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STUDY OF MORPHOLOGICAL, CHEMICAL AND PHYSICAL PROPERTIES OF SOILS AFFECTED BY SALTS USING THE TECHNIQUES OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS IN BASRA GOVERNORATE

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Abstract

Study was conducted in the southern parts of the sedimentary plain located within the administrative borders of Basra Governorate, which is confined between the Shatt Al-Arab in the east and Al-Dabdaba formation in the west, and between the Euphrates River in the north, and up to the Abi Al-Khaseeb district in the south. ',lies Between longitude and latitude 47^{o} $^{-}$45 - 47^{o} $^{-}$43 east and 30^{o} 21^{-}-30^{o} 18^{-} north an area of 2819.06 km^2. The study aims to know the importance of using some indicators and spectral evidence (salinity index, vegetation index, vegetative difference index, simple percentage index) in the study of detection and analysis and rates of variation in vegetation and types of degradation of sedimentary soils affected by salts and the state of saline degradation of soils and vegetation and its rates for different time periods, Adopting field work, remote sensing technology and GIS. The study area was deducted from Landsat 2017, 2014, 2000 satellite imagery using the (ERDAS IMAGINE, 2013) program and through the data obtained by the USGS Mapping Sensors, then the treatment and correction operations were performed. Also, some operations and relationships were conducted on multi-time Satellite images to extract some evidence related to the research topic such as the Salinity index (SI), Normalized Difference Vegetation index((NDVI), Simple Ratio (SR), and Standard Generalized Difference Vegetation Index(GDVI). Soil units were separated according to the SI categories and 8 locations on the ground were selected by the GPS device as a typical reality and representative of the soil pedons, as were identified three locations for sampling by Auger to the depths (0-10) (10-20) (20-30) (30-40) (40-100) cm Then the correlation results showed a strong relationship between spectral evidence and the values of the bands, also found that GDVI index had different values according to the years, and that their values were greater than the NDVI index values, as the index values in the 2000 satellite image had a range of 0.24617-0.592415) and (0.048472-0.136140) and in the middle of a range of 0.4192945 and 0.092306 for the above two guides, respectively. Then there was a clear increase in the range of values for both guides in 2014, as the ranges and middle of a ranges for them ranged between (0.670257-0.4504915) and (0.080789-0.155065) And in the middle range of 0.56037425 and 0.117927, respectively. In the image captured at 2017, there was a clear decrease in the range of values and middle of a range values for them, as they ranged between (0.745522- 0.39296759) and (-0.0287505-0.016994) in the middle of a range of 0.56924479 and -0.0058782, respectively. The study found two classes of degradation that was weak degradation and very severe degradation.

Keywords: Remote sensing, spectral evidence, geographic information systems

Introduction

Spectral evidence is one of the most important improvements applied to satellite images, resulting from dividing the values of the numerical numbers of one of the spectral bands by the corresponding values - in another spectral package, and this is of great importance in sparing the spectral characteristics of the visible phenomena affected by luminosity, as these visuals show the variation in The spectral reflectivity curve of the two bands regardless of the reflectance values absorbed by the spectral-bands (Hassan, 2009). Digital evidence is widely used in mineral investigation, plant analysis, desertification, and environmental monitoring, and its importance lies in many cases, as evidence is the best in distinguishing the differences that cannot be observed in satellite image with basic color bands, as well as from the effect of shadows in multi-spectral satellite image, as There are many digital evidence used in soil science studies. Huttich *et al.* (2006) used NDVI and NDWI in a time series from 1998-2005 effectively to determine the variation in land cover and its degradation. They found that in the spring season, the time series gave a highly significant positive slope with evidence for the difference in vegetation, and a negative highly significant slope with evidence of different water content for evergreen plants with needle, broad and mixed leaves in Russian and Scandinavian forests. Silleos *et al.* (2008) demonstrated that the NDVI and RSI have the ability to detect biomass, plant distribution, density and area calculations. *Lin et al*., (2010) studied changes in vegetation in China using a set of plant indices and indicators that include NDVI, IPVI, and MSAVI by infrared, Whenever these values are close to 1, this means the presence of a dense vegetation, but the values less than 0.1 represent the abandoned lands and empty from vegetation, while the values ranging from 0.1-0.4 indicate the presence of shrubs and weeds, while the values above 0.4 represent dense plants such as trees. The higher value of the indicator, this indicates the density of the vegetation, while the lower value is considered less than the vegetation cover and barren land (Jinrux.and Baofeng, 2017). Therefore, this study aimed to use spectral evidence and some indicators in detecting and analyzing temporal and spatial changes in soil salinity and vegetation and its degradation.

Materials and Methods

The study area is located within the administrative borders of Basra Governorate, Qurna District in the north, passing through the Basra District to the northern parts of the Abu Al-Khaseeb District in the south, bordered to the east by the Shatt Al-Arab River, and from the west, the modern deposits of Al-Dabdaba formation lie between longitude and latitude 47^{o} $^{-}$45 - 47^{o} $^{-}$43 east and 30^{o} 21^{-}-30^{o} 18^{-} north an area of 2819.06 km^2 (Figure 1). After obtaining the satellite imagery on different dates 2017, 2014, 2000, the study area was deducted using the ERDAS IMAGINE 2014 program and through the data derived from the satellite imagery of the USGS and the Landsat satellite map. Some information and characteristics of the satellite images used in the study founded in table1.

A processing operations were carried out, such as filling in the gaps and aerial correction, after that the contour map was drawn using Surfer 8, as the coordinates were obtained from Google Earth, then exported to Arc map 10.4, corrections were made, and converted to a vector map, after which a visit to the region to record field notes for Corrections satellite image and converted to a digital image than separated into eight classes, depending on the SI, using Erdas 8.4. (Fig. 2 and 3).

The values of plant indicators and indicators used in the study were calculated as follows: Salinity Index (SI) used the equation reported by Khan *et al*. (2005)

$$SI = (B3 * B4) / B2$$

Normalized Difference Vegetation Index (NDVI) used the equation reported by Rouse *et al.* (1974).

$$NDVI = \frac{NIR - Red}{NIR - Red} = \frac{B_5 - B_4}{B_5 + B_4}$$

NIR : Near infrared, B : Band

Generalized Difference Vegetation Index (GDVI2) used the equation suggested Wu (2014)

$$GDVI2 = \frac{[(B_4)2 - (B_3)2]}{[(B_4)2 + (B_3)2]}$$

Simple Ratio Index(SRI) the simplest indicators of vegetation or the ratio of vegetation ratio indicates the amount of vegetation in the resulting visual and its value is 1 or close to 1 used the equation reported by Leblon (2009)

