



## Analyzing Urban Growth in Zagazig City, Egypt, Using GIS and Remote Sensing from 1976 to 2021

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### ABSTRACT

Analyzing the characteristics of urban growth by monitoring and measuring urban growth through urban development and mapping its direction in Zagazig city, the capital of Sharkia Governorate, is of great importance in supporting decision-making to determine strategies and policies for sustainable land use because the governorate occupies the third place at the level of the Republic in terms of population. 2017 (380,980) people, it is an attractive city for residents due to immigration

This study identifies the Spatio-temporal characteristics of urban sprawl in Zagazig during the years 1976, 1986, 1996, 2007, 2017, and 2021 by using the Arc Map 10.3 program to analyze the data of Landsat satellite images downloaded from the US Geological Survey website and the strategic plan for Zagazig city. In 2007 to support the decision-maker over 45 years of study between 1976 and 2021, it found an increase in built-up areas in Zagazig city by 495.26% due to the natural increase in the urban population and internal migration from the governorate's villages and cities to Zagazig city to improve education, employment, entertainment and living standards, By knowing the rate of urban growth in each direction, it is possible to predict the amount of urban growth for the target year and compare the planned and the target.

The study resulted in the benefit of the integration of geographic information systems and remote sensing.

### 1. Introduction

As a result of urban growth on agricultural lands outside the urban mass of the city, marginal and intermediate areas arise, which are semi-urban areas between rural and urban areas<sup>[1]</sup>

The spatiotemporal analysis of urban growth helps decision-makers and city planners achieve sustainability through effective management and

resource planning for future urban expansion areas, which reduces the wasteful use of non-renewable resources and maintains the ecological balance<sup>[2], [3]</sup>.

The urban sprawl takes the form of scattered, striped and centralized growth based on the extension of road networks to the suburbs and peripheral areas of low density, and the classification of roads in terms of speed and width<sup>[4]</sup>

Many scientific types of research addressed this subject in the study of urban growth and its different

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effects on different cities such as Central India<sup>[5]</sup>, Raiganj Urban Agglomeration, India<sup>[6]</sup>, Tamil Nadu, India<sup>[7]</sup>, West Bengal India<sup>[8]</sup>, Mangaluru India<sup>[9]</sup>, Guangzhou (China)<sup>[9]</sup>, Malaysia<sup>[10]</sup>, Tshwane (South Africa)<sup>[4]</sup>, Fez Morocco<sup>[11]</sup>, Bandar Abbas, Iran<sup>[12]</sup>, Shiraz city, Iran<sup>[13]</sup>, Ankara<sup>[14]</sup>, Qom<sup>[2]</sup>, Los Angeles<sup>[15]</sup>, Dakahlia Governorate, Egypt<sup>[16]</sup>, Sri Lanka<sup>[17]</sup>.

Within the researcher's knowledge, previous studies did not address urban growth quantitatively and directionally as a means to support decision-making and determine the amount of future growth in each direction and compare it with the proposed detailed plan.

### 1.1. Research problem

The urban mass of Zagazig city is growing rapidly in several directions, due to the increase in its population, and that was for many reasons, the most important of which are:

Zagazig city is the capital of Sharkia Governorate, which occupies the third place in population growth at the level of the Arab Republic of Egypt, according to the 2017 census.

The continuous internal migration from the centres and villages of Sharkia Governorate to Zagazig city to work there.

The natural increase in the population results from an increase in the number of births over the number of deaths.

As a result of the housing increase, the demand for housing for immigrants to the city and its residents increased, and this was a reason for the increase in the prices of land allocated for construction in the city and the tendency to build on agricultural lands adjacent to the urban mass due to its low prices. The random growth of buildings in large quantities and several directions became State agencies unable to manage and follow up on urban growth quantitatively and in a direction, so the decisions of the future detailed plans for the city were not supported by information because there is no tool to support decision-making. The future is quantitatively and oriented and compared to what has been identified in plans. The current research used decision support tools such as geographic information systems and remote sensing in analyzing the urban growth of Zagazig city during the period from 1976 AD to 2021 AD

### 1.2. Target

It is an analysis of the spatial characteristics of urban growth in Zagazig city in terms of urban

development and urban growth direction in Zagazig city.

### 1.3. Importance

Assist decision-makers in directing urban growth to control urban management.

## 2. Materials and methods

### 2.1. Study area

Zagazig city is the capital of the Sharkia Governorate, and the Sharkia Governorate is one of the six governorates that make up the Suez Canal Region, next to the governorates of Suez, Port Said, Ismailia, North and South Sinai. In the north is Lake Manzala at the Mediterranean Sea, from the south by Qalyubia and then Cairo, from the east by Ismailia, Port Said and Qalyubia governorates (where the desert hinterland), and from the west by Dakahlia and Qalyubia governorates, there are three natural phenomena in the river site (Damietta branch), the Mediterranean (Lake Manzala), the desert in the south and east with Qalyubia Governorate, Fig. 1

It lies between longitudes 31° 15' and 32° 15' east, and between latitudes 30° 15' and 31° 15' north

It covers an area of about 4,957 km<sup>2</sup> and its population is About 7.192355 million people in 2017, representing 68% of the region's total population of 10,538,158 million.

Al Sharqiya Governorate has divided administratively into 13 centres, 17 cities, 2 districts, 88 rural local units, 2841 Izbato, Kafr and Naga,

Zagazig city is the capital of the Zagazig Center, where the Zagazig Center is located between latitudes 42, 30, 28, and 30 and longitudes 37, 31, 22, and 31. The centre is bordered on the east by Abu Hammad Center, on the north by Hahya Center, Ibrahimiya Center and Dirb Najm Center, and from the west by the governorate Dakahlia, and from the south the Centre of Minya al-Qamh and the Centre of Belbeis Fig. 1, and the Centre occupies an area of 313232038.345787 m<sup>2</sup> approximately 313 km<sup>2</sup> with a percentage of 6.32 of the area of the governorate and occupies the first place in the governorate in terms of population size, where the population in 2017 reached about 877.997 thousand people, representing about 12.20 % of the total population of the province<sup>[18]</sup>



Table 1. Data sources\*

| Sensor                                     | Date Accusation | No's of Bands | Spectral Resolution | Path/ row |
|--|-----------------|---------------|---------------------|-----------|
| LANDSAT 1 MSS C2L1                         | 07/01/1976      | 7             | 60m                 | 190/039   |
| LANDSAT_5 TM C2L2                          | 08/07/1986      | 7             | 30m                 | 176/039   |
| LANDSAT_5 TM C2L2                          | 03/07/1996      | 7             | 30m                 | 176/039   |
| LANDSAT_7ETM+C2L2 LANDSAT_8_ OLI/TIRS C2L2 | 18/07/2007      | 7             | 30m                 | 176/039   |
|  | 27/06/2017      | 11            | 30m                 | 176/039   |
|  | 22/06/2021      | 11            | 30m                 | 176/039   |

\*(source: <https://earthexplorer.usgs.gov/>)

