Time Series Analysis Using Digital Classification of Data on Land Use and Land Cover in Dohuk Governorate

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Abstract
This study deals with the analysis and detection of changes in land cover patterns and land uses, especially forests in Amadiya district in Dohuk Governorate. It carried out in northern Iraq by area is (2775.21) km² and the district is located astronomically between longitudes (01.°04 ° 43), (17.°08 ° 44), it extends between two circles of latitude, which are (16.°50 ° 36) and (30.°21 ° 37) north, during the periods (1999-2006-2013-2019). Application of the Supervised Classification and the detection of change over time in a comparative manner and by relying on the satellite images of the Landsat ETM satellite were used. The Landsat OLI satellite with a distinctive capacity of 30 meters in the Arc Map 10.6.1 program, and one of the indicators of environmental degradation in the land cover patterns, which is the NDVI index for all study periods, was used to reveal the role of natural and human factors that lead to changes in the land cover patterns in the study area. The classification revealed the existence of five types of common land cover, which included dense forests, open forests, urban areas, bare soil and water, which showed clear changes in these land coverings during the period from 1999 to 2019, which were represented by a decrease in forests, bare soil and water by a percentage of (54.76%) (5.21%) (2.15%) respectively, while the Dense and urban areas by (16.35%) and (21.51%) in 2019, respectively. The classification accuracy of the Spatial indicator was estimated based on the error matrix from there we found that the accuracy was (93.29%) this indicates that the classification accuracy is very good. It is acceptable and can relied upon and recommended for classification.

Keywords: Geographic Information Systems, Normalized Difference Vegetation Index (NDVI)

1. Introduction
In general, renewable natural resources have increased dramatically in the last three decades because of their essential role in human development, in addition working on the sustainability of these resources for future generations. [1]. Therefore, it must be search for metrics that enable us to measure changes in these natural resources, which gives us a clear picture of the interactions between humans and the environment in which they live. An example of this study is the modern technologies of remote sensing, geographic information systems and the Global Positioning System (GPS), which it provides repeated measurements across a range of spatial scales and is well suited for identifying changes in natural resources [2].

Furthermore, the great development in remote sensing applications, the use of plant spectral indicators, the conduct of statistical equations, the ease of applicatio, the speed of implementation, accuracy and their low cost helped in many studies to reveal changes and deterioration in both vegetation and land cover. There are many previous research studies that dealt with the subject of studying land cover patterns and changes in land use using satellite visuals and geographic information systems according to the objectives behind these studies and the factors that affect them.

In 2020 [3], who used the Landsat satellite data to assess land use and land cover change in the Kashmir Valley, where land use and land cover change (LULC) is one of the most significant and tangible shifts in the earth's surface. Hence, it used on various spatial levels is high imperative in a wide range of perspectives such as environmental conservation, resource management, land use planning and sustainable development. The work aims to study changes in land use and land cover in the Kashmir Valley between the time periods from 2001-1992-2015 using A group of Landsat satellite images where classification maps and land uses and land cover were extracted for specific time periods, and the results revealed that there are significant changes in land use and land cover change during different time periods [3].

[4], who monitored changes in land use and vegetation indicators over the past 16 years by analyzing the time series of land use change, land cover and vegetation index in Negpur area using RS, GIS technologies, providing an index of vegetation cover resulting from the satellite data. By remote sensitivity, information not only about the vegetative mass difference in
time series, but also reflects changes in this field during the period 2000-2016 to simulate the changes, then use the LISS-3 data for LULC and M Modis, NDVI multi-time for 16 days which correlates with the degree of temperature, rainfall, deforestation. Thus, this analysis provides basic change information that will benefit the future use of natural resources. In this study, high probability algorithms for wave classification were used. This study provides ideas to study changes in crop behavior and how agricultural areas can be improved and utilized. Of the available water resources in Negpur district, the results of the study included rapid changes in soil structure, arid lands and lean forests Open up and reduce dense forest and water bodies [4].

[5], discussed time series analysis of land cover change by developing statistical tools to determine the significance of land changes in stability analysis through some simple statistical tests that should be applied to time series derived from NDVI for remote sensitivity data. Methods determine the statistical significance of three separate measures of persistence. Vegetation or changes within the landscape compared to different forms of distinctive features.

Directional stability is (changes in the signal with respect to some fixed reference values). Relative directional stability is (changes in the signal relative to previous values).

The tremendous constancy is (change in size relative to previous values).

