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Using Remote Sensing and Geographic Information Systems to Detect Desertified Agricultural Lands in Al-Qadisiyah Governorate

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Abstract

Desertification is one of the phenomena that threaten the ecological system, otherwise economic and social. This study aims to assess and control desertification in Al-Qadisiyah Governorate through the use of remote sensing techniques and geographic information systems. Vegetation Index (NDVI) and Crust Index (CI) were used, which were applied from both (OII) and Landsat (ETM) satellite images during the years 2013 and 2020. The results showed that the total area of vegetation cover in 2013 was 2902 square kilometers. With a percentage of 32.30% of the total area, which made it classified in that year within the medium desertification? However, this percentage did not remain the same, but decreased significantly in 2020. The vegetation cover was only 17.43%. That is, the area of vegetation decline reached (373) km, which made it classified as high desertification. The study also showed; the sand area in 2013 was classified within the low sand drift in most of the study districts. With the exception of the district of Hamza, in which sand erosion is classified as high, meaning high desertification. Be the sand erosion more and more expansive in 2020. Where we find that most areas of the governorate have recorded moderate desertification, as is the case in Al-Diwaniyah and Afak districts, while Al-Shamiya district recorded high desertification.

Keywords: remote sensing, desertification, sand

استخدام الاستشعار عن بعد ونظم المعلومات الجغرافي في الكشف عن الاراضي الزراعية المتصرحة في محافظة القادسية من العراق

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الملخص

تعد ظاهرة التصرّر من الظواهر التي تهدّد النّظام البيئي والاقتصادي والاجتماعي، تهدف هذه الدراسة إلى تقييم ومراقبة التصرّر في محافظة القادسية من خلال استخدام تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية، تم استخدام مؤشر الغطاء النباتي NDVI ومؤشر القرشة CI والتي طبقت الاثنين من صور القمر الصناعي لاندستس ETM خلال السنوات ٢٠١٣ و ٢٠٢٠ أظهرت النتائج إن المساحة الكلية للغطاء النباتي في سنة ٢٠١٣ كانت قد بلغت ٢٩٠٢ كمتر مربع، بما يُولّف نسبة ٣٢،٣% من المساحة الكلية مما جعل إن يصنّف في تلك العام ضمن التصرّر المتوسط، لكن لم تبقى هذه النسبة على حالها وإنما نقصّت نقصان كبير في عام ٢٠٢٠ إذ بلغت نسبة الغطاء الخضري فقط ١٧،٤٣% أي بلغ مساحة تراجع الغطاء الخضري (٣٧٣) كمتر مربع مما جعله يصنّف ضمن التصرّر العالى. أظهرت الدراسة أيضاً إن مساحة الرمال عام ٢٠١٣ كان قد صنّفت ضمن انجراف الرمال المنخفض في اغلب أقضية الدراسة باستثناء قضاء الحمزة التي صنّف فيه انجراف الرمال مرتفع أي تصرّر عالى، لكن قد تزايد اتساع انجراف الرمال في عام ٢٠٢٠، حيث نجد إن اغلب مناطق المحافظة قد سجلت تصرّر متوسط كما هم الحال في قضائي الديوانية وعفك بينما سجل قضاء الشامية تصرّر عالى

الكلمات المفتاحية: الاستشعار عن بعد ، التصرّر ، الرمال

Introduction:

Desertification is a dangerous global environmental phenomenon, because its effects are not limited to specific places, but generally cover large areas of the world, especially in dry and semi-arid environments, in addition to semi-humid areas.

The international community has recognized the problem of desertification and has taken action towards it. In 1977, During the United Nations Conference on Desertification (UNCOD) in Nairobi, Kenya, the problem of desertification as a global issue was discussed for the first time. An Action Plan to Combat Desertification (PACD) was prepared. In 1992, at the United Nations Conference on Environment and Development (UNCOD) held in Rio de Janeiro, Brazil, The Earth Summit and Agenda 21 called on the United Nations General Assembly to form a committee of member governments to prepare an integrated legal mechanism to address the problem of desertification .

