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USE OF REMOTE SENSING TECHNIQUES AND GEOGRAPHIC INFORMATION SYSTEMS TO IDENTIFY DEGRADED LAND IN DHI QAR REGION FROM IRAK

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Abstract

This study was conducted to monitor the manifestations of land degradation in the area located within the administrative boundaries of the governorates of Dhi Qar, Qadisiyah and Muthanna, which has a surface of 37,984 km and specified by the space coordinates of Path = 167 and 38 = Row with the help of remote sensing technology through the use of satellite visuals from Landsat 8 satellite with field observations. A map of soil units was prepared using the software Arc GIS. Soil samples were taken from each site for physical and chemical analysis. The results obtained from the research showed that when using the spectral index represented by the plant difference index (NDVI) its value ranged between (-0.68 to 0.78). It was found that the study area suffers from a lack of vegetation cover by 72%. As for the salinity index values, they ranged between 0.68 to -0.78. Therefore, the study area suffers from a chemical deterioration represented by the salinity of the soil, estimated at 61%. For arid lands, the index ranged between -399.4 to -28.30, and the total surface of decertified lands represented 45%. As for the land degradation index, its value ranged from 1.21 to 2.84 and the percentage of degraded lands was estimated at 75% of the total lands that were study.

***Key words**: degradation, remote sensing, geographic information systems, land degradation index.*

INTRODUCTION

Soil is one of the natural resources that plays an essential role in human life and therefore it is necessary to manage this resource efficiently to face the tremendous growth in population numbers.

The optimization of land resources is the main factor driving a significant increase in global food production.

For the purpose of exploiting the land resources, this process requires a use planning which is in turn a systematic assessment of the land and water potentials, alternative patterns of land use, and other physical, social and economic conditions.

Many researchers have endeavored to define the concept of soil degradation, the main cause of desertification (Al-Jawad, 1996).

The process of soil degradation is a result of wrong practices of agricultural lands that cause low productivity in the present and the future, which has a direct relationship to human life.

Degradation occurs all over the world, whether in developed or developing countries, the percentage of agricultural land degradation in dry areas has reached 70% of the countries of the world (Farahat, 2000; Al-Azzhami, 2001).

Farahat added that more than 110 countries were affected by desertification such as the United States of America, but it was more severe in South Africa, then North and South America and European countries, especially Portugal, Spain, Greece and Italy.

Desertification has many concepts, Dograme (1999) defines desertification as the process of changing different ecosystems, the main cause of which is the misuse of natural resources (soil, plants, water) by humans.

The Arab Organization for Agricultural Development in 2001 clarified the main factors causing desertification and land degradation.

The organization pointed two main factors, namely the human factor, which is the misuse of natural resources, rapid population growth, overgrazing, logging and wrong plowing for agricultural purposes and the second factor is represented by natural factors such as the impact of climatic fluctuations and recurrent droughts which lead to degradation of vegetation cover, soil degradation, sand dune movement, and land degradation and waterlogging. Therefore, the sustainability of these lands is a major goal of the sustainable agricultural development that aim to achieve self-sufficiency which requires the use of modern and successful management methods that help increase productivity while preserving lands from degradation processes (Ziboon et al., 2015).

MATERIALS AND METHODS

The studied area is bordered from the north-west by Al-Muthanna Governorate, from the south-west by Dhi Qar Governorate, from the south-east by Al-Qadisiyah Governorate, and from the south-west by Basrah Governorate, with a surface of 37983.892 km and is located between two longitudes. Figure 1 shows the studied area and some of it's main features.

