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Using Remote Sensing Techniques and Geographic Information Systems in Changes Detection of Marsh Al Dalmaj Period 2000-2017 and Its Impact on Some Engineering Properties

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Abstract

Al- Dalmaj area is a large water body in Iraq in the Afak district, which feeds from the general downstream between the Tigris and the Euphrates. The present study focused mainly on the changes detection in Al-Dalmaj area through analysis of the Landsat images for four selected years (2000, 2002, 2013 and 2017) to determine the changes in marsh waters, wetlands area, drylands areas and other land classes, The Landsat images of Al-Dalmaj area were analysed with the scene that includes the water surface and the area surrounded by the fixed geographical boundaries. The combination of remote sensing and GIS techniques have been found to be successful and effective in monitoring the spatial and temporal changes in land cover. These changes in the land cover of Al-Dalmaj area were detected using various analyses, including Normalised Difference Vegetation (NDVI), the Normalised Difference Water Index (NDWI), the Salinity Index(SI), and the Salinity ratio using Geographic Information Systems (GIS) programs v.10, using ERDAS Imagine v. 9.2 and spectral index techniques were used in this study to determine the land changes, to analyse Landsat images for the years (2000,2002,2013 and 2017). From the application of the equations of evidence referred to, it was found that the salinity (%) increased in the study area. 2002 represents the most extreme stage of the lack of natural conditions in Al- Dalmaj area. It was concluded that the water change was 83.8% for 2002 as 2000 as a reference. As for the natural vegetation, the percentage of change was 84.5% for the same year. The results showed that the percentage change in salinity was 127.5%, a high percentage compared to the rest of the study years. The bulk density values range between (0.70 - 0.89) Mg/m^3.

Keywords: Marsh of Iraq, Change detection, Land cover, NDVI, Landsat image

استخدام تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية في كشف تغيرات هور الدلمج للفترة 2000-2017 وتأثيره على بعض الخواص الهندسية

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الخلاصة

منطقة الدلمج مسطح مائي كبير في العراق في قضاء عفك، يتم تغذيته من المصب العام بين دجلة والفرات. ان الهدف الرئيسي من الدراسة الحالية هو الكشف عن التغير في منطقة الدلمج من خلال تحليل مرئيات القمر الصناعي لأربع سنوات مختارة (2000، 2002, 2013و2017) لتحديد تغير مياه

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الأهوار ومساحة الأراضي الرطبة ومساحة الأراضي الجافة وغيرها من فئات الأراضي، نتيجة لإجراءات التجفيف التي لها تأثير كبير على البيئة في الاهوار العراقية. تم تحليل المرئيات الفضائية لمنطقة الدلمج المتمثلة بالمشهد المستقطع الذي يشمل المسطح المائي والمنطقة التي تحيطها بالحدود الجغرافية المثبتة.وقد تبين أن الجمع بين تقنيات الاستشعار عن بعد وتقنيات نظم المعلومات الجغرافية ناجح وفعال لرصد التغيرات المكانية والزمنية في الغطاء الأرضي. تم تحديد التغييرات التي تم اكتشافها في الغطاء الأرضي لمنطقة الدلمج باستخدام طرق التحليل المختلفة مثل مؤشرالغطاء النباتي الطبيعي(NDVI) ومؤشر المياه (NDWI) ، ومؤشر الملوحة(SI) ، ونسبة الملوحة، باستخدام نظم المعلومات الجغرافية(GIS v.10) ، و(Erdas Imagine v. 9.2)، تم استخدام تقنيات المؤشرات الطيفية في هذه الدراسة لتحديد تغير الأرض، وتحليل صور الأقمار الصناعية للسنوات (2000,2002,2013و2017). من تطبيق معادلات الادلة المشار اليها على المشهد المحدد لمنطقة الدلمج تبين ان نسبة الملوحة زادت في منطقة الدراسة ويمثل عام 2002 اقصى مرحلة لانعدام الظروف الطبيعية في منطقة الدلمج. بالاعتماد على عام 2000 كقيمة مرجعية تم التوصل الى ان النسبة المؤية للتغير في المياه 83.8% لعام 2002، .اما بالنسبة للنبات الطبيعي فكانت النسبة المؤية للتغير 84.5% لنفس العام. وبينت النتائج ان النسبة المؤية للتغير في الملوحة 127.5% وهي نسبة عالية مقارنة ببقية سنوات الدراسة.اما قيم الكثافة الظاهرية فقد تراوحت بين (0.70–0.89) ميغاغرام/م^3.

1. Introduction

Marshlands are generally defined as wetlands characterised by prominent vegetative cover emerging herb that adapts to water saturated soil conditions that remain at or above the water level permanently or temporarily[1]. Iraqi Marshes represent the most extensive wetlands in the Middle East. Iraqi Marshlands are subjected to many environmental changes [2]. Change detection is the process of monitoring differences in the circumstances of the phenomenon or objects at different periods; it means the capability to quantify temporary effects using different multitemporal sets of information. The degradations of the land do not necessarily represent the land cover changes by the land use. However, lands shifted due to socialite causing, resulting in changes in land cover that will affect the radiation, trace gas emission, and_biodiversity_water budget, and other procedures beneficial to climates and biosphere[3]. By investing in remote sensing and Geographical Information System (GIS) techniques, land cover mapping has been found useful in selecting the better industrial, agricultural or urban areas of designed areas [4]. The remotely sensed data provides the scientist with enormous information to study the effect of the land cover at low cost and good accuracy within a short time with the cooperation of the GIS company. GIS company has been supplied with trieval and update information analysis using an appropriate juncture (platform). Using the high-resolution spatial satellite images and another imagery processing analysis with GIS technologies has enabled to control the monitoring process to be more consistent and routine, which allows the creation of a patterns model of land-use to land cover. The collective images and data of land cover mapping by GIS techniques show the significance of remote sensing applications[5].