Naturally occurring hypotheses and naturally distributed variables are developed and sequenced, the critical values are determined theoretically in numerical properties of variables. NDVI values were analyzed at the dummy unit level indicating the state of Florida over a period of 25 years, which demonstrating the technologies and capabilities needed to identify regions and times of changes. The great diversity of strength and interest and the technology of swimming in remote sensitivity studies and change sciences, especially in the field of specialization [5].

[6], who interested in tracking the change in the land cover of the five-year region for the years 2015, 2001, 1987, using remote sensing techniques. Where the operations of fragmentation, deduction, improvement, non-directed classification and the method of maximum probability were relied on in the data-oriented classification process. It showed that the study area was classified into 6 covers, which are forest lands and shrubs, irrigated agricultural lands, urban lands, rainfed agricultural lands, pasture lands, and barren lands for all the years of study. It was also found that forest lands decreased, while irrigated lands increased. As for urban lands and barren lands have been increased, while, lands of rain-fed crops and pasture had decreased. The results indicated that the decline in rangelands and forests in the region may lead to a deterioration of vegetation cover and the exacerbation of desertification. The study also reveals the importance of using remote sensitivity techniques in monitoring the changes that occur on land cover and explain those changes [6]. [7], studied the application of remote sensing techniques and geographic information systems in order to predict and monitor forest reserve degradation through reliable information on the dynamics of land use by studying the integration of remote sensitivity data and geographic information systems for application in urban areas and determining the effects of growth on the Illy forest reserve. In Ibadan for a time series from 1972-1984-2000 using the Landsat satellite data to identify and classify the Elijah forest reserve.

Al-Allaf and Narmeem were used unsupervised classification of data (1989, 2009) from the data (1989, 2009) of the American satellite Landsat. The result showed that we obtained six land cover types (dense forests, open forests, pastures, agricultural lands, soil and rocky lands). These all-lands types identified and compared with the land control points of 65 samples and for both of the data. The accuracy of classification of the spatial data was calculated and evaluated depending on the scales used for this type of studies, which include: the error matrix of the percentage of each type and for the map as a whole. The accuracy of both of the data (1989, 2009) were (84.62%) and (83.08%) respectively and that indicates a good accuracy for both classifications. Furthermore, the statistical scale (Kappa) was used to calculate the accuracy (0.81 and 0.79) for the two data classified for the year (1989 and 2009), respectively [8].

[9], explained the use of remote sensing data as one of the modern methods of preparing a set of maps for planning and economic development purposes in the Bashiqa area in te northeast of the city of Mosul. The map of the morphotectonic effect on the surface drainage system indicates the presence of anomalies in the intensity and locations of gully erosion, which were documented in the form of a contour map in which these sites were determined based on the USGS system [9]. This study aims to calculate the spatial and temporal changes in the uses of the land and the land cover, and hence to assess the trends of change during the study period and their locations by:

- Use of modern technologies for monitoring vegetation cover from remote sensitization, geographic information systems, and NDVI vegetation guide to fix sites of change and their quantities.
- Preparing different maps of land cover and land uses during different time periods.
- Prepare tables and graphs that determine the rates of change and their locations.
2. Materials and Methods

This study is based on an analysis of land cover patterns and changes in its uses and analysis of environmental degradation indicators in the study area to determine the role of natural factors and human factors responsible for the occurrence of a change in land cover patterns, especially forest lands during the periods (1999-2006-2013-2019) and the approach of detecting change over time by a comparative method for detection. On the changes in land cover patterns, its uses and areas, and the role of natural and human factors that led to the occurrence of changes in land cover patterns and its uses during the study periods.

### Table 1. Shows the satellite data used in the study.

| Sensor       | Spatial discrimination | Band   | Date of data |
|--------------|------------------------|--------|--------------|
| Land sat ETM | 30*30                  | B07-B1 | 11/08/1999   |
| Land sat ETM | 30*30                  | B07-B1 | 11/06/2006   |
| Land sat OLI | 30*30                  | B11-B1 | 22/06/2013   |
| Land sat OLI | 30*30                  | B11-B1 | 23/06/2019   |

Among the proven procedures for completing the work methodology in the study are:

Cut the satellite visuals: In this study, the boundaries of the study area were cut according to Shipfile for the area using Arcmap software 10.6.1 for all the years of study.

Field work: In this stage, the process of analyzing and interpreting satellite visuals was verified by taking homogeneous training points representing the types of land cover and its uses in the study area using the Global Positioning System (GPS) in preparation for the classification process by analyzing satellite visuals and extracting and distributing patterns of land and land cover uses in a region studying.