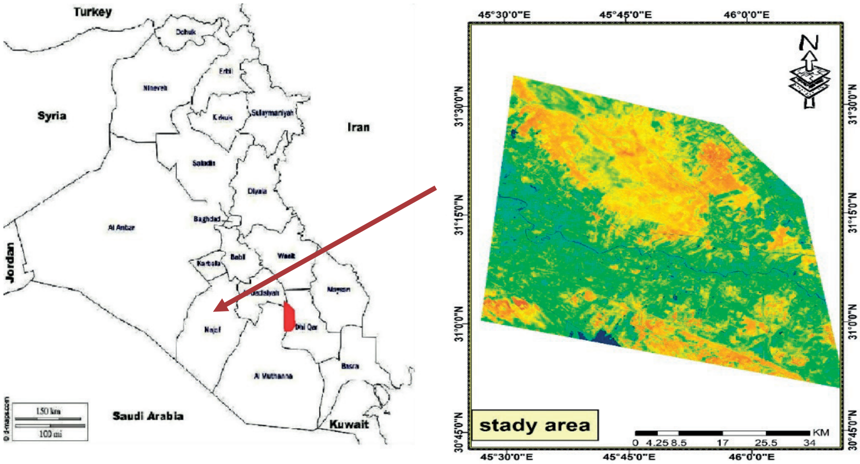

Figure 1. The Map of the study area

Physical and chemical analyzes

The soil material samples taken from the horizons of the Bedoon soil were analyzed as followed: Quantify the size distribution of soil particles according to the absorbent method described by Day (1965). The bulk density was estimated by the Clod method according to Black (1965). Organic matter according to Walkely and Black method. EC electrical conductivity, Calcium sulfate, calcium carbonate according to the method mentioned in Handbook, USDA.

Visuals and analyzing the satellite data

The satellite images provide a lot of information about spatial space, especially the multi-spectral visuals (MULTISPECTRAL IMAGERY), the information includs data about of the number of beams, obtained after the processing satellite visuals. One scene that covered the study area included the sensor data ETM obtained by the American satellite Landsat 8, while the other visual data for the sensor OLI for the year 2020 was obtained from the USGS site as a punch in the plates (-) and the existing ones. Maps (1 & 2) were used to classify the land cover of the study area, to determine the most important aspects of degradation, to derive vegetation cover and sites of its spread and to determine its areas.

Digital indexes

Digital index represents one of the most important improvements applied to satellite visuals, as it is the best choice for detecting differences that cannot be observed in visuals applied with basic color beams. The most important evidences are:

The Normalized Difference Vegetation Index (NDVI), as indicated by the formula defined by (Rouse et al., 1974).

$$NDVI = ((NIR-Red))/((NIR+Red))$$

$$NDVI = ((B5-B4))/((B5+B4))$$

As: NIR: Near infrared, B: Band

Salinity Index (SI):

As in the formula indicated by (Khan et al., 2005).

Salinity Index = (B3 * B4)\B2

Barren soil Index (BSI):
As in the formula indicated by (Jamalabad and Abkar, 2004).
BSI = ((SWIR+Red)-(NIR-Blue))/((SWIR+ Red)+(NIR+ Blue)) + 1
((B6+B4)-(B5+B2))/((B6+B4) + (B5+B2)) + 1 = BSI
Whereas: NIR: Near infrared, B: Band

Land Degradation Index (LDI)
This index was used in 2010 by Zhao and Meng according to the following formula:
LDI = ((255-(B2+B3))\(255+(B2+ B3))
Land degradation index cam be determinated by using Inverse Distance Way IDY for obtaining the soil specification maps in Information Systems Environment.