### 2.3. Method

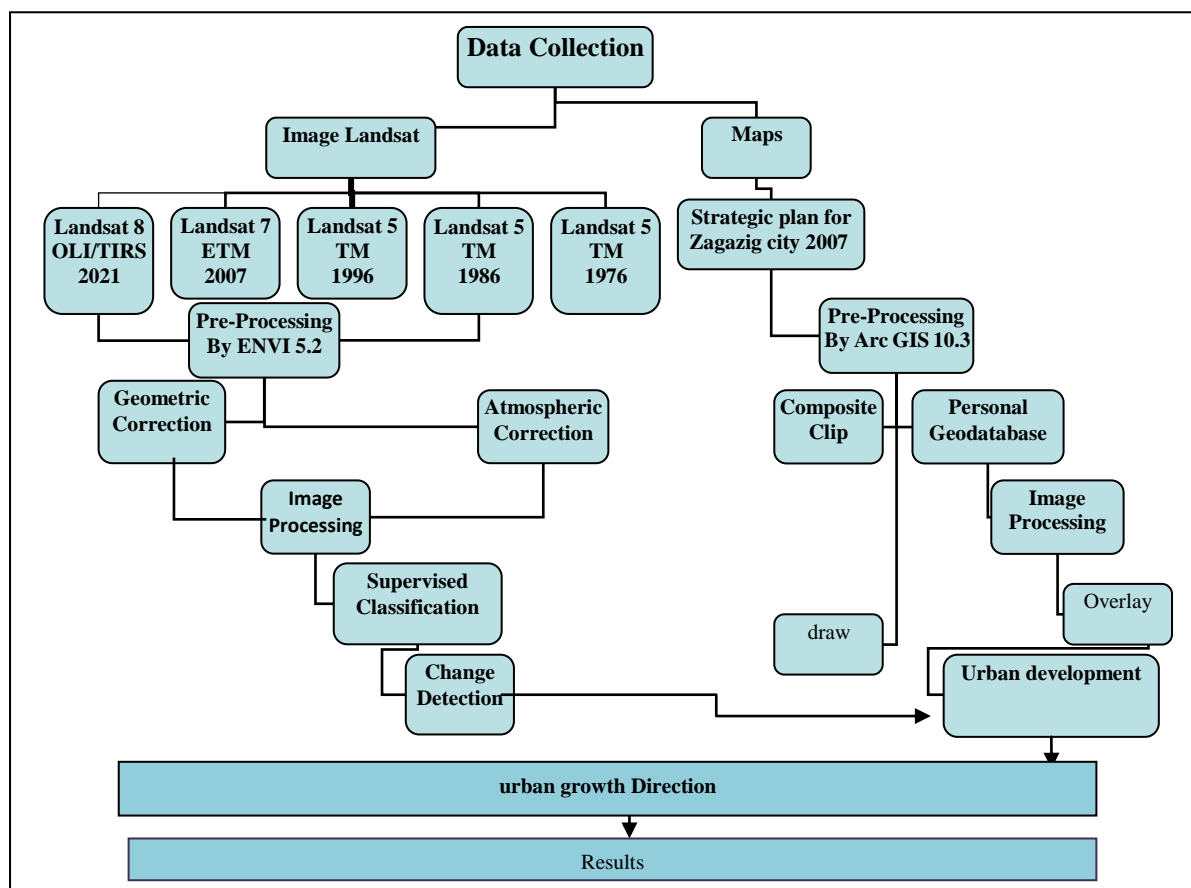


Fig. 3: Research Methodology (source: The researcher worked)

Urban growth was studied during these periods for the years (1976, 1986, 1996, 2007, 2017, and 2021) and these years were chosen because they are related to the official population censuses of the Central Agency for Public Mobilization and Statistics and finally the change in the year 2021, the last year, and thus the availability of data from more than one source.

During that period, according to the maps of the Urban Planning Authority <sup>[19]</sup>, which showed the changes in the years (1976, 1986, 1996, and 2007) And US satellite visuals for Landsat 8 OLI/TIRS

C2L2 for 2017, 2021, Landsat 7ETM+C2L2 for 2007, Landsat 5 TM C2L2 for 1986, 1996, and Landsat1 MSS C2L1 for 1976 obtained from the US Geological Survey website <https://earthexplorer.usgs.gov/>

Through the program Arc GIS 10.3 from the window menu, image analysis was selected, and a Composite was made for the bands of each satellite image to merge and create RGB colour visuals. Atmospheric Correction, Geometric Correction

A polygon layer was made to determine on it the boundaries of the urban block for each of the satellite

visuals, and an intersection was made between each layer of each visible and between the layer of the sheikhs and the villages of the Sharkia governorate. The level of shaykhs and villages whose urbanization is connected to the urbanization of Zagazig city using Arc GIS 10.3 program for each year, so the total area for each year of study was calculated. fig. 3 shows Research Methodology

**3. Analysis of the spatial characteristics of urban growth in Zagazig city :**

The urban growth and its pattern and urban spaces are determined in different periods, where urban growth takes on two clear dimensions, the first is the quantitative dimension, in which the quantitative elements of urban growth are analyzed, represented in the urban increase area, the rate of urban growth, and the other dimension, which is the spatial dimension, in which the spatial elements of growth are analyzed Urban and its directions

*3.1. Quantitative analysis of the stages of urban development of the city from 1976 to 2021*

The researcher worked using Arc GIS 10.3 program with the help of urban development in the strategic plan for Zagazig city in 2007 issued by the General Authority for Urban Planning, and satellite images for the years 1976, 1986, 1996, 2007, 2017, 2021, Fig. 4 shows the stages of urban development in Zagazig from 1976 to 2021.

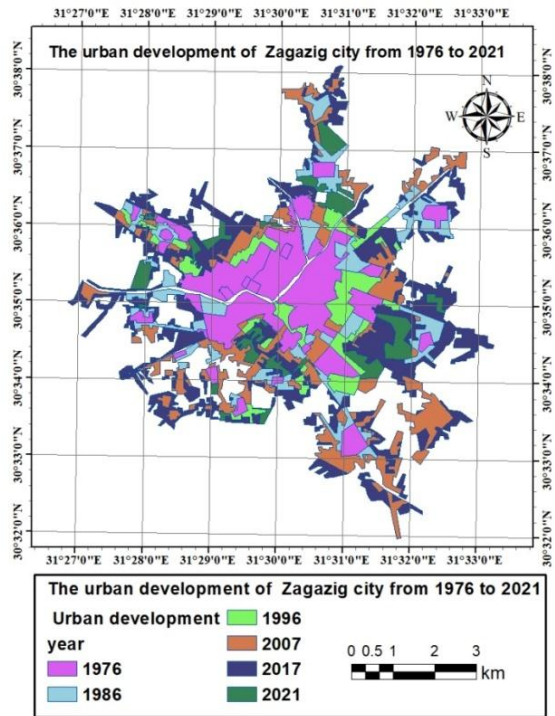


Fig. 4: The urban development of Zagazig city in the period from 1976 to 2021(Source: The researcher worked using Arc GIS 10.3 with the help of urban development in the strategic plan for the city of Zagazig in 2007 issued by the General Organization for Urban Planning, and satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, 2021)

