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Study on Change in Area of Vegetation Using NDVI and Remote Sensing Data in Basra Province

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Abstract: Remote sensing and geographic information systems technologies were used to monitor changes in the vegetation cover of Basra Province during the period 2002– 2018. Satellite imagery with ETM $^{+}$ OLI sensors has been used for the years 2002, 2014, 2018 and NDVI index was calculated to produce digital maps to detect changes in vegetation, density and area. The highest degradation of the vegetation cover occurred in the year 2014, while the lowest in 2002. There was an improvement in the growth of the vegetation cover in the study area for 2018 due to the variation in the severity of climatic conditions in the region. The maximum area of land occupied with vegetation was in the year 2002 (883.756 km^2) followed by green lands which decreased to 664.436 km^2 n 2014. There was a noticeable improvement in the area of green lands for the year 2018 which amounted to 682.640 km^2. The degradation of the vegetation cover was classified according to the range of the NDVI values, which ranged between negative and positive values, while the density of the vegetative cover varied between barren soils to soils with good vegetation density and thus the degrees of degradation varied from very severe to weak, as the barren soil with degradation was very severe with negative NDVI, while the soil with good vegetation reaches a value of 0.4.

***Keywords*:** Remote sensing, GIS, Digital maps, NDVI, Soil degradation, Vegetation

Monitoring the changes in the areas of the vegetation cover is one of the important things that require investigation and detection through remote sensing technologies based on satellite data to know the changes that occur in the exploitation of natural resources and other human activities. Therefore it is necessary to study these areas through quantitative analysis and spatial redistribution is to find out the amount of change in the area of vegetation by studying the difference in the spectral reflectivity values of the land cover. Many recent studies and research indicated the possibility of using remote sensing techniques and technologies in identifying and evaluating the cases of deterioration in vegetation, which is one of the methods of natural improvement. Depending on what is known as the Normalized Difference Vegetation Index (NDVI) and requires measuring reflectivity in visible red rays that are absorbed by chlorophyll dye and near infrared that are subject to high reflection by plant. The vegetation can give very tangible indices of the environmental conditions of the region. Therefore the soil conditions can be predicted through their chemical properties, such as salinity, the readiness of nutrients, and thus their productive ability. The vegetation is a reflection of the influence of soil properties and dry climate elements that prevail in the study area through its density or its occupied area. Ibrahime (2008) used remote sensing techniques by NDVI to monitor vegetation degradation in semi-arid regions and their relationship to climate and established a correlation between precipitation ratio and vegetation density. Khalaf and Shallal (2013) assessed the state of rangelands using remote sensing technologies in determining four different degrees of plant degradation depending on the values of NDVI, explaining that most of these areas suffer from severe and very severe degradation with high values of plant indices and indicators in sites located to the north of Mosul. Al Jazeera region suffers from the risks of deterioration and desertification significantly, as well as the deterioration of the physical and chemical characteristics of the soil resulting from tillage, overgrazing and poor management operations. The present study aimed at investigating and exploring the possibility of utilizing Spectral data to determine the problem of vegetation degradation, through calculating NDVI values and determining their degraded areas to produce digital maps with NDVI values for different time periods.

MATERIAL AND METHODS

Study Area

The study area was part of the sedimentary plain that is characterized by soils of sedimentary limestone origin due to the entisol sand is located in southern Iraq within Basra Province , which is characterized by its eastern section adjacent to the Shatt Al-Arab River, with the intensity of palm trees and low vegetation in its western part and lies between latitudes 31 ° 0'17 ”- 29 ° 42'17” north and longitude 46 ° 34'21

”- 48 ° 13'46” east and with an area of 11690.128 km^2 (Fig. 1).

Satellite images used in the study: Satellite images were obtained from the internet from the official website of the USGS Global Visualization Viewer for Landsat7 and Landsat8 satellites for three time periods (Table 1).

Spectral data: Satellite images (Fig. 2, 3 and 4) captured by Landsat 7 and Landsat 8 for 2002, 2014 and 2018 respectively were fully corrected after all steps were taken to eliminate distortions caused by multiple causes. Digital images were processed using Arc map 10.4.1 software, the spectral bands 2, 4, and 7 of the Landsat 7 satellite and the spectral bands 7, 5 and 3 of the Landsat 8 satellites, which have the highest differential coefficient (OIF) Optimum index factor were chosen to create the best color combination to distinguish soils in study area. Satellite imagery was used to extract spectral data for the purpose of calculating spectral indices The Normalized Difference Vegetation Index (NDVI) proposed by (Rouse et al 1974).

