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Study of Desertification using Remote Sensing Imagery in South Iraq

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Abstract:
Recently The problem of desertification and vegetation cover degradation become an environmental global challenge. This problem could be summarized as as the land cover changes. In this paper, the area of Al- Muthana in the south of Iraq will be consider as one of Semi-arid lands. For this purpose, the Ladsat-8 images can be used with 15 m in spatial resolution. In order to over Achieve the work, many important ground truth data must be collected such as, rain precipitation, temperature distribution over the seasons, the DEM of the region, and the soil texture characteristics. The extracted data from this project are tables, 2-D figures, and GIS maps represent the distributions of vegetation areas, evaporation / precipitation, river levels and discharge, temperature, dust storms and any factors that influencing in the desertification**.**

keywords: Desertification, Remote Sensing, sand dunes , Image processing; classification.

دراسة التصحر باستخدام صور الاستشعار عن بعد في جنوب العراق

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الخلاصة
تعتبر مشكلة التصحر وانحسار الغطاء النباتي من أهم التحديات البيئة في الوقت الحاضر. يمكن تلخيص التصحر وتواجد الغطاء النباتي على إنها تغيير في طبيعة الغطاء الأرضي. في هذا البحث، سيتم دراسة التصحر والغطاء النباتي لمنطقة المثنى (جنوب العراق) والتي تصنف ضمن المناطق شبه الجافة. ولهذا الغرض فان صور الساتل لاندسات 8 (بدقة تمييز حيزية 15 متر) يمكن أن تستخدم لإنجاز العمل. وعند الخوض في تفاصيل المشروع فيجب دراسة بعض البيانات الأرضية مثل، التساقط المطري، التوزيع الحراي في فضول السنة، نموذج الارتفاع الرقمي لمنطقة الدراسة، وكذلك خواص نسيج تربة المنطقة. يمكن أن تتمثل نتائج هذا البحث بمجموعة من الجداول، الرسوم البانية، وخرائط نظم المعلومات الجغرافية والتي يمكن أن تمثل التوزيع النباتي، التساقط والتبخر، منسوب النهر والتصاريف، العواصف الترابية، وأي عوامل أخرى تؤثر على التصحر.

1. Introduction

In the Summit of (1992) held in Rio de Janeiro-Brazil, the term desertification was defined as land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including

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climatic variations and human activities. The most general definition of desertification defined by UN Convention as a process of "land degradation in arid, semi-arid and dry sub-humid, [1].

Land desertification points mainly the geography phenomenon of the flowing and half fixed sand dune in arid and semi-arid region. Desertification usually occurs in the arid, semi-arid and parts of sub-humid district, under the condition of drought, windy and loose sand earth's surface, because the factors of over utilization by human on the land and others, the balance of frangible ecosystem was broken, turns the undesertting region into a deteriorating process, taking the sandstorm activity as the main marking, [2].

Sand movement by wind is a complex process involving several styles of grain movement that occur more or less simultaneously. The process of movement of sand is saltation, surface creep is the jerky forward movement of larger grains that are too heavy to be lifted by the wind, but are jolted forward when struck by smaller flying grains and then the third manner in which smaller sizes of sand moves is by suspension. Suspended grains are so smaller than they are carried for which are thrown into the air for long distance, [3].

A typical sand dune is created by the transport of sediment (small loose rock particles) by the wind and involves the interaction of the wind and the ground surface. Sand is defined as particles with a size between 2 mm to 0.0625 mm (2 mm equals 0.078 inches). Wind moves sand near the surface, usually within 1 meter of the ground, and carries it only a short distance. Very small particles are transported in suspension by the wind and stay in the air for a relatively long distance. Silt-clay size sediments, particles less than 0.0625 mm, are usually deposited downwind and are called loess. These small sized particles play a minor role in the development of dunes. Dunes begin to form when winds carrying sediment encounter an obstacle that slows the wind. The reduced wind velocity causes the coarsest (largest) fraction of the sediment to fall back to the ground. This build- up of sand creates a larger obstacle that constitutes a wind break, causing more deposition, [4].

