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Monitoring the Movement of Sand Dunes in Thi Qar Governorate Using Some Spectral Indices

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Abstract: ***As purpose of monitoring the dunes changes in Thi Qar Governorate, using remote sensing and geographic information systems. It has been selected to install the dunes station in Al-Fajr, The study area is located between longitudes 45 ° 49'30 "and 45 ° 53'30" east and latitudes 31 ° 41'00 "and 31 ° 44'30" north of the study area, and an area of 1693.08 hectares, for the purpose of the follow-up to the temporal variation dunes. Three satellite visuals for continued US-made Land Sat been selected for different kinds of sensors TM, ETM + and OLI and the years 1993.2002, and 2015 respectively. Satellite image processing was visually and digitally conducted by radiation and spatial enhancements also removed distortions and deducted the study area. Some of the indices used as indicators to determine the spectral variation in three years selected, The NDVI and the soil bare index BSI and land degradation indexLDI were identified, the proportion of variation in the index between different years were also measured to determine the percentage of variation between each year and to see the dunes movement during the study period, and to outputs the final maps required. The study showed an increase in the bare land compared with vegetation, Sand dunes movement was observed by 45 m / year.***

Keywords: Monitoring, sand dunes, spectral indices, ndvi

1. Introduction

The process of desertification and the movement of sand dunes one of the environmental problems facing most areas within arid and semi-arid regions, sand movement is the result of extreme climatic conditions as well as geological, biological and geomorphologic factors besides Inefficient exploitation of natural resources by humans.

Despite the diversity of opinions in defining the concept of desertification, but it no more than being the transmission of desert environment with its dry circumstances toward wetlands, some classify it as a phenomenon of the decline in land productivity under arid and semi-arid environments because of natural and human factors, (Michael, H, 1977), or is the phenomenon of turning farmland and natural grasslands to desert unproductive in semi-arid areas because of ongoing drought or unregulated and excessive exploitation, as well as the accumulation of salts and sand dunes (Al-Tai, 1984).

Adhami 2001 was enabled to estimate the rate of movement of sand dunes in some agricultural sites suffer from sand encroachment in Efak district - Sumer (Qadisiyah province) using the means of sensors and found that the speed of movement was 25 m / year.

Lafta 2009, concluded on his study of the nature, origin, movement and stretches of sand dunes in the Baiji area / northern of Iraq, that all of the detailed field studies for dunes and the use of remote sensing and GIS in the study of desertification have shown that there is an increase in the decertified land, as well as an increase in the area covered by the sand dunes in the study area during the past few years.

Abdullah 2010 estimates shifting sand dunes in the area of Iraq by about 30.6% and has a negative impact on a lot of projects and agricultural land, which lies on the line; it led to the land filling of agricultural land and the destruction of agricultural crops.

Sand encroachment defined as the movement or the movement of sand granules on the roofs of the dunes or on flat ground surfaces when the wind speed of up to 5.5 meters per second, and is dangerous in the ability of the sand to crawl at speeds wind and cover large areas in a short time (Dawood and Al-Obaidi, 2012).

In a study by Nguyen 2009 for the purpose of detecting variations in the earth's cover and land use using natural vegetation NDVI indices and the soil bareindexBSI considering that the two indexes are the best in the identification and detection of vegetation threshold.

Zhao and Meng, 2010 used of land degradation index (LDI) to determine the degree of deterioration in Kenli County in China for three time periods (1987, 1998 and 2005), they found out that the most degraded lands were within the coastal and the northern part of the study area because of mild salts interaction deterioration distributed within the agricultural areas while non-degraded land was concentrated in a part of the forest and herbal areas in the eastern parts of the study area.

Mohaimeed and Abbas found in 2011 when studying the spectral reflectivity of the soil of some soils units in a project in the middle of the alluvial plain north of Kut. The bare soil Index BSI has recorded the highest values for this index in locations have high accumulation of salt, and it was the lowest values in agricultural areas.

Dulaimi 2015 also concluded in that natural difference vegetation index NDVI is an important indicator in monitoring the phenomenon of desertification and sand dunes, through studying the use of natural difference vegetation index (NDVI) and some plant indicators for monitoring desertification and sand dunes in Baiji / Iraq.

