# A Study of Urban Expansion in the City of Al-Mahaweel Using Supervised Classification Method For The Period from 2003 To 2020 Using Geographic Information Systems (GIS)

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**Abstract**
This study sought to reveal the urban expansion of the city of Mahaweel in the province of Babylon for the period from 2003 to 2020 using remote sensing techniques and geographic information systems, and if there were changes in the patterns of the main land uses of the city, the study used the analytical method in describing the change in land uses Which occurred through the use of the observed classification in analyzing satellite visuals from the Landsat 7 and Landsat 8 satellites, and following the Anderson system for the first level of land classification, based on which four classifications were studied in the study area: (vegetation cover, arable land, and land Arid and urban lands). The study concluded that there is a noticeable change in the area of land uses in the region, and the study also showed that the urban areas increased by (11.32) km2, and the vegetation cover decreased by (37.68) km2, in addition to that the area of arid lands increased by (28) km2, while there was a slight decrease in the area of arable land by (1.66) km2 during the study period, in addition to that the study confirmed that GIS and remote sensing are of great importance due to their high ability and great accuracy in identifying patterns of land use and calculating its area easily It is facilitated by multiple programs.
Keywords: Supervised Classification, ArcGIS program, Accuracy rating, ground cover

## 1. Introduction

The study of land cover is considered one of the vital and important studies, especially in light of the expansion of urban areas at the expense of agricultural lands resulting from patterns of wrong use of the land, which supports decision-making processes for planning, managing natural resources and updating databases, which contributes to achieving the greatest sustainable development of society.

The use of remote sensing techniques and geographic information systems is one of the effective modern means to study various natural resources, identify their characteristics and whereabouts, then monitor them and develop optimal plans for their exploitation, through entering, storing, analyzing data, information and producing automated maps, and drawing conclusions and indicators that benefit To predict the future and change the different types of land cover and land uses [1].

Many researchers pointed out that the decline in land cover and land use in the city of Al-Mahaweel may be due to the most important reasons: the decline in the number of workers in the agricultural sector, the increase in demand for jobs in the public and private sectors, and the decline in the economic conditions of the population, due to the spread of the phenomena of poverty and unemployment in the city, and the high Land prices, their exploitation for construction purposes, the decline in the amount of rain[2], the weakness of services and infrastructure, the expansion of their services by municipalities at the expense of large areas of agricultural land, and the decline in the size of agricultural holdings as a result of the inheritance system[3].

The integration of remote sensing and GIS applications has provided researchers with advanced tools for managing the environment by assisting the data provided by these techniques in the holistic analysis of the terrestrial system on local, regional and global scales across different time stages, in addition to the importance of these techniques in monitoring and revealing important relationships Between the natural and human dimensions in changing patterns of land cover and land use, and their contribution to determining the location, direction, rate, size and nature of this change to reach a digital change detection approach in land cover and land uses [4].

## 2. Aims of the Study

1. Establishing a classification of land cover patterns in the city of Al-Mahaweel, developed from international classification systems, by carrying out the Classification Supervised process of satellite visuals of land cover and land uses during the period from 2003 to 2020 using geographic information systems and remote consulting.
2. Studying the effects of change in land cover and land uses in the study area during different times to benefit from it in planning and sustainable development programs and the preservation of

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natural resources.

3. Identifying the rate of change in the area of urban lands in the city of Mahaweel during the period from 2003 to 2020 using geographic information systems.

## The importance of studying

1. The importance of studying change in land cover and land uses using remote sensing techniques and geographic information systems as modern techniques, as they are characterized by their accuracy, spatial and temporal comprehensiveness, compatibility and suitability for studying spatial and temporal changes of land cover and land uses, in addition to their importance in identifying, evaluating and analyzing problems resulting from changes in land use. Ground cover and land uses.
2. Identify and analyze the problems caused by the change in land cover and land use.
3. Analyzing digital maps of the land cover and uses of Al Mahaweel city for the period from 2003 to 2020.

## The problem of study

1. The city of Mahaweel witnessed fundamental changes in the patterns of land cover and land use during the period from 2003 to 2020, and its reflection on natural resources and economic activities, especially agricultural, and this study came to answer the following questions:
2. What are the types of land cover and land uses in the city of Mahaweel during the period from 2003 to 2020?
3. What is the rate of change in the types of land cover and land uses in the city of Mahaweel during the period from 2003 to 2020.