Figure-1 shows the sand dunes areas in Iraq, There are many sites of sand dunes in Iraq , such as BIJI , AL-Aieth in Salaaldien Governorate ,AL-Hadhar area, the area between Ramadi and AL-Tharthar Lake and AL-Hamad groundwater basin near the Iraqi-Jordanian border. Also, the sand dunes existed as the longitudinal area at the Euphrates right bank between Najaf and Samawah cities, and the area from Babylon City along with AL-Massab AL-Aam Project to Thiqar marshs. Finally, there are some small areas at Almuqdadyah and AL-Udhayem within dyala ,west Imarah city and west of Basrah city, [5]. Figure-2 shows the sand dunes areas in Muthanna Governorate, [6].

Figure 1-show the sand dunes areas in Iraq, [5].

Figure 2-the spread of sand dunes in the study area, [6].

2. study area

Muthanna province is located in the south of Iraq (Figure-3). Iraq's borders are shared with Kuwait and Saudi Arabia to the south, Jordan to the west, Syria to the northwest, Turkey to the north, and Iran to the east, [7]. The area of Muthanna province (51740) Km^2, and the proportion of the amount (11.9%) of the total area of Iraq, Regarding its astronomical location, it lies between latitudes (31° 43′ 43″ - 29° 03′ 45″) north and longitudes (46° 41′ 15″ - 43° 48′ 45″) east . The main sections or large

geospatial units from which a surface is formed The study area, is the Mesopotamia Plain and Southern Desert, [8].

Figure 3-Muthanna province, [7].

3. Climate

Winds are the main factor in the formation of sand dunes in the plain of the sedimentary plain. Sand dunes are present Longitudinal extension to the northwest-southeast direction of the prevailing winds in the region**.** The northwest wind is the wind prevailing in Area of study if the frequency of its occurrence is recorded (28.4) In the Samawah stations, as shown in Table-1, [9].

Table 1-Wind direction of Samawah station for the period (1970-2007), [9]

Wind direction	calm	North	Northeast	East	Eastern	South	Southwest	West	NorthWest
	12.3	12.0	5.2	7.0	5.8	2.7	4.8	21.8	28.4

The annual average wind speed (3.1 m/ s) was in the study area, So recorded in the station of Samawah. Wind speed varies between seasons,Wind speed increases in the summer months (April , May , June , , August), To its general average (3.5 , 3.6 , 3.7) m / s, In July, the overall rate of wind speed (3.8 m/s) is the maximum speed, Due to high temperatures and air expansion. As shown in Figure-4, [10].

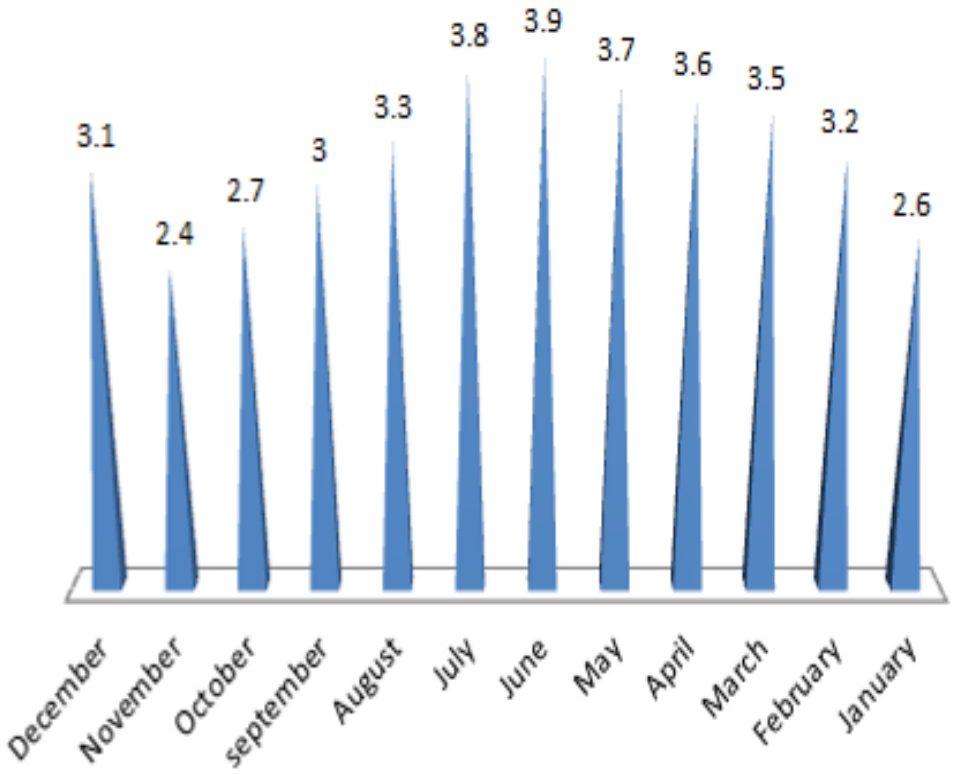

Figure 4-The annual average wind speed in Samawah station for the period (1985-2015), [10].