Table 2. Population, an area, increase in area, annual rate of increase in area, percentage of increase from current area and rate of urban growth in Zagazig city during periods\*\*\*

| the year | population | Total area in acres | increase in acres | Annual increase (acres/yea) | The percentage increase from the current surface (%) | *urban growth rate |
|----------|------------|---------------------|-------------------|-----------------------------|--|--------------------|
| 1976     | 238279     | 1855.60             | -                 | -                           | 20.19  |                    |
| 1986     | 296558     | 3285.70             | 1430.10           | 143.01                      | 15.56  | 5.88               |
| 1996     | 322660     | 4012.80             | 727.10            | 72.71                       | 7.91   | 2.02               |
| 2007     | 379303     | 5846.20             | 1833.40           | 166.67                      | 19.95  | 3.48               |
| 2017     | 380980     | 8524.60             | 2678.40           | 267.84                      | 29.15  | 3.84               |
| 2021     | 381652     | 9190.10             | 665.50            | 166.38                      | 7.24   | 1.90               |
| 2027**   | 382664     | 4451.13             | -4738.97          |                             |  |                    |

\* The urban growth rate was calculated using the EXCEL2010 program from the equation (((Urban mass in the most recent year / Urban mass in the oldest year)^(1/n)) - 1) \* 100

\*\* Planned year without the use of GIS

\*\*\*(source: The researcher worked using Arc GIS 10.3 3 and Microsoft Excel 2010 with the help of satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, 2021 )

### Calculating the population in 2021:

1) Using the arithmetic progression by applying the equation to the EXCEL program

Population in 2021 = census (last census) in 2017 + (annual absolute population increase \* number of years of difference between the year to be estimated and the year of the last census)

2) Using the geometric progression by applying the equation to the EXCEL program

Population in 2021 = Census (last census) in 2017 x (1 + population growth rate according to the engineering equation) ^ (the number of years of difference between the last census and the target year for which the population is to be expected)

Population in 2021 = the arithmetic mean of the expected population in the numerical progression and the expected population in the geometric progression

Population in 2021 = (381650.8 + 381652.8)/2 = 381651.8 people.

#### 3.1.1. The period from the beginning of the city's establishment until the year 1976

Urbanization extended on the outskirts, especially in the east in Harit Razaneh, Banayos, Alsayaadin, Zagazig, tribal and Bahariya. In the north, a new housing area arose in Kafr al-Eshara, Shaybah, and al-Nakaria, in the west, Mansha'at Abaza, Kafr Muhammad Hussein, Sherweida, and to the south, al-Aslouji, Shobak Basta, al-Nahal and al-Hariri, with an area of 1855.6 acres, and a population of 238,279 people Table (2)

#### 3.1.2. The period from (1976 to 1986)

The establishment of the university led to the explosion of urbanization in 1986 with an area of 3285.7 acres, an increase of 1430.1 acres, at an annual increase rate of 143.01 acres/year, with an increase from the current surface of 15.56%, and the population reached 296,558 people, and an urban growth rate of 5.8 Table (2)

The two villages of Zinkolon, with an area of 10.6 acres on the west side, and Mashtoul al-Qadi, with an area of 49.6 acres on the north side, joined the urban bloc, in addition to the increase in the areas of the sheikhdoms and the coalescing villages formed in 1976. , followed by Shobak Basta village with an

increase of 162.1 acres in the east and southeast direction, followed by the village of Harriet Razaneh with an increase of 134.7 acres in the northeast direction, followed by the village of Al-Aslouji with an increase of 123.6 acres in the south and southeast direction, followed by Sherweida village with an increase of 117.2 acres in the direction West to the southwest, followed by the village of Kafr al-Hamam, with an increase of 102.2 acres in the north and northeast direction, then the village of Shayba al-Nakariah, with an increase of 74.9 acres in a west and north direction. Then the village of Kafr Muhammad Husayn with an increase of 49.2 acres in the southwest direction, then Sheikh Yusuf Bey with an increase of 48.7 acres in the northeast direction, then the village of Mansha'at Abaza with an increase of 48.2 acres in the west and southwest direction, then the fishermen with an increase of 35 acres in the northeast direction. Then Manshiyat Hassan Saleh with an increase of 33.6 acres in the north-east direction, then Al-Nakaria with an increase of 27.9 acres in the north-west direction, then Bnayous with an increase of 25.3 acres in the north and north-east direction, then Al-Nahal with an increase of 23.3 acres in the south-east direction, then Al-Hussainiya with an increase of 18.5 acres in the direction of the north and north-east. towards the south, then Bahgat with an increase of 12 acres in the direction of the southwest, then Zinkolon with an increase of 10.6 acres, then Kafr Al-Shawishiya with an increase of 4.5 acres in the direction of the southwest, then Kafr Abu Al-Hakim with an increase of 1.4 acres, then Kafr Abdel Aziz with an increase of 0.8 acres in the north-east direction, Then Youssef Salameh Kafr with an increase of 0.2 acres in the southwest direction, Figure (4), and Table (3)

#### 3.1.3. The period from (1986 to 1996)

A second urban explosion phase in 1996, with an area of 4012.8 acres, an increase of 727.1 acres, an annual increase of 72.71 acres/year, an increase from the current surface of 7.91%, and the population reached 332,660 people, and an urban growth rate of 2.02 Table (2), Where the village of Kafr Al-Hosr joined with an area of 29.6 acres, in addition to the increase in the areas of the sheikhdoms and the combined villages formed in 1986. Most of the

sheikhdoms and villages increased in the area. The village of Shobak Basta with an area increase of 105 acres in the southeast direction, then the sheikhdom of the sign with an increase in the area of 83.5 acres To the north-east, then Sheikha Al-Nahal with an increase of 71.6 acres in the east direction, then Al-Aslouji village with an increase of 65.7 acres in the south direction, then Kafr Abdel Aziz with an increase of 64.2 acres in the east direction, then Sheikha Al-Hariri with an increase of 47.9 acres, then Shaybah Al-Nakariah With an increase of 46.3 acres, then Youssef with an increase of 33 acres, then Mowad with an increase of 32.7 acres, then Al-Hussainiya with an increase of 31.7 acres, then Kafr Al-Hasr with an increase of 29.6 acres, then Manshiyat Hassan Saleh with an increase of 25 acres, then Al-Zaqazi Al Bahariya with an increase of 23 acres, then Bahgat with an increase of 21.5 acres, then Al-Nakariah with an increase of 21.4 acres, then Kafr Youssef Salama with an increase of 9.7 acres, then Hariya Razanah with an increase of 6.2 acres, then fishermen with an increase of 4.3 acres, then the system with an increase of 4.2 acres., then Kafr Muhammed Hussein, with an increase of 0.4 acres, Fig. 4, and Table (3)