## The area of study

The study is determined by spatial and temporal boundaries, and includes the spatial boundaries of Al-Mahaweel district with all its administrative units, which lies between longitudes (24 and 44°) to the east and between two latitudes (40, 32°) to the north, as the study area is located in the province of Babylon, located in the central region of Iraq The study occupies the eastern and northeastern part of the governorate, taking a rectangular shape that extends in a northwestern, southeastern direction, and it has a longitudinal extension from north to south of (46) km, and its extension from east to west is (62) km [5].

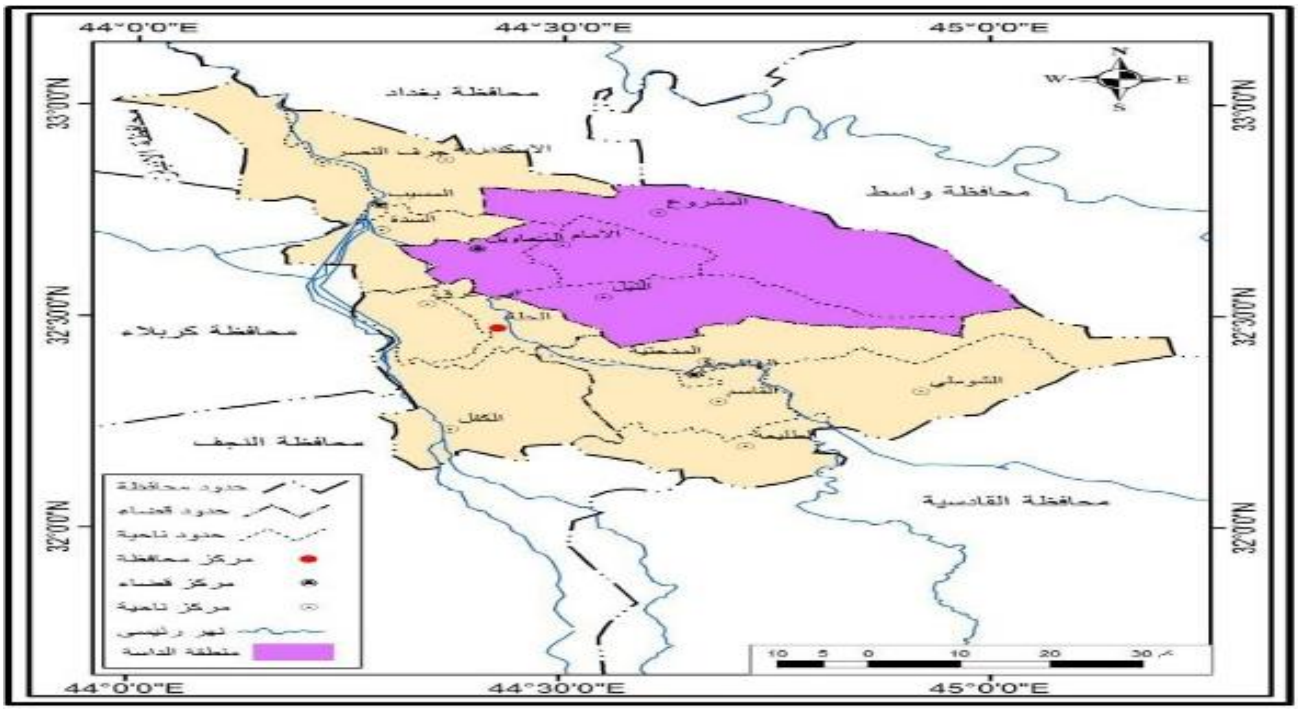


*Figure (1) The location of the city of Mahaweel in Babylon Governorate [7]*

The total area of the study area is (1667) km$^2$, which is equivalent to (33%) of the area of Babylon Governorate, which is (519) km$^2$ [6]. As for the temporal limits of the study of the city of Al-Mahaweel, it is represented by the period (2003 – 2020).

## Study Methodology

The research adopted several methods to describe, analyze and treat the research problem, present it, and then analyze and compare the results, which are:

Sensing Ways: The research analyzes three satellite visuals (Landsat-7 and Landsat-8), for the dates 2003, 2013 and 2020, with a spatial discrimination accuracy of (30) meters after Merge Resolution operations, and processes them Using satellite image analysis programs (Image Preprocessing program), and then classifying them in an automated and controlled classification, and the resistance between the classification results of satellite visuals for the mentioned period to detect changes in land uses and calculate the areas of urban expansion during the studied period.