Desertification means land degradation in arid and semi-arid areas and in dry and semi-humid areas which is caused by various factors. Including climatic changes and human activities (Dulliam, 2015 p, 20), (UNCCD, 1994 p,32). This does not mean closing the door for discussion to put the definition as suggested at the level of the United Nations and the competent authorities. This is because the study of desertification is relatively recent, as the first scientific text defining the meaning of desertification appeared about 50 years ago. In 1977, the subsidiary bodies of the United Nations made the first map of desertification, and that coincided with the convening of the United Nations Conference on Desertification in Nairobi, Kenya (Rouse,1997,p 17).

In fact, desertification is the process of destroying or destroying the vital energy of the earth, which can eventually lead to conditions similar to those of the desert. It is a manifestation of the widespread degradation of ecosystems that leads to a reduction in the vital energy of the earth, whether plant or animal production, and thus affect the sustainability of human existence. There are many stages in the desertification process, but whatever its form the final stage will be complete desert with zero vital productivity .

Iraq is located in the arid and semi-arid region prone to desertification problems, especially in the central and southern parts of Iraq, which is estimated at about one million hectares (Karnieli, 1997, p1207).

The causes of desertification in the study area were identified as meteorological, biological, geological and agricultural problems. It lies in drought, increase in dust storms, scarcity of surface water, high salinity in it, lack of vegetation cover, overgrazing, lack of drainage channels, and poor behavior of farms. The main result is losses in agricultural land and soil fertility, desert environment movement, population migration, and significant losses in human and material resources. Many researchers have studied this phenomenon such as, Wuhan Hands Study Monitoring desertification in Shaanxi Province, China. The results showed that the study area suffers from severe desertification, as the desertification area constituted 88.9% of the total area .

And in 1999 (Jabbar, 2001, p113). Hadeel et al studied the sensitivity of desertification in Basra city, and the results showed that severe desertification is located in the southwestern parts of the region (Jawad, 2018, p1132) . The study of Bachai et al., an indicator of desertification vulnerability in Iran, and the results showed that about 22% of the study area was classified as moderately affected by desertification, while 60% were classified as highly vulnerable to desertification (Thornes, 1995, p169) . Abdul Razzaq and his colleagues used remote sensing data in Karbala governorate, and the results showed that the study area suffers from severe desertification because the area suffered from erosion, urban growth and poverty of water resources Dolyami study monitored desertification in the Baiji region, where the results showed the prevalence of severe and very severe degradation in sand dunes, while the degrees of low and medium degradation were relatively lower (Hadeel, 2010, p101).

The aim of this study is to assess and monitor desertification in the central parts of Iraq between the Tigris and Euphrates rivers through the use of remote sensing techniques and geographic information systems using the vegetation cover index and the crust index CI