4. Materials and Methods

4.1 Download satellite images

In this study, long-term satellite measurements were compared with field monitoring data for the assessment of desertification. For this reason, and in order to pursue a change in the study areas for long periods, Landsat images were used to cover 26 years from 1990 to 2016. The main source which was adopted to obtain spectral bands of the studied area was the USGS Earth Explorer. Representing by using Landsat 4-5, Landsat 7 and Landsat 8. For more information see Table-2.

Table 2-Information about satellite images for the study area, [6].

information	1990	2000	2010	2016
Spacecraft Identifier	LANDSAT_5	LANDSAT_7	LANDSAT_7	LANDSAT_8
Collection Category	T1	T1	T1	T1
Data Type Level-1	TM_L1TP	ETM_L1TP	ETM_L1TP	OLI_TIRS_L1GT
Sensor Identifier	TM	ETM	ETM	OLI_TIRS
Map Projection Level-1	UTM	UTM	UTM	UTM
UTM Zone	38	38	38	38
Datum	WGS84	WGS84	WGS84	WGS84

4.2 Test Sites and Samples Collection

Field measurements were conducted in spring season, 2017 and 2018 in Muthanna Governorate. Data were collected from different locations depending on different types of soil and water in the study area. Each location was recorded using a GPS device for the purpose of integrating results with climate data and the landsat images data. Samples were analyzed in the laboratory of the Faculty of Agriculture - University of Baghdad, Table-3.

Table 3-Physical properties of the soil of the study area

Number	Geographical coordinates	Clay	silt	sand	Soil texture
1	31°16'15.71"N, 45°6'41.43"E	17	13	70	sand dunes
2	31°20'27.19"N, 45°5'19.98"E	7.6	6	86.4	swamp (loamy sand)
3	31°15'26.89"N, 45°17'52.91"E	16	11	73	loam
4	30°24'39.38"N, 44°49'31.25"E	8.8	32	59.2	limestone + chert + sandy loam
5	30°53'56.42"N, 44°48'29.32"E	12.8	25	62.2	chert + sandy loam
6	31°8'11.85"N, 44°46'37.71"E	0.2	30.6	69.2	limestone+ sandy loam
7	30°18'23.96"N, 44°39'34.35"E	0.4	60.4	39.2	silty loam
8	31°25'41.67"N, 45°39'56.46"E	10.8	10	79.2	loamy sand
9	30°57'10.20"N, 45°34'18.87"E	0.16	10.64	89.2	saline (loamy sand)
10	31°6'0.97"N, 45°22'30.85"E	8	3	89	clay loam
11	31°19'59.77"N, 45°7'54.35"E	0.32	50.48	49.2	sandy loam

5. Results and discussion

5.1 Land cover classification of selected images

The classification methods used in the current study are classification techniques (unattended, under supervision). Supervised classification techniques are (the minimum and maximum category of the banned supervision category). The classification techniques not covered and used in this study are Isodata classification techniques. The study area can be classified into 18 categories. When comparing the results obtained from the methods of classification with the real data we found that the best method is **Minimum Distance classifier,** as shown in the following Figure-5.