Geomatics method: The research depends on the geoinformatics method mainly to enter, process

and analyze data and display the results of classifying the selected satellite visuals, by taking them out in the form of maps to clarify these results and obtain information that can be deduced from the visuals, and help to form complete perceptions about the uses of The land area and the distribution of urban areas at the beginning and end of the studied time period, in order to be able to compare the results of classification of satellite visuals that were selected for the mentioned period to find the urban expansion that occurred during this period.

## Comparative Research Methodology:

Through the research, a comparison was made between the results of the automated observational classification of the satellite video captured at the beginning of the studied time period in (2003) and in (2013) and the meeting visual at the end of the studied time period in (2020) and the conclusion of changes Emergency and areas and trends of urban expansion of the city of Mahaweel.

| Side panelsTable (1) Landsat satellite types used for satellite visuals. | | | | |
|---|---|---|---|---|
| Spectrum Number | Discriminative Capacity | **sensitive Senor ID** | **The moon** | **General** |
| 9 | 30 | ETM+ | Landsat 7 | 31/8/2003 |
| 11 | 30 | OLI | Landsat 8 | 27/8/2013 |
| 11 | 30 | TIRS | Landsat 8 | 17/8/2020 |

## Experimental part

### Digital processing1

Digital image processing of satellite images means dealing with and analyzing them, through computers and programs for analyzing satellite images.
Small cells in the form of small squares called the image element (pixel), and this element contains a digital value (DN) (Digital Numbers) that represents the value of the spectral radiation reflected or emitted from an area of the earth recorded by the sensor, which in turn forms a space scene and is represented by a digital matrix that represents Brightness value, and its value is limited between (0 - 255) gray scale levels in an 8-bit binary system, where the value of black (zero) represents the lowest energy values and the number (255) the highest value of energy ( Therefore, all the land features have an intensity of illumination between these two colors).

## The digital processing used in the study includes the following

### Geometric Correction

The final goal of the engineering correction process is to make the visual coordinates used with a real value identical to the values of one of the geological references and thus obtaining a corrected satellite visual as close as possible to reality and geometrically unified with the maps used. Numeric with dates for different years [8]. All satellite images obtained from the USGS website were corrected. As in Figure (2).

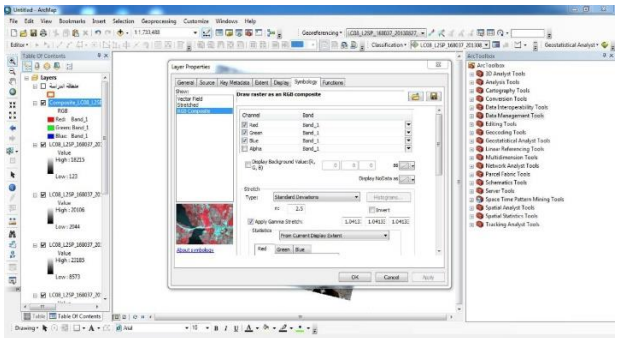

*Figure [2] shows the engineering correction process for the visuals used.*

## Cut Processer

The process of cutting out the study area from the visuals resulting from the merger process was carried out based on the file determining the area of interest (Area of Interest) in order to exclude areas that are not included in the study area (surrounding it). Reducing the data or visual size for speeding up the processing process. The benefit of this process becomes clearer when dealing with large-sized multi-domain visuals, in order to speed up the processing process and avoid many problems that may lead to slowing down the computer, in addition to avoiding the problems of calculating areas, shortening time and effort, and not scattering the interpreter's eye to distant areas outside the study area. The cutting process was carried out for all the visuals and reference maps in the programs used in the study after the borders of the city of Al-Mahaweel were obtained from the Map Production Department of the General Authority for Survey of the Iraqi Ministry of Water Resources and with the extension (Shape File) that was approved as a file in the area of interest, in The process of cutting out the study area.