3.1.4. The period from (1996 to 2007)

A third urban explosion stage in 2007, with an area of 5846.2 acres, an increase of 1833.4 acres, an annual increase of 166.6727 acres/year, with an increase from the current surface of 19.95%, and a population of 379,303 people, and an urban growth

rate of 3.48, Table (2), Where the villages joined (Al-Ghar, with an area of 140.3 acres, Al-Maslamia, with an area of 18.4 acres, Bani Amer, with an area of 21.5 acres, and Kafr Awad Hijazi, with an area of 59.7 acres), in addition to the increase in the areas of the sheikhdoms and the fused villages formed in 1996. The area is 341.2 acres, then Kafr Muhammed Hussein with an increase in area of 164.4 acres, then we indicate an increase in area of 127.9 acres, then Kafr Abdel Aziz with an increase in area by 124.4 acres, then Shobak Basta with an increase in area of 96.6 acres, then Mashtoul Al-Qadi with an increase The area is 79.7 acres, then Sherweida is an increase in the area by 78 acres, then Haryet Razanah is an increase in the area of 77.7 acres, then Kafr Al-Hamam is an increase in the area of 73.5 acres, then Al-Husayniyah is an increase in the area of 64.4 acres, then the Nahal with an area increase of 63.2 acres, then Zinkolon with an increase in area of 53.9 acres, then Shaybah and Al-Nakariah with an increase in area of 44.1 acres, then Al-Nakariah with an increase in area by 36.1 acres, then Kafr Youssef Salama with an increase in area by 36 acres, then Banayos with an increase The area is 33 acres, then Kafr al-Shawishiya with an increase in area of 29.7 acres, then fishermen with an increase in area of 27.1 acres, then Bahgat with an increase in area of 14.7 acres, then Zagazig Bahriyah with an increase in area of 13.1 acres, then Kafr Abu Al-Hakim with an increase in area The area is 10.6 feddans, then Kafr al-Hasr with an area increase of 2.6 feddans, then Mansha' Abaza with an increase in area of 0.5

Table 3. The total area and the increase in the urban mass of each Sheikha and the city in each period in acres\*

| Alshiyakha           | Mass  | increase      | Mass  | increase      | Mass  | increase      | Mass  | increase      | Mass  | increase      | Mass  |
|----------------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|
|                      | 1976  | 1986          | 1986  | 1996          | 1996  | 2007          | 2007  | 2017          | 2017  | 2021          | 2021  |
|                      | acres | Area in acres | acres | Area in acres | acres | Area in acres | acres | Area in acres | acres | Area in acres | acres |
| Alasharuh            | 340.0 | 303.8         | 643.7 | 83.5          | 727.3 | 127.9         | 855.1 | 118.5         | 973.6 | 14.7          | 988.3 |
| Aljamie              | 18.1  |               | 18.1  |               | 18.1  |               | 18.1  |               | 18.1  |               | 18.1  |
| Alhariraa            | 42.0  |               | 42.0  | 47.9          | 89.9  |               | 89.9  |               | 89.9  |               | 89.9  |
| Alhusaynih           | 68.2  | 18.5          | 86.7  | 31.7          | 118.4 | 64.4          | 182.8 | 80.7          | 263.5 | 37.9          | 301.4 |
| Alhukma              | 29.3  |               | 29.3  |               | 29.3  |               | 29.3  |               | 29.3  |               | 29.3  |
| Alzaqaziq Albahrih   | 32.4  | 23.0          | 55.4  | 23.0          | 78.4  | 13.1          | 91.6  | 10.4          | 102.0 |               | 102.0 |
| Alzaqaziq Alqabalayh | 12.5  |               | 12.5  |               | 12.5  | 0.4           | 12.8  |               | 12.8  |               | 12.8  |
| Alsayaadin           | 25.5  | 35.0          | 60.4  | 4.3           | 64.7  | 27.1          | 91.8  |               | 91.8  |               | 91.8  |

|                           |        |        |        |       |        |        |        |        |        |       |        |
|---------------------------|--------|--------|--------|-------|--------|--------|--------|--------|--------|-------|--------|
| Aleuslujaa                | 90.1   | 123.6  | 213.7  | 65.7  | 279.5  | 341.2  | 620.7  | 323.0  | 943.7  | 2.9   | 946.6  |
| Almuntazah                | 72.8   |        | 72.8   |       | 72.8   |        | 72.8   |        | 72.8   |       | 72.8   |
| Almanshah - Hasan Salih   | 23.2   | 33.6   | 56.8   | 25.0  | 81.7   |        | 81.7   |        | 81.7   |       | 81.7   |
| Alnahaal                  | 206.7  | 23.3   | 230.0  | 71.6  | 301.7  | 63.2   | 364.8  |        | 364.8  | 0.5   | 365.3  |
| Alnizam                   | 50.3   |        | 50.3   | 4.2   | 54.5   |        | 54.5   |        | 54.5   |       | 54.5   |
| Alnakarih                 | 13.2   | 27.9   | 41.1   | 21.4  | 62.5   | 36.1   | 98.6   | 103.5  | 202.1  | 5.2   | 207.2  |
| Binayus                   | 55.7   | 25.3   | 81.0   | 0.0   | 81.0   | 33.0   | 114.0  | 49.7   | 163.7  | 23.8  | 187.5  |
| Bihajat                   | 16.9   | 12.0   | 28.9   | 21.5  | 50.4   | 14.7   | 65.1   | 10.6   | 75.7   | 14.7  | 90.4   |
| Shiruidih                 | 65.3   | 117.2  | 182.5  |       | 182.5  | 78.0   | 260.5  | 178.7  | 439.2  | 5.0   | 444.2  |
| Shubik Bisatih            | 194.8  | 162.1  | 356.9  | 105.0 | 461.9  | 96.6   | 558.5  | 517.9  | 1076.4 | 207.3 | 1283.8 |
| Shaybuh Alnakarih         | 73.5   | 74.9   | 148.3  | 46.3  | 194.6  | 44.1   | 238.7  | 251.1  | 489.9  | 105.5 | 595.3  |
| Kafar Abu Hakim           | 15.3   | 1.4    | 16.8   |       | 16.8   | 10.6   | 27.3   | 21.4   | 48.7   | 9.7   | 58.4   |
| Kafar Alhamaam            | 43.3   | 102.2  | 145.5  |       | 145.5  | 73.5   | 219.0  | 85.8   | 304.8  | 102.0 | 406.8  |
| Kafar Alshaawishih        | 0.0    | 4.5    | 4.5    |       | 4.5    | 29.7   | 34.2   | 15.2   | 49.3   |       | 49.3   |
| Kafar Eabdialeaziz        | 30.9   | 0.8    | 31.7   | 64.2  | 95.8   | 124.4  | 220.2  | 82.3   | 302.5  |       | 302.5  |
| Kafar Muhamad Husayn      | 58.0   | 49.2   | 107.2  | 0.4   | 107.6  | 164.4  | 272.0  | 48.2   | 320.2  | 61.4  | 381.6  |
| Kafar Yusuf Salamah       | 4.3    | 0.2    | 4.5    | 9.7   | 14.2   | 36.0   | 50.2   | 80.2   | 130.4  | 7.9   | 138.3  |
| Mueawad                   | 10.0   |        | 10.0   | 32.7  | 42.6   | 0.5    | 43.2   |        | 43.2   |       | 43.2   |
| Minshah Abazih            | 185.5  | 48.2   | 233.8  | 0.0   | 233.8  | 0.5    | 234.3  | 0.2    | 234.5  |       | 234.5  |
| Harayh Raznuh             | 55.3   | 134.7  | 190.0  | 6.2   | 196.2  | 77.7   | 273.9  | 279.9  | 553.8  | 11.9  | 565.7  |
| Yusif                     | 22.5   | 48.7   | 71.1   | 33.0  | 104.1  | 0.3    | 104.4  | 33.2   | 137.6  |       | 137.6  |
| Alzankilun                |        | 10.6   | 10.6   |       | 10.6   | 53.9   | 64.5   | 204.7  | 269.2  | 0.0   | 269.2  |
| Mashtawl Alqadaa          |        | 49.6   | 49.6   |       | 49.6   | 79.7   | 129.3  | 52.7   | 182.0  |       | 182.0  |
| Kafar Alhasr              |        |        | 0.0    | 29.6  | 29.6   | 2.6    | 32.3   |        | 32.3   | 55.2  | 87.4   |
| Alghar                    |        |        | 0.0    |       | 0.0    | 140.3  | 140.3  | 70.0   | 210.3  |       | 210.3  |
| Almuslimih                |        |        | 0.0    |       | 0.0    | 18.4   | 18.4   |        | 18.4   |       | 18.4   |
| Banaa Eamir               |        |        | 0.0    |       | 0.0    | 21.5   | 21.5   | 25.7   | 47.2   |       | 47.2   |
| Kafar Eiwad Allah Hijazaa |        |        | 0.0    |       | 0.0    | 59.7   | 59.7   | 29.2   | 88.8   |       | 88.8   |
| Banaa Ashibal             |        |        | 0.0    |       | 0.0    |        | 0.0    | 1.0    | 1.0    |       | 1.0    |
| Kafar Eata Allah Salamah  |        |        | 0.0    |       | 0.0    |        | 0.0    | 0.5    | 0.5    |       | 0.5    |
| Kafar Muhamad Shawish     |        |        | 0.0    |       | 0.0    |        | 0.0    | 4.1    | 4.1    |       | 4.1    |
| Total                     | 1855.6 | 1430.1 | 3285.7 | 727.1 | 4012.8 | 1833.4 | 5846.2 | 2678.4 | 8524.6 | 665.5 | 9190.1 |