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

As that NIR: Near infrared.

Classification of degradation in the area of vegetation: The spectral reflectivity values of the Normal Difference Vegetation Index (NDVI) proposed by Rouse et al (1974) were used to find out the changes in the values of vegetation, the degree of deterioration, the density of the vegetation and calculate its areas for different time periods. Depending on the values of NDVI, the degrees of degradation of vegetation were classified according to Dregne (1983) (Table 2).

Preparing digital maps for the NDVI indices: After calculating the values of the aforementioned spectral index using the ArcMap10.4.1 program and extracting their values in order to determine the values of vegetation, degree of degradation, density of vegetation and calculating their areas, numerical maps of the NDVI spectrum were prepared for the above-mentioned Satellite images for different time periods.

Table 1. Satellite images used in the study

Satellite	Resolution(m)	Sensor type	Date of capture
Landsat – 7	30	ETM^+	2002
Landsat – 8	30	OLI	2014
Landsat – 8	30	OLI	2018

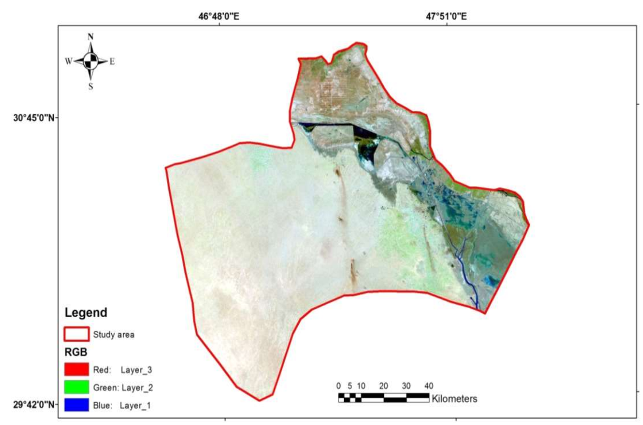

Fig. 2. Study area of the Landsat7 satellite (2002)