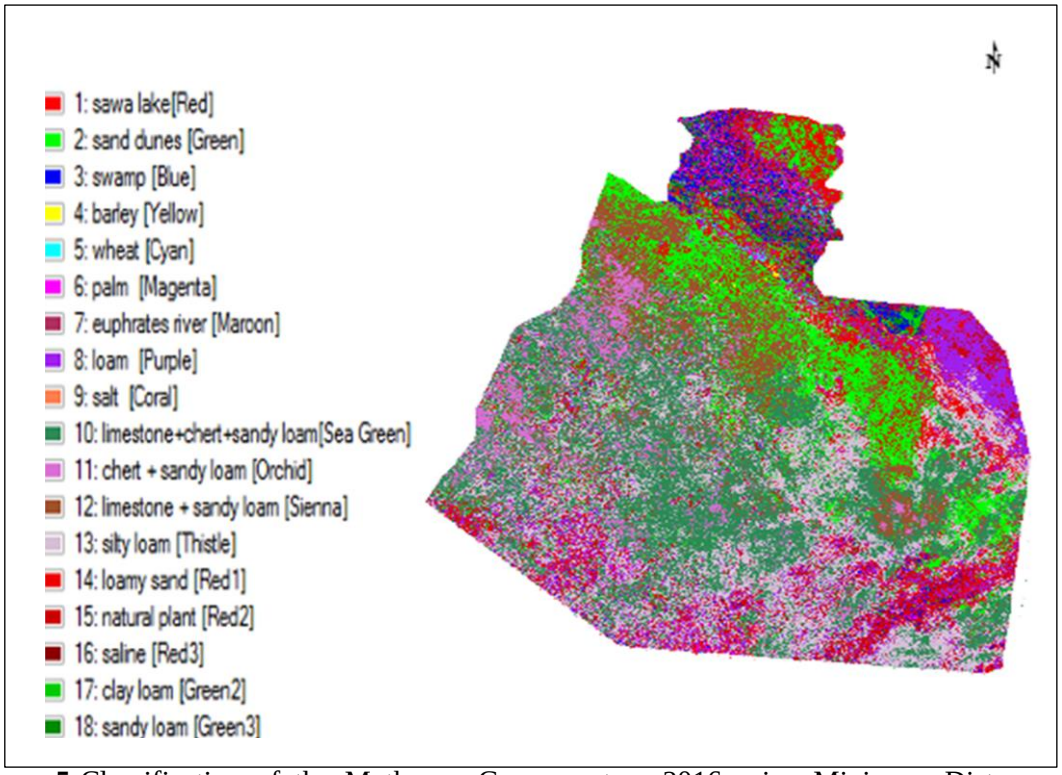

Figure 5-Classification of the Muthanna Governorate - 2016 using Minimum Distance classifier technique.

5.2 Change detection

Change detection analysis is performed using multi-date imagery. Single date imagery show the land uses and land covers for a particular point in time but multi-date imagery show the land use and the land cover of a particular place at different points in time, (t1, t2… tn). Land use (commercial, residential, transportation, utilities, cadastral, and land cover (agriculture, forest and urban etc). Mapping has been especially improved over the years by the use of multi-date imagery, which has been used in cases of progressive or gradual environmental changes such as erosion or reforestation for which more than one image may be necessary, [11].

The routines found under the Toolbox menu Change Detection offer a straightforward approach to measuring changes between a pair of images that represent an initial state and final state. The changes the expansion of the desertification have been computed by subtract the first data image from the second data image; pixel by pixel, Image (2000- 1990) , (2010 –1990) and (2016 -1990). Where the black color refers to the increase of sand dunes, as in the following Figure-6

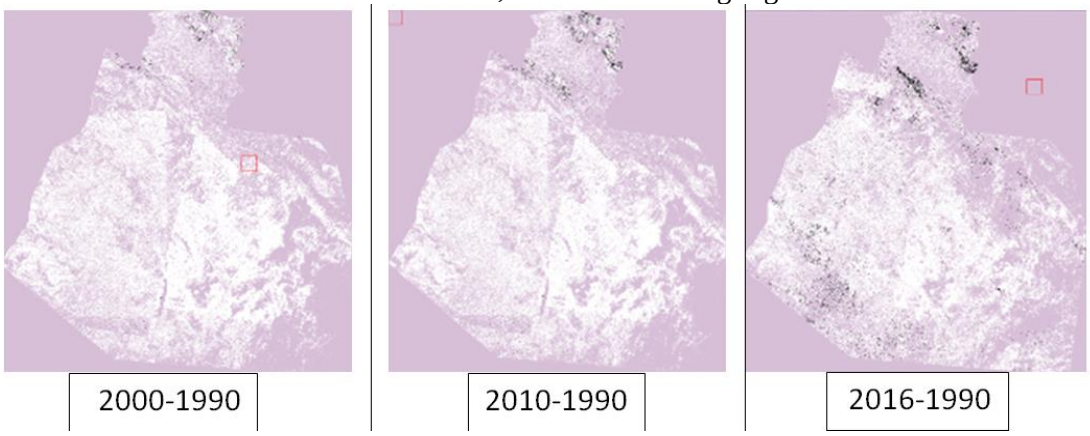

Figure 6-The change detection by taken the differences in maps for the images (2000-1990, 2010-1990, and 2016-1990) respectively.