This research aims to:

1. Study the spatial distribution of the movement of sand dunes using some indices of remote sensing in the study area.
2. Draw the distribution of sand dunes movement maps using GIS.

2. Materials and Methods

Geographical location

The study area is located in Al- Fajer area northern part of the governorate of Thi Qar south of Iraq, study area is located between longitudes 45 ° 49'30 "and 45 ° 53'30" east and latitudes 31 ° 41'00 "and 31 ° 44'30" north and it lies about 110 kilometers northern of Nasiriyah city and as shown in Figure (1).

Space data:

A number of space-based data obtained from the International Network (Internet) and compressed format of the official website of the US Geological Survey (USGS), Global Visualization Viewer US satellite 5, 7 and 8 of the Landsat sensors: TM, ETM + and OLI for the years 1993, 2002 and 2015 respectively, and which are space-based data and a digital processing spatial data was collected through it. Visible classification image was classified using ERDAS software Version 14.00.0 and work in geographic information systems environment using the ArcMap program for the purpose of preparing the required maps.

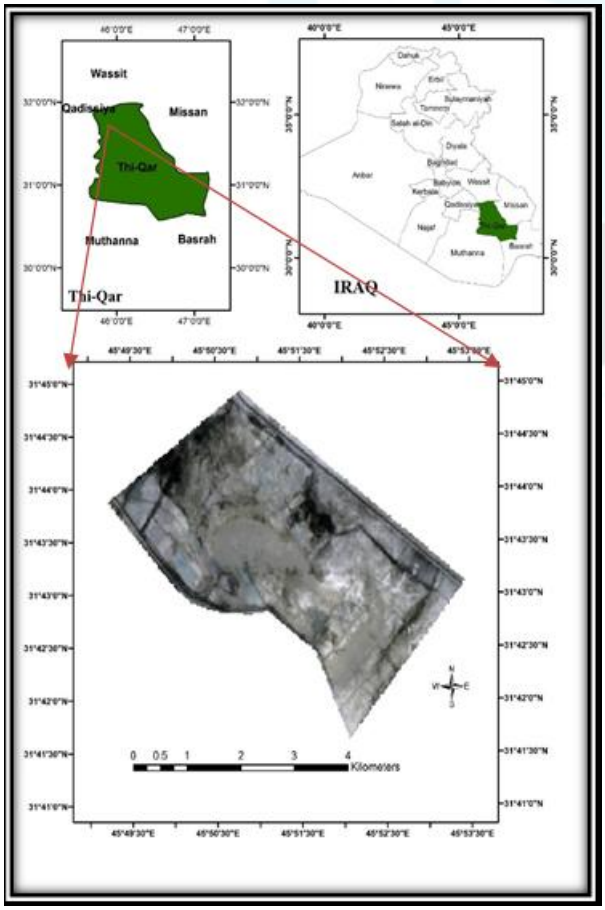

Figure 1: location of study area for Iraq

Study of some indices from satellite images that have a relationship with desertification:

1. Normalized Difference Vegetation Index (NDVI):It is equivalent guide Directory Statistics Percentage according to (Huete et al., 2002):
NDVI = (NIR - Red)/ (NIR + Red) ----------(1)
Where: R = red band
NIR = near infrared band.
2. Bare Soil Index (BSI): used by (Jamalabad, 2004).
BSI = [(SWIR + Red) - (NIR+BLUE)/ (SWIR + Red) - (NIR+BLUE)] *100+100-------- (2)
Were the Red and SWIR and NIR and BLUE represent short package and the package of red near infra-red and blue package, respectively.
3. Land Degradation Index (LDI)
Zhao and Meng, 2010 used this index according to the following equation:
a= ((*255- (Green +Red)) / (255+ (Green +Red)) …… (3)
Green and Red bands respectively, and 255 is a higher numerical value for the two sensors TM and ETM + and higher numerical value of the sensor OLI is 65535.
The calibration procedure for this index using the extent method according to the following equation:
LDI_0= (a-Mina/Max a-Min a) *100 …….. (4)
where is:
LDI_0:value for land degradation Index.
a: the value of land degradation Index LDI to be calibrated.
Min a: minimum value of land degradation Index.
Max a: maximum value of land degradation Index.