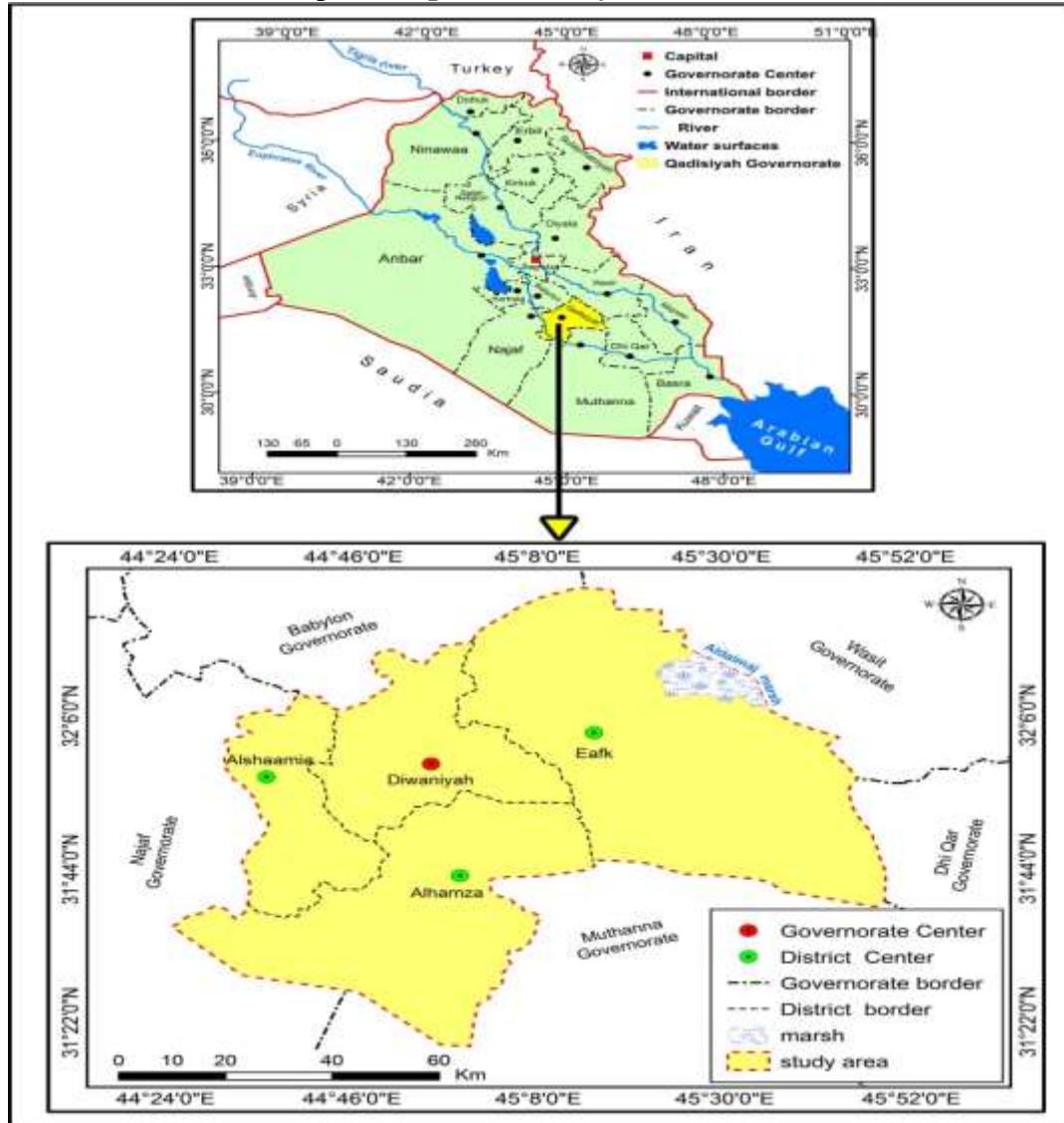
Materials and methods

Study area

The alluvial plain is a large part of Mesopotamia, consisting of the Tigris and Euphrates rivers (Nicholson, 1998, p815). The study area is located in the central part of the sedimentary plain, which is Al-Qadisiyah Governorate. It is bordered by five governorates from the north, Babil Governorate, and from the south it is bordered by Al-Muthanna Governorate, while Wasit and Dhi Qar governorates are bordered from the east and north-east. The study area included four districts, each of Al-Diwaniyah, Al-Hamza, Afak and Al-Shamiya. The study area was chosen because it contains agricultural lands, which is one of the fertile agricultural lands in Iraq. Map (1).

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Map(1) map of the study areas location



Source: Adeeb .H. Q. and Y. K. Al-Timimi,. GIS techniques for mapping of wind speed over Iraq , Iraqi Journal of Agricultural Sciences. Vol .50, no.6, pp1621-1629, 2019

Iraq can be divided into three regions, the arid and semi-arid region, where the annual rainfall is more than 400 mm, the steppe region, where the annual rainfall is 200-400 mm, and the desert region, Where the annual precipitation is less than 200

mm, the spatial distribution of the average annual precipitation in the study area ranges between 50-100 mm (Khudhairy,2018,p103).