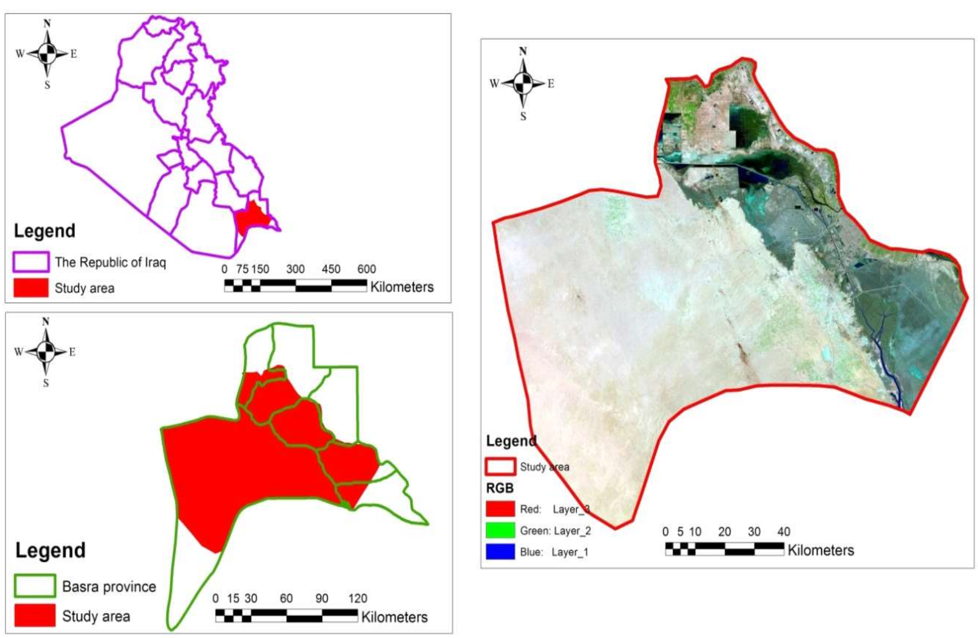

Fig. 1. Study area

RESULTS AND DISCUSSION

NDVI vegetation indices: There was a variation in the values of the NDVI in the study area and ranged between (-1.195) **–** (0.532), (- 0.521) **–** (0.49) and (- 0.798) **–** (0.44) for the years 2007, 2014 and 2018, respectively (Table 3). This represents the case of variation in the vegetation cover, so the closer values to 1.0, means the presence of dense vegetation, but the values less than 0.1 represent the abandoned soils and barren areas without vegetation and residential areas and values ranging from 0.1 to 0.4 indicate the presence of shrubs and weeds. The values higher than 0.4 refer to dense plants such as trees (Rouse et al 1974). The results showed that the highest value of NDVI in the area adjacent to Shatt al-Arab and the Safwan area ranged between 0.108 **–** 0.532, 0.173 **–** 0.49 and 0.166 **–** 0.44 for the years 2002, 2014 and 2018, respectively. These regions are located in the river levees soil with vegetation of seasonal crops with the presence of some palm trees and some farms, especially in the area of Safwan, while the dominance of barren and abandoned soils in the rest of the areas was negative and ranged between (-0.093) **–** (-1.195). Therefore, this NDVI can be used in the diagnosis of vegetative cover, which depended on the ratio between the spectral reflectivity values of the infrared band and the red band that are suitable

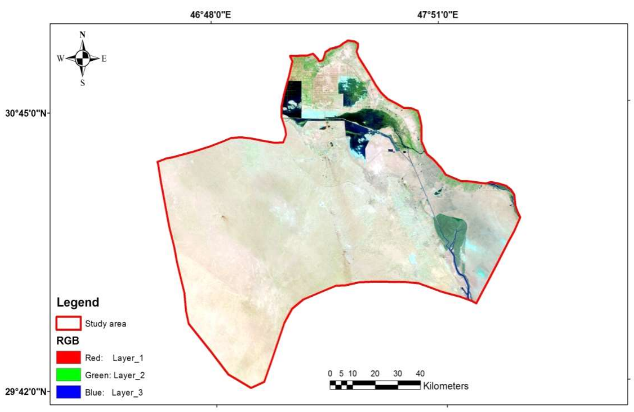

Fig. 3. Study area of the Landsat8 satellite (2014)

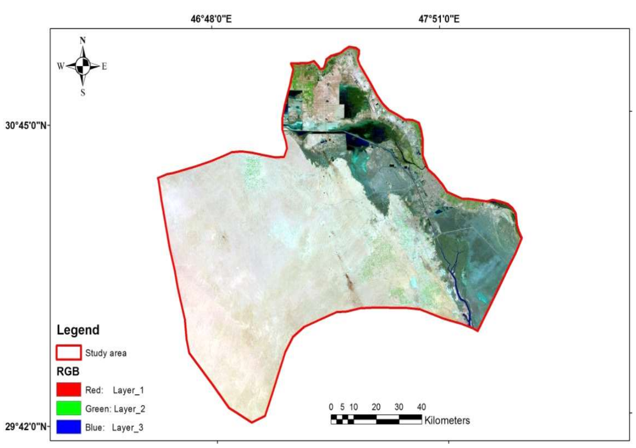

Fig. 4. Study area of the Landsat 8 satellite (2018)

Table 2. Degrees of degradation of vegetation according to the ranges of NDVI

NDVI range	Density of vegetation	Degree of degradation
Negative values	Barren	Very severe
0.00 – 0.19	A few	Severe
0.20 – 0.49	Medium	Moderate
0.50 – 0.79	Good density	Weak
0.80 – 1.00	Very dense	Not degraded

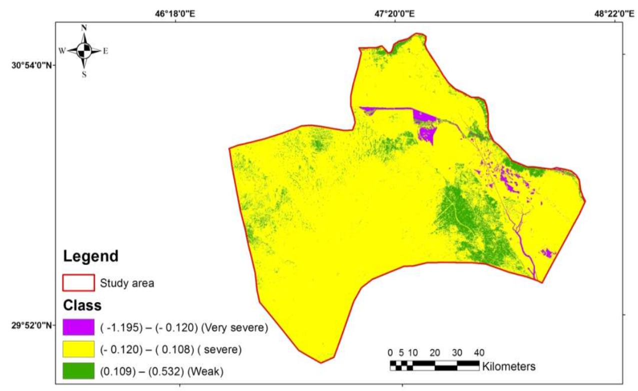

Fig. 5. Spatial distribution of the NDVI index (2002)