\*(source: The researcher worked using Arc GIS 10.3 and Microsoft Excel 2010 with the help of satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, and 2021, the administrative division of Egypt from the Central Agency for Public Mobilization and Statistics)



feddan, then Mowad with an increase in area of 0.5 feddan, then Zagazig tribal with an increase in area of 0.4 acres, then Youssef with an area increase of 0.4 acres. 0.3 acres, Fig. 4, and Table (3).

3.1.5. The period from 2007 to 2017

The fourth urban explosion stage in 2017, with an area of 8,524.6 acres, an increase of 2678.4 acres, an annual increase of 267.84 acres/year, with an increase from the current surface of 29.15%, and a population of 380,980 people, and an urban growth rate of 3.84, Table (2), Where the villages joined (Bani Eshbel, with an area of 1 acre - Kafr Atallah, with an area of 0.5 acres - Kafr Muhammad Hussein, with an area of 48.2 acres), in addition to the increase in the areas of the sheikhdoms and the fused villages formed in 1996. Al-Aslouji with an increase of 323 acres, then Hariya Razanah with an increase of 279.9 acres, then Shayba Al-Nakariah with an increase of 251.1 acres, then Zinkolon with an increase of 204.7 acres, then Sherweda with an increase of 178.7 acres, then Al-Shirah with an increase of 118.5 acres, then Al-Nakaria with an increase of 103.5 acres, then Kafr Al-Hamam with an increase of 85.8 acres, Then Kafr Abdel Aziz with an increase of 82.3 acres, then Al Husseinia with an increase of 80.7 acres, then Kafr Yusuf Salama with an increase of 80.2 acres, then Al Ghar with an increase of 70 acres, then Mashtoul Al Qadi with an increase of 52.7 acres, then Banayos with an increase of 49.7 acres, then Youssef with an increase of 33.2 acres, then Kafr Awad Allah Hijazi with an increase of 29.2 acres, then built Amer with an increase of 25.7 acres, then Kafr Abu Al-Hakim with an increase of 21.4 acres, then Kafr Al-Shawishiya with an increase of 15.2 acres, then Bahgat with an increase of 10.6 acres, then Zagazig Bahariya with an increase of 10.4 acres, then Kafr Muhammad Shawish with an increase of 4.1 acres, then Abaza facility with an increase of 0.2 acres, Fig. 4, and Table (3)

3.1.6. The period from 2017 to 2021

A fifth urban explosion stage in 2021, with an area of 9190.1 acres, an increase of 665.5 acres, an annual increase of 166.375 acres/year, an increase of 7.24% from the current surface, a population of 381652 people, and an urban growth rate of 1.9, Table (2), and increase The areas of the sheikhdoms and the combined villages that were formed in 1996 and the most of the sheikhdoms and villages increased in the area. The village of Shobak Basta with an increase of 207.3 acres, then Shaybah Al-Nakariah with an increase of 105.5 acres, then Kafr Al-Hamam with an

increase of 102 acres, then Kafr Muhammad Hussein with an increase of 61.4 acres, then Kafr Al-Hosr with an increase of 55.2 acres. , then Al-Hussainiya with an increase of 37.9 acres, then Banais with an increase of 23.8 acres, then Al-Eshara with an increase of 14.7 acres, then Bahgat with an increase of 14.7 acres, then Hariyah Razanah with an increase of 11.9 acres, then Kafr Abu Al-Hakim with an increase of 9.7 acres, then Kafr Yusuf Salama with an increase of 7.9 acres, then Al-Nakaria With an increase of 5.2 acres, then Sherweida with an increase of 5 acres, then Al-Aslouji with an increase of 2.9 acres, then Al-Nahal with an increase of 0.5 acres, Fig. 4, and Table (3)

3.1.7. The proposed urban boundary in 2027 and the existing mass in 2021

In fig. 5, we notice that the urban boundary planned for 2027 is smaller than the urban mass of the city in 2021 by -4738.97 acres, Table (2) which is visible from the satellite LANDSAT\_8\_ OLI/TIRS C2L2 in 22/6/2021 Table (1).

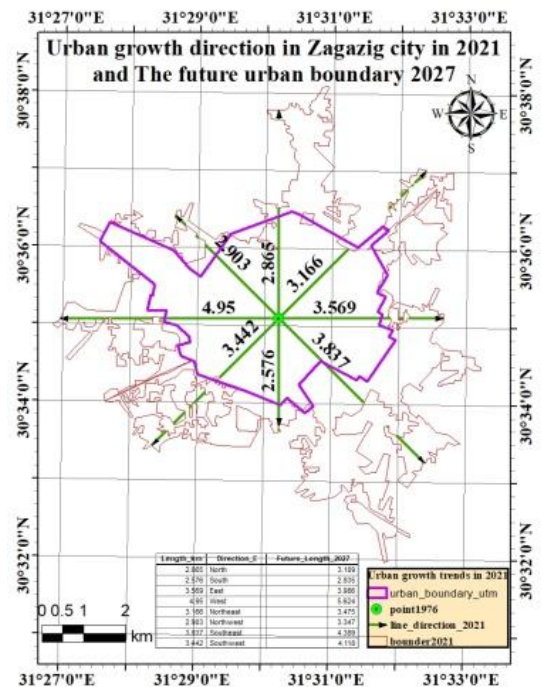


Fig. 5: Urban growth direction in Zagazig city in 2021 and The future urban boundary planned for 2027(Source: The researcher worked using Arc GIS 10.3 with the help of a personal Geodatabase for Zagazig city at the Utility Networks Center - Sharkia Governorate, satellite images from the US Geological Survey website for the year 2021)

The area of the planned urban space in 2027 amounted to 4451.13 acres, while the urban mass area in 2021 was 9190.10 acres Table (2), and this indicates the extent to which geographic information systems are useful in supporting decision-making.