The temperature reached the highest value for the months of August and July, which amounted to degrees Celsius, and the lowest value for the months of January and December, which amounted to 9 degrees Celsius, and the average temperature in the study area ranges between (20-25) degrees Celsius (Nicholson,1998,p815). The annual mean wind speed was 3.5 to 4.5 m/s (1). My Landsat image which was Path 168 and Row 37 was downloaded from the USGS server. The first image was a Landsat 5 objective chart obtained in April 2013, while the second image of the Landsat 8 was the OLI required in April 2020 for a period of 7 years (2013-2020). The image preprocessing included geometric corrections. The two Landsat images were

the UTM N 38 projection area. All indications are from Landsat satellite images downloaded from the USGS website (www.earthexplorer.com). the two pictures . A Landsat whose path was 168 and Row 37 was used in this study and was downloaded from the USGS server. The first image was a Landsat 5 objective chart obtained on April 24, 2013, while the second image was for Landsat 8, the OLI operational ground imager required on March 21, 2020 for a period of 29 years (2013-2020). The image preprocessing included geometric corrections. The two Landsat images were of the UTM N 38 projection area. All indicators are from Landsat satellite images downloaded from the USGS website (www.earthexplorer.com). These indicators are :

Crust Index (CI)

Crust Index, known as CI, is used to recognize the soil having sand deposition. Soil having sand deposition will appear dark as compared to the other soil types due the absence of organic matter in it. This index can be used on any satellite imagery having Blue (400-500 nm) and Red (500- 600 nm) band. The value of CI ranges from 0 to +2. This guide represents the difference between the third and first bundles on their sum subtracted from one. As it is the highest in the first package, and it is characterized by monitoring the thin layer that forms on the surface of the soil or sand dunes, and hence is considered one of the important indicators in expressing the movement and activity of sand dunes(Kosmas,1999,p31). The form of spectral crust index can be given by:

$$CI = 1 - \left(\frac{RED - BLUE}{RED + BLUE} \right)$$

Crust index and NDVI algorithms were applied to images. The vegetation cover, drifting sand images were interpreted and statistically analyzed to produce desertification severity maps based on the vegetation cover and extent of drifting sand .

The Normalized difference vegetation index (NDVI)

The Normalized difference vegetation index, known as NDVI, is one of the most widely used spectral indicators in the field of satellite image analysis, vegetation study, fire and desertification, and other natural phenomena . NDVI can be defined as a ratio between the red (R) and near-infrared (NIR) values (Thomas,1997,p599) ;

$$\text{NDVI} = \frac{\text{NIR} - \text{RED}}{\text{NIR} + \text{RED}}$$

Table 1. Indices of factors used in assessment of land desertification .

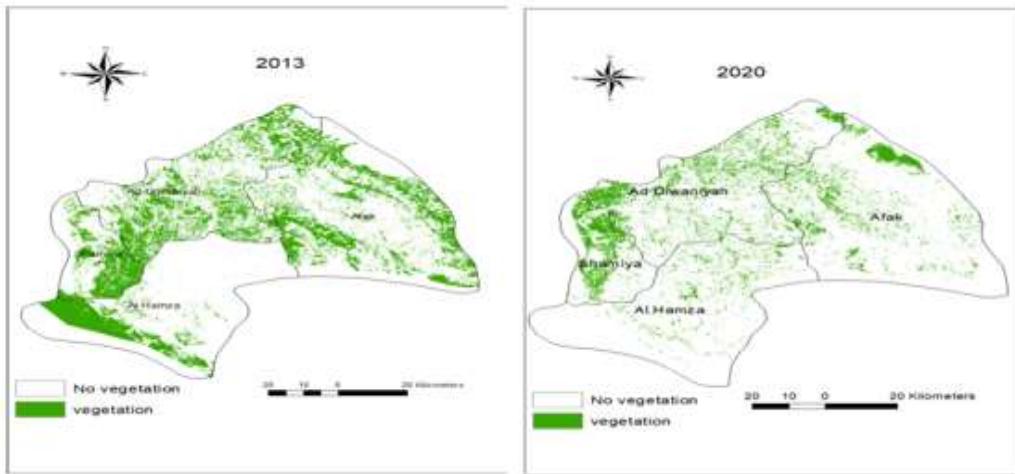
Indicator	Severe	Severity Level			Weight
		High	Medium	Low	
Vegetation Cover	< 10	10 - 25	25 - 40	> 40	0.40
Drifting Sand Cover	> 65	15 - 65	5 - 15	< 5	0.25