$SRI= B_4/B_3$

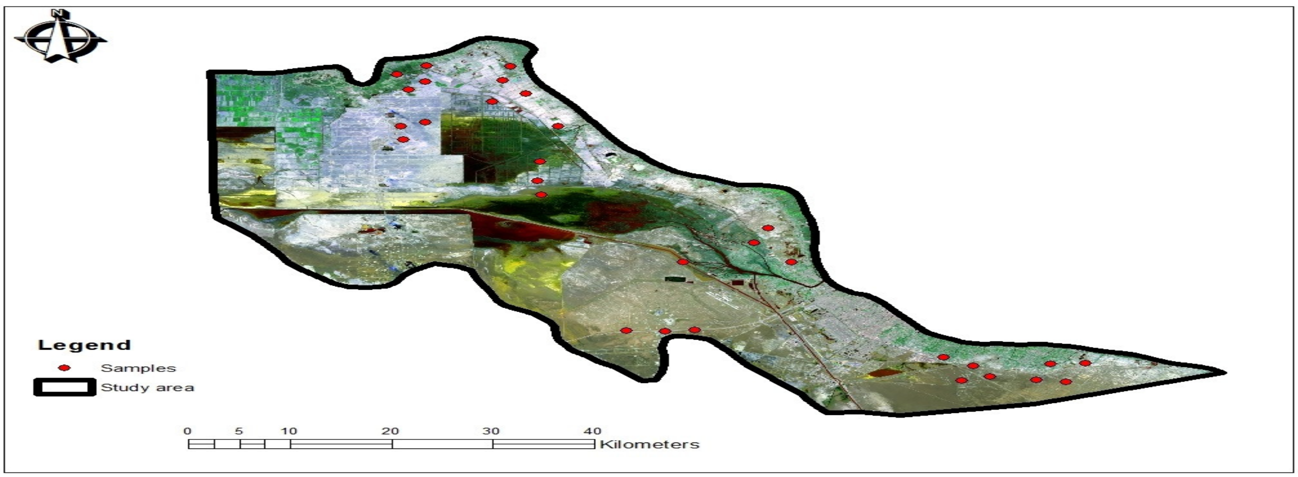


Fig. 1 : Map of the study area with the locations of the pedon

Table 1 : Some information and characteristics of the satellite images used in the study

Date of visual capture	Precision discriminatory	Type sensor	Moon name
2000	30*30m	ETM+	Landsat7
2014	30*30m	OLI	Landsat8
2017	30*30m	OLI	Landsat8

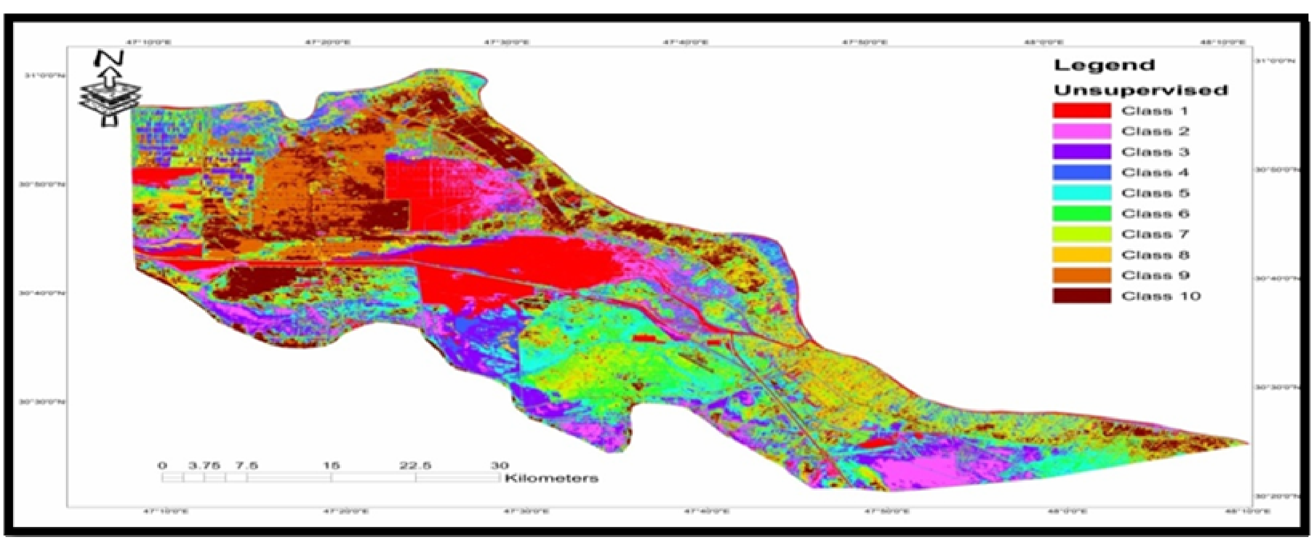


Fig. 2 : Shows the spatial distribution of the salt index items on a non-directed map