Can be used (Basic Tools > change Detection > Change detection statistics) to get, Pixel count , Percentage and Area(Square Meters) as in the following Figure-7, 8, and 9

Pixel Count | Percentage | Area (Square Meters) | Reference

		Initial State		
		sand dunes [Green]	Row Total	Class Total
Final State	Unclassified	0	0	0
	sawa lake[Red]	4103	4103	47480
	sand dunes [Green]	740823	740823	6376187
	swamp [Blue]	16350	16350	1118454
	barley [Yellow]	4722	4722	39193
	wheat [Cyan]	13221	13221	170282
	palm [Magenta]	50852	50852	750299
	euphrates river [Maroon]	3672	3672	75548
	loam [Purple]	159952	159952	4756214
	salt [Coral]	2	2	3601
	limestone+chert+sandy loam[Sea Green]	329772	329772	14367319
	chert + sandy loam [Orchid]	53248	53248	2801926
	limestone + sandy loam [Sienna]	551944	551944	5663152
	silty loam [Thistle]	288268	288268	11398652
	loamy sand [Red1]	424843	424843	4553186
	natural plant [Red2]	156798	156798	4038803
	saline [Red3]	369	369	41618
	clay loam [Green2]	5751	5751	409617
	sandy loam [Green3]	6038	6038	679025
	Masked Pixels	14684	14684	31705360
	Class Total	2825412		
	Class Changes	2084589		
	Image Difference	3550775		

Figures 7- Change detection statistics For sand dunes (Pixel count).

Pixel Count | Percentage | Area (Square Meters) | Reference

		sand dunes [Green]	Row Total	Class Total
Final State	Unclassified	0.000	0.000	0.000
	sawa lake[Red]	0.145	8.642	100.000
	sand dunes [Green]	26.220	11.619	100.000
	swamp [Blue]	0.579	1.462	100.000
	barley [Yellow]	0.167	12.048	100.000
	wheat [Cyan]	0.468	7.764	100.000
	palm [Magenta]	1.800	6.778	100.000
	euphrates river [Maroon]	0.130	4.860	100.000
	loam [Purple]	5.661	3.363	100.000
	salt [Coral]	0.000	0.056	100.000
	limestone+chert+sandy loam[Sea Green]	11.672	2.295	100.000
	chert + sandy loam [Orchid]	1.885	1.900	100.000
	limestone + sandy loam [Sienna]	19.535	9.746	100.000
	silty loam [Thistle]	10.203	2.529	100.000
	loamy sand [Red1]	15.036	9.331	100.000
	natural plant [Red2]	5.550	3.882	100.000
	saline [Red3]	0.013	0.887	100.000
	clay loam [Green2]	0.204	1.404	100.000
	sandy loam [Green3]	0.214	0.889	100.000
	Masked Pixels	0.520	0.046	100.000
	Class Total	100.000		
	Class Changes	73.780		
	Image Difference	125.673		

Figures 8 -Change detection statistics For sand dunes (Percentage)

Pixel Count | Percentage | Area (Square Meters) | Reference

		sand dunes [Green]	Row Total	Class Total
Final State	Unclassified	0.00	0.00	0.00
	sawa lake[Red]	3692700.00	3692700.00	42732000.00
	sand dunes [Green]	666740700.00	666740700.00	5738568300.00
	swamp [Blue]	14715000.00	14715000.00	1006608600.00
	barley [Yellow]	4249800.00	4249800.00	35273700.00
	wheat [Cyan]	11898900.00	11898900.00	153253800.00
	palm [Magenta]	45766800.00	45766800.00	675269100.00
	euphrates river [Maroon]	3304800.00	3304800.00	67993200.00
	loam [Purple]	143956800.00	143956800.00	4280592600.00
	salt [Coral]	1800.00	1800.00	3240900.00
	limestone+chert+sandy loam[Sea Green]	296794800.00	296794800.00	12930587100.00
	chert + sandy loam [Orchid]	47923200.00	47923200.00	2521733400.00
	limestone + sandy loam [Sienna]	496749600.00	496749600.00	5096836800.00
	silty loam [Thistle]	259441200.00	259441200.00	10258786800.00
	loamy sand [Red1]	382358700.00	382358700.00	4097867400.00
	natural plant [Red2]	141118200.00	141118200.00	3634922700.00
	saline [Red3]	332100.00	332100.00	37456200.00
	clay loam [Green2]	5175900.00	5175900.00	368655300.00
	sandy loam [Green3]	5434200.00	5434200.00	611122500.00
	Masked Pixels	13215600.00	13215600.00	28534824000.00
	Class Total	2542870800.00		
	Class Changes	1876130100.00		
	Image Difference	3195697500.00		

Figures 9-Change detection statistics Area For sand dunes (Square Meters).