RESULTS AND DISCUSSIONS

Physical attributes

The laboratory results and field observations showed that there are important differences in soil properties between the studied sites and within relatively short distances, despite the fact that the parent material for all soils of these sites is developed from alluvial-Lacustine in addition to some wind sediments (Al-Aqidi, 1986). There is a stratification of different textures. It turns out that the soils representing the two paths fall under the group Typic Torrifluvents which are characterized by the following. It does not have a horizon with a thickness of more than 15 cm during the first meter of the soil surface, containing more than 20% solid knots (durinodes) in a ground that is not fragile and has a solid cohesion when it is wet. It does not possess the following characteristics: Cracks for periods and for most of the years within 125 cm of the soil surface, which is 5 cm or more in width and 30 cm or more in depth. More than 30% clay from horizons whose total thickness is more than 50 cm within the first meter. The results of the analysis of the particle size distribution in Table 1 showed that there are differences in the textures of the horizons of the sites, as the boundaries between them are clearly distinguished, and the degree of clarity is proportional to the percentage of the soil content of clay and silt. The surface tissue was 0-30 cm for the eight headquarters loam at five sites and silt loam at site A2, while the tissue for sites A4 and A8 and near the river was sandy loam. And, most likely, this difference in the percentage of time for the eight sites is due to the different intensity of the erosion processes represented by abrasion and the ablation that these sites were subjected to due to differences in the nature of land use and the quality and density of their vegetation cover, which in turn produced disparities in the depths of the different surface horizons where we find a continuous agricultural vegetation. The results of Kubota et al. (2005) showed that there was a significant decrease in the thickness of the surface layer with increasing soil roughness. He attributed these changes in the thickness of the horizon to the different effect of soil erosion with different tissues. In contrast, the depths of the subsurface horizons were not affected due to the limited erosion work at the surface. On the other hand, the textures of the subsurface horizons ranged from sandy loam to clay, this distinction in tissues may be due to the location of each mud from the supposed source of processing (the Euphrates River), which is consistent with West et al. (1980) results that confirmed the increase of clay in the soil content. The fine and medium silt increased in the logarithm of the distance from the source of the supply, while the proportion of coarse fractions decreased in the soils of the American floodplain. The average bulk density for all depths was 1.45 µg. M^{-3}, as the highest value for this characteristic was recorded in the surface layer of the site A4 and the depth of 60-90 cm for the site A3, at 1.58 micrograms. M^{-3}, while it decreased to its lowest level at 30-60 cm depth at the A4 site. The soil bulk density rates of the sites can be assessed as falling within the natural levels that do not impede or prevent the growth of plant roots, according to SSI Report, 2004. The bulk density values reflect the nature of the size distribution of site soil particles. Kubota et al. (2005) stated that soils with a low content of clay and a high proportion of fine sand and silt tend to be compacted due to the expansion and contraction factors that accompany the conditions of wetting and drying.

The differences can also be attributed to the effect of the moisture content on these soils. This is confirmed by Alexander (1980) regarding the correlation of the bulk density value with the water content of sedimentary soils where the largest value of bulk density appears with the water content below the permanent wilting point -15 bar. As the bulk density is highly dependent on soil conditions, changes in soil volume resulting from water content will change the bulk density values that are a function of different soil properties rather than a single value, according to Soil Survey Investigations Report, 2004. These differences can also be explained by the fact that the bulk density is related to the characteristics of the natural soil, which include tissue, organic matter and soil construction. The bulk density is variable throughout the year due to many processes such as freezing, thawing, soil disintegration by drought, the effect of agriculture, animal activities, plant roots and tillage processes. The total porosity of the soil which expresses the spaces occupied by water and air, as well as the degree of soil compaction, influence the general rates of depths 0-30 (44.21%), 30-60 (46.02%), 60-90 (45.25%). Dorner (2010) confirmed that the porosity of the soil acts as a direct measure of the bulk density and explained the relationship between the moisture content to the porosity which explains the decrease of the porosity in soil that can be explain my the decrease of the surface area necessary for the movement of water in soil.

Table 1. The physical characteristics of the study soil materials

Point	Clay, %	Silt, %	Sand, %	Texture	Bulk density, g/cm^3	Density, g/cm^3
A1	24.15	34.88	40.97	Loamy	1.39	2.63
A2	8.12	51.45	40.43	Silty Loamy	1.44	2.68
A3	8.51	47.24	44.25	Loamy	1.36	2.59
A4	7.88	30.07	62.05	Sandy Loamy	1.58	2.6
A5	25.56	33.77	40.67	Loamy	1.35	2.61
A6	13.41	45.22	41.37	Loamy	1.49	2.6
A7	7.89	44.67	47.44	Loamy	1.39	2.63
A8	7.41	31.46	61.13	Sandy Loamy	1.49	2.65