Al-Dabbas *et al.* [6] studied the hydrochemical evaluation of the Main Drain and Hor Dalmaj, and they suggested that both Dalmaj and the main drain water are unsuitable for human drinking because has exceeded permissible limits and they are acceptable grades for livestock and poultry.

2. Location of the study area

The study area represents a part of the central sector of the Mesopotamian Plain, Figure 1. Al-Dalmaj area is located west of the Tigris River, extending from the borders of Al-Qadisiya Governorate to the near of Wasit Governorate, about 35 km southwest of Kut city [7]. it is bounded by latitudes 32 ˚03΄ 43 ˝ to 32 ˚25΄ 06 ˝ N and longitudes 45 ˚11΄ 01 ˝ to 45 ˚41΄ 48 ˝ E .

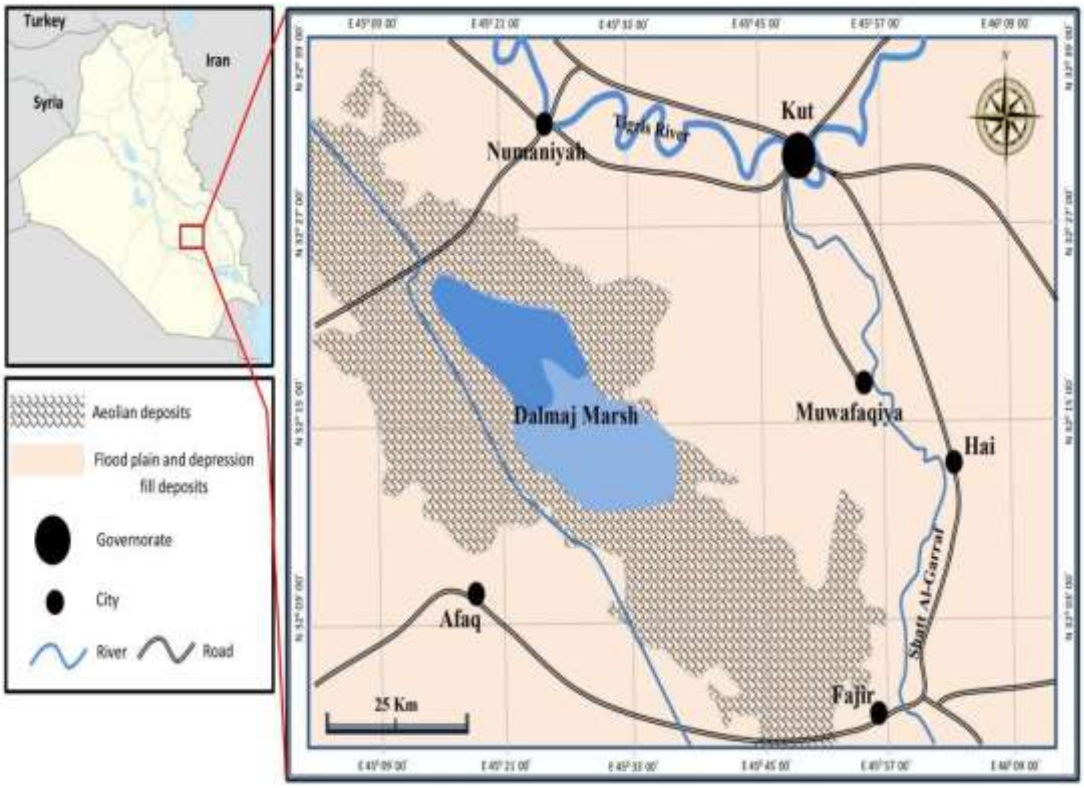


Figure 1: Geological map of Al-Dalmaj area after Sissakian, 2015[8]

3. Geological Settings

Al-Dalmaj area is covered totally by the Quaternary sediments, which include:

3.1 Floodplain sediments

Floodplain sediments are exposed in almost part of the area. These sediments consist mainly of silty clay followed by silts and fine sand the common color of the salty clays is reddish brown [9].

3.2 Marsh sediments

Marsh sediments are either at the surface or buried under the sediments. These sediments are of the black or dark gray horizon at the top 10-20cm, consisting of organic material mixed with mud. This dark horizon rapidly matures into light greenish-grey or bluish-grey mud with molluscas shells [9]. The thickness of sediments ranges from a few cm to 2m.

3.3 Aeolian Sediments

Wind-blown sediment is spread over the whole map area because of the low rate of precipitations in many places. Nebkhas and drifting sand sheets, which are the simplest form of aeration sediments, appear as scattered patches. The main area where eolian sediments have large areal extent and wide strip NW-SE trending passing around Al- Dalmaj area. The thickness of the aeolian sediment depends on the form of accumulation. The sand sheets' thickness is scarcely more than one meter, exceptionally reaching 2 meters in some fields, while aeolian sediments reach 5m or more locally. [9].

