Assessment of soil degradation in northern Basrah governorate using geospatial techniques and spectral Indices

(Some location characteristics)

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Abstract

This study was conducted to evaluate the degradation of soils in northern Basra Governorate using remote sensing techniques, geographic information systems and some spectral indicators. The soils of the region are characterized by being of calcareous sedimentary origin, belonging to the Entisols rank. The study area is located north of Basra Governorate, southern Iraq, within the administrative borders of Al-Qurna District, extending south to Al-Deir District. It is bordered to the east by the Shatt Al-Arab River and lies between longitudes 47°22'10" - 47°39'8" east and latitudes 30°44'41" - 31°3'49" north, with an area of 429.681 km^2. The results of the physical analysis showed that there was a difference in the distribution pattern of soil particles (sand, silt and clay) within a single soil site or between different soil sites. This is due to the variation in the sedimentary environment of the studied sites. It was noted that the content of clay and silt was high in general depths of the sites compared to the small amount of sand in some sites. The dominance of silt particles was in most sites, ranging between 206.90 - 703.20 g kg^{-1}, then clay, ranging between 202.80 - 659.20 g kg^{-1}, while sand ranged between 16.40 - 425.30 g kg^{-1}. The results of the chemical analysis showed that the organic matter content of the sites ranged between 2.1 - 16.6 g kg^{-1}. The highest values appeared in the surface depths, especially at site 6, and the soil salinity ranged between non-saline soils and highly saline soils, ranging from 3.33 to 90.82 dsm^{-1}. The lowest salinity appeared at site 4, reaching 3.33 dsm^{-1}, which is affiliated with the Kutuf Al-Anhar section located east of Shatt Al-Arab.

Key words : Remote sensing , Soil degradation ,Geographic information system .

i. Introduction

Cases of land desertification and soil degradation have taken different forms, including physical degradation represented by wind and water erosion or dust storms, and chemical degradation, which primarily includes soil salinization, in addition to biological soil degradation resulting from physical and chemical soil degradation, degradation of vegetation cover, climate change, or degradation due to various types of pollution. To study the state of land degradation and its suitability for agricultural production according to a comprehensive scientific vision, it is necessary to follow methods based on scientific foundations with the aim of optimal use of land and water resources . he process of collecting information and data related to these resources is one of the methods followed in a number of international studies and systems that aim to enhance decisions related to agricultural planning and development in any country. This process requires the integration of information and data from several sources and the use of efficient and effective means and tools in building a solid structure for databases that are ready and available to stakeholders, including geographic information systems and remote sensing. Other causes of degradation are erosion processes, which often result from poor management of irrigation operations, removal of vegetation cover, and low soil organic matter content that stabilizes particles (Vanderkniff, 2000). Soil degradation negatively disrupts the ecosystem by decreasing the soil's biological production capacity. The area of degraded soils in the world has reached 46 million km2, of which 11 million km2 are in the Arab world, or about 24%, according to international statistics, and large areas have become degraded or threatened with deterioration (Habib and Al-Shaihabi (2012). It is worth noting that Iraq loses 5% of its arable land annually, and the World Bank estimates that what is lost annually worldwide reaches 2%, and the difference between the two percentages indicates the extent of the deficiency in maintenance, preservation, and conservation of agricultural land in Iraq (Rasham, 2012). The study aimed to evaluate the state of soil degradation using satellite and location data using geographic information systems and remote sensing.

i. Materials and methods

1 – Study Area

The study area was selected as part of the alluvial plain containing the sediments of the Shatt al-Arab River. The soils of this area are characterized by their calcareous sedimentary origin, belonging to the Entisols class. The study area is located north of Basra Governorate, southern Iraq, within the administrative borders of Al-Qurna District, extending south to Al-Dayr District. It is bordered to the east by the Shatt al-Arab River and lies between longitudes 47°22'10" - 47°39'8" east and latitudes 30°44'41" - 31°3'49" north, with an area of 429.681 km^2, as shown in (Figure 2) . 28 sites were identified for taking soil samples and projecting them onto the map using GPS and the UTM system .