Table (1) represents degrees of land degradation, according to the ranges of the land degradation Index LDI.

Table 1: degrees of land degradation, according to the ranges of land degradation Index LDI (Zhao and Meng, 2010)

The degree of degradation	Not degraded - light	Moderate	Severe	Very severe
Ranges of Index LDI	More than 90	60-90	30-60	Less than 30

3. Results and Discussion

1-1 NDVI

The result of table (2) and Figure (2) showed different natural vegetation index values for the years 1993, 2002 and 2015, of the study area and an area of 1693.08 hectares. It is noted from the table that the percentage of the class covers the ground bare of vegetation (No Vegetation Ie, soil and geological materials, sand only) amounted to 21.92%, 21.40% and 18.41% for the three years respectively. as the highest percentage observed in 1993 the reason is due to the degradation of land was critical because of the nature of climate, which is characterized by high degrees of severe summer heat and lack of rainfall that does not exceed 200 mm / year and the region's vulnerability to sandstorms that cause the accumulation of sand.

In 2002, noted a decline in the bare land ratio compared to territory covered here seems clear positive impact of

operations sand dune stabilization carried out by the sand dune stabilization projects, particularly in areas in the north and northwest, which is the source of the accumulation, and increase the scope of the dunes in the study area. Then followed by more than a drop in 2015 for the previous mentioned reasons.

An increase of projects implemented to stabilize sand dunes in the source regions on one hand and the advance of the dunes outside the study area to the south-east by a north wind western and northern prevailing in the study area on the other hand.

Also recorded a small plant coverage category Weak Veg. percentages of 17.32% and 21.51% and 32.44% for the years 1993, 2002 and 2015, respectively, which indicate an increase in the percentage of arid land and this increase was due to the geographical nature of the region's hard climate and nature as mentioned above. The rest of the plant density values in the study area observed that the medium plant density ratio 25.22% for 2015 have been the highest, due to the reduction of the impact of sandstorms and increased susceptibility to natural plant growth, mostly from herbaceous plants tolerant to hard conditions which can vegetation distinguishes it within this level of the index values.

The ratio of percentage of vegetation was thick for the years 1993, 2002 and 2015 were 27.12% and 22.01% and 13.82%, respectively. The vegetation density has fallen in this category with the progress of time as the index values within this taxonomic level represents in most cases, herbs, and field crops

In 1993 had recorded by the state the highest values because of intensive agriculture and the forced agriculture because of the economic embargo imposed on Iraq on one hand and the return of activity which was the catalyst for the expansion of the agricultural area on the other hand.

The percentage of high density of vegetation has reached to 11.13% and 10.24% and 9.61% for the years 1993, 2002 and 2015 respectively. This also shows that in 1993 scored the highest percentage and if we take into considered the summation of medium, Dens. And very Denes. Classes of NDVI, we find with time the value 60.77, 57.09 and 48.65 for the years 1993, 2002 and 2015 respectively. Despite all this, the vegetation index has given a clear indication of the shrinking area of sand dunes in the study area, if we take considered the first level of classification No Veg. it represents concentrations of sand dunes and it has support for this category of field work and visual interpretation of space visuals used in the study.

Table 2: Percentage of NDVI classes and density of vegetation for the years 1993, 2002 and 2015 of the study area

Veg. Dens.	COLOR& NDVI	1993	2002	2015
No Veg.	<0.08	21.92%	21.40%	18.41%
Weak Veg.	0.081-0.1	17.32%	21.51%	32.94%
Moderate	0.1-0.15	22.52%	24.79%	25.22%
Dens.	0.15-2	27.12%	22.01%	13.82%
Very Dens. Veg.	2-4	11.13%	10.29%	9.61%
SUM M&D&V.D	0.1- 4	60.77%	57.09%	48.65%

1-2 Change detection of NDVI:

As shown in Figure (3) the difference in result of NDVI in the study area and the percentage of decline in soil degradation amounted to 76.60% and 5.55% and 59.12% the rate of increase in the decline amounted to 23.40% and 94.45% and 40.88% of the study periods 1993-2002 and 2002-2015 and 1993-2015, of the total area respectively, thatis the rate of decline in the vegetation area.