Chemical properties

The results showed that the general average of saturated aqueous conductivity values amounted to 0.246 m day^{-1}, within a range between 0.433 m day^{-1} at the 0-30 cm depth for site A4 and decreased to reach its lowest levels by 0.056 m day^{-1} at depth 60-90 cm for site A1. The same method increased the general rate of this characteristic to the three depths for A4 location that recorded an average of 0.359 m day^{-1}, while it decreased for the A1 site to 0.132 m day^{-1}. These values indicate a high water loss rate for site A4 of 131 meters per year, compared to 48 meters per year for A1 site, which leads to an increase in the speed of water penetration into the depths of the soil and a decrease in the storage capacity of those sites. These differences in the Ksat values between the three sites may be mainly due to the soil texture, as sandy soils with large pores have a higher water conductivity than soft tissue soils that have small pores and higher porosity. As confirmed by Cornelis et al. (2001), the tests showed that the correlation relationship between the Hydrophilic properties and particle sizes are very good for soils with high sand content, but they are not as accurate for soils with high clay. Zeleke et al. (2005) explained the reason for the great influence of mud on the values of water conductivity in comparison with the soil content of sand and silt due to the swelling and contraction characteristic, which determine the number and size of the flow paths. The saturated water conductivity of the sites' soils can be classified on the basis of their general rates into a fast class of highly desertified soils and a medium velocity classification for both medium and light desertified soils according to an assessment (USDA-NRCS, 2002). The results showed that the soil of site A6 recorded the highest pH for the three depths, reaching 8.48, while site A8 recorded the lowest value for this characteristic with an average of 7.81. Despite the differences in the chemical and physical properties of the soil of the eight sites, the presence of high levels of calcium carbonate led to the regulation of the values of soil interaction degree in the different sites ranging from mild to moderate alkaline according to the Soil

Survey Division Staff (1993). This indicates the high regulatory capacity of these soils due to their high calcium carbonate content, as confirmed by Doner and Lynn, 1989.

Table 2. Chemical properties of the study soil materials

Point	Capillary rise, mm/day	Field capacity, %	Williting point, %	Ksat, mm/day	Total porosity, %	ECe, Ds m-1	pH	$CACO_3$, G kg-1
A1	2.576	35.34	16.758	0.2475	47.148	78.8	7.72	243
A2	0.784	31.752	12.348	0.181	46.269	26.2	7.88	218
A3	2.208	31.62	14.994	0.285	47.490	12.15	8.12	275
A4	0.735	24.304	9.3	0.4332	39.231	9.51	7.34	229
A5	2.806	37.82	17.934	0.255	48.276	79.6	7.56	208
A6	2.392	32.86	15.582	0.265	42.692	34.1	8.16	217
A7	2.139	30.69	14.553	0.305	47.148	12.65	7.17	206
A8	0.651	20.181	11.2	0.3876	43.774	10.14	7.44	233

Normalized Difference Vegetation Index (NDVI)

The results indicated that the NDVI values are situated between 0.25 to -0.25. The reason is that there is a clear variation in the distribution of the type of land cover prevailing in the studied area and in a disparate manner distributed between agricultural lands, natural plants and plants growing in the areas near the river (Shallal et al., 2007).

Table 3. Ranges of land degradation and its relationship to the NDVI

NDVI Range	Area, km	Veg. Cover ratio	Land Deg.
Non Veg	29114.45	77%	Hight Deg.
Moderate veg	6850.026	18%	Moderate Deg.
Very veg	1703.619	4%	Non Deg.

The absence of vegetation cover an occupied area estimated at 29114.45 km from the total area of the study, with a 77% due to the presence of arid lands affected by salinity and desertification. It covers an area of about 6850.026 km (14%) due to the high rate of salinity and the impact of difficult climatic conditions, the lack of rain and high temperatures that affected the growth of plants, which led to the reduction of vegetation cover of the area. As a result, most of the lands that comprise the studied area are not for agricultural use. As the vegetation covered area, it is estimated at 1703.619 km (4%), and the reason is due to the fact that these lands are located in the river banks or it is an agricultural use of crops or economic farms (Table 3, Figure 2) (Ibrahim, 2008).