### 3.1.8. Results and discussion :

The search found in 1976 the city was made up of the following sheikhdoms (Shobak Basta, Hariya Razaneh, Sherweida, Shaybah Al-Nakariah, Al-Aslouji, Kafr Muhammad Hussein, Youssef, Al-Hussainiya, Banayos, Al-Nahal, Al-Nizam, Al-Montazah, Al-Isharah, the origin of Abaza, Moawad, Al-Manshiya - Hassan Saleh, Kafr Abdel Aziz, Hariri, Zagazig tribal, Zagazig Bahriya, fishermen, Hakama, Al-Jami) and coalesced into the city during the period from (1976 to 1986) Zinkolon and Mashtoul Al-Qadi, and during the period from (1986 to 1996) the village of Kafr Al-Hasr coalesced into it, and during the period from (1996 to 2007) joined it (Al-Ghar - Al-Masaliyah - Bani Amer - Kafr Awad), and during the period from (2007 to 2017), the villages of (Bani Eshbal - Kafr Atallah - Kafr Muhammad) joined Table (3), and during this period the issuance of Unified Building Law No. 119 of 2008, and during the period from (2017 to 2021), no new villages joined the urban bloc, but the area of each village increased due to the issuance of Law No. 17 of 2019 regarding the reconciliation of some building violations and the legalization of their

conditions, which led to an increase in violations and non-removal .

Deduce the highest rate of increase in the urban mass area took place in the period from (2007 to 2017) by 267.84 acres/year, with an increase of 29.15% of the urban mass area, and it ranked second in the urban growth rate by 3.84 and this was the reason for the issuance of Law No. 17 For the year 2019 regarding reconciliation in some building violations and legalizing their conditions, which led to an increase in violations and non-removal of them, followed by the period from (1996 to 2007) by 166.6727 acres/year, an increase of 19.95% and a construction growth rate of 3.48 and was caused by the issuance of the Unified Building Law 119 for the year 2008, followed by the period From (1976 to 1986) 15.56% with the highest urban growth rate of 5.88, then the period from 1986 to 1996 by 7.91%, then the period from (2017 to 2021) increased by 166.375 acres/year at the rate of 7.24% Table (2)

When comparing the planned urban boundary for the year 2027 without the use of geographic information systems, the area was 4451.13 acres, while what was reached in 2021 is 9190.10 acres, meaning there is a decrease from the expected in 2027 by -4738.97 acres, and this indicates that the plan is wrong because there is supposed to be An increase in 2027 from 2021, not a decrease, as the results appeared, which indicates a lack of information for not using GIS, Table (2), Fig. 4

Table 4. The length of each urban growth direction and the growth rate in each direction from 1976 to 2021, and the expected length in each direction in 2027\*

| Direction | Length km<br>1976 | Length km<br>1986 | Length Km<br>1996 | Length Km<br>2007 | Length Km<br>2017 | Length Km<br>2021 | Growth<br>rate | Prediction<br>km<br>2027 |
|-----------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|----------------|--------------------------|
| North     | 1.550             | 2.140             | 2.140             | 2.578             | 2.865             | 2.865             | 0.014          | 3.109                    |
| Northwest | 1.000             | 1.404             | 1.600             | 1.959             | 2.699             | 2.903             | 0.024          | 3.347                    |
| West      | 1.902             | 3.500             | 3.500             | 3.726             | 4.950             | 4.950             | 0.021          | 5.624                    |
| Southwest | 0.897             | 1.149             | 1.149             | 2.733             | 2.775             | 3.442             | 0.030          | 4.118                    |
| South     | 1.256             | 1.527             | 1.527             | 2.242             | 2.520             | 2.576             | 0.016          | 2.835                    |
| Southeast | 1.400             | 1.400             | 1.675             | 2.606             | 2.905             | 3.837             | 0.022          | 4.389                    |
| East      | 1.557             | 1.557             | 1.938             | 2.571             | 3.350             | 3.569             | 0.018          | 3.986                    |
| Northeast | 1.577             | 2.032             | 2.071             | 2.946             | 3.166             | 3.166             | 0.015          | 3.475                    |

(source: The researcher worked using Arc GIS 10.3 3 and Microsoft Excel 2010 with the help of satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, 2021 )

### 3.2. Analysis of urban growth Directions for the stages of urban development of the city from 1976 to 2021

The nucleus or centre of Zagazig city has been identified, from which four main directions of growth are branched: north, east, south and west, and four other directions of sub-growth are: northeast, southeast, southwest, and northwest.

It is clear from these results that the information of the current research was accessed from several directions, through satellite visuals (remote sensing) from the website of the US Geological Survey, and from maps of urban development from the General

Authority for Urban Planning until 2007, the urban mass was reached During fixed periods to measure urban growth, and by obtaining a digital map of the administrative division of the sheikhs and local units from the Central Agency for Public Mobilization and Statistics, and by entering this information and processing it in geographic information systems through the (Arc-gis) program, where the results revealed that the absence of satellite visuals And the lack of processing and engineering correction at fixed intervals for the urban mass of Zagazig city from the US Geological Survey site, when this analysis was obtained, which indicates the existence of integration between GIS and remote sensing.

Table 5. Evolution of urban growth directions rates in the city of Zagazig during the period from (1976 to 2021)\*

| the Year  | 1976    | 1986    | 1996    | 2007    | 2017    | 2021    |
|-----------|---------|---------|---------|---------|---------|---------|
| direction | %       | %       | %       | %       | %       | %       |
| North     | 13.912  | 14.549  | 13.719  | 12.069  | 11.355  | 10.490  |
| South     | 11.272  | 10.378  | 9.786   | 10.495  | 9.988   | 9.433   |
| East      | 13.977  | 10.585  | 12.424  | 12.035  | 13.277  | 13.067  |
| West      | 17.072  | 23.795  | 22.437  | 17.445  | 19.622  | 18.127  |
| Northeast | 14.157  | 13.816  | 13.276  | 13.791  | 12.550  | 11.594  |
| Southwest | 8.055   | 7.811   | 7.366   | 12.796  | 10.997  | 12.604  |
| Northwest | 8.980   | 9.544   | 10.259  | 9.171   | 10.697  | 10.632  |
| Southeast | 12.570  | 9.520   | 10.735  | 12.200  | 11.513  | 14.051  |
| Total     | 100.000 | 100.000 | 100.000 | 100.000 | 100.000 | 100.000 |

\*The researcher worked using Arc GIS 10.3 and Microsoft Excel 2010 \*(source: The researcher worked using Arc GIS 10.3 3 and Microsoft Excel 2010 with the help of satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, 2021 )

Deduce the highest percentage of urban growth trends during the years (1976, 1986, 1996, 2007, 2017, and 2021) is to the west. In 1986 he passed through the village of (Al-Zangalun - Shayba - Al-Nakariah) and in 1996 he passed through the villages (the Abaza facility - Al-Eshara - Shaybah Al-Nakariah) and in the year 2017 he passed through the villages (the Abaza facility - Sherweda - Al-Zankaloon - Shayba Al-Nakari facility - Al-Eshara - Al-Nakariah) and in 2021 Overwhelmed villages (Sheroida - Alnakarya) Table (5)