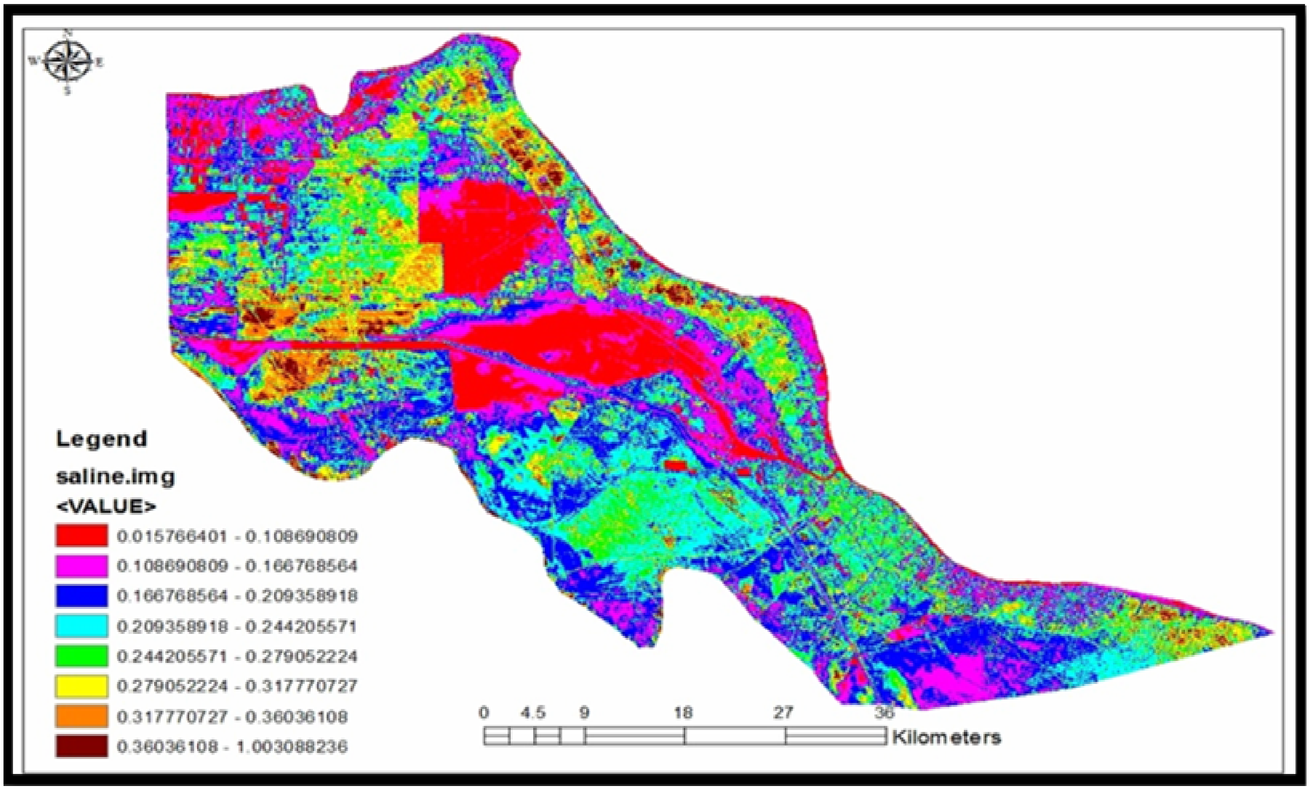


Fig. 3 : Shows the spatial distribution of the salt index items on directly rated map

Result and Discussion

Salt index (SI)

Results in Figure 4 show the spatial distribution of the values of the salt index for the years 2000, 2014, 2017 in the study area, which is an important evidence in predicting chemical characteristics, Covariance was observed in the index values for the surface layers of the study area, whether the spatial distribution or in chronological order, that variance depends on Covariance soil characteristics. In satellite image taken in 2017, it ranged between 0.395 and 0.104 and the highest values appeared in the area of Kut Al-Zain, Al-Shars, Al-Shafi and then Basra Airport at a rate of 0.241, 0.263, 0.278, 0.234, respectively and the lowest values appeared in Al-Madinah, Al-Shuaiba and talaa Al-Hamza. The average values for these values were 0.197, 0.217, 0.161 respectively. The difference in the values of the salt index for the 2017 study area is affected by soil properties, the most important of which are light materials due to the presence of surface saline crusts, as in Al-Shuaiba, airport, and tala Al-Hamza. Khan *et al.* (2005) indicated in his study that he obtained the highest reflectivity in the values of the numerical number of spectral bandss in the areas affected by salts with their decrease in the areas of waterfall and obtained a highly significant positive correlation between salt index and spectral bands, and able to distinguish between the areas affected by the salts and the wet areas by forming a false color combination through the spectral bands B3 and B4 included in the calculation of SI and producing a map of soil salinity and there is a variation in the value of the salt index between years. As for the temporal variation between these sites, it is due to the intensity of salt accumulation, whose content was low in 2000 and increased in 2014 in the above-mentioned sites. This is due to the occurrence of salinization and saline accumulation at the surface due to the capillary characteristic of the groundwater transport ,particularly at in Almedanea, Kut Al-Zain, Al-Shuaiba, and tala Al-Hamza. As for 2017 decrease in some sites compared to 2014, as in Almadeana Al-Shuaiba, and Tala Al-Hamza due to the occurrence of salt removal operations by washing towards the subsurface layers. As for the sites where there was no significant change in the salt index in 2014 compared to 2017 Represented by Al-Sharsh, Al-Shafi, Al-Deir, and Basra Airport, this may be due to the presence of similarities in the processes of uniformity in the intensity of operations salinizing the soil between the period 2014-2017 and this is due to the sites did not get significant changes in soil characteristics in the hydraulic or physical properties From the above, it is possible to refer to the accuracy of the evidence (SI) and spatial distribution of the soil salinity characteristic of the study area due to the presence of the influence relationship of this index on the reflectivity values with firmness that are directly included in the calculation of this index or presence of the cover increases the absorption ratio (Al-Juraisi 2013) the soil. In general, there was an increase in the values of the salt index for the year 2014 for most of the sites, especially in tala Al-Hamza index on the reflectivity values