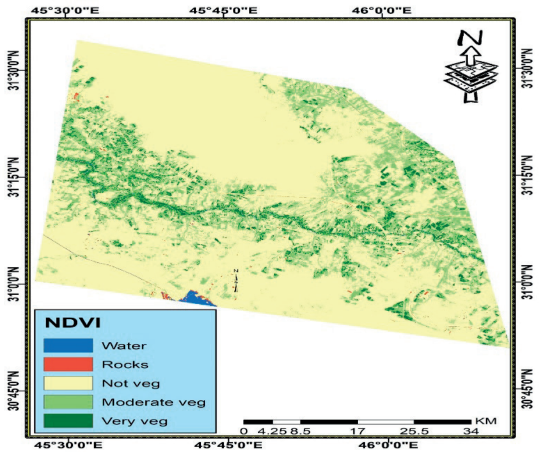

Figure 2. A map showing the Natural Vegetation Index (NDVI)

Salinity Index (NDSI)

The results showed that the salinity index values ranged from -0.45 to - 0.30. The results shown in Table 4 and Figure 3 indicate that there are 5 categories that represent the salinity index values in the study area (NDSI).

Table 4. Ranges of the salinity index values

NDSI range	Area of salinity, ha	Salinity cover ratio
Not salinity	1561.86	4%
Low salinity	4840.614	13%
High salinity	31239.94	82%
Very high salinity	203.121	1%
Water	138.366	0%

The salinity category occupied an area estimated at about 1561.86 km of the total area (4%) as it is cultivated land or located on the rivers banks and this is considered natural drainage. The low salinity category occupied an area of 4840.614 km (13%). The salinity reflects the poor quality and scarcity of water, not the low percentage of cultivated land. The salinity is due to the fluctuation of groundwater levels and the high salt content in them. It has effectively contributed to the emergence of soil salinization processes, which negatively affected the growth and development of vegetation cover and the deterioration of the physical and chemical properties of the soil, while the highly saline and saline variety occupied an area of 31239.94 (82%) and 203.121 km (1%), respectively. This indicates the presence of desertified soil (Al-Zubaidi et al., 2003).

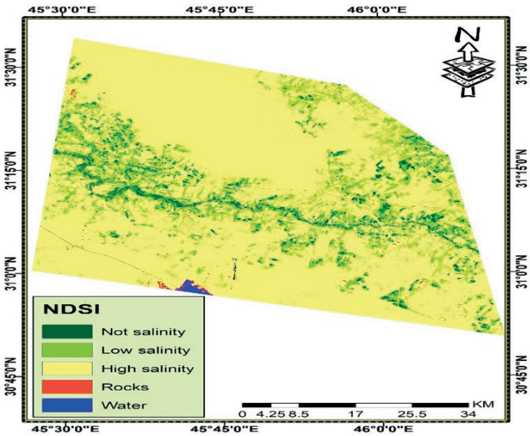

Figure 3. Map that shows the salinity index

Barren Soils Index BSI

The values of the arid land index ranged between (0.25-0.1), possibly due to the high level of salinity and the impact of difficult climatic conditions, including the lack of rain and high temperatures, which affected the growth of plants, which led to a decrease in the area of vegetation cover and land degradation (Mahdi, 2019).

Table 5. Ranges of degradation to the study land according to the Barren Soils Index (BSI)

Range BSI	Area of class	Ratio	Land degradation
<zero	4187.772	11%	Non-deg.
0.0-.-0.1	9067.374	24%	Light-Deg.
0.1-0.25	8050.023	21%	Moderate Deg.
0.25-0.5	9267.291	24%	High Deg.
>0.5	7411.437	20%	Very high Deg.

The non-desertified type occupied an area estimated at about 4187.772 km (11%) of the total studied area which is located in the rivers slopes and is exploited in agriculture, while the land with little desertification occupied large surfaces within the study area 9067.374 km representing 24%. As for the medium type in desertification, it occupied 21% of the area. This may be due to the fluctuation of vegetation cover in these lands, the low percentage of cultivated lands and the existence of dry water bodies (dry swamps). Desertification severe occupies an area of 9267.291 (24%) and moderate desertification total sum of 7411.437 km (20%), wich is determinated by the high percentage of salts and the absence of vegetation cover (Table 5, figure 4).