Next in 1976, the northeastern direction was passed through the following sheikhdoms and merging villages (Al-Montazah – Al-Jami’ – Al-Hakama – Youssef – Zagazig Al-Bahriya – Kafr Abd

Al-Aziz – Al-Sayyed – Hariya Razanah) followed in 1986 by the north direction and it was passing (the signal – the fishermen – Banayus – Kafr al-Hamam - Mashtoul al-Qadi) followed in 1996 by the north direction and was passing (The Signal - Banayos - Kafr al-Hosr - Zagazig Bahariya) and in 2007 the northeastern direction and it was passing (Youssef - Zagazig Bahariya - Hariya Razanah - Kafr al-Hosr - Kafr al-Hamam - Bani Amer - Al-Maslamiyah) followed in 2017 by the east direction and it was passing (Kafr Abdel Aziz - Hariya Razanah - Shobak Basta) followed by the year 2021 by the southeast direction and it was passing (Al-Nahal - Shobak Basta - Al-Asluji - Al-Ghar - Kafr Awad Allah Hijazi) Table(5)

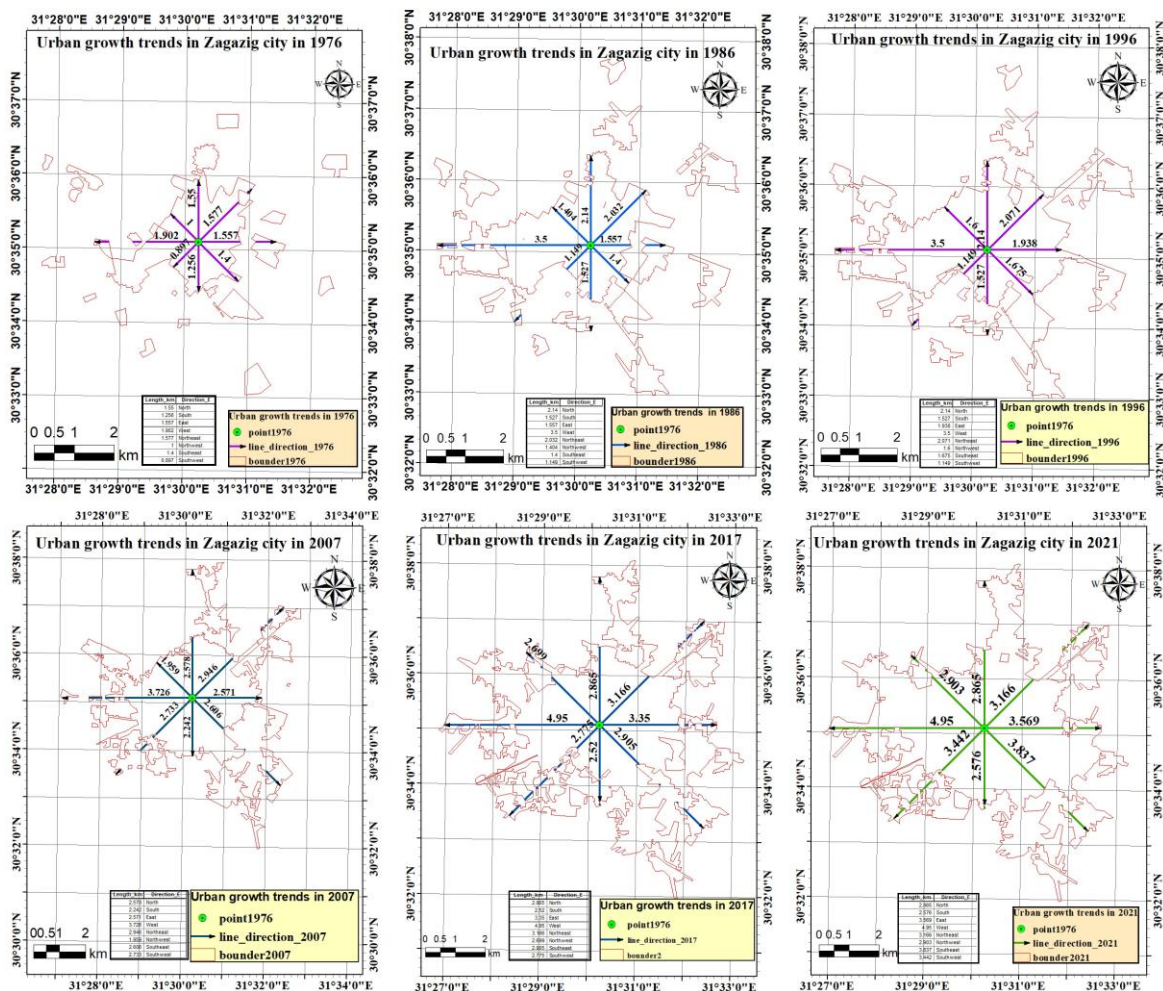


Fig. 6: Main and subsidiary urban growth Direction during the urban development periods from 1976 to 2021(source: The researcher worked using Arc GIS 10.3 with the help of satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, 2021 )

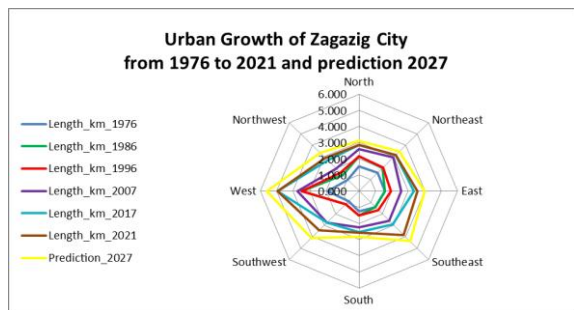


Fig. 7: Radar chart The length of each urban growth direction from 1976 to 2021, and the expected length in each direction in 2027\*(source: The researcher worked using Microsoft Excel 2010 with the help of Table 4)

In Fig. 6, fig. 7, Table (4) show the amount and direction of growth, and that the direction of growth from 1976 to 1996 is to the west, to the north, east and northeast a little, and from 2007 to 2021 it began to take with the west the southwest direction

Table 6. The evolution of the rate of urban addition in the different geographical directions in Zagazig city during the period (1976 - 2021) "average in km/year"\*

| Period<br>direction | 1976-<br>1986 | 1986-<br>1996 | 1996-<br>2007 | 2007-<br>2017 | 2017-<br>2021 |
|---------------------|---------------|---------------|---------------|---------------|---------------|
| North               | 0.059         | 0.000         | 0.040         | 0.029         | 0.000         |
| South               | 0.027         | 0.000         | 0.065         | 0.028         | 0.006         |
| East                | 0.000         | 0.038         | 0.058         | 0.078         | 0.022         |
| West                | 0.160         | 0.000         | 0.021         | 0.122         | 0.000         |
| Northeast           | 0.046         | 0.004         | 0.080         | 0.022         | 0.000         |
| Southwest           | 0.025         | 0.000         | 0.144         | 0.004         | 0.067         |
| Northwest           | 0.040         | 0.020         | 0.033         | 0.074         | 0.020         |
| Southeast           | 0.000         | 0.027         | 0.085         | 0.030         | 0.093         |
| Total               | 0.357         | 0.089         | 0.524         | 0.387         | 0.208         |