Note from the previous tables about there is a significant increase in sand dunes. When comparing sand dunes between satellite images in 1990 and 2016, we see a clear increase in the area of sand dunes, to calculate sand dunes statistics; we use (Class Statistics) to calculate statistics based on the classification results of any relevant entry file. Dune statistics were recorded in 1990 (2542876200 m^2), while in 2016 (5738568300 m^2), the area increased (3195692100 m^2) During the last 26 years this is a significant increase and poses a danger to the region, as in the following Figure-10.

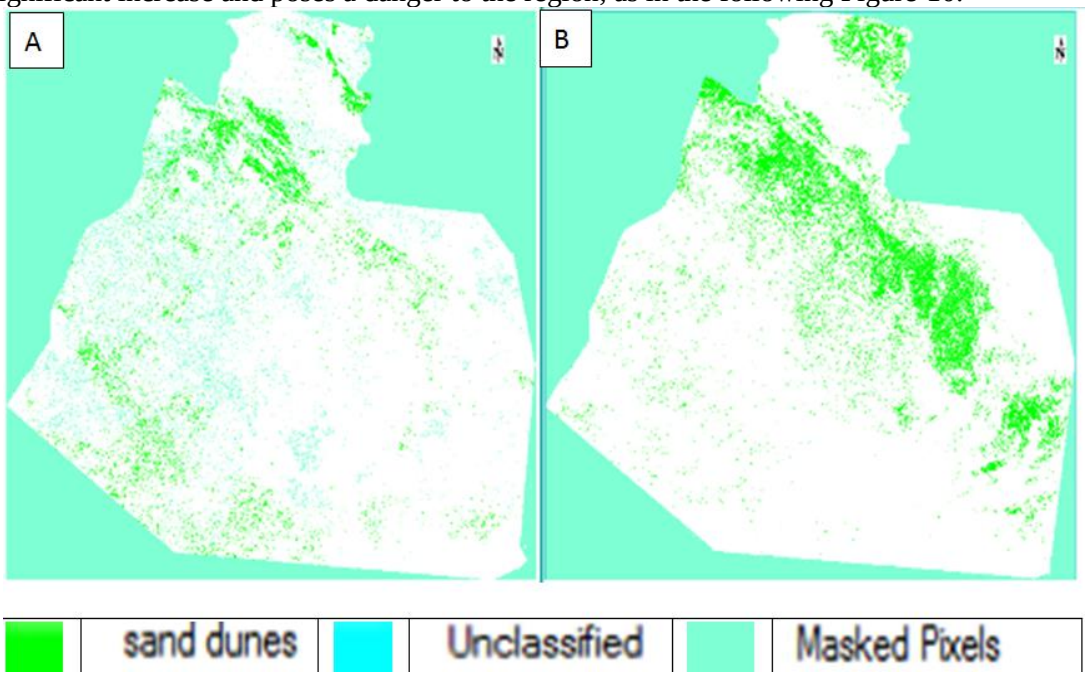

Figure 10-(a) Sand dunes in Muthanna Governorate in 1990. **(b)** Sand dunes in Muthanna Governorate in 2016.

6. Conclusions

1- The use Landsat 1-5, Landsat 4-5, Landsat 7 and Landsat 8, for various years provides a good assessment of desertification, which gives an adequate perception of changes from the future.
2- The wind trend prevailing in the region (north-west) is the same as that of sand dunes, indicating that wind is the main factor in the formation of sand dunes.
3- Remote sensing data for classification and mapping of desertification and vegetation provide a detailed, detailed product in a timely and cost-effective manner
4- Based on the information obtained during the field observations, the data collected from the study area and the results of processing the satellite images, it seems that significant changes in the land cover occurred during the study period, the most important phenomenon is sand dunes, which caused the transformation of land into land unsuitable for agriculture

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