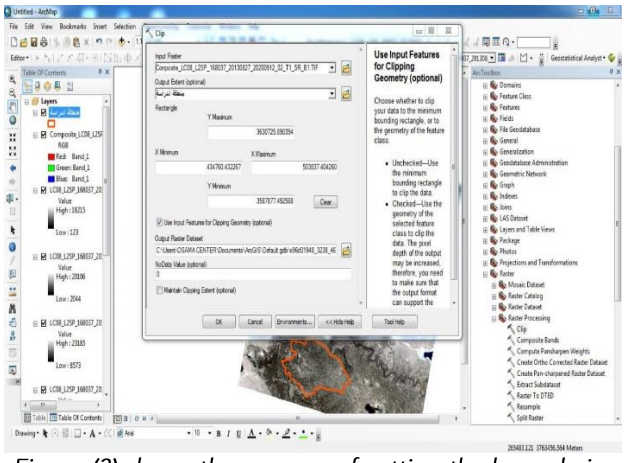

*Figure (3) shows the process of cutting the boundaries of the study area from the satellite visual field*

## Digital Image Enhancement

The main objective of improving digital satellite visuals is to facilitate the process of visual

interpretation of satellite visuals, which is derived from the corrected original visual, to be more suitable for the interpretation and analysis of goals and landmarks, by increasing the distinction between the parameters of satellite visuals [9] and the process of improving the satellite visuals used in the study is carried out in two ways:

### spatial Enhancement

The spatial optimization is based on the method of local processing, where the values of the image element (pixel) are modified depending on the values of the surrounding elements, and the spatial optimization deals greatly with the spatial frequency (Spatial Frequency) [10] and to increase the visual accuracy and clarity in order to detect spectral indicators and monitor changes in coverage The spatial improvement process was carried out through the Arc GIs 10.8 program, where multiple methods were used to deal with increasing its spatial accuracy to (30) meters with the eighth band.

## 3. Radiometric Enhancement

The Histogram Equalization method was used, as it converts the range and values of the input visual brightness into a range and brightness values that are close to the reference visual, meaning that the reflectivity values are close to 255, so this method distributes the reflectivity values again [11], which leads to a clear contrast between the phenomena And it helps to improve in distinguishing the characteristics of the land cover of the study area.

### Supervised Classification

The monitored classification depends on information about the spectral characteristics of the land uses in the region, which is collected in advance through field visits and maps, where the spectral image classifier selects the training areas, as shown in Figure (4), for each phenomenon or class of uses. The differentiated land in the study area so that these samples are representative of the objectives to be categorized in order to develop a digital interpretation guide describing its spectral characteristics, then statistical coefficients are calculated from the data of the training areas and a set of spectral digital setting values, but an element of the picture, is compared with these statistical parameters. If the characteristics agree the spectrogram of a land use is attributed to the studied image element for this use, and thus all image pixels are classified according to a controlled classification [12].

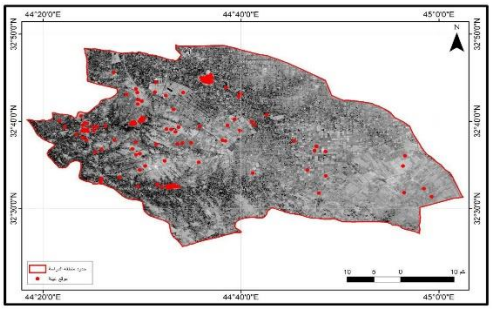

*Figure (4) shows the locations of the training sample points for the study area*

The researcher applied the observed classification to the study area, by studying the land uses for the period from 2003 to 2020, through the following stages:

The first stage: selecting samples from the satellite visuals in the various regions of the region, as this process requires many samples for each type of land use, figure (5) illustrates the observed classification process.

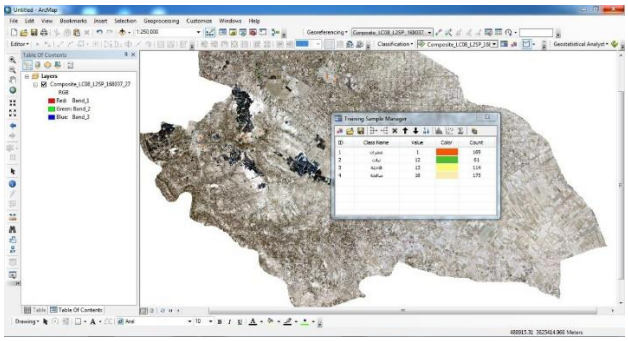

*Figure (5) shows Supervised Classification process for the study area.*

The second stage: the application of the monitored classification through the Classification tool in the ArcGIS program. Through this process, we obtain an output in Raster format that includes the types of land uses (vegetation cover, urbanization, suitable lands, and arid lands) as shown in Figure (6).