Source: Adeeb ,H. Q. and Y. K. Al-Timimi. , GIS techniques for mapping of wind speed over Iraq , Iraqi Journal of Agricultural Sciences. Vol .50, no.6, pp1621-1629, 2019

Results and discussion:

The standard vegetation index (NDVI) and crust index (CI) were derived from Landsat images for 2013 and 2020. Figure 1 shows the map of vegetation cover derived from the NDVI index over the study area between 2013 and 2020, while Table 2 reveals the relevant statistics that include, the amount of area per area, the percentage of all areas. The results of the NDVI index showed that the districts of Al-Diwaniyah and Afak were the largest decline .

The results showed in Table (2) that the maximum value of the rate of decrease in vegetation cover was 676 km² in Afak in the first year, while Shamiya district had the lowest value, as the value of the decline was 175 km²

Figure1 Vegetation cover of the study area in 2013, 2020

Source: Adeeb 'H. Q. and Y. K. Al-Timimi'. GIS techniques for mapping of wind speed over Iraq , Iraqi Journal of Agricultural Sciences. Vol .50, no.6, pp1621-1629, 2019

Table (2). Area and percentage of vegetation cover study area for the years 2013 and 2020 .

boycott	elimination space km2	Green space for the year 2013	The ratio %	Green area km2 for the year 2020	%	The area of change of vegetation cover km2 (2013-2020).	Percentage change of vegetative cover km2 (2013-2020)%
Diwaniyah	1212	504	35.57	230	19.32	234	16.25
Afak	3669	1140	28.15	403	11.53	676	16.62
Shamiya	948	587	47.28	303	32.62	175	14.66
Hamza	2324	669	18.21	1394	6.28	408	11.93
Total	8153	2902	32.30	2330	17.43	373	14.86

Source: Arnold, E. UNEP, 1992. World atlas of desertification, London
The average rate of total vegetation decline in the study area was 53 km2 per year-1. The results showed

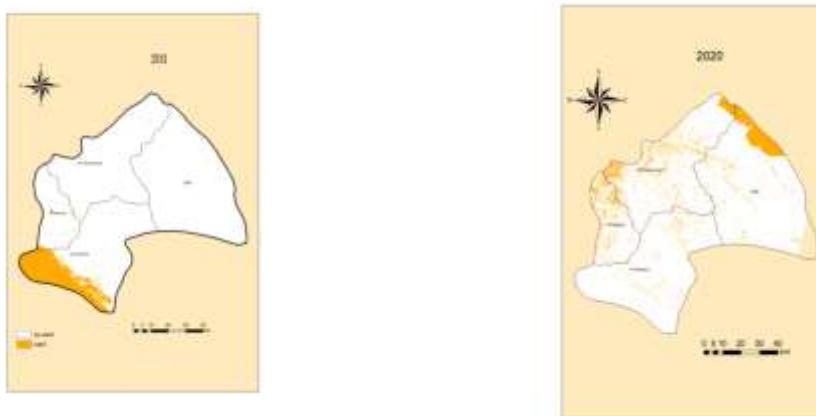
The study showed for the year 2013 that the general rate of the study area was average desertification, as the rate of desertification reached 32.30%. These percentages varied according to the district in the study area. The district of Al-Hamra witnessed high desertification, as the percentage of desertification in it reached (18.21%), in contrast to the district of Al-Shamiya, which witnessed low

desertification. As the percentage of desertification reached (47.28%), while the districts of Afak and Diwaniyah witnessed average desertification, as the percentage of vegetative cover reached (28.15% and 35.57%), respectively.