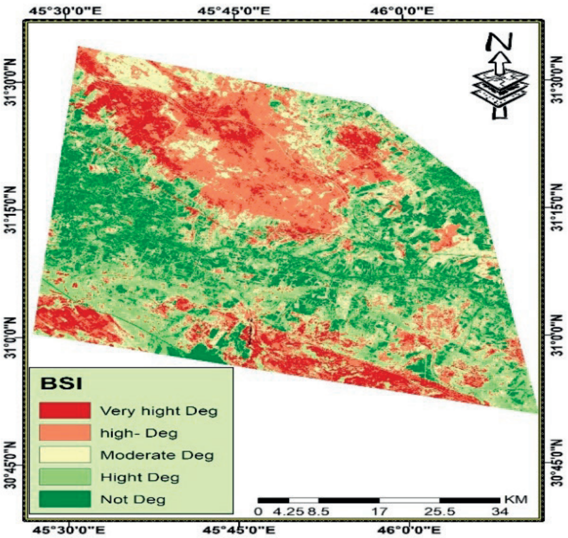

Figure 4. Map that shows the barren soils

Land Degradation Index (LDI)

The results showed that the values of the Land Degradation Index ranged in Figure 5 between 1.2-2.8. This is due to the fact that most of the lands of the study were affected by the high temperatures and the increase in the percentage of salts in the accompanying soil. The transfer of groundwater with capillary property to the surface of the soil and its evaporation, caused the accumulation of salts that formed a layer of salt marsh soil, beeing considered one of the main causes of its deterioration (Al-Rawi and Al-Jorsi, 2014).

Table 6. Shows the ranges of lands degradation according to LDI at the study area

Type of Deg.	Ratio	Area KM
Water	13%	5102
Non-degraded	24%	9301.54
Moderate degradation	21%	8262
Severity degraded	30%	11607
Very sever degradation	12%	4712

The non-degraded variety reached an area estimated at 5102 km (13%) of the total area and the reason for this is the presence of these sites in rivers. As for the lands of light degradation, they measured a surface of 9301.54 km (24%), which is occupied by agricultural land with crops and economic farms. As for the medium deterioration, it summed 8262 km (22%), the main reason beeing the influence of the semi-arid climate, the lack of rainfall and the mismanagement of irrigation, causing the degradation of these lands, in addition to the conditions prevailing in the region (Muhammad, 2017). The type of severe deterioration and very severe deterioration reached the area estimated at about 11607 (30%) and 4712 km (12%) (Table 6). The reason for the existance of deterioration may be attributed to the vast areas devoid of vegetation as a result of the influence of the prevailing climate. Conditions in the study area varies from high temperatures, lack of rainfall, high salinity in the soil, as well as poor management irrigation and drainage operations that affect the growth of plants.

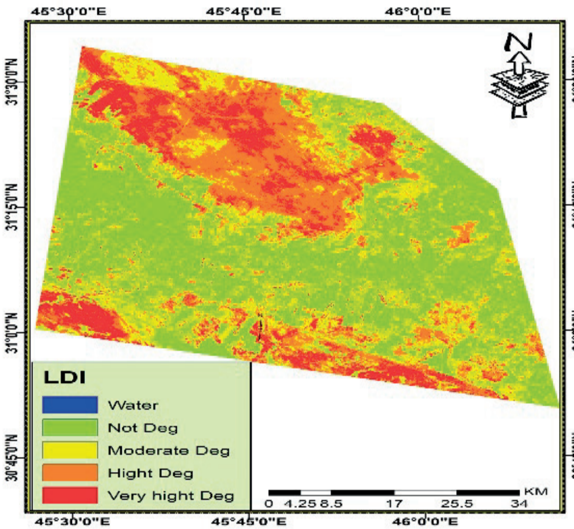

Figure 5. Map of land Degradation index (LDI)

CONCLUSIONS

The study demonstrated the ability of remote sensing and geographic information systems to survey, monitor, identify, analyze and classify aspects of land degradation in the study area and detect spatial and temporal changes that may occur.

Landsat satellite visuals are used for regional studies that are conducted over a relatively large area due to the relatively low spatial resolution, which ranges between 6-15 meters, the accuracy of its results increases through spectral, spatial improvements and matching operations with reference information, whether it is maps or pictures.

The digital indicators (INDEX) contributed to highlighting the land features very effectively in clarifying the spatial distribution picture and the quantitative and qualitative assessment of the types of land degradation manifestations in the study area, such as the visuals resulting from the natural difference index of vegetation cover, Salinity Guide, Arid Soil, Soil Degradation Guide.

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