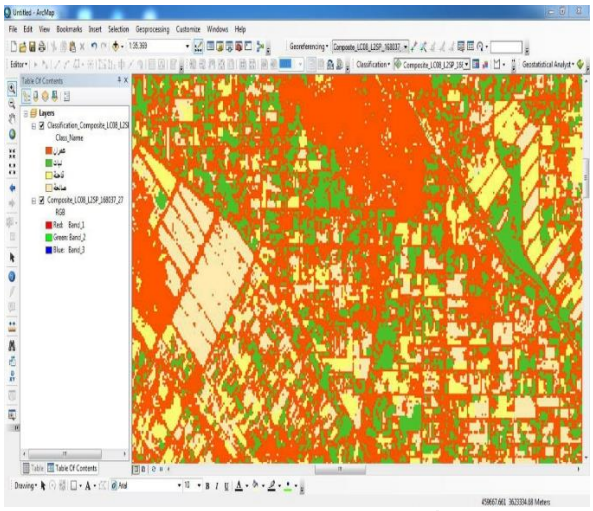

*Figure (6) shows the second stage of Supervised Classification process for the study area*

The third stage: During this stage, the researcher converted the outputs from the Raster format to the Vector format in order to calculate each type of land use (vegetation cover, urban land, Arable land, Barren land) and convert them into thematic maps representing the land uses in the study area, a table showing the area Every type of land use.

## 4. Results and Discussion

### Land use patterns for the year 2003

In order to know the land uses in the city of Al-Mahaweel for the year 2003, the coverage of satellite

images taken for the study area for the year 2003 was analyzed using ArcGIS 10.2 program.
Figure (7) the results of the analysis of satellite visuals for the year 2003, as shown in Table (2), the areas of land use and their proportions.

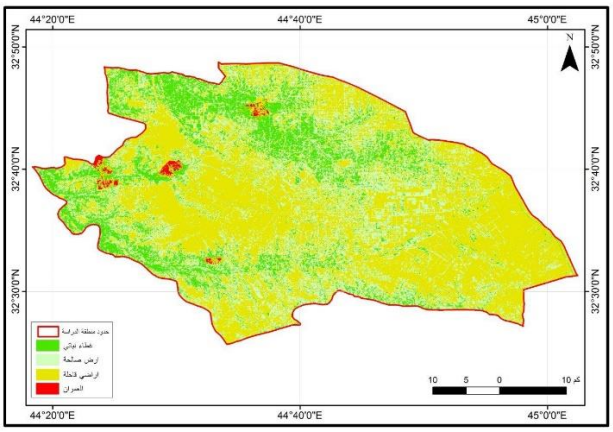


*Figure (7) shows the map of land uses for the city of Al-Mahaweel resulting from Supervised Classification for the year 2003*

| Table [2] Land uses for the year 2003 | | |
|---|---|---|
| The ratio % | Area / km2 | Type of use |
| 16.78 | 299.58 | vegetation cover |
| 31.92 | 569.89 | Arable land |
| 50.80 | 907.02 | Barren land |
| 0.5 | 8.671 | urban lands |
| 100 | 1785.16 | the total |

Through the previous figure and table, it is clear that the urban areas represent the least area, with an area of about (8.671) km2 with a percentage (0.5%) of the area of the study area, followed by vegetation cover with an area of about (299) km2 with a rate of 16.78%. Then came the arable areas, with an area of about 569.89 km2, or 31.92% of the area of the study area, while the arid areas occupied the highest percentage, with an area of about 907.02 km2, or 50.80%. This is because the city of Mahaweel has not yet witnessed development projects and is still Underdevelopment, development and urban expansion, in addition, investment in the agricultural sector was weak during that period.

