2023

| # | Use | Area / hectare | Percentage / 100% |
|---|---|---|---|
| 1 | Residential Land Uses | 3808.61 | 41.06% |
| 2 | Commercial Land Uses | 365.73 | 3.94% |
| 3 | Industrial Land Uses | 146.47 | 1.58% |
| 4 | Land uses for transportation purposes | 2747.16 | 29.61% |
| 5 | Educational Land Uses | 432.72 | 4.66% |
| 6 | Healthy land uses | 36.05 | 0.39% |
| 7 | Religious land uses | 66.65 | 0.72% |

| 8 | Green and cultural land uses | 525.88 | 5.67% |
|---|---|---|---|
| 9 | Land uses for open spaces | 550.85 | 5.94% |
| 10 | Recreational land uses and sports fields | 66.60 | 0.72% |
| 11 | Administrative Land Uses | 42.59 | 0.46% |
| 12 | Technical Land Use and Public | 487.50 | 5.25% |
|  | **Total area of the urban area** | **9276.79** | **100.00%** |
| 13 | Expansion Areas | 3543.91 | 22.20% |
| 14 | Public Cemetery | 1065.67 | 6.67% |
| 15 | Najaf International Airport | 797.88 | 5.00% |
| 16 | Greenbelt | 1281.60 | 8.03% |
|  | **Total area of the baseline chart** | **15965.86** |  |

Source: Researcher based on Arc GIS and relying on the Ministry of Municipalities and Public Works, Najaf Municipality Directorate, Planning and Follow-up Department, unpublished data, 2023.

## 4. Urban problems and determinants of the holy city of Najaf:

The city of Najaf, which was planned using recognized planning standards to ensure a decent level in it, will be exposed to a significant deterioration in the facilities of this environment due to changes that would increase densities to higher than the planned level, and the restructuring of some urban sectors of the city will lead to the deprivation of areas that They represent the few remaining open spaces to meet the great demand for central services in the future.

Also, the current situation regarding the city of Najaf is that more than half of the urban population in the governorate lives in the city of Najaf, and the city of Najaf attracts high percentages of the technological foundation in its administrative region, centers of economics, trade and finance, research centers, universities, graduate studies, and specialists in various branches of science, and these percentages increase from The natural share of the city represented by the ratio of its population to the population of its administrative region. The urban structure of the city of Najaf, which extends over an area not exceeding (13,745) hectares, which is less than the limits of the basic plan (Najaf Planning Directorate, unpublished data, 2023), contains all these features and technical balance, which It poses a strategic risk to spreading this concentration over an urban area wider than the boundaries of the urban structure. Therefore, one of the most important goals of the urban development axis of Najaf Governorate is to reduce concentration in the city of Najaf and spread growth in its immediate region instead of letting the concentration increase steadily, which increases the negative historical urban concentration of the city. Najaf.

4.1 The concentration located in the center of the holy city of Najaf

First: Population and housing densities:

According to Malthus's theory of population, it confirms that population grows in a geometric sequence and resources grow in a numerical sequence, which confirms that population grows at a faster rate than housing, and thus produces a housing crisis. In addition to migration to the city for many reasons, including the search for work, family connections, the desire to live near relatives, and displacement from hot areas, as happened in the Iran-Iraq war, where (10,000) families were displaced from Basra, and also after the events of 2003 AD, about 5,868 people were displaced to Najaf. (Al-Yasiri) (2015, p. 91)

1- The absence of government support in the field of providing housing needs, as there are few allocations for the housing sector granted to the Ministry of Housing, which led to the exacerbation of the housing problem in Iraq in general and Najaf in particular.

2- Weak housing policies followed and the adoption of partial and temporary solutions that are not compatible with the city's population growth and migration from the countryside to the city.

3- The inefficiency of state institutions in providing residential lands serviced by infrastructure for the establishment of housing projects, as is the case in union lands and the poor area that were distributed recently.

4- The weak tendency to invest in solving the housing problem, especially low-cost housing, with the lack of incentive for investors in the field of housing, the absence of facilities for investors, and the weakness of the investment law and its implementation mechanisms.