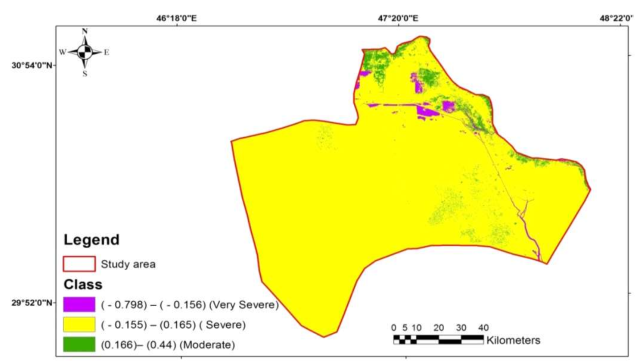

Fig. 6. Spatial distribution of the NDVI index (2014)

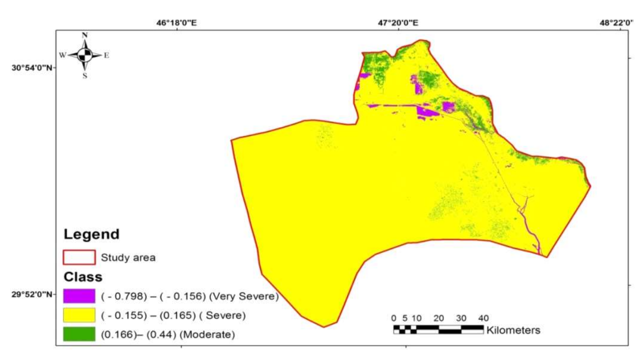

Fig. 7. Spatial distribution of the NDVI index (2018)

Table 3. NDVI and the degree of degradation of the study area

Satellite images	Class	NDVI value range	Density of vegetation	Degree of degradation	Area km^2
2002	1	(-1.195) – (- 0.120)	Barren	Very severe	397.7775
	2	(- 0.120) – (0.108)	Barren- A few	Very severe – severe	10408.8033
	3	(0.108) – (0.532)	Good density	Weak	883.7568
2014	1	(- 0.521) – (- 0.093)	Barren	Very severe	424.2087
	2	(- 0.093) – (0.172)	Barren- A few	Very severe – severe	10601.6922
	3	(0.173) – (0.49)	Medium	Moderate	664.4367
2018	1	(- 0.798) – (- 0.156)	Barren	Very severe	285.8958
	2	(- 0.155) – (0.165)	Barren – A few	Very severe – severe	10856.8017
	3	(0.166)– (0.44)	Medium	Moderate	547.6401

for this purpose, and then these values appeared very low and this is an indication of poor agricultural investment in the study area.

Changes in NDVI values and assessment of degradation status: The variation in the density of vegetation was classified into three classes depending on the values of the NDVI (Table 3). For all years, class 1 was, completely devoid of vegetation, and the degree of degradation was classified to very severe, and the values of the NDVI were negative and ranged between (-1.195) **–** (-0.093) and these areas were purple in the map. In the class 2 the density of the vegetation ranged from barren to its degradation was classified as severe and very severe, and the values of the NDVI were negative and positive and ranged between (0.172) **–** (-0.093) and these areas were yellow in the map while the class 3 and for all years was the density of vegetation ranging from medium to good density and the degree of its degradation was classified as moderate and weak and the values of the NDVI were positive and ranged between (0.108) **–** (0.532). These areas are represented in green on the map. In general, the study area was characterized by low density of vegetation in it, and this is due to the impact of harsh climatic conditions due to the scarcity of rains and high rates of temperature, which made these lands suffer from significant degradation and desertification, which led to the destruction of the vegetation cover and the disintegration of soil and its degradation (Fadhel 2009). The results showed the highest degradation of the vegetation cover occurred in the year 2014, while the lowest degradation was in the year 2002 (Fig. 8) due to the variation in the severity of climatic conditions experienced by the region from low precipitation rates and high temperatures and this was confirmed by Ibrahime (2008). There was an improvement in the growth of vegetation in the study area for the year 2018, due to the increased amount of precipitation during that period, which encouraged the growth of some natural plants and a decrease in drought rates.