2 – Field work and determination of sample locations

The study area was visited in the field several times during the period from 9/1/2023 to 11/1/2023 with the aim of determining the sampling and survey sites for the study area as a preliminary step to observe the nature of the area. Field observations focused on determining the type and density of natural vegetation, as well as the salinity status and the nature of agricultural exploitation within the boundaries of the study area. It was noted that most of the areas are not agriculturally exploited and are abandoned lands (fallow) and residential areas, with the exception of some lands along both sides of the Shatt al-Arab River, which were exploited by palm trees and some small areas invested in wheat and barley cultivation. Based on this, the sampling sites were determined, which amounted to 28 sites based on the results of the directed and undirected classification (Figures 3 and 4). The geographical coordinates of the study sites were determined using a global positioning device (GPS) and projected onto the map, and soil samples were taken from each site for the purpose of conducting laboratory analyses of some physical and chemical properties. The study area was divided into two sections :

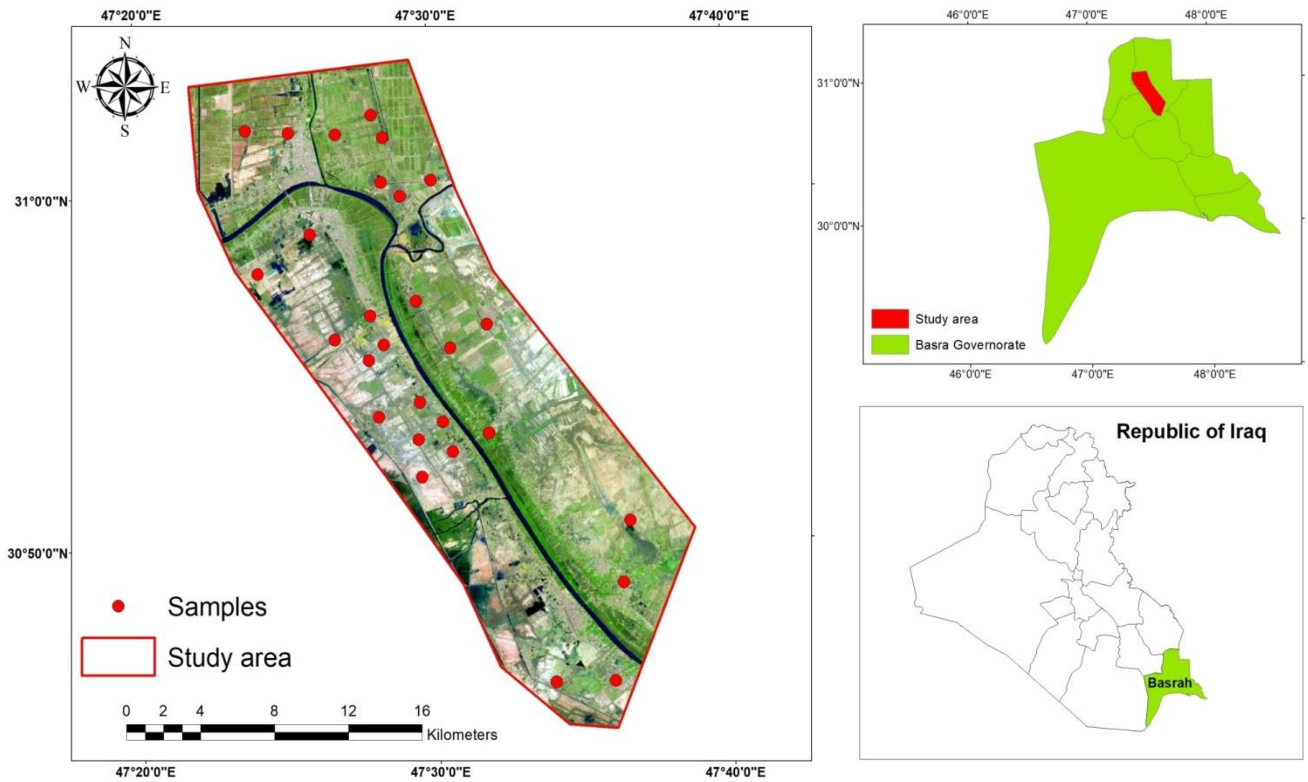

Figure 1. study area

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1 – The first section: This section represents the river shoulders unit located east of the Shatt al-Arab River and extending from the Qurna District (Mizra'a) in the north to the Dayr District in the south, represented by sites starting from 1 to 12.