5- The problem of underdeveloped (informal) urban areas. The share of the Najaf district center reached (26,916) random housing units, i.e. (52%) of the total random housing units in the urban centers of the governorate, which amounted to (53,810) (Najaf Al-Ashraf Planning Directorate, Studies Division, 2021 ).

Second: The negative complications resulting from the polarization towards the holy city of Najaf:

The holy city of Najaf is one of the Iraqi cities that attracts residents with the aim of seeking education and job opportunities. Due to this continuous increase in natural population and immigration, it is higher than the carrying capacity of the city of Najaf, and in the long run, major problems will be generated, including:

• The deterioration of the level of the urban environment and its negative impact on the city's function as a religious tourist city.

• Weak functional, productive and economic relations between the holy city of Najaf and neighboring cities due to the imbalance in the urban balance of the Najaf region.

• Weak investment in natural resources in Najaf Governorate due to weak infrastructure and economic base in the surrounding small cities, weak markets, and limited numbers of skilled labor.

• The urban expansion of the city of Najaf is a horizontal pattern that requires low population densities, and if it continues in this situation, it will require services and networks of public facilities over large areas.

• The basic plan for the city of Najaf (2008-2030) was exhausted in 2017, and there is noticeable urban growth in the city as well as an increasing housing need.

## 5. Analysis of land use in the city of Najaf using planning methods:

I have previously reviewed the research problem: the existence of a need for an urban development axis as an urban policy that follows the causes and justifications related to development and sustainability priorities, as well as contributing to developing solutions to the concentration that the city center suffers from due to population momentum and the presence of a high concentration in urban services and land uses. This will be done in this part of The research used planning and statistical methods and geographic information systems (Arc GIS 10.8.1), as follows:

5.1 Use the standard distance method

The standard distance is the equivalent in spatial analysis of the standard deviation indicator used in analyzing non-spatial data, that is, it is an indicator to measure the

extent to which the components of a phenomenon are spatially dispersed or concentrated. The value of the standard distance is often used to draw a circle called the Standard Circle, through which the extent of the concentration or spread of the spatial dimension of the phenomenon can be known, and the center of this circle is the location (coordinates) of the average center. The larger the value of the standard distance and the larger the size of the standard circle, the more this indicates an increase in the spread and spatial dispersion of the distribution of the phenomenon, and the opposite is also true.

The idea of the standard distance is based on calculating the square root of the sum of the squares of the deviations of the x and y values from the arithmetic mean and dividing it by the number of point values, so that the result is a number that shows the extent to which 68% of the values (coordinates) are concentrated around the average point. Hence, this distance shows the extent of the spread and difference of a group of points around their average center (Daoud, Juma Muhammad, p. 33, 2018), and this test is implemented through (ArcGIS 10.8) software, relying on the Spatial Statistical Tool. Box) for the Geospatial Information Systems program, which produces a new layer representing the standard distance by drawing a circle with a radius of one standard deviation from the mean center.

The standard distance for land uses in the holy city of Najaf has been reached. See Table (4):

Table (4) Standard Distance and Concentration of Urban Land Use in Najaf City for 2023

| Use | Standard distance | Significance |
|---|---|---|
| Educational | 5041.2 m | Usage is concentrated (71%) in the center of Najaf. |
| Commercial | 3451.9 m | Usage is concentrated (58.75%) in the center of Najaf. |
| Educational | 4711.1 m | Usage is concentrated (68.64%) in the center of Najaf. |
| Health | 4224.14 M | Usage is concentrated (64.99%) in the center of Najaf. |
| Religious | 3498.3 m | Usage is concentrated (59.14%) in the center of Najaf. |
| Green | 4767.8 m | Usage is concentrated (69.05%) in the center of Najaf. |
| Administrative | 4928.9 m | Usage is concentrated (70.21%) in the center of Najaf. |
| transportation | 4412.05 M | Usage is concentrated (66.42%) in the center of Najaf. |

Source: Researcher using Arc GIS 10.8 and relying on the Najaf Planning Directorate, Studies and Planning Division.