The grain size distribution of aeolian sediments strongly depends on the distance of aeolian transport and source materials. The sediments of Al-Dalmaj area are fine sand with small parts of medium sand, and they show much scatter sorting due to the more significant transport distance. In addition, many fragments of shells are partially in the area of dry marshes or depressions [9].

3.4 Anthropogenic sediments

The anthropogenic sediments are accumulated exclusively by human activities. The most prominent sediments are bodies of hill traces of ancient settlements (tells). The tells are composed ruins of mud huts, brick fragments. Sediment of dust storms and sediment of floods cover a number of tells [9].

3.5 Shallow depression sediments

The depression sediments have different areal extents; they originated from local micro morphological conditions and a network of ancient irrigation canals. All these shallow and small depressions are filled with rainwater. A large shallow depression is in fact, elongated flood basins such as Al-Dalmaj area. Water is covered throughout the year, and some water is brought artificially through canals. The most common constituent of shallow depression fill is silty clay, sand and silt. The important characteristic feature of shallow depression sediment is the higher biological activity which was closely connected with higher soil moisture [9].

3.6 Hydrology

The Tigers River represents the main source of water in the study area, and it is used for different purposes such as Human use, irrigation, and livestock drinking. Another water body within the study area is - Al-Dalmaj area- which represented a shallow depression in the central part of the studied area. The main feeding water of Al-Dalmaj area comes from the general drainage canal, which gathers the draining water from the surrounding agricultural lands. The water is controlled by two small regulators, one at the inlet canal and the other at the outlet canal, so the water quality is commonly brackish to high brackish [9].

3.7 Climate

The climate is one of the most important components of the natural environment, and it affects other environmental components such as vegetation cover, soils, precipitations and water quantity and quality. The area lies in arid or semiarid desert climates with very hot summers and little seasonal rains[9]**.**

4. Methodology

4.1 Data

The data used in this study are:

1- The satellite image of the landsat-7 ETM+ sensor for the years 2000 and 2002 in the summer.

2- One scene of the Landsat-8 (OLI) was acquired in summer the 24th of July for 2013 and 2017 with spatial resolutions of 30m for eight bands, 15 meters for the panchromatic bands, and 100meters for two thermal bands, which was downloaded from the Website of USGS[10]. As illustrated. OLI collect data and information from eleven spectral bands. Seven bands are consistent with the Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) sensors found on early Landsat satellites. Two new spectral bands, a deep blue coastal/aerosol band and a shortwave infrared cirrus band, are measured water quality and improve the high detection of thin clouds. The thermal Infrared Sensor (TIRS) bands 10 and 11 were collected at 100 meters but resampled to 30 meters to match OLI multispectral bands. The band has been used (2, 3, 4, 5, 6, and 7).

4.2 Software

The processing study used software such as ERDAS Imagine 9.2 and Arc GIS 10. ERDAS Imagine 9.2 was used for image processing and change detection. Arc GIS 10 was used for data and information preparations, analyses and map compositions. (Word) was used for reporting and analysis.

4.3 Pre-processing

Two scenes of landsat7 images for the years 2000 and2002 and a Two scenes of Landsat 8 (OLI) images for the years 2013 and 2017, all these information and data subset it by using areas of interest (AOI) file and made using of a nearest neighbor polynomial corrections within the ERDAS 9.2 software. The images are carried out with UTM- WGS84, zone 38 projections using nearest neighbor resampling.

5. Analysis Methods:

5.1 Normalised Differences Vegetation Index

The image ratios are often useful for discriminating subtle difference in spectral variation, in a scene masked by the brightness variation. Different band ratios give the numbers of spectral bands of the satellite images. The utility of any given spectral ratio depends on the particular reflectance characterised by the features involved and the applications at hand. Near-infrared/red ratio images might help differentiate between stressed and non-stressed vegetation. Various mathematical combinations of satellite bands have been found to be sensitive indicators of the presence and conditions of green vegetation. These band combinations are thus referred to as vegetations indices. The simple vegetations index (VI) and the normalised difference vegetations index (NDVI) are two such indices as "Eq. 1" [11].

