Using of Temporal Variability for Monitoring Change of Vegetation via Remote Sensing in Anbar Province

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Abstract. The use of spectral indicators and evidence based on remote sensing and the results of space data is one of the most important means of detecting changes in vegetation and land cover. Three space scenes were selected to assess vegetation changes in Anbar governorate, consisting of 33 satellite shots in different dates for the years 1999, 2009 and 2019, captured by the Landsat 5 and Landsat 8 for the two sensors TM and OLI. Spectral data were used to calculate NDVI normal vegetative variation index values. The results showed that the area of barren land continued to increase by 24,809.19 km² by 11.47, 11.98 and 30.56% for 1999, 2009 and 2019 respectively and the area of dense vegetation decreased by 857.73 km² by 0.30, 0.17 and 1.40% for the same years respectively.

1. Introduction
Change detection is the process of determining the difference in observing the phenomenon over different time periods, modern technologies have contributed to the possibility of monitoring and observing changes in vegetation cover and very large areas at different times. To control and monitor the density and distribution of vegetation in desert environments with unlimited boundaries, repeatedly and continuously integrated by means of remote sensing, is considered important in the preservation of this ecosystem and its maintenance and the preservation of what is deteriorating for the purpose of developing implementation plans to maintain that wealth.

Vegetation cover is one of the most important natural resources, especially in fragile drylands ecosystems, as drylands ecosystems do not have the ability to restore their natural balance without human intervention [1]. As for the study [2] used NDVI remote sensing techniques to monitor the degradation of vegetation cover in semi-dry areas and their relation to climate, he found a relationship between rainfall and vegetation density. The study [3] used the calculation of NDVI values and botanical evidence to assess the state of deterioration of grassland lands in Ninawa province within protected and unprotected grazing lands. The findings concluded that the island's territory within Ninawa governorate suffers from significant deterioration and desertification risks. As for the study [4] the width of the transition zone between the desert and the oasis was determined on the basis of NDVI and TCI. It was concluded that NDVI and TCI can identify different directions of vegetation and surface temperature within spatial transitional gradients in the oases and desert areas. [5] Studied temporal and spatial differences in NDVI values and factor analysis in northern China's desert regions from 1998 to 2015 by evaluating the effectiveness of large-scale environmental restoration projects.
carried out in northern China and the analysis of the impact of the main climates (precipitation and temperature) on vegetation cover and the spatial distribution of NDVI and its changes.

The problem of the research is represented in the following question: Could remote sensing data be used as a basis for assessing the change in vegetation cover of Anbar governorate? This research aims at studying the change of vegetation cover and observe the changes in the area of deteriorated land between 1999 – 2019 based on evidence of (NDVI).

2. Materials and Methods

2.1. Study area

Anbar governorate is located in the western-central part of Iraq between with longitude (38° 47' 37" - 44° 09' 35") north and latitude ( 30° 35' 59" – 35° 09' 30") east, and its geographical location has drawn administrative and international boundaries, as it is bordered on the north by Ninawa governorate, on the North-East by Salahuddin governorate and on the East by Baghdad governorate, Babylon, Karbala and Najaf governorates are bordered to the south-east, from the South by Saudi Arabia, from the West by the Hashemite Kingdom of Jordan and from the North-west by the Syrian Arab Republic. Figure 1.

Figure1. Map of the location of Anbar governorate for Iraq.

The area of the governorate is 137,808 km2 or equivalent to 31.7% of Iraq's 435,052 km2 [6], (the Central Bureau of Statistics, 2019) this geographical and astronomical location of the study area and its occupation of the western part of Iraq has affected its climatic conditions and was a direct cause of natural causes in the occurrence of the variability of vegetation distribution in this territory.
2.2. Specifications of space data and programmes used

2.2.1. Space data. Using the satellite data of the US Landsat satellite series and multiple sensors on board, three space scenes were selected, consisting of 33 space shots taken by the 5 Landsat 8 & sensor satellite TM and OLI across different time series for the years 1999, 2009 and 2019 to study and evaluate vegetation changes in Anbar governorate, and through Table 1[7], we observed the types of space visuals used in the research and Figure 2 shows a satellite visuals of Anbar province 2019 captured by the satellite 8 Landsat.