\*( source: The researcher worked using Arc GIS 10.3 and Microsoft Excel 2010 with the help of satellite images from the US Geological Survey website for the years 1976, 1986, 1996, 2007, 2017, 2021)

The highest rate of urban addition was to the west in the period 1976-1986, by 0.16 km/year, followed by the southwest direction in the period from (1996 to 2007) by 0.144 km/year, followed by the direction to the west in the period (2007 to 2017) by 0.122 km/year. The direction is southeast in the period from (2017 to 2021) by 0.093 km/year, then the direction is southeast in the period (1996 to 2007) by 0.085 km/year, then it is heading north-east in the period (1996 to 2007) by 0.08 km/year and then it is east in the period from (2007 to 2017) by 0.78 km/year, followed by the direction northwest in the period (2007 to 2017) by 0.074 km/year, then followed by the direction southwest in the period from (2017 to 2021) by 0.067 km/year, then followed by the direction south in the period From (1996 to 2007) by 0.065 km/year, Table (6)

The largest period of urban addition was from (1996 to 2007) by 0.524 km/year, followed by the period from (2007 to 2017) by 0.387 km/year, followed by the period from (1976 to 1986) by 0.357 km/year, followed by the period from (2017 to 2021) by 0.208 km/year Then followed the period from (1986 to 1996) by 0.089 km/year, Table (6)

#### 4. Conclusion

The spatial variables were monitored at the city level through the database available to the city and updated during different periods by downloading satellite images from the US Geological Survey website or Google Earth and converting them to a shapefile, and through the union of the different

layers of the years resulted in a map of the development of urban growth, and from Through the intersection of polygon layers of satellite visuals of different years resulted in the buildings that were built or demolished (spatial change) during these years.

The development of urban growth was analyzed and a conclusion from the Arcmap program quantitative analysis of extracting the areas of each urban block during a certain period. Any trend in the city during the coming periods of the target year 2027 and comparing it with what was determined without the use of GIS. It became clear from the results that the urban mass in 2021 is much larger than the expected mass in 2027 without the use of GIS, which indicates that the use of GIS is a tool To support making the right decision, and identifying the spatial variables of the different buildings from their appearance or disappearance during two or more periods, and thus determining these variables appeared based on a permit or a violation of the law.

Recommendations are made defining the direction of future urban growth, defining the future urban boundary for the target year 2027 using geographic information systems, and controlling urbanization by issuing a suspension decision for the spatial variables that appeared without a permit, implementing the decision to create an urban boundary that shows the locations of urban expansion, and issuing a removal decision to implement the suspension decision for violating works. And follow-up after implementation to make sure that no new spatial variables appear, and if there are deficiencies, it is returned to the first stage

#### References

- [1] Narain, V., Anand, P. & Banerjee, P., "Periurbanization in India: A review of the literature and evidence". *Rural to Urban Transitions Peri-urban Interface, SaciWATERS*, 2013.
- [2] Mosammam, H. M., Nia, J. T., Khani, H., Teymouri, A. & Kazemi, M., "Monitoring land use change and measuring urban sprawl based on its spatial forms: The case of Qom city". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 20, pp. 103–116, 2017.
- [3] UN-Habitat., *Regional Cities Reports: State of the World's Cities 2008/2009 – Harmonious Cities*. (2009).
- [4] Magidi, J. & Ahmed, F., "Assessing urban sprawl using remote sensing and landscape metrics: A case study of City of Tshwane, South Africa (1984–2015)". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 22, pp. 335–346, 2019.
- [5] Kar, R., Obi Reddy, G. P., Kumar, N. & Singh, S. K., "Monitoring spatio-temporal dynamics of urban and peri-urban landscape using remote sensing and GIS – A case study from Central India". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 21, pp. 401–411, 2018.
- [6] Roy, B. & Kasemi, N., "Monitoring urban growth

- dynamics using remote sensing and GIS techniques of Raiganj Urban Agglomeration, India". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 24, pp. 221–230, 2021.
- [7] Sudalayandi, R. S., Srinivasan, E. & Kasaragod, G. R., "Urban growth analysis of Tamil Nadu state, India using VIIRS DNB night data during 2012 and 2016". *Remote Sens. Appl. Soc. Environ.*, Vol 23, pp. 100559, 2021.
- [8] Shaw, R. & Das, A., "Identifying peri-urban growth in small and medium towns using GIS and remote sensing technique: A case study of English Bazar Urban Agglomeration, West Bengal, India". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 21, pp. 159–172, 2018.
- [9] Liu, G., Li, J. & Nie, P., "Tracking the history of urban expansion in Guangzhou (China) during 1665–2017: Evidence from historical maps and remote sensing images". *Land use policy*, Vol 112, pp. 105773, 2022.
- [10] Aburas, M. M., Abdullah, S. H. O., Ramli, M. F. & Asha'Ari, Z. H., "Land Suitability Analysis of Urban Growth in Seremban Malaysia, Using GIS Based Analytical Hierarchy Process". *Procedia Eng.*, Vol 198, pp. 1128–1136, 2017.
- [11] El Garouani, A., Mulla, D. J., El Garouani, S. & Knight, J., "Analysis of urban growth and sprawl from remote sensing data: Case of Fez, Morocco". *Int. J. Sustain. Built Environ.*, Vol 6, pp. 160–169, 2017.
- [12] Dadras, M., Shafri, H. Z. M., Ahmad, N., Pradhan, B. & Safarpour, S., "Spatio-temporal analysis of urban growth from remote sensing data in Bandar Abbas city, Iran". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 18, pp. 35–52, 2015.
- [13] Sabet Sarvestani, M., Ibrahim, A. L. & Kanaroglou, P., "Three decades of urban growth in the city of Shiraz, Iran: A remote sensing and geographic information systems application". *Cities*, Vol 28, pp. 320–329, 2011.
- [14] Cengiz, S., Görmüş, S. & Oğuz, D., "Analysis of the urban growth pattern through spatial metrics; Ankara City". *Land use policy*, Vol 112, 2022.
- [15] Ewing, R., "Is Los Angeles-Style Sprawl Desirable?". *J. Am. Plan. Assoc.*, Vol 63, pp. 107–126, 1997.
- [16] Hegazy, I. R. & Kaloop, M. R., "Monitoring urban growth and land use change detection with GIS and remote sensing techniques in Daqahlia governorate Egypt". *Int. J. Sustain. Built Environ.*, Vol 4, pp. 117–124, 2015.
- [17] Manesha, E. P. P., Jayasinghe, A. & Kalpana, H. N., "Measuring urban sprawl of small and medium towns using GIS and remote sensing techniques: A case study of Sri Lanka". *Egypt. J. Remote Sens. Sp. Sci.*, Vol 24, pp. 1051–1060, 2021.
- [18] Statistics, C. A. for P. M. and., "Central Agency for Public Mobilization and Statistics Final results". 2017.
- [19] Amer, Engineering Studies Office, D. I., "The project of preparing the general strategic plan and the detailed plan for the city of Zagazig, Sharkia Governorate 2027". pp. 58, 2007.