The percentage of desertification has increased in the study area for the year 2020, as the general average in the study area was classified within the high desertification, as the percentage of vegetation cover throughout the study area reached (17.43%). Most of the districts of the study area were also classified in 2020 within the areas of high desertification, as is the case in the districts of Hamra, Afak and Al-Diwaniyah, where the percentage of desertification in them reached (6.28%, 11.53% and 19.32%), respectively, with the exception of the Shamiya district, which was classified as including medium desertification. The percentage of vegetative cover in it reached (32.62%), in other words, severe desertification has expanded to include most parts of the study area, where its area has expanded to reach the percentage of severe desertification in it to (91.26%), which warns of a dangerous situation in the study area.

If we compare the rate of decline in vegetation cover between the years (2013) and (2020), we find that the total vegetation cover in the entire study area for the year 2013 amounted to 2902 square kilometers (32.30%), while it decreased in the year 2020 to 2330 square kilometers 17.43%. That is, there is a noticeable decrease in the vegetation cover in the study area during the period of 7 years from 2013 to 2010, amounting to 14.86

Figure 2. A Sand drifting of the study area in 2013, 2020



Source: From the researcher's work based on remote sensing and(GIS

The sand erosion table (3), which is derived from the CI indicator, showed that the general rate of sand erosion in the study area for the year 2013 was average, reaching 10.54%, while the sand erosion rate (desertification) varied according to the district. Where we find that the district of Al-Hamra had a high percentage of sand erosion (desertification), reaching 36.91%, in contrast to the districts of Al-Diwaniyah and Afak, in which the percentage of sand erosion (desertification) decreased to less than one percent to record low desertification. Likewise, in Shamiya district, low desertification was recorded, but with a higher rate than the previous two districts, as the sand erosion rate was (1.93%).

In 2020, the general rate of sand erosion (desertification) was 10.79%, which is a percentage that places the area within the limits of average desertification, and slightly higher than in 2013, a slight increase of less than one percent. But at the level of the district, we find that there is a discrepancy, while the Shamiya district was recorded within the high sand erosion, as the sand erosion rate in it reached 17.66%, in contrast to the Hamra district in which the sand erosion rate (desertification) was recorded as low, reaching 2.52% While both Al-Diwaniyah and Afak districts recorded a medium rate of sand erosion (desertification), where the percentage of desertification for each of them was (11.41% and 12.31%), respectively

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Table (3). Quantity and rate of sand erosion in 2013 2020

bcott	elimination space km2	Sand space for the year 2013	The ratio %	Sand area km2 for the year 2020	%	The area of change of Sand cover km2 (2013-2020).	Percentage change of Sand cover km2 (2013-2020)%
Diwaniyah	1212	1.21	0.10	145.44	12.31	145	12.20
Afak	3669	3.66	0.10	403.59	11.41	403	11.30
Shamiya	948	18.01	1.93	161.16	17.66	142	15.72
Hamza	2324	836.64	36.91	58.1	2.52	790-	34.38-
Total	8153	859.53	10.54	768.29	10.79	16	1.12-

Source: From the researcher's work based on remote sensing and(GIS

Conclusion:

The use of remote sensing technologies and geographic information systems are absolutely essential for the management of natural resources. In this study, Mapper (TM) images and operational images (OLI) were used to detect desertification changes. In this study, the trend of desertification was increasing during this period.

The results of NDVI showed that the total vegetation cover amounted to 2,902 square kilometers in 2013, while it decreased to 2,330 square kilometers in 2020. The decline was 14% of the total area.

While the general rate of vegetation cover decreases to 53 square kilometers per year, either for sand drift. Floating sand areas in 2020 are larger than those in 2013. Although the general average has decreased, we find that the difference was large in most of the districts, as is the case in the districts of Aqak, Diwaniyah and Shami. As the rate of increase in sand erosion for the year 2020 compared to 2013 amounted to (11.30%,

12.20% and 15.72%), respectively, the decrease in vegetation cover can be attributed to the poverty of irrigation water and water resources during drought periods. As well as the massive urban sprawl in the study area and the surrounding governorates. The reason for the decrease in vegetation cover in the study area is due to the decrease in the amount of rain during the study period. Then the decrease in the amounts of rain led to a significant decrease in the surface and ground water resources of the study area such as rivers, lakes and groundwater, and consequently a decrease in the soil moisture content.

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