Table 1. Satellite visuals used in the search for the Landsat satellite.

| SPACECRAFT | Path | Raw    | DATA / SENSOR |
|------------|------|--------|---------------|
|            |      |        | 1999/ L5_TL  |
|            |      |        | 2009/L5_TL   |
|            |      |        | 2019/L8_OLI  |
| Landsat    | 196  | 37     | 25/6/1999    |
|            | 38   |        | 25/6/1999    |
| Landsat    | 170  | 36     | 16/6/1999    |
|            | 37   |        | 16/6/1999    |
| Landsat    | 171  | 36     | 23/6/1999    |
|            | 37   |        | 23/6/1999    |
| Landsat    | 172  | 37     | 14/6/1999    |
|            | 38   |        | 14/6/1999    |

Figure 2. Satellite visual landscape map of Anbar governorate, American satellite (Landsat 8), resolution 30 meters, extension (JPEG 2000), dated 16/21/23 and 30/6/2019.

2.2.2. software used in research

- Erdas Programme ERDAS IMAGINE 2014.
- Arc GIS software Arc GIS 10.4.1.
2.2.3. Working mode / application of NDVI indicator

1. The identification of the study area and the result of this process is the visuals of the study area for different periods and for the same coordinates where the integration of bands and the work of the Mozaic was conducted by program (ERDAS), and the production of maps and practical applications was conducted in the program (Arc GIS 10.4.1) within its internal accessories like (Arc Map) which is an application for making maps, analyzing information and displaying results, in addition to other applications within the program.

2. Analysis of the Landsat satellite image archive for the years 1999, 2009 and 2019 for the search area. The satellite images were obtained from the internet and in compressed format from the official website of the U.S. Geological Survey (USGS Global Visualization Viewer) to study and evaluate vegetation changes in Anbar governorate via using and applying the Normalized Difference Vegetation index (NDVI) as a guide of the natural difference of vegetation.

3. NDVI analysis using Erdas2014 is calculated according to the following equation [8, 9].

\[
\text{NDVI} = \frac{(\text{NIR} - \text{RED})}{(\text{NIR} + \text{RED})}
\]

In Landsat 5, \(\text{NDVI} = \frac{(\text{Band 4} - \text{Band 3})}{(\text{Band 4} + \text{Band 3})}\).

In Landsat 8, \(\text{NDVI} = \frac{(\text{Band 5} - \text{Band 4})}{(\text{Band 5} + \text{Band 4})}\).

NDVI values vary from -1.0 to 1.0, large values express high values for the density and abundance of the green plant but the specificity of each plant in the absorption and reflection of the Rays must be taken into account in this area, while the small negative value expresses manifestations in which there is no vegetation cover such as the barren land. Figure 3(a,b,c) represents the NDVI maps of the study area, with a white to black color gradient, as white represents vegetation cover and its values are referred to as positive, and gray to black gradient represents barren land and other uses with negative values.

4. Classification: Classification of NDVI outputs for the years 1999, 2009 and 2019 was done for each element by spectral reflectivity and for the study of biomass density of vegetation. The study area was classified and divided into five varieties, two of which are degraded in vegetation, and other two with positive development in vegetation and a last type for water.
Figure 3 (a, b, c). The Image Resultant by Applying NDVI Method, for years1999, 2009& 2019.

3. Results and Discussion

3.1. Assessment of deterioration using the NDVI natural vegetative variation guide.

In Figure 4(a,b,c), we find that the areas that are located within the basin of the Euphrates River valley from Al-Qaim to Al- Fallujah and other agricultural areas have a good vegetation density, which are referred to by dark green and areas with green color are represented by areas with a simple density of vegetation cover as grassland and catchment areas in Al-Rutbah and Al-Nikheb areas. The date of space visuals has a role and clear influence in the extent of the prevalence of vegetation cover, the month of June was chosen for all the visuals over the time series to show the reality of the vegetation of Anbar governorate, which is characterized by its desert environment and most of its vegetation seasonal. We found that the area of areas with good vegetation cover for the years 1999, 2009 and 2019 (411.71, 234.29 and 1927.19.2) was sequentially, and the area of vegetation-free zones increased significantly to reach 15804.69, 16512.48 and 42110.4 km² for 1999, 2009, 2019 sequentially. It was noted through the values that the space visuals (2019) have given the highest rates of (NDVI), which ranged from (0.17 - 0.62) through the extrapolation and viewing and the values shown in the space visuals, especially in areas within the desert lands, which are sprawling in Anbar governorate suffering from degradation and desertification due to a number of factors resulted in the degradation of vegetation specifically, the natural and the disintegration of the soil due to overgrazing as well as the impact of extreme weather conditions, lack of rainfall and high temperatures. Through the satellite visual values for 2019, it was found that the density of good vegetation increased to 1.40% over the rest of the years due to the increase in agriculture within the areas of the river valley basin due to the stability witnessed by the governorate.
3.2. Monitoring changes in deteriorated land area