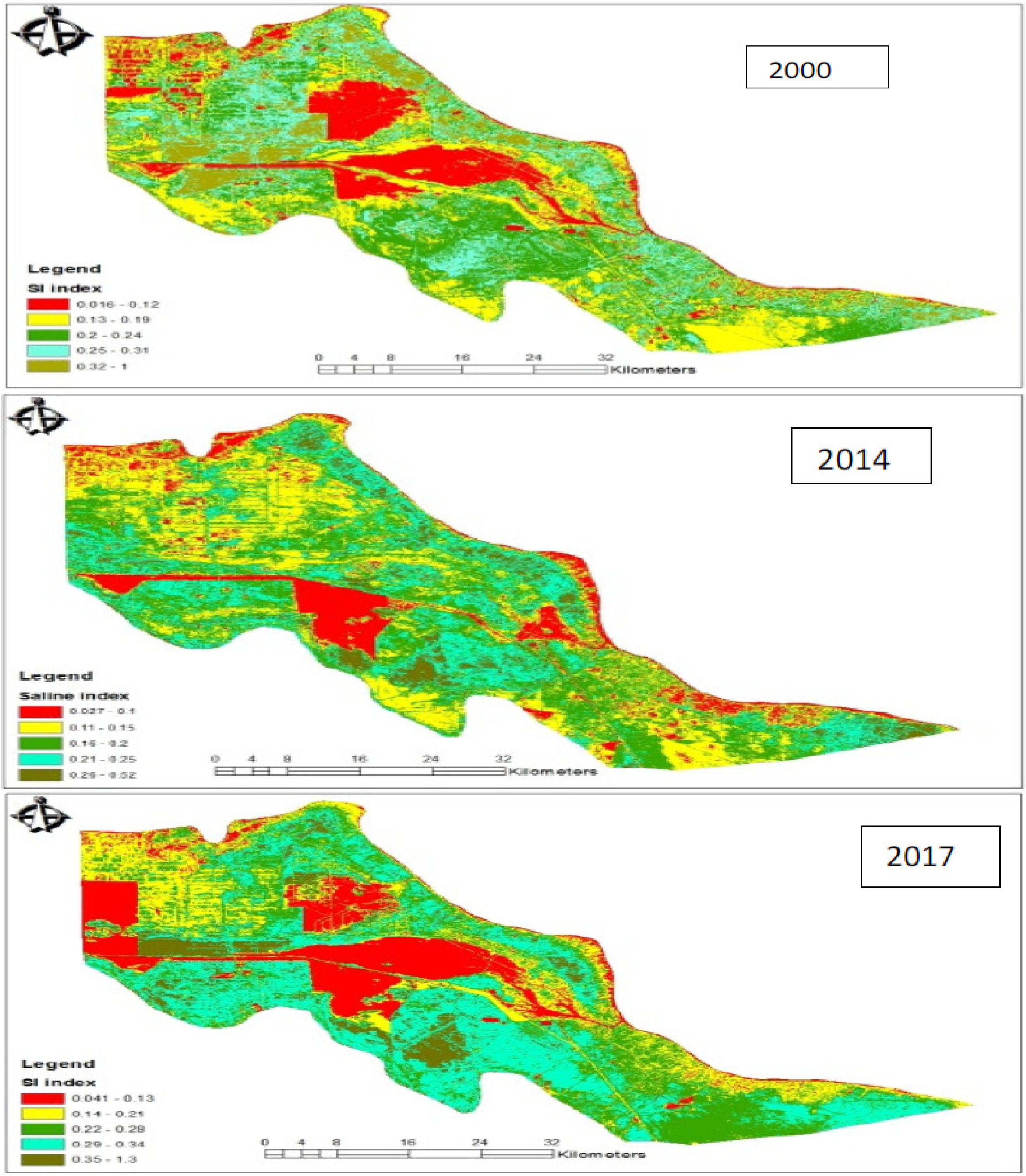


Fig. 4 : Map of the salt index of the soil

Table 2 : values of evidence rates for the study area

Digital evidence												Region	No
2000				2014				2017					
RSI	GDVI	NDVI	SI	RSI	GDVI	NDVI	SI	RSI	GDVI	NDVI	SI		
0.210	0.344	0.095	0.161	0.283	0.533	0.124	0.378	1.221	0.481	0.099	0.227	Amadeinah	1
0.205	0.415	0.093	0.229	0.234	0.542	0.105	0.268	1.149	0.464	0.069	0.278	sharesh	2
0.225	0.363	0.101	0.170	0.291	0.499	0.127	0.260	1.127	0.436	0.060	0.263	Shafi	3
0.272	0.360	0.119	0.189	0.367	0.503	0.155	.0.249	1.134	0.513	0.063	0.232	Deer	4
0.318	0.396	0.136	0.131	0.351	0.507	0.148	0.266	1.210	0.454	0.095	0.241	Basrah airopt	5
0.101	0.268	0.048	0.217	0.175	0.409	0.080	0.313	1.034	0.337	0.016	0.221	shuabiah	6
0.157	0.438	0.072	0.197	0.217	0.526	0.098	0.273	0.949	0.516	-0.028	-0.225	Tala Al-hamzah	7
0.171	0.268	0.078	0.234	0.233	0.467	0.104	0.302	1.122	0.400	0.057	0.324	Kut Alzean	8

Normalized Difference Vegetation index (NDVI)

Result in Table 2 and Figure 5 were shown Normalized Difference Vegetation index to years 2000, 2014, 2017, the spatial distribution of the vegetative cover in the study area, which is an important evidence in the distinction of the case of vegetation deterioration, which is based on finding relationships between spectral bandss, especially B5l whose reflectivity is spectrally proportional to the presence and density of the plant cover, B3 that is inversely proportional to the vegetation (Shalal, 2007), where a clear variation in the values of this guide is observed for the surface layers of the study area, whether the spatial distribution or the chronological sequence and that this variance depends on the A variation in the vegetation that is affected by soil properties, and the highest rate appeared in Almadana, Basra Airport, Al-Shuaiba, and Al-Sharsh, And the lowest values that appeared in tala Al-Hamza, Kut Al-Zein, and Al-Deer were average values of 0.063.0.028.0.057, respectively. As for the temporal variation, the average of NDVI values shows from the results of Table (2) that there was increase in 2014 compared to 2017, and this increase was close, as the highest values appeared in Al-Deer, then Basra Airport, Shafi, then Al-medina, and Kut Al Zain, at a rate of 0.104, 0.124, 0.127, 0.148, 0.155 and the lowest values were recorded in Shuaiba and tala Al- Hamza reached 0.098, 0.080 respectively. As for the year 2000, the values were low by 2014, but in the year 2000 there was a decrease in some locations compared with 2017 such as Al medina, a section of them showed a clear decrease compared to 2014 and 2017, including Kut Al Zain, Talaa Al-Hamzah and Al-Shuaiba reached 0.048,0.072,0.078 . The spatial variation in the values of the vegetable index is due to the density of the vegetation, as the lowest values were in the tala Al-Hamzah, Kut al-Zayn and al-Shu'aiba, because these areas have a high salinity level and the highest values are in Basra airport. and Al madina, Due to the availability of vegetation growth and that most of the vegetation cover of the study area is desert salt plants, the density of the vegetation varies temporally and spatially, depending on the intensity of the rain and its effectiveness and the short period of time between falls, which helped the growth of salt plants whose initiatives need a dilute saline solution for periods the first growth.