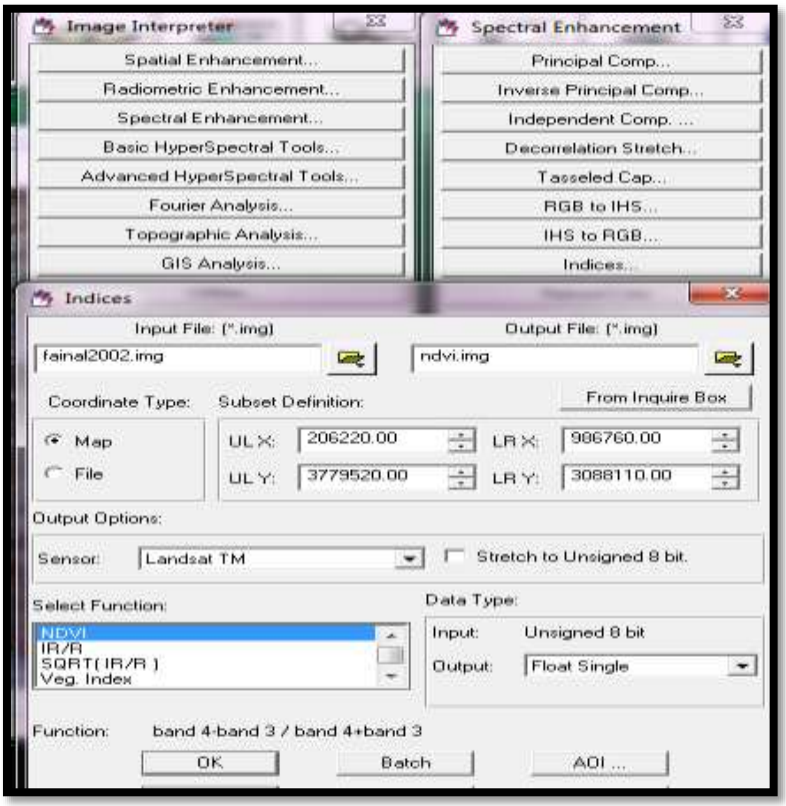
$$NDVI = (NIR - Red) / (NIR + Red) \quad (1)$$

Vegetated areas have a relatively high reflection in the near-infrared and a low reflection in the visible ranges of the spectrum. Waters have larger visual than near-infrared reflectance. Soils have similar reflectance in both spectral regions.[11].

The results of applying general evidence images and vegetable evidence, in particular, are single-band images, and when displayed in ERDAS IMAGINE, show grey, this type of image shows the greenest areas which are covered by a substance containing a large amount of chlorophyll (Chlorophyll) in white, the less chlorophyll, the darker the pixels, while the blackened pixels represent no-vegetation areas, this indicator is used for forest corrosion knowledge, crop monitoring and desertification detection and locating vegetation regardless of its type, also has applied the vegetation index to the flooding plain area for 2002-2013 according to the following "Eq. 2".

$$NDVI= (IR-R)/ (IR+R) = band\ 4 - band\ 3 / band\ 4 + band\ 3 \quad (2)$$

NDVI is one of the most used and fundamental indicators. Figure 2.



Input File: (*.img) fainal2002.img

Output File: (*.img) ndvi.img

Coordinate Type: ● Map ○ File

Subset Definition: UL X: 206220.00 LR X: 986760.00 UL Y: 3779520.00 LR Y: 3088110.00

Sensor: Landsat TM

Select Function: NDVI

Data Type: Input: Unsigned 8 bit Output: Float Single

Function: band 4-band 3 / band 4+band 3

Figure 2: Normalised Difference Water Index (by a researcher, using Erdas V.9.2)

5.2. Normalised Difference Water Index

Normalised Difference Waters Index (NDWI) can be referred to as one of two remote sensing-derived indexes: to monitor changes in the water content of leaves and to monitor changes related to water content in water bodies. It is a satellite-derived index from the Near Infrared (NIR) and Shortwave Infrared (SWIR) channels. The SWIR reflectance reflects a change in the vegetation waters content and the spongy mesophyll structures in vegetation canopies, while the NIR reflectance is affected by internal leaf structures and leaf dry matter contents but not by water contents. [12].

The water index serves to determine precisely what water sources already exist. The water guide equation has been adopted to determine the water area in the study area, and it gives the high reflective value of water a value of 1 and looks white. The rest of the phenomena take the weight of zero, look grey, and a mathematical model is designed to apply the following equation "Eq. 3" [13]**.**

$$\text{NDWI} = (\text{GREEN} - \text{NIR}) / (\text{GREEN} + \text{NIR}) \qquad (3)$$

Where, Green is the green band, and NIR is the near-infrared band.

The water body has strong absorbability and low visible and infrared radiation. The NDWI can be enhanced the water's information effectively in most cases. It is sensitive to built-up lands and often results in overestimated water bodies. [13]. Figure 3.