5.2 Average Nearest Neighbor:

This spatial analysis tries to find out the pattern of spread of a particular phenomenon spatially, by comparing the actual distribution of the phenomenon with a certain theoretical distribution, also called the neighborhood link coefficient.It represents the ratio of the measured distance (the average distances from each point to its nearest point) divided by the theoretical distance or the expected distance in the case of the random pattern of the same number of points and the same area of the phenomenon on the ground (Dawood, Juma Mohammed, p. 38, 2018). This method can be calculated through geographic information systems (Arc GIS 10.8). ) used the toolkit called the  Measuring Geographic Distributions toolset, which is part of the Spatial statistics toolbox. Its patterns are as in Table 5:

Table (5) Nearest Neighbor Patterns and Coefficient Value

| Style | The value of the nearest neighbor coefficient | Substyle | The value of the nearest neighbor coefficient |
|---|---|---|---|
| **Convergent/clustered** | Less than 1.0 | Perfectly assembled | zero |
| | | Convergent but irregular | From zero to 0.5 |
| | | Convergent heading towards the random | 0.5 to less than 1.0 |
| **Indiscriminate** | 1.0 | | |
| **Spaced/Regular** | Greater than 1.0 | Dispersed Dispersed | Greater than 1.0 to less than 2.0 |
| | | Uniformly spaced (square (shape | 2.0 |
| | | Uniformly spaced (hexagonal shape) | Greater than 2.0 to 2.15 |

Source: Daoud, Gomaa Mohamed, Advanced Statistical and Spatial Applications, Cairo, Egypt, 2018.

The analysis of the proximity relationship to reveal the current distribution pattern for each use in the center of Najaf was Table 6:

Table 6

| USE | NEIGHBORLINESS | SIGNIFICANCE |
|---|---|---|
| **Educational** | 0.68 | The distribution is convergent and goes towards the random, |
| **Commercial** | 0.30 | The distribution is close but irregular |
| **Educational** | 0.51 | The distribution is convergent and goes towards the random |
| **Health** | 1.11 | Dispersed spaced distribution |
| **Religious** | 0.57 | The distribution is convergent and goes towards the random |
| **Green** | 0.86 | The distribution is convergent and goes towards the random |
| **Administrative** | 0.505 | The distribution is convergent and goes towards the random |
| **transportation** | 0.41 | The distribution is close but irregular |

Source: Arc GIS 10.8  Finder

From the method of analyzing the nearest neighbor or neighborhood connection, we find that most of the distribution patterns for uses in the city of Najaf are clustered patterns ranging from unorganized convergence to heading towards randomness, which means in other words the presence of a concentration of these uses in the city center.

5.3 Simpson Index:

The Simpson Index is a measure used to analyze the diversity of land use in cities and urban areas. This indicator aims to measure the balance of land use distribution in the region, showing the diversity and balance between different uses. (Carole, Gianmarco, Dino and Rullani, P1-12,2003)

Equation: Simpson Index Equation

$$D = 1 - \Sigma \left( \frac{A_i}{A_n} \right)^2$$

where:

$=D$ Simpson Cadastral Diversity Index.

$= A\_i$ sum of each land-use category (sum of each use)

$=A\_n$ Sum of areas of all categories (total area of uses)

Interpretation of values: The values of the Simpson index range between 0 and 1. The higher the value, the greater the diversity of land uses in the region, indicating a better balance and diversity in land use.

Uses of the Simpson Index in Urban Planning:

Used to measure the balance of land use in urban areas.

It can be used to analyze the diversity and balance between residential, commercial, industrial, service and other activities.

Contributes to the assessment of the quality of urban planning and the diversity of living and economic environments in the region.

The Simpson Index is a powerful tool in analyzing the balance of land use in urban planning. It can be modified and customized to suit the requirements of the study and the context of the particular urban planning. Diversity balance in land use contributes to the creation of sustainable and balanced urban communities

To apply the Simpson equation, we use the land use areas for the city of Najaf for the year 2023 from Table (2) and then we perform the calculations for this equation as follows

Diversity Index =

$$D = 1 - \Sigma((0.004591028)^2 + (0.039424197)^2 + (0.007179207)^2 \\ + (0.046645445)^2 + (0.056687712)^2 + (0.007184597)^2 \\ + (0.410552573)^2 + (0.003886042)^2 + (0.015788867)^2 \\ + (0.296132606)^2 + (0.059379376)^2 + (0.052550505)^2)$$

$$D = 1 - 0.269867589$$
$$D = 0.730132411$$

So the diversity coefficient (Simpson index) = 0.73 is a good percentage that reflects a fairly high diversity of activities. However, we find that there is a concentration of some uses in areas and their deprivation to other areas, as well as the high momentum of residential uses and their great pressure on the rest of the uses in the city of Najaf.