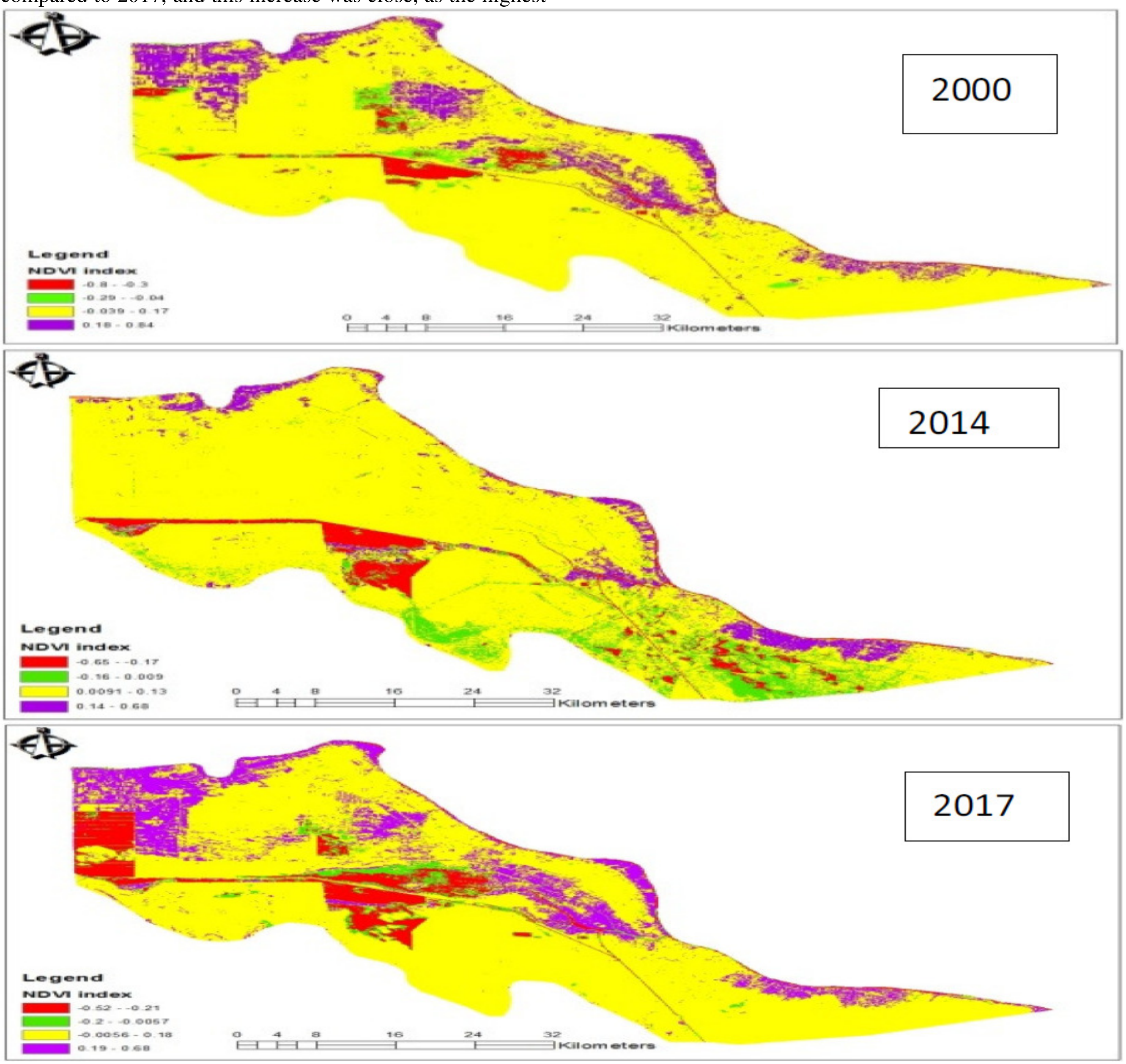


Fig. 5 : Map of different soil NDVI effectiveness and the short period

Generalized Difference Vegetation index (GDVI)

The results in Table (2) and Figure (**6**) indicate the Generalized Difference Vegetation index(GDVI)for the years 2000, 2014, 2017 for the locations of the study area, as the values recorded a clear increase in 2014 compared to 2017 and this increase was for all soil pedons except Al-Deer pedon was its highest value in Satellite image 2017 compared to 2014. The highest value was in Al-Sharh, Al-Madinah, Tala'a Al-Hamza, Basra Airport, Al-Shafi, Kut Al-Zein, and Al-Shuaiba, with an average of 0.409, 0.467, 0.499, 0.503, 0.507, 0.526, 0.533, 0.542, respectively. As for the year 2000, the values GDVI were close to each other, but recorded a decrease compared to 2014 and 2017 among them, at the same time low compared to 2014 and 2017, as the highest values were in pedons of Tala'a Al-Hamza and Al-Sharsh, at the rate of 0.438, 0.415 respectively, while the lowest values were Kot Al Zain pedon at 0.268. This is due to the effect of these indications on the state of the plant health and density (WU, 2014).

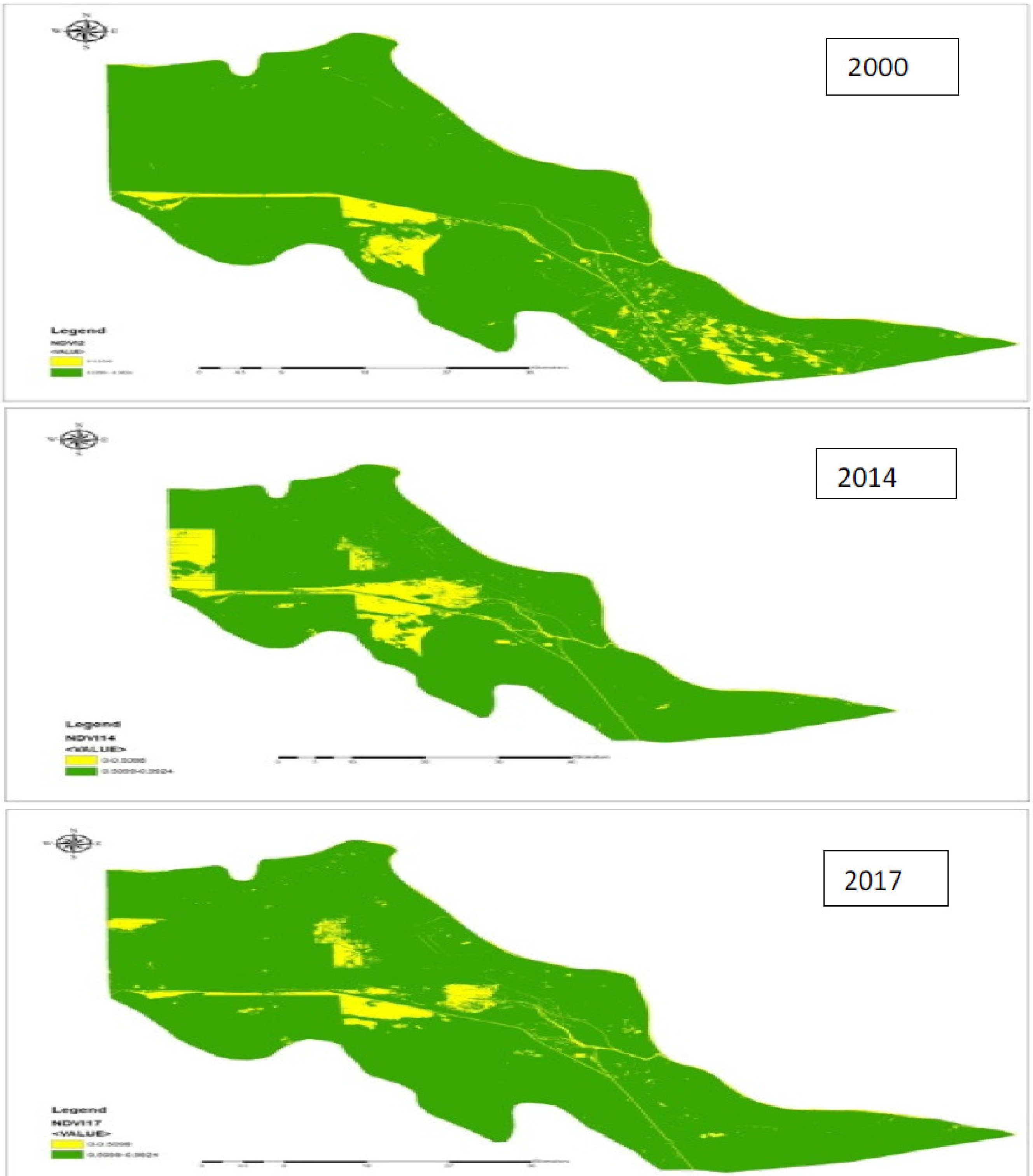


Fig. 6 : Map of Generalized Difference Vegetation index (GDVI**)**

Simple Ratio Index (SRI):