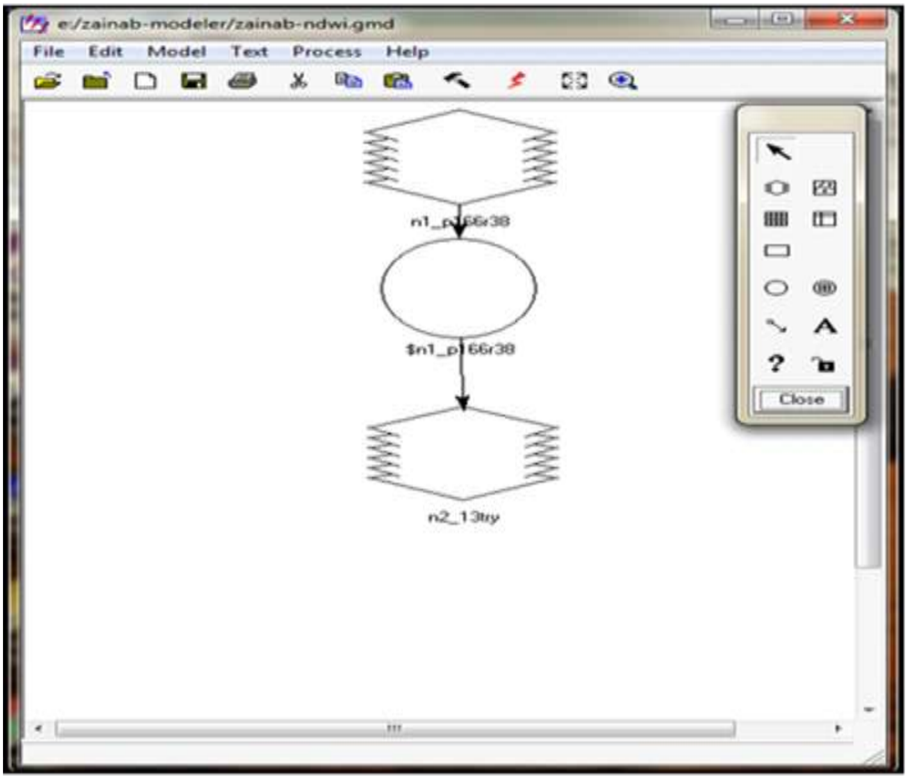


Figure 3: Statistical Model of Water Manual Formula (by a researcher, using Erdas V.9.2)

5.3. Salinity Index and salinity ratio

The Soil Salinity Index was adopted to determine the saline soils and the salinity ratio index. The results of the two equations were achieved in determining the soils of ionised salts, which appear to be light gray, and were adopted together to confirm the results of the study, Figure 4. The model calculates both indices based on Equations "Eq.4 and Eq. 5 "[14].

Salinity Index (SI) = SQRT (ETM3*ETM4) (4)
Salinity ratio = (ETM3-ETM4) / (ETM2+ETM4) (5)

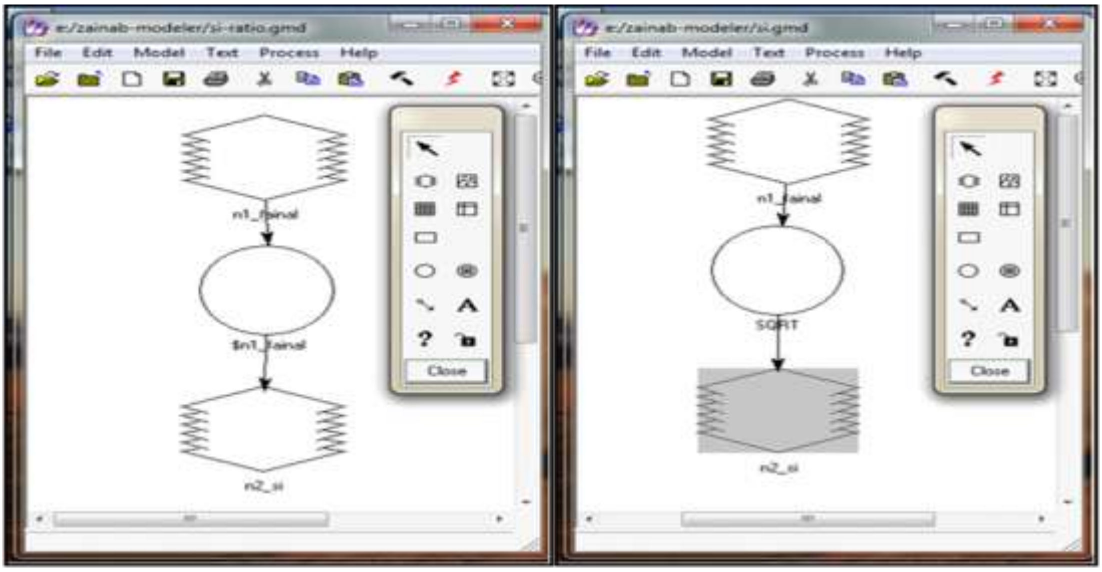


Figure 4: Statistical Model of Soil Salinity Guide Formula and Salinity Ratio (byResearcher, using ERDAS_ V.9.2)

5.4 Bulk Density

It is an important property in materials, in which it identifies the soil's quality and extent of validity. As a physical characteristic, it is necessary for engineering calculations [15]. As density increases, the values of soil's mechanical properties will increase [16].

*Bulk d*ensity is defined as the sample's weight to the total volume "Eq.6 and Eq.7". [17]

$$\rho_b = \frac{w_{dry}}{v_t} \tag{6}$$

$$v_t = \frac{w_{sat} - w_{sub}}{\rho_w} \tag{7}$$

Where ρ_b = Bulk density of soil,- (g /cm3); ρ_w = water density,-(g/cm^3); W_{dry} = weight of oven dry soil-(g); W_{sub} = weight of a submerged soil,- (g); W_{sat} = weight of water saturated soil,- (g); V_t =total volume of soil,-(cm^3)

The apparent density affects the soil, where the higher density value, the lower percentage of water held by the soil, and the lower percentage of soil water conductivity values lead to poor soil ventilation. (18)

The increase of the value of apparent density in the soil increases the cohesion between grains in the soil and stiffness. All that resulted in a negative reflection on both water and air movements. Thus, their agricultural production decreases, and when density decreases, the porosity increases. The reason for their high value is due to the coarse grain size of soil that increases the apparent density values, and the reason for their decrease is due to the disagreement of the proportion of organic substances contained in the soil. (19)
In this study, five soil samples from different locations in Al Delmaj area were taken for laboratory examinations to find the bulk density.