The period 1993 - 2002 was very high and this is due to the nature of the prevailing climate in the study area, which is characterized by dicers the amount of rainfall in the region does not exceed of 200 mm per year and high temperatures in summer since the maximum temperature was (48C°) in addition to the nature of the dry prevailing winds north and northwestern, all these factors have helped in decreasing of vegetation, which is usually under the influence of circumstances mentioned.

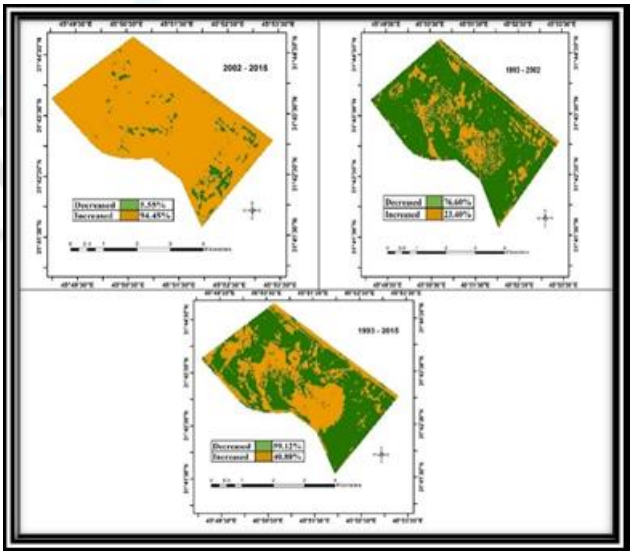

Figure 1: NDVI for the years 1993, 2002 and 2015 of the study area

The proportion of variation in the NDVI for the period 2002 – 2015 recorded a significant increase in vegetation space and marked improvement in the status of soil degradation due to the installation of continuous sand dunes and its positive impact in the high value of NDVI operation in general, the period 1993 - 2015 showed that there is a marked improvement in the condition of the soil degradation.

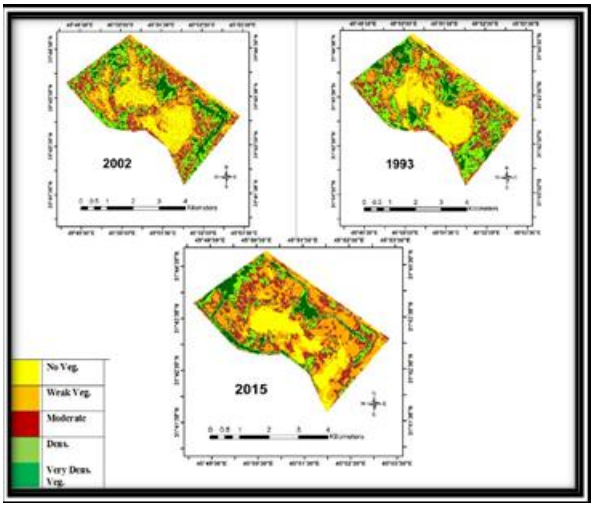

Figure 2: Change detection of NDVI between theyears 1993, 2002 and 2015 for the study area

2 – 1 Bare Soil Index BSI:

Figure 4 and Table 3 shows the bare soil index that reflects the free soil of the plant values was observed that the highest calculated value of the index was

112.25, 111.58 and 109.56 for the years 1993, 2002 and 2015 respectively.

The less counted value of the index was 60.77 and 86.21 and 72.65 for the years 1993, 2002 and 2015 when these values go up the closer to zero and this means the abundance of vegetation.

But if the rate raised this indicates that the soil is bare. index classified into two levels, vegetation cover and bare cover, Table 4 shows the percentage of the level of classification of the total area of the study area, amounting to 1693.08 hectares.