Results of Table (2) and Figure (7) it was found that the study sites varied in the value of this indicator. In 2000, the highest value appeared in the central and northern parts of the study area. The value had the following sequence represented in the airport area, Al-Der, Al-Shafi then Al-Madinah at 0.210,0.225,0.272,0.318, respectively. And the lowest values that appeared in the southern parts of the study area represented by Al-Shuaiba, Tala Al-Hamza and Kout Al-Zein, at rates of 0.171, 0.157, 0.101 respectively, In 2014 increased value and takr the same indicator in 2000 The increase ranged between 0.08-0.02 depending on the spatial variance. This evidence indicates that there is an improvement in vegetation and this corresponds to the salt index and the vegetation index. As for 2017, there has been a clear increase in the values of this indicator for all sites in the study area, An increase reached 1.188 as average, in order the highest increase occurred in the northern and then central locations of the study area where the highest values for index were in the Al madenah at a rate of 1.221 and the airport at a rate of 1.210 and Al Sharsh at the rate of 1.149 and Al shafi at a rate of 1.127 while the sites of Shuaiba and the tala Al-Hamzah and Kut Zain are the lowest values (Table 2). This is due to the aforementioned reasons related to the availability of favorable conditions that occurred in the years leading up to 2017 to provide effective conditions for increasing vegetation. In addition, it helped the presence of rivers and their branches, which helped raise the level of ground water on

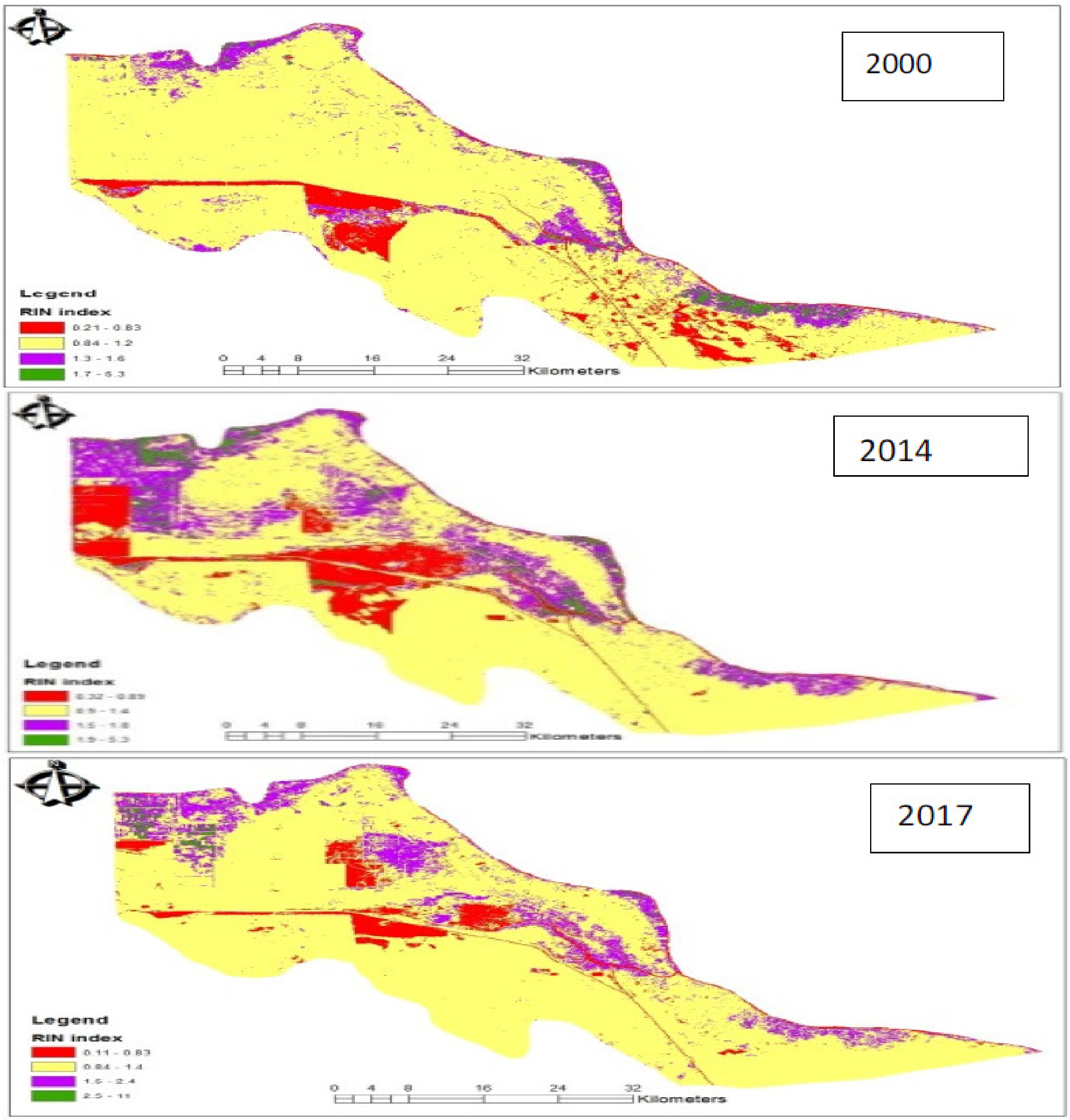


Fig. 7 : Simple ratio index map

Status and rates of heterogeneity in vegetation and its deterioration of the study area.

The results in Table (3) showed the values of ranges of some indicators of evidence of vegetation degradation calculated from satellite data for the study area using the ERDAS IMAGIN 8.6 program. The values of the GDVI were relatively uneven according to the years, they were greater than the values of the NDVI, as the values of the index for the year 2000 were with a range of 0.24617-0.592415) and (0.048472-0.136140) and with a mid range of 0.4192945 and 0.092306 for the above two indexes, respectively. Then there was an increase in the range of values for both indices in 2014 as the ranged between (0.670257-0.4504915) and (0.080789-0.155065) and in the middle of the range of 0.56037425 and 0.117927, respectively. In the image captured at 2017, there was a clear decrease in the range of values ranged between (0.745522) - (0.39296759) and (-0.0287505-0.016994) with a mid range of 0.56924479 and -0.0058782, respectively. Whereas, the index values for year 2000 with a range of 0.101-0.272 and in the middle of 0.1865 range. In 2014, the ranges between0.175-0.367 and the middle of the range of 0.271. In the image taken at 2017 the ranged between 0.949-1.221 in the middle of a range of 1.085 that these changes came in line with the changes in climate elements affecting the vegetation represented by rainfall, temperature, evaporation and relative humidity. We note that there was an improvement in 2014 compared to 2017, which was directly reflected. The soil properties affect the growth and development of vegetation, the most important of which are salt content and other soil characteristics. From the above we can conclude that the vegetation in the study area is located within the critical vegetation and is affected by the level of rain and other elements. because the vegetation is annual plants that grow after the fall of rain and the decline of perennial plants with deep roots that need a long irrigation period in order to be a radical growth that can reach the ground water, so we find through field observation it is observed that perennial plants have been limited to their presence near rivers Or swamps that collect water only (Al-Atab, 2001)