6. Results

From the application of the equations of Index on the specific scene of the study area referred to, it was found that the percentage of salinity increased in the studied area, the fluctuation of the amount of water and the area of vegetation cover due to the lack of rain and the scarcity of surface and groundwater, in addition to the high temperatures and the intensity of evaporation (Table 1). The year 2000 shows a rise in the water area as it reached (102) km^2 in addition to the area of the vegetation cover (308) km^2, the salinity amounted to (193) km^2 (Figure 5).

Table 1: Area change of water, vegetation and salinity (km^2) in Al-Delmaj area for the period (2000-2017)

Year	NDWI	NDWI%	NDVI	NDVI%	SI	SI%
2000	102	REF.	308	REF.	193	REF.
2002	16.5	83.8	47.8	84.5	439	127.5
2013	166	62.8	154	50	207	7.3
2017	125	22.5	66.8	78.3	214	10.9

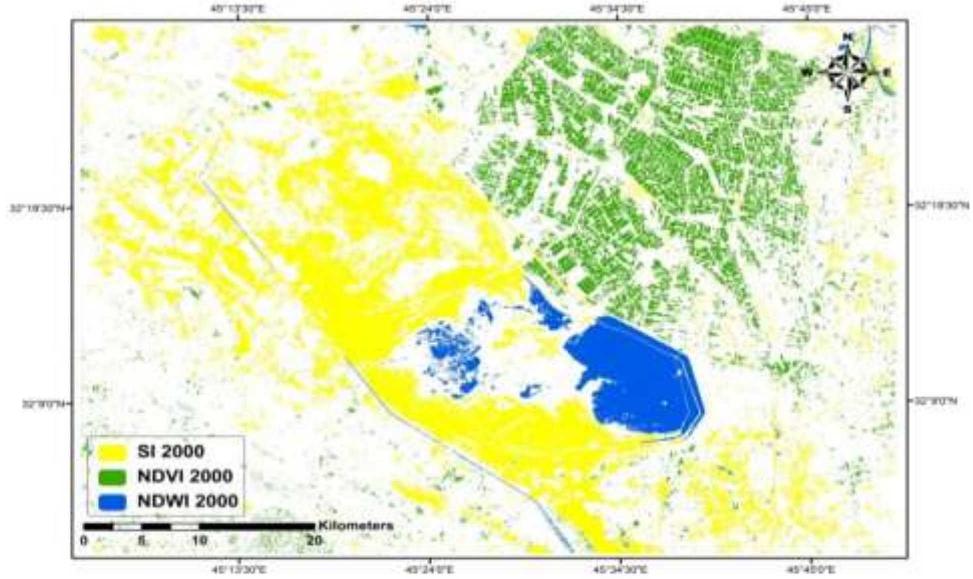


Figure 5: Map showing the results of the NDVI and NDWI during 2000.

The year 2002 represents the most extreme stage of the lack of natural conditions in Al-Dalmaj area. The area of water reached (16.5) km^2, while the area of vegetation cover reached (47.8) km^2, and as a natural result, the salinity increased to cover an area of (207) km^2, Figure 6.

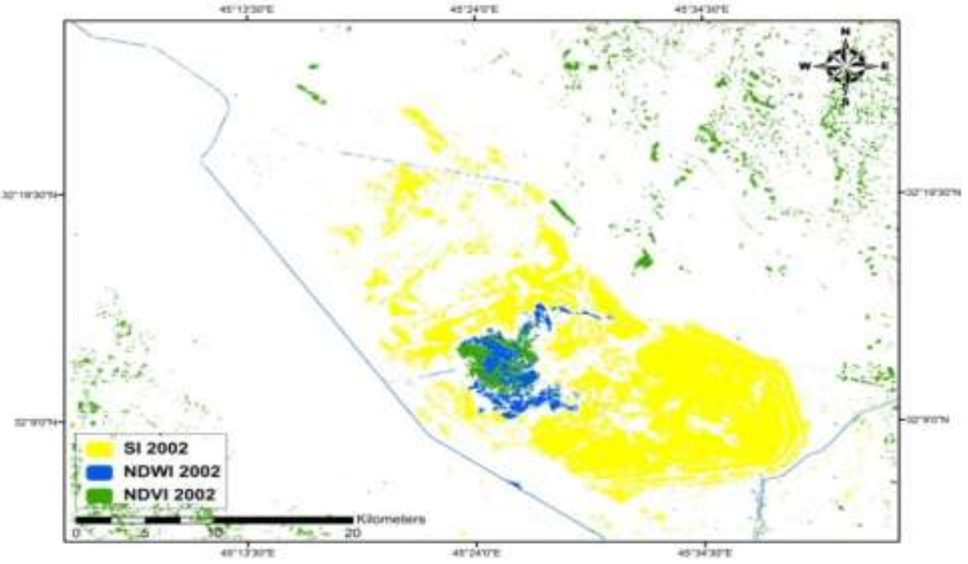


Figure 6: Map showing the evidence results for Al-Dalmaj area during 2002.

The year 2013 represents a balanced year between the area of water and the area of vegetation cover, which respectively amounted to 166 km^2 (154) km^2, while the salinity amounted to 439 km^2 (Figure 7).