## 6. Conclusions

The Holy City of Najaf exemplifies a unique paradigm of the interplay between religious influences and economic, social, and urban features. It employs development tactics that strive to strike a harmonious equilibrium among these various dimensions, while also catering to the requirements of both inhabitants and tourists. The urban development of Najaf, a significant religious center, exhibits an irregular and disproportionate trajectory, characterized by excessive growth in certain regions while neglecting the full potential of other expansion axes. The phenomenon of urban growth and development naturally occurred along the northern and northwestern axis, specifically known as the Najaf-Karbala axis, and this spatial expansion has become a distinguishing characteristic. One of the axioms formulated by urban planners during the planning process of Najaf city, as explicitly manifested in its fundamental design, pertains to the accommodation of industries. It is acknowledged that certain industries can be appropriately situated within the city center, while others, due to their significant pollution levels or spatial

requirements, are deemed unsuitable for such placement. The Najaf district center comprises 26,916 random dwelling units, accounting for 52% of the total random housing units in the urban centers of the governorate, which totaled 53,810. The city of Najaf is currently facing a housing issue, with projections indicating that future population growth will necessitate the expansion of residential zones in order to accommodate the anticipated demand. The growth axis leading to the city of Kufa is deemed unsuitable for further expansion due to the exhaustion of available land parcels and the existing urban connectivity between the cities of Kufa and Najaf. The growth axis leading to the city of Manathira is deemed unsuitable for further expansion owing to the presence of a cement factory and the existing urban connection between the cities of Najaf and Manathira. The western growth trajectory towards the Bahr al-Najaf depression is deemed unsuitable for further expansion owing to the presence of a distinct depression in the Bahr al-Najaf region and the significant decrease in land elevation. The direction of expansion in relation to the northern axis, specifically the Najaf-Karbala axis, The term "Iqraha" refers to a concept that is commonly discussed in academic The reason for its superiority is in the abundance of expansive, level terrains devoid of any inherent limitations, such as geological or topographical factors, as well as other variables that allocate specific regions for various purposes. Through the application of the conventional distance approach to analyze land uses inside the urban area of Najaf, it was determined that a significant concentration of these uses exists. The application of neighbor relationship analysis, specifically closest neighbor analysis, revealed that the majority of land uses within the city of Najaf have a closely distributed pattern that demonstrates either irregularity or a tendency towards randomness inside the cluster. The diversity coefficient, specifically the Simpson index, exhibits a value of roughly 0.73 when applied to the land uses within the city of Najaf. This proportion signifies a favorable level of diversity, indicating a notable range of activities within the area. Nevertheless, it is evident that certain uses are concentrated in specific regions while being lacking in others. Furthermore, residential uses exhibit significant velocity and exert considerable strain on services.

In order to accommodate industries that cannot be absorbed by the central area, it is necessary to develop peripheral areas. Urban development hubs offer a viable solution for diversifying sectors and absorbing those that the central area is unable to accommodate. The preservation of fundamental and urban plans, such as the structural plan, is crucial in terms of its viewpoint on the Najaf-Karbala axis and its alignment with sustainability indicators. The utilization of the Urban Observatory is crucial in monitoring and implementing measures to mitigate encroachment on land usage within the urban development axis of Najaf-Karbala, with a specific focus on the city of Najaf. The formulation of a population policy aimed at managing the influx of individuals and external migration to the sacred city of Najaf is necessary due to the significant strain placed on services that fall outside the scope of the existing plan's objectives. The creation of a digital database focused on activities and projects that can be geographically limited to the study area is intended to support the execution of development studies, as well as the monitoring and management of implemented projects.

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