## Land use patterns for the year 2013

We note by studying the patterns of land cover and land use in the city of Al Mahaweel for the year 2013, as shown in Figure (8) and Table (3)

The area of the vegetation cover amounted to (294.58) km2, the area of urban lands amounted to (10,176) km2, the area of arable land amounted to (574.96) km2, and the area of barren land amounted to about (905.37) km, where the agricultural use decreased at a rate of -1.64% from In 2003, it constituted 16.50% of the area of the study area, and the urban use recorded an increase of (17.3%) and constituted (0.6%) of the area of the study area, and the area of valid lands increased by (0.88%) and constituted a percentage of (32.20%). From the area of the study area, the barren land decreased by (0.18%) and accounted for (50.71%), as we note from the above that the urban lands and arid lands increased in proportion to their areas at the expense of the vegetation cover due to the construction of roads and the urban expansion that occurred as a result of the work of the facilities Industrial development in addition to the development of population numbers in the city of Mahaweel.

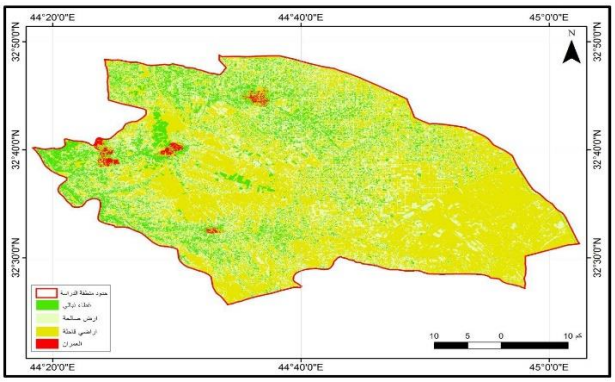


*Figure (8) shows the map of land uses for the city of Mahaweel resulting from Supervised Classification for the year 2013*

| Table [3] Land uses for the year 2013 | | |
|---|---|---|
| The ratio % | Area / km2 | Type of use |
| 16.50 | 294.66 | vegetation cover |
| 32.20 | 574.96 | Arable land |
| 50.71 | 905.37 | Barren land |
| 0.6 | 10.176 | urban land |
| 100 | 1785.16 | the total |

By applying the equation for extracting the percentage change for the four classifications between 2003-2013, the following appears:
Percentage change of vegetation cover: (299.58-294.66) /299.58 * 100 = -1.64%
Percentage change Arable land: (569.89-574.96) /569.89 * 100 = 0.88%
Percentage change in Barren land: (907.02-905.37) / 907.02 * 100 = -0.18%
Percentage change in urban land : (8.671-10.176) /8.671 * 100 = 17.3%

## Land use patterns for the year 2020

The spatial spread of the four types (vegetation cover, arable land Barren land, urban lands) appears in the city of Al Mahaweel for the year 2020, as the area of vegetation cover amounted to about (261.9) km2, where it constituted a rate of (14.67%), and the area of urban lands amounted to (19.992). ) km2, which constituted (1.2%), and the area of arable land lands reached (568.23) km2, which constituted (31.80%), while the arid lands amounted to about (935.04) km2, which constituted (52.3%) of the area The study area, where the agricultural lands recorded in 2020 a significant decrease by (12.50%) compared to 2013, due to the population's orientation during this period towards commercial activity, and the highest expansion was the share of urban lands, where it recorded a higher increase by (49.09%), This is one of the reasons for the decrease in the area of agricultural use, as the population increase expanded the urban lands at the expense of agricultural lands in this period, and the area of arable lands decreased by (-2.56%) and the reason is attributed to the urban expansion in

the city, while the arid lands increased by ( 3.17%) compared to 2013. As shown in Figure (9) and table (4).

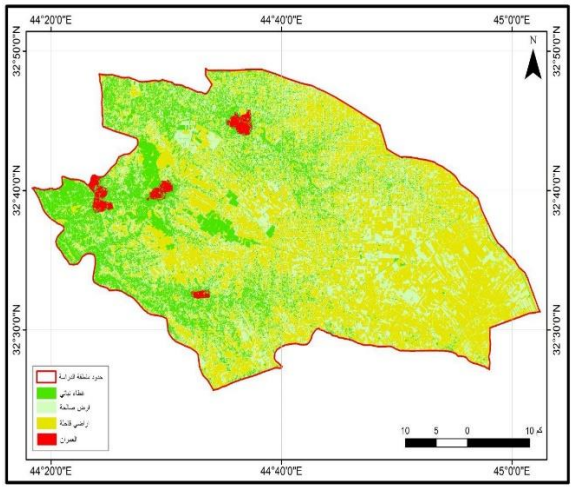


*Figure (9) shows Supervised Classification map of land use patterns for the city of Al-Mahaweel for the year 2020*

| Table [4] Land uses for the year 2020. | | |
|---|---|---|
| The ratio % | Area / km2 | Type of use |
| 14.67 | 261.9 | vegetation cove |
| 31.80 | 568.23 | Arable land |
| 52.3 | 935.04 | Barren land |
| 1.2 | 19.992 | urban land |
| 100 | 1785.16 | The total |