Visuels of NDVI were classified into four varieties of vegetation according to the reports by both (Younes and Abdel-Hady 2006) [3] which included slightly mild deterioration, Moderate deterioration, severe deterioration and very Severe deterioration. The study area's visuals were classified for degradation depending on the NDVI visuals depending on the density of vegetation and were divided into severe degradation, moderate degradation, mild degradation and non-degradation. We note from Table 2 which explained the deterioration. between 1999 and 2019, there was a variation in the degrees of deterioration, as it found that degrees of moderate and severe deterioration have shaped the area, and the largest compared with the other, which accounted for the severe 11.47 11.98 and 30.56 % respectively for the years 1999 and 2009 and 2019. Concerning the rates of moderate degradation recorded the highest rates of degradation for the same years respectively 76.44, 81.59 and 46.84% and found that most of the lands are with moderate and severe degradation, whereas non-degraded lands accounted for a small percentage of the area of the province and
amounted to 0.30, 0.17 and 1.40 % respectively for the years 1999, 2009 and 2019. The continental location of Anbar governorate is remote from water bodies and their effects, as well as its climate, which is characterized by high temperatures in the summer due to its location within the range of tropical displays, its low rain during the cold half of the year and non-existent during the summer. The location directly affects the climatic characteristics, and was a direct natural cause of land deterioration, lack of natural vegetation and the occurrence of the problem of desertification in its various manifestations in this region.

Table 2. Degrees of degradation of vegetation according to NDVI standard

| NDVI values for years | Vegetation Cover | Degradation Score       | Area km² | Percentage |
|-----------------------|------------------|-------------------------|----------|------------|
| 0.1 - 0.1             | waters           |                         |          |            |
| -0.9 - -0.045         | Bare lands       | Severe degradation      | 15804.69 | 11.47      |
| -0.013 - 0.014        | Moderate density | Low degradation         | 14108.19 | 10.24      |
| 0.13 - 0.057          | Good density     | Good density            | 411.71   | 0.30       |
| 0.05 - 0.09           | waters           |                         | 1307.11  | 0.95       |
| -0.089 - -0.045       | Bare lands       | Severe degradation      | 16512.48 | 11.98      |
| -0.044 - 0.014        | Slight density   | Moderate degradation    | 112441.73| 81.59      |
| 0.03 - 0.12           | Moderate density | Low degradation         | 7312.39  | 5.31       |
| 0.13 - 0.15           | Good density     | Good density            | 234.29   | 0.17       |
| 0.05 - 0.01           | waters           |                         | 1738.96  | 1.26       |
| 0.011 - 0.01          | Bare lands       | Severe degradation      | 42110.4  | 30.56      |
| 0.14 - 0.2           | Slight density   | Moderate degradation    | 64549.96 | 46.84      |
| 0.13 - 0.16           | Moderate density | Low degradation         | 27481.49 | 19.94      |
| 0.17 - 0.62           | Good density     | Good density            | 1927.19  | 1.40       |

4. Conclusion

The results of the study indicate the feasibility and effectiveness of the adoption of the remote sensing technologies and (NDVI) in the study and assessment of vegetation changes in Anbar Governorate. Based on the calculation of (NDVI) values, four different degrees of degradation were identified according to the prevalence of vegetation density and were marked by severe degradation, moderate deterioration, mild deterioration and not deteriorated. Most of the province areas were found to fall within moderate and severe degradation and the areas with high vegetation density within the river valley basin in agricultural areas. The study recommends the expansion in studies and researches on spectral indicators, particularly the plant ones, in the study of distribution of vegetation cover prevalence based on the use of remote sensing techniques it achieves a comprehensive vision within multiple times series.

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