Satellite visual analysis and classification procedure: At this stage, the area was classified using Supervised Classification and based on training points that were field-scanned and maps were created in it.

2.1 Normalized Difference Vegetation Index (NDVI)

The vegetative difference index was calculated for the Landsat ETM and Landsat 8 OLI satellite data taken for the study area and for the years 1999-2006-2013-2019 through the following equation:

\[ NDVI = \frac{\text{NIR Band} - \text{RED Band}}{\text{NIR Band} + \text{RED Band}}. \]

3. Results and Discussion

The numerical analyzes resulting from the classification directed to the study area during the specified period between (1999-2006-2013-2019) and as in Figures No. (1,2,3,4) showed the diversity of land cover with varying areas as in Table No. (1) and the land cover was represented by open forests where it occupied The largest area of the study area was 1701.141, 1644.796, 1460.315, and 1519.872 km$^2$ for the years (1999-2006-2013-2019) respectively, followed by the urban areas, which occupied an area of 280.5608, 606.1634, 587.0253 and 597.0312 km$^2$ respectively for the years (1999-2013-2006-2019) and then the forests area. Its dense area in 1999 was 135.1875 km$^2$, 2006 was 121.7283 km$^2$, 2013 was 303.7182 km$^2$ and in 2019 its area was 454.0018 km$^2$. As for the barren soil, its area in 1999 was 576.8975 km$^2$, (2006) amounted to 369.9646 km$^2$, 2013 was 389.7575 km$^2$ and in 2019 its area was 144.6531 km$^2$. As for the water, its area was 81.4228 km$^2$ in year 1999 and 32.5576 km$^2$ in 2006, but in year 2013 its area was 4.393809 km$^2$ and in a year 20 19 reached 59.65227 km$^2$.

![Classification Map for 1999](image_url)
Figure 2. Represents the classification map for the year 2006.

Figure 3. Represents the classification map for the year 2013.

Figure 4. Represents the classification map for the year 2019.

Where the Ratio and area of the land varieties and for all the years were extracted from the map table classified by Arcmap 10.6.1, where the Ratio and area were calculated by the following equations:

\[
\text{Ratio} = \frac{\text{Count}}{\text{Sum Count}} \times 100
\]

\[
\text{Area} = \frac{\text{Ratio}}{100} \times \text{Sum area}
\]

The area and Ratio of each type of land cover were extracted as shown in Table (2).
Table 2. Shows the area and Ratio of each type of land cover.

|               | 1999   | 2006   | 2013   | 2019   |
|---------------|--------|--------|--------|--------|
|               | RATIO  | AREA   | RATIO  | AREA   | RATIO  | AREA   | RATIO  | AREA   |
| Dense forests | 4.871  | 135.188| 4.386  | 121.728| 10.944 | 303.718| 16.359 | 454.002|
| Open forests  | 61.298 | 1701.141| 59.267 | 1644.796| 53.701 | 1490.315| 54.766 | 1519.872|
| Waters        | 2.934  | 81.423 | 1.173  | 32.558 | 0.158  | 4.394  | 2.149  | 59.652 |
| Barren soil   | 20.788 | 576.898| 13.331 | 369.965| 14.044 | 389.758| 5.212  | 144.653|
| Urban areas   | 10.109 | 280.561| 21.842 | 606.163| 21.152 | 587.025| 21.513 | 597.031|

3.1 Accuracy Rating

The process of evaluating the classification accuracy of the different elements of the land cover has a special importance in classifying the lands and through this accuracy we can determine the extent to which the classification matches the covers. Furthermore, the possibility of relying on the classified map and its future use. The map classified according to the indicators for the space statement for the year 2019, and we got an accuracy of 93.29%, and this indicates that the overall accuracy of the classification is good, and a single classification accuracy (for each type) was also obtained and it was high for all varieties, reaching (100%) for dense forests and bare soil, and the least of which was for water with a rate of 83.33%, this is acceptable for the evaluation used according to the Error Matrix.

3.2 Changes in land cover patterns in the study area

Recently, the use of remote sensitivity data has greatly helped in monitoring the changing pattern of forest cover and provides the most accurate means for measuring the extent and pattern of changes in land cover conditions over a short period [10]. Satellite data has become a major application for forest and land cover detection due to continuous coverage for satellites over short distances. Figures (5, 6, 7 and 8) represent the change in land use, through which it is possible to increase the understanding of the changes occurring during the study period.

![Figure 5](image1.png)  
Figure 5. Represents the map of change between years 1999-2006.