Changes in the area of vegetation : There was variation in the area of lands containing vegetation for the years 2002, 2014 and 2018 respectively and the study area was classified into three classes depending on the values of the NDVI and for all years (Table 3 and Fig. 9). The barren lands area of the vegetation It is located in the class 1 with an area that ranged between 285.8958 **–** 424.2087 km^2, while the class 2 distinguished the area of its lands between the barren and low vegetation and ranged between 10408.8033 **–** 10721.8017 km^2, while the area of lands occupied by vegetation and located in the class 3 (664.4367 **–** 883.7568 km^2). The dominance of the presence of vegetation was only within the class 3 and for all years, the highest area of

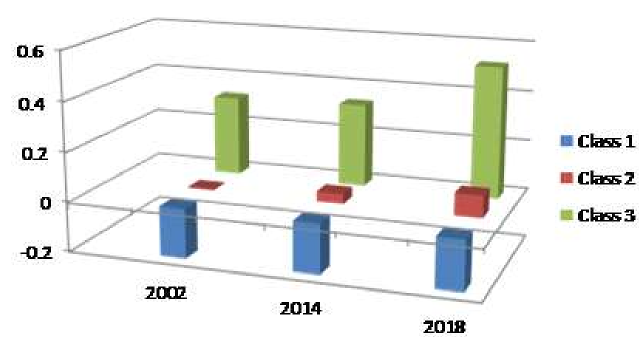

Fig. 8. NDVI in the study area

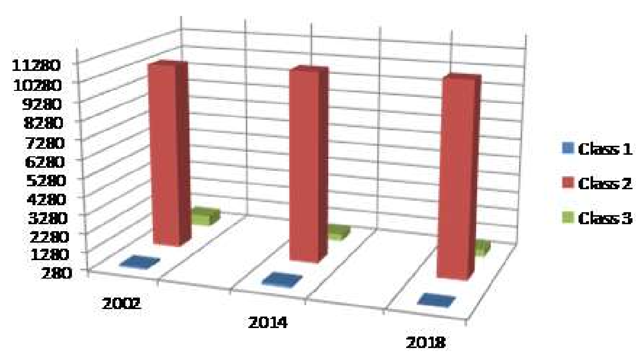

Fig. 9. Area of vegetation in the study area

land occupied with vegetation was in 2002 (883.7568 km^2) and then the area of green lands began to decrease, reaching, 664.4367 km^2 in year 2014. There was a marked improvement in the area of green areas for the year 2018, which amounted to 682.6401 km^2. In general, the dominance of the barren and low vegetation throughout the study area was for all years. The variation in the areas of the vegetation cover of the study area is due to the degradation of the vegetation cover that occurred in the year 2014 while the lowest degradation was in the year 2002 and this is due to the variation in the severity of climatic conditions that the region went through from the low precipitation rates and the rise in temperature after which there was an improvement in growth vegetation cover in the study area 2018 due to the increase in the amount of precipitation during that period that encouraged the growth of some natural plants and the decrease in drought rates and a noticeable increase in vegetation cover areas and this is consistent with Jumaili (2012) when studying about the changes in the area of vegetation in Anbar province. Through the foregoing and depending on the results of the NDVI values, the vegetation cover can be determined as it is represented by shrubs, weeds and some natural plants whose values of NDVI ranged between 0.1 – 0.4, while there were some areas that contain a dense vegetation represented by palm trees and some trees, especially in the eastern side of the study area on the banks of the Shatt al-Arab River, which had NDVI values higher than 0.4, while NDVI negative values indicated the barren soils without vegetation and Urban area in the study area. In general, the degradation of the vegetation cover was classified according to the range of the NDVI values, which ranged between negative and positive values, while the density of the vegetative cover varied between barren soils to soils with good vegetation density and thus the degrees of degradation varied from very severe – weak, as the barren soil with degradation very severe are negative values of NDVI, while soils with good vegetation have values approaching 0.4.The highest degradation in vegetation occurred in 2014, while the lowest degradation was in 2002.

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