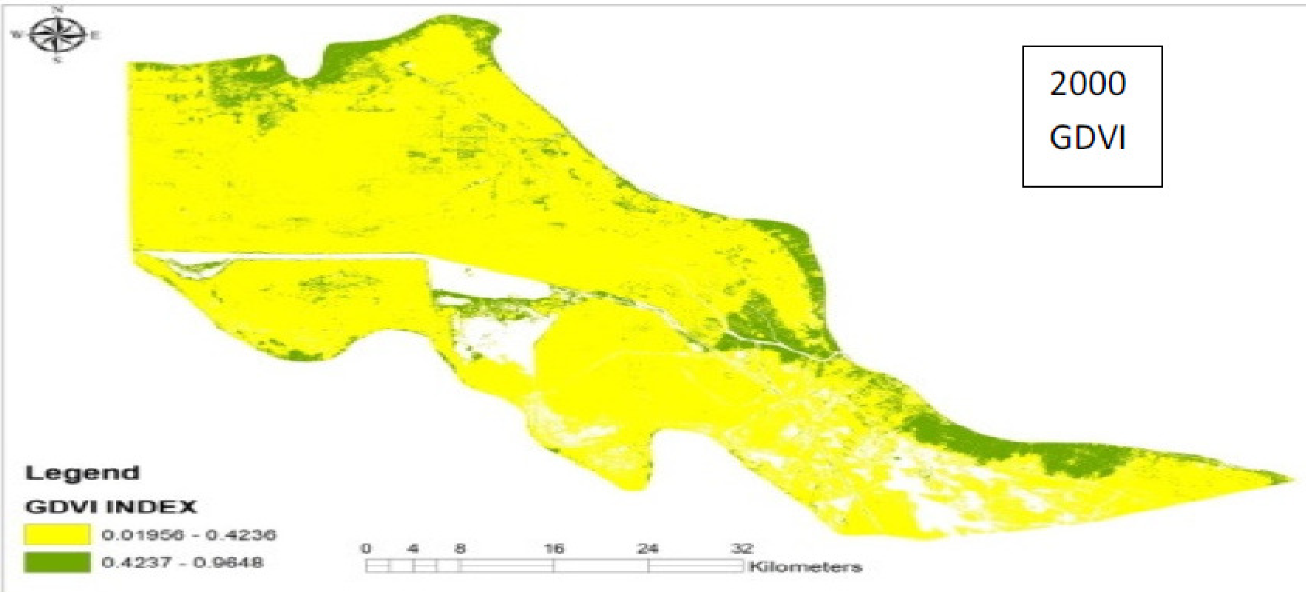
Table 3 : The ranges of the values of some plant evidence and indicators calculated from satellite image using the ERDAS IMAGIN 8.6 program for the study area

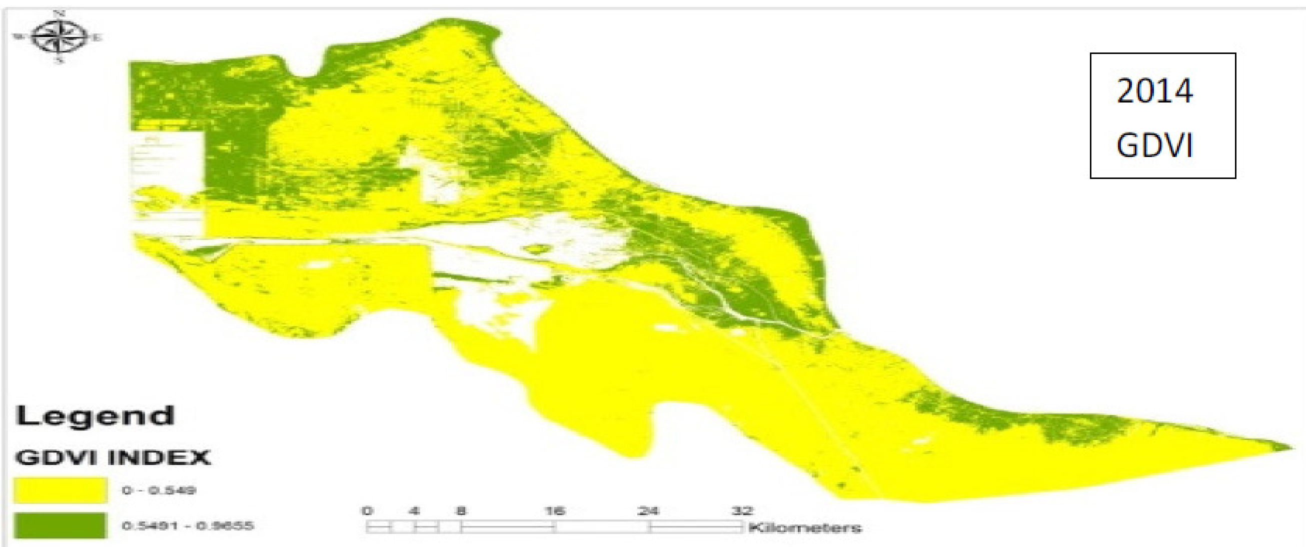
The years			**Evidence Vegetations Cover**
2017	**2014**	**2000**	
0.392-0.745	0.450-0.670	0.362-0.592	GDVI
-0.028-0.016	0.080-0.155	0.048-0.136	NDVI
0.949-1.221	0.175-0.367	0.101-0.272	RSI