It is noted that the first category (class vegetation cover) percentages had recorded 27.28% and 21.60% and 16.83% for the years 1993, 2002 and 2015 respectively, this illustrates that the vegetation cover were reduced with the progress of time as it recorded its lowest level in 2015 compared with between 1993 and 2002 this is consistent with the NDVI values, percentage of class bare land and had recorded 72.72% and 78.40% and 83.17% for the years 1993, 2002 and 2015 since the covered bare were less worthless in 1993, then it increase in 2002 and increase more in 2015 this is also consistent with the NDVI.

Table 3: The highest and lowest value for bare soil index BSI for the years 1993, 2002 and 2015

1993		2002		2015	
Low Value	High Value	Low Value	High Value	Low Value	High Value
60.77	112.25	86.21	111.58	72.65	109.56

Table 4: percentages for bare soil index units BSI for the years 1993, 2002 and 2015

BSI	Area%		
	1993	2002	2015
Vegation	27.28%	21.60%	16.83%
Bare Land	72.72%	78.40%	83.17%

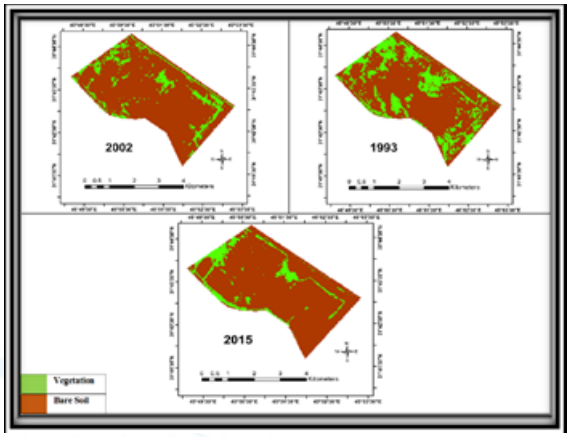

Figure 3: bare soil index BSI for the years 1993.2002, 2015 to the study area

2-2 Change detection of bare soil index BSI

Figure (5) shows the results of covariance in the bare soil index of the study area and that the percentage of decline in soil degradation amounted to 15.39%, 90.91% and 56.03% that the rate of increase in the decline amounted to 84.61%, 9.09% and 43.97% of the study periods 1993-2002 and 2002 - 2015 and 1993 - 2015 respectively, The total area as the closer value to zero means that the abundance of vegetation, and when it increased that indicates that the soil is bare.

It is noted from Figure 5 that there is a decrease in the index values as low 15.39% accounted for the period 1993-2002, and the reason is that both of the climate and geology of the study area does not improve. On the contrary, Iraq, like all parts of the globe suffers from global warming, which is reflected in the noticeable change in temperature are continuously higher than average and a sharp decrease in amounts falling rain also had little effect, especially in the study area where located within the dry thermal region.The increase of in the value of covariance index has reached 84.61%, which is a normal result mainly to the fact that the region suffers from desertification.

There is a severe decline happened in the bare soil index values for the period 2002 -2015, and the devaluation of index means an increase in green cover, this is entirely consistent about what has been obtained from the covariance in vegetation index for the same period. In general the period 1993 - 2015 pointed out an increase in the amount of impairment this indicates that there is an improvement and increase in the earth's cover from what it was in the past .

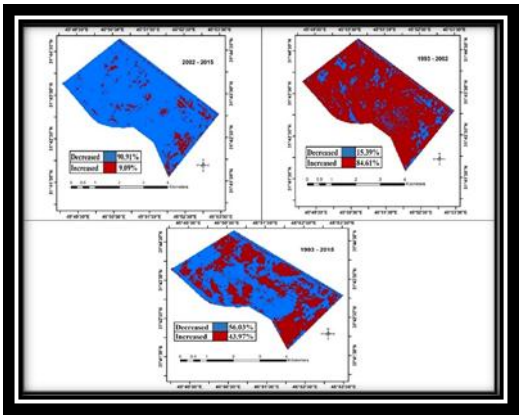

Figure 4: Change detection of Bare Soil Index BSI between the years 1993 and 2002 and 2015, for the study area

3-1 LDI land degradation index.

The results of the study, which is illustrated by Figure (6) and table (5) percentages for land degradation index in the study area with an area of 1693.08 hectares noted that the percentage of light deterioration has formed around 0.42% in 1993 fell to about 0.12% in 2002 and returned it raise to nearly 1.39% in 2015.