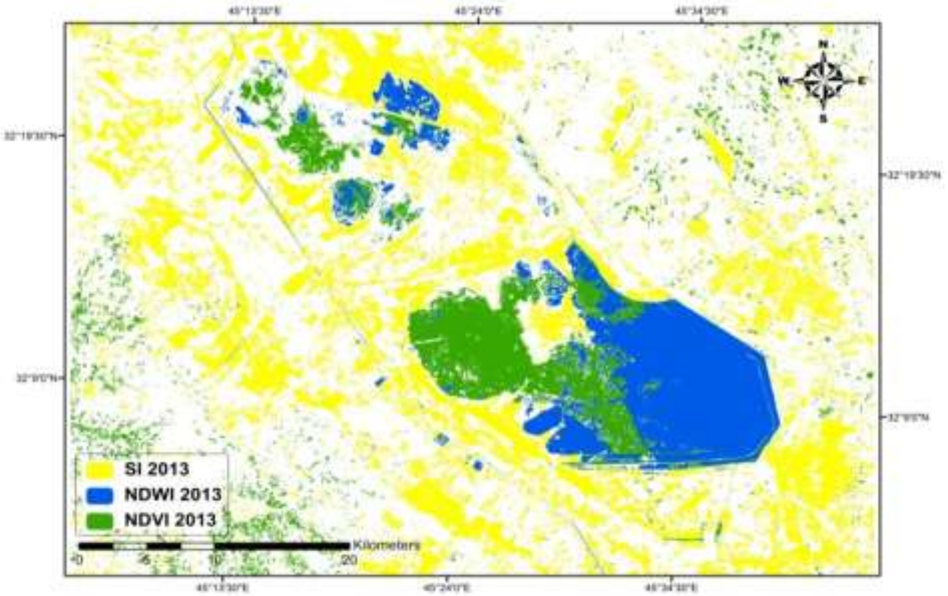


Figure 7: Map shows the results of the evidence for Al-Dalmaj area during the 2013

The amount of water received in 2017, which amounted to (125) km^2, affected the vegetation cover area, which decreased to (66.8) km^2, and the continued spread of salts, which amounted to (214) km^2 (Figure 8).

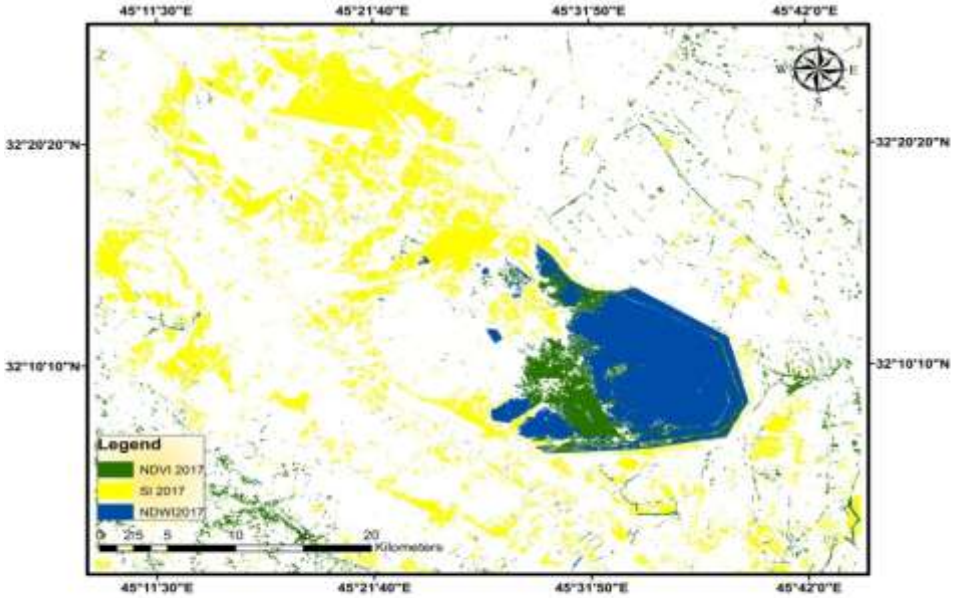


Figure 8: Map showing the evidence results for Al-Dalmaj area during 2017.

The bulk density values range between (0.70 - 0.89) Mg/m^3. The increase of the NDVI and NDWI in the year 2000 led to a decrease in the density because of the high organic matter content related to the increase of the vegetation cover and the water area. The low density has a positive role in reducing the mechanical resistance of the soil to plant growth.

7. Conclusions and Recommendations

It is clearly shown that the identification between Three land cover types, such as the normalised vegetation cover index (NDVI), the water's index (NDWI), the soil salinity index (Salinity Index), and the salinity ratio. These indices are considered important equations in detecting the elements that exist, as it helps distinguish the subtle differences in the spectral differences, as these indices give a value of 1 for the existing land cover while it gives a value of zero for other phenomena. Depending on the year 2000 as a reference value, it was concluded that the percentage of change in water was 83.8%for the year 2002 and 62.8% for 2013, while in 2017, the percentage of change was 22.5%. As for the natural plant, the percentage change was 84.5% for the year 2002, while the years 2013 and 2017 were 50% and 78.3%, respectively. The results of the percentage change in salinity showed 127.5% for the year 2002 and 7.3% for the year 2013, while in 2017, the percentage change was 10.9%. The values of the bulk density that ranges between (0.70 - 0.89) Mg/m^3 have an inverse relationship with the soil content of the organic matter, which depends on the increase or decrease of the area of water and vegetation.