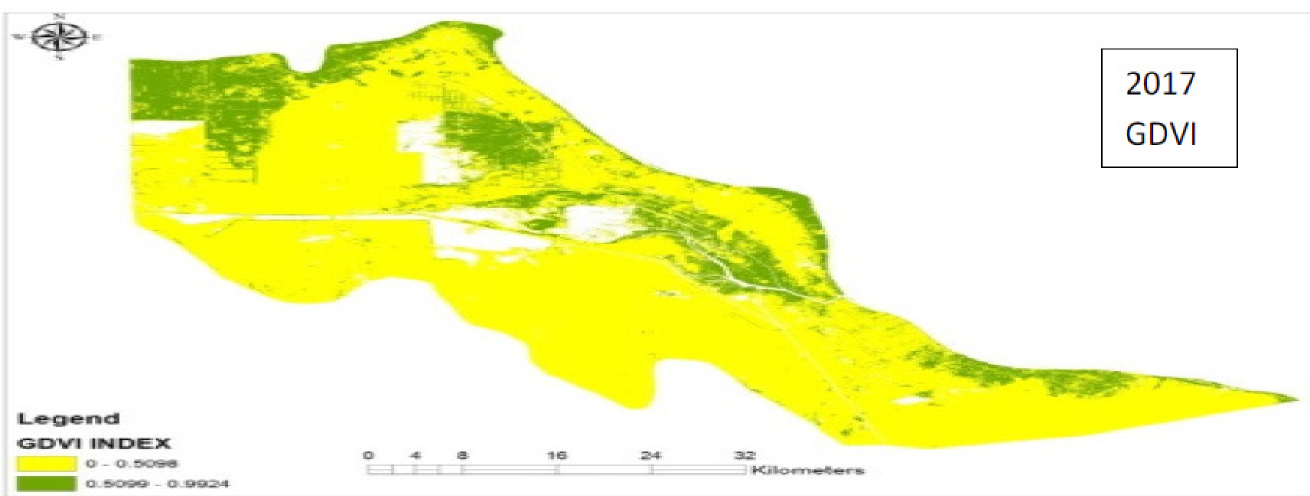
For the purpose of calculating the criteria for the degree of degradation of the vegetation cover of the study area (Shallal *et al.*, 2007) which indicates the degree of deterioration due to the presence of two types of degradation in the general region, which is weak and very severe deterioration, shown in the figure (8) From Table (4) it clarifies the changes in the degrees of degradation for the years 2000, 2014, 2017, as it notes changes in the areas of the types of degradation with the passage of time, which is due to the further deterioration of the state of physical, chemical and biological soil conditions. As the area of the highly deteriorating variety, represented by the yellow space satellite captured on the year 2000, amounted to 1568.546 km^2, with a percentage of 55.64074% of the area of the study area, the degree of this class in the satellite image captured in 2014 was 1453.721 km^2, with a percentage of 51.56756% The area of the study area As for the degree of this variety in the visualization captured on 2017, it reached 1476.777 km^2, with a percentage of 52.38544, i.e. its area decreased by an estimated rate of 15% of the area of the study area. As for the degree of weak deterioration, it is represented in the black color. This category represented by black. When calculating the rate of variation in the degree of annual deterioration in the year 2014 compared with Year 2000 was reached1% annually. In the image captured in the year 2000, the area occupied by it reached 1250,514 m^2. The class of degradation very little, Represent 44.35926% of the area of the study area. This variety in the image captured on 2017 reached 1342,283 km ^{2}, with a percentage of 47.61458%, that mean area decreased by an estimated rate of 10%

Table 4 : Deterioration in vegetation

%	**Area m^2**	**color**	**Satellite image**	**Degree of degradation**	**Class**
55.64074	1568.546	Yellow	Landsat7 etm+ 2000	Very deteriorating	**1**
44.35926	1250.514	Black		weak	**2**
100	2819.06				sum
51.56756	1453.721	Yellow	Landsat7 OLI 2014	Very deteriorating	**1**
48.43245	1365.34	Black		weak	**2**
100	2819.06				sum
52.38544	1476.777	Yellow	Landsat7 OLI 2017	Very deteriorating	**1**
47.61458	1342.283	Black		weak	**2**
100	2819.06				sum


2000
GDVI
Legend
GDVI INDEX
0.01956 - 0.4236
0.4237 - 0.9848
0 4 8 16 24 32
Kilometers


2014
GDVI
Legend
GDVI INDEX
0 - 0.549
0.5491 - 0.9855
0 4 8 16 24 32
Kilometers


2017
GDVI
Legend
GDVI INDEX
0 - 0.5098
0.5099 - 0.9924
0 4 8 16 24 32
Kilometers

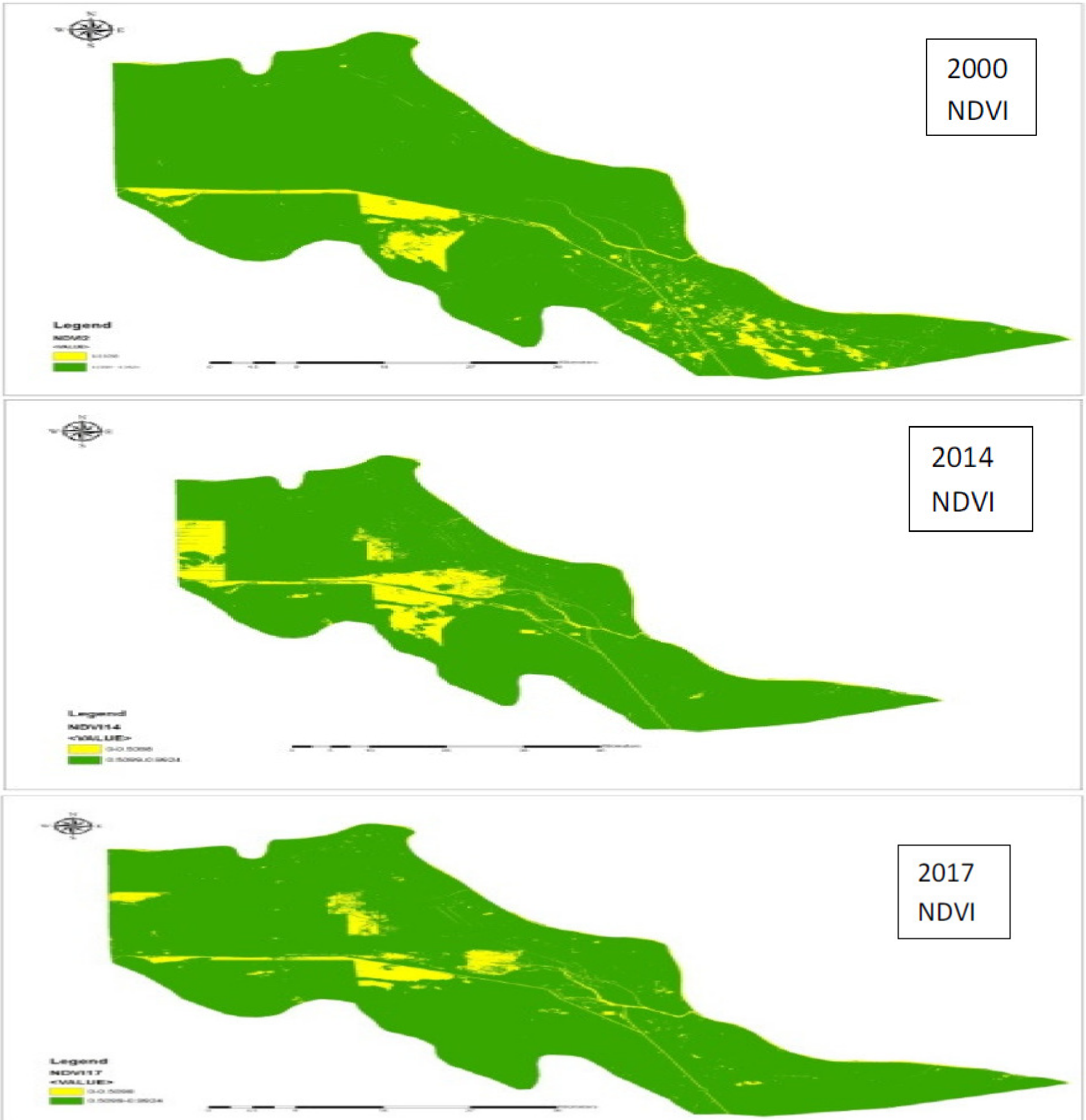


Fig. 8 : GDVI and NDVI vegetation guide map for the study area

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