![Figure 6](image2.png)  
Figure 6. Represents the map of change between years 2013-2006.
The table (5) shows that the type of bare soil has shifted in the negative direction, as its percentage decreased between 1999-2019 and the loss was by 8.894% for forests, 8.881% for urban areas and 0.143% for water, while it gained 1.132% from forests, 0.571% from urban areas and 0.342%. For water, this increase is slight compared to the percentage of loss, and this shift is positive and closer to the reality in the study area, while the forests class shifted in the positive direction, where the positive increase was higher than the percentage of loss from the forest class for the rest of the varieties in the study area, where the percentage of forest loss to barren soil was 1,132. While for urban areas 4.069% and for water 1.386%, the positive increase gained from bare soil was 8.894% and for urban areas 2.515% and the increase in water gained 0.538%. As for the
urban areas category also shifted in the positive direction, the positive increase gained from other varieties was 8.881% of barren soil, 4.069% of forests and 1.374% of water, while the percentage of loss was from the category of urban areas. For the rest of the varieties, it was 0.571% for bare soil, 2.515% for forests, and 0.084% for water, meaning that the percentage of loss is small compared to what the variety gained from the rest of the varieties. While the water category shifted in the negative direction, where the percentage of acquisition was less than the percentage of loss, so the positive increase gained from bare soil was 0.143% of forests, 1.386%, and of urban areas 0.084%. As for the percentage of water loss for other varieties, it was 0.342% for bare soil, 0.538% for forests, and 1.374% for urban areas. This indicates that the spatial distribution of the rates of transformation trends shifted in a negative and positive direction for the types of land cover for a region. The study between 1999-2019.

In general, the percentage of increase in forests in the study area was (5.36%), and this represents the increase in forest area in general.

| Variety                  | 1999-2006% | 2006-2013% | 2013-2019% | 1999-2019% | 1999-2006% |
|--------------------------|------------|------------|------------|------------|------------|
| Forests - Barren soil    | 2.768      | 2.995      | 3.888      | 8.894      | 2.768      |
| Urban areas - Barren soil| 1.821      | 4.866      | 6.056      | 8.881      | 1.821      |
| Waters - Barren soil     | 0.388      | 0.768      | 1.292      | 0.143      | 0.388      |
| Barren soil - Forests    | 4.945      | 4.620      | 1.432      | 1.132      | 4.945      |
| Urban areas - Forests    | 0.550      | 3.974      | 4.059      | 0.469      | 0.550      |
| Waters - Forests         | 0.533      | 0.048      | 0.304      | 1.386      | 0.533      |
| Barren soil - Urban areas| 7.213      | 3.568      | 0.709      | 0.571      | 7.213      |
| Forests - Urban areas    | 4.750      | 5.500      | 9.110      | 2.515      | 4.750      |
| Waters - Urban areas     | 0.714      | 0.125      | 0.360      | 0.084      | 0.714      |
| Barren soil - Waters     | 0.035      | 0.064      | 0.0001     | 0.342      | 0.035      |
| Forests - Waters         | 0.525      | 0.012      | 0.002      | 0.538      | 0.525      |
| Urban areas - Waters     | 0.011      | 0.007      | 0.001      | 1.374      | 0.011      |

Table 5. The trend of shifting between items for the study area for all years.

![Normalized Difference Vegetation Index (NDVI)](image)

**Figure 9.** Represents the NDVI natural vegetative difference map.

| NDVI Value | Few class | Middle class | Upper class |
|------------|-----------|--------------|-------------|
| 1999       | -0.33333  | 0.05934      | 0.54167     |
| 2006       | -0.55072  | -0.00974     | 1.0000      |
| 2013       | -0.09283  | 0.24426      | 0.57254     |
| 2019       | -0.24716  | 0.28023      | 0.62264     |

Table 6. Represents the categories for the NDVI index and for all years of study.

The values of this index range between (-1 , +1), as values close to +1 indicate the presence of dense vegetation, and that values approaching zero indicates the presence of non-dense and scattered vegetation. This indicator depends on the near infrared (NIR) range and the range Red rays (RED).
Conclusions

This study found the determination of the land cover covering Amadiyah district and the changes that took place during the time periods from 1999 to 2019 through the classification of space data for the years 1999, 2006, 2013, 2019 and they were as follows:

- This study concluded that the study area is represented by five types of land of different areas, namely (dense forests, open forests, urban areas, bare soil, water). The study area is heading in the right direction regarding the management of this area, through our monitoring of the increase in forests in general and the scarcity of arid areas in it.
- The different ground covers were not fixed in their locations, but moved in the direction of negative and positive due to the different activities at the site of the study (negatively and positively).

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