These indices enhance the value of green plants, water and salts, giving them the highest value and negative values for the rest of the phenomena. Soil salinity is one of the issues that are exposed to increasing environmental pressures and continuous deterioration despite the environmental concern, as the Al-Dalmaj area represents a unique natural environment with its various resources. However, the disparity in discharge rates and water quality depends on the difference in water revenues, the construction of dams in the sources of nutrition, the lack of rain, the high temperatures and the intensity of evaporation. It had a significant impact on achieving the environmental balance in the study area due to the high salinity in the study area. Benefiting from the salts through industrial investment and economic benefit by establishing salt refineries and canning them, Reducing the destruction of the plant environment, reclaiming land, and encouraging agriculture in the region, by summarising plants that tolerate high salinity.

References

[1] B. M. H. Al-Thahaibawi, S. A. K. Al-Hiyaly, I . K. A. Al-Mayaly, "Seasonal Variations of Some Physio- Chemical Parameters of Al-Auda Marsh in Maysan Province," *Iraqi Journal of Science,* vol 55, no.3A, pp. 957-967,2014.

[2] C. Aoki, A. Al-Lami and S. Kugaprasatham, *Environmental management of the Iraqi marshlands in the post-conflict.* In *Water and Post-Conflict Peacebuilding,* ed.E. Weinthal, J. Troell, and M. Nakayama. London: Earthscan, 2014.

[3] W. E. Riebsame, W. B. Meyer and B. L. Turner, "Modeling Land use and Cover as part of Global Environmental Change " *Climatic Change,* Vol. 28, no.1-2, PP. 45-64، 1994.

[4] R. E. I. S. Selçuk, R. Nisanci, B. A. Yalcin, H. Inan and T. Yomralioglu, "Monitoring land–use changes by GIS and remote sensing techniques: Case Study of Trabzon، " in *Proceedings of 2nd FIG Regional Conference,* Morocco PP. 1-11. 2003.

[5] J. S. Rawat and M. Kumar," Monitoring Land use/Cover Change Using Remote Sensing and GIS Techniques: A Case Study Of Hawalbagh Block, District Almora, Uttarakhand, India," *The Egyptian Journal of Remote Sensing and Space Science,* Vol.18, no. 1, PP.77-84, 2015.

[6] M. A. Al-Dabbas, W. M. Jassim and W.H. Kadhim, "Hydrochemical Evaluation Of The Main Drain And Hor Dalmaj, Central Iraq". Iraqi Geological Journal, Vol.39 – 49, No.1, 2016.

[7] M. M. AL-Mashhadani and H. K. Jasim "Mineralogy of Sand Dune Fields around Hor Al-Dalmaj Between Wasit and Al-Qadesiyah Governorates - Central Iraq،" *Iraqi Journal of Science,* vol. 63، no.8, pp. 3478-3488, 2018

[8] V. K. Sissakian, S. F. Fouad, "GEOLOGICAL MAP OF IRAQ, scale 1: 1000 000, 4th EDITION, 2012," *Iraqi Bulletin of Geology and Mining,* Vol.11, No.1, pp.9-16,2015.

[9] J. Domas," The geology of Karbala – kut Ali – Al- Gharbi Area, the Mesopotamian Plain Project(Central Sector),", internal report GEOSURV Library No. 1384. Baghdad, Iraq.1983.

[10] USGS science for a chaging world: Landsat 8 by Landsat Mission. Available : https://www.usgs.gov/landsat-missions/landsat-8

[11] L.Noam, *Fundamentals of Remote Sensing, Italy: IMO - International Maritime Academy,Trieste,* 1999.

[12] European Commission. NDWI: Normalised Difference WaterIndex.2011. Available : http://edo.jrc.ec.europa.eu/documents/factsheets/factsheet_ndwi.pdf

[13] S. K. Jain and at el., *Delineation of Flood-Prone Areas Using Remote Sensing Techniques, Water Resources Management* 19: 333–347. *Remote Sensing Application Division, National Institute of Hydrology, Bhawan Roorkee Jalvigyan 247 667, India*, 2005, P.341

[14] A. Dehni, M. Lounisb, *Remote Sensing Techniques for Salt Affected Soil Mapping Application to the Oran Region of Algeria, Algeria : a Spatial Techniques Center, Laboratory of SIRS, BP13, 31200, Arzew* ,2012, P. 188 – 198.

[15] Krokida MK, Kiranoudis CT, Maroulis ZB, Marinos-Kouris D. 2000. Drying related properties of apple. *Drying Technol* 18(6): 1251– 67.

[16] S. Hassan, "The Limestone reserve calculation for engineering purposes for the Formation of Nfayil (middle Miocene)/Najaf Sea Depression/Iraq," *Iraqi Journal of Science*, vol. ,no. pp.3536, 2022

[17] S. K. Duggal, *Building Materials. New age international publishers*, third revised edition, 2008.

[18] M. M. Al-Barakat, *Spatial variation of soil properties in Warka district and its impact on agricultural production, MA. Thesis, University of Thi-Qar*,2016, p.56 (Arabic).

[19] S. K. Al-Samaraei, Spatial Analysis of Soil and its Impact on The Uses of Agricultural Land in Terms of The Dijla Subdistric, MEh. Thesis, Tikrit University, 2010, P.76 (Arabic).