By applying the equation for extracting the percentage change for the four classifications between 2013-2020, the following appears:

Change percentage of vegetation cover: (294.66-261.9) /294.66 * 100 = -11.11%

Percentage change of Arable land: (574.96-568.23) /574.96 * 100 = -1.17%

Percentage change in Barren land: (905.37-935.04) / 905.37 * 100 = 3.27%

Percentage change in urban land: (10.176-19.992) /10.176 * 100 = 96.4%

## Accuracy rating

Overall accuracy was evaluated. The number of reference points should be ten times the number of classified ground cover in the image. Project outline Four types of land cover were fabricated in the study by selecting 40 reference points for each type, with a total of 160 points. Simple random sampling method was used. And homogeneously distributed across the images, the error matrix for MLC methods is shown in Table 5, Table 6, and Table 7, respectively. The accuracy was 88.1%, 91.1%, and 87.5% for the years 2003, 2013, and 2020, respectively This study demonstrated the Classification Method (MLC) and Landsat satellite data as a highly effective method for mapping land cover classes with high classification accuracy.

| Table 5: Accuracy Evaluation for the Year 2003 Using Error Matrix. | | | | | | |
|---|---|---|---|---|---|---|
| types of ground cover | | Items based on reference points | | | | |
| | | vegetation cover | Arable land | Barren land | urban land | the total |
| Calculated items | vegetation cover | 34 | 0 | 0 | 0 | 34 |
| | Arable land | 0 | 39 | 0 | 0 | 39 |
| | Barren land | 5 | 1 | 33 | 4 | 43 |
| | urban land | 2 | 0 | 7 | 36 | 45 |
| | the total | 41 | 40 | 40 | 40 | 161 |
| Total accuracy = 88.1 | | | | | | |

| Table 6: Accuracy Evaluation for 2013 Using the error Matrix | | | | | | |
|---|---|---|---|---|---|---|
| types of ground cover | | Items based on reference points | | | | |
| | | vegetation cover | Arable land | Barren land | urban land | the total |
| Calculated items from photos | vegetation cover | 36 | 0 | 0 | 0 | 36 |
| | Arable land | 0 | 39 | 0 | 0 | 39 |
| | Barren land | 3 | 0 | 35 | 3 | 41 |
| | urban land | 2 | 1 | 5 | 37 | 45 |
| | the total | 41 | 40 | 40 | 40 | 161 |
| Total accuracy = 91.1 | | | | | | |

| Table 7: Accuracy evaluation for 2013 using the error matri. | | | | | | |
|---|---|---|---|---|---|---|
| types of ground cover | | Items based on reference points | | | | |
| | | vegetation cover | Arable land | Barren land | urban land | the total |
| Calculated items from | vegetation cover | 38 | 0 | 6 | 2 | 46 |
| | Arable land | 0 | 39 | 0 | 1 | 40 |
| | Barren land | 0 | 1 | 27 | 0 | 28 |
| | urban land | 3 | 0 | 7 | 37 | 47 |
| | the total | 41 | 40 | 40 | 40 | 160 |
| Total accuracy = 87.5 | | | | | | |

## 5. Results

1. Through the study, it was found that the city of Al-Mahaweel greatly affected the occurrence of clear changes in the patterns of land use during the period from 2003 to 2020.
2. The region witnessed a great urban expansion at the expense of agricultural lands, as the area of urban lands was about (8,671) km2 in 2003, while its area in 2020 reached about (19.99) square km, while the area of vegetation decreased from 299.58 km2 in 2003 to 261.9 square kilometers in 2020 as a result of the urban expansion of the city, which was at the expense of the agricultural areas

adjacent to the cities.

3. Geographical information systems and remote sensing are of great importance in studying the observed classification due to its high ability and great accuracy in identifying the patterns of land uses and calculating its area easily through multiple programs.

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