The moderate decline was 10.48% in 1993 and fell to 9.67% in 2002 and rose to the highest value of 14.48% in 2015, the severe deterioration accounted for 68.91% in 1993 and rose to 74.30% in 2002 and then dropped to 68.44% in 2015, respectively, The very severe decline amounted to 20.20% in 1993 and dropped to 15.91% in 2002 also dropped to 15.69% in 2015.

Hence show that each of the categories are very severe deterioration and severe degradation and record the highest values compared to light and moderate deterioration which record the lowest values for the three years of the study and this indicates:

Continuation of follow the process of fixing and conservation the soil and work to cultivate the bareland to prevent further degraded the lands. The land degradation index LDI has given through invisible for the years 1993, 2002 and 2015, a clear view of the mechanism of decline with time for the purpose of taking appropriate ways in maintenance operations and reduce the phenomenon of desertification and sand dune encroachment.

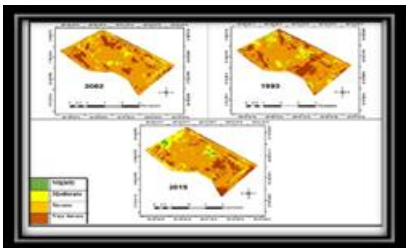

Figure 6: land degradation index LDI for the years 1993 2002, and 2015, for the study are

Table 5: percentages to land degradation index for the years 1993, 2002 and 2015 according to the proportion of decline

LDI	Area %		
	1993	2002	2015
Slightly	0.42%	0.12%	1.39%
Moderate	10.48%	9.67%	14.48%
Severe	68.44%	74.30%	68.91%
Very Severe	20.20%	15.91%	15.69%

3-2 Changes Detection of land degradation index:

Figure 7 shows the results of variation in soil degradation index for the study area and the percentage of decline in soil degradation amounted to 78.25% and 21.12% and 49.53%

The rate of increase in the decline amounted to 21.75% and 78.88% and 50.47% of the study periods 1993-2002 and 2002-2015 and 1993-2015, respectively, of the total area, the low value of the index means an increase in the severity of the deterioration for the period between 1993 and 2002. The results of covariance suggest that the study area is still in a state of deterioration due to the prevailing environmental conditions. The variation in the value of the index between 2002 and 2015, indicates that there are large areas where values rose this index, which decreased the severity of deterioration. this was due to the positive impact of operations sand dune stabilization implemented by installing sand dunes by Department of combating desertification and forest projects which is one of the formations and the Ministry of Agriculture, also showed variation for the period between 1993 and 2015.

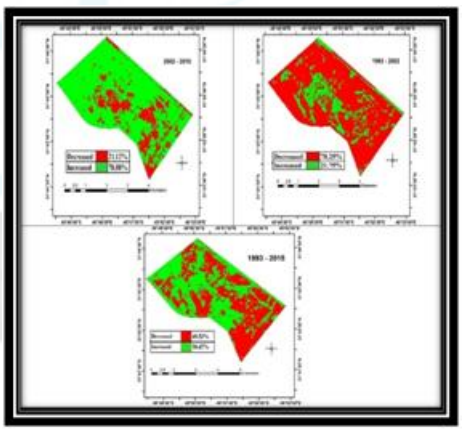

Figure 7: land degradation index LDI between the years 1993 and 2002, 2015, the study area

The severity of the decline has decreased between 1993 and this is also due to sand dune stabilization operations, where the climatic conditions there has been no improvement, this indicates an improvement in the status of land degradation for the reasons mentioned.

4. Conclusions and Recommendations

Conclusions

1. The use of remote sensing techniques had the greatest benefit in the diagnosis of sand dunes gatherings sites and to shorten the effort, time and expense.

2. A controlled study of covariance NDVI and BSI and LDI showed an increase in the bare land on the vegetation.

Recommendations

1. We recommend using remote sensing and geographic information systems as a means to monitor land cover covariance in their various forms, including sand dunes.
2. To make use of spectral index for ground coverings like NDVI, BSI and LDI to identify different forms of ground covers.

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