2 – The second section: This section represents the river shoulders unit located west of the Shatt al-Arab River and extending from the Qurna District (west of the Tigris River) in the north to the Dayr District in the south, represented by sites starting from 13 to 28.

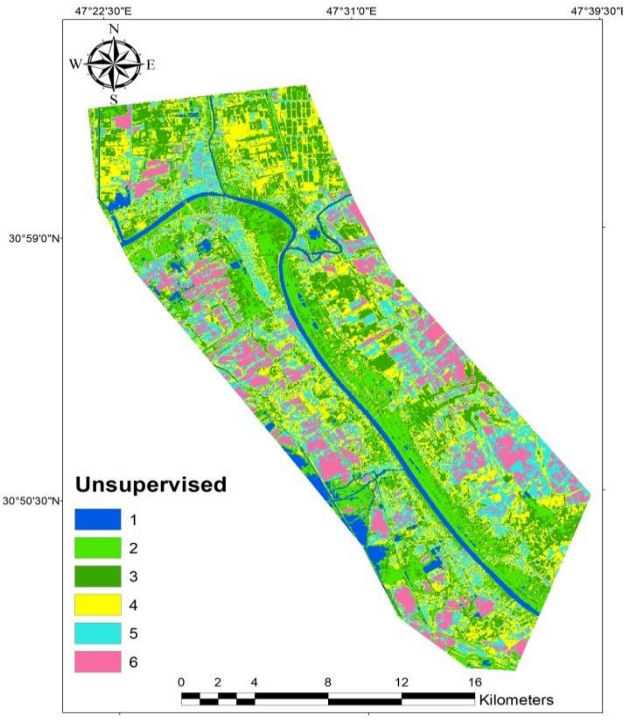

Figure 3 . Unsupervised Classification

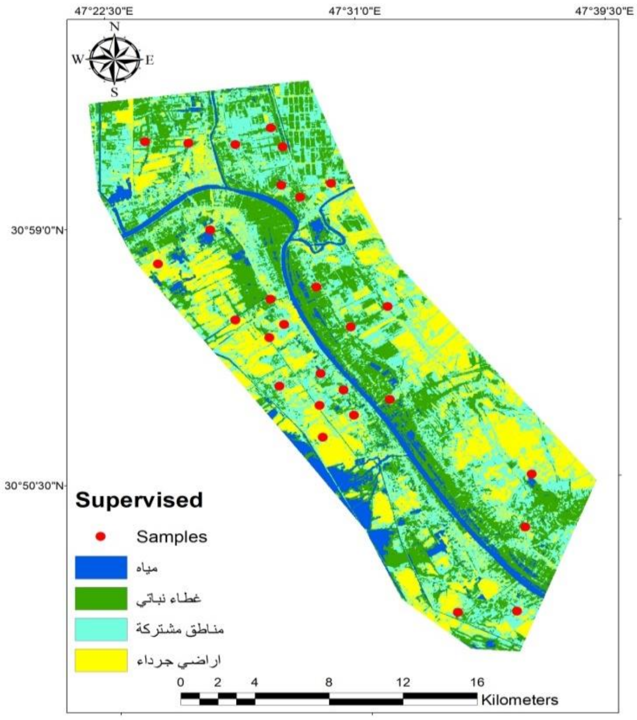

Figure 4 . Supervised Classification

3 – Satellite image

The satellite image was downloaded from the Internet and the official website of the USGS for path 166 and row 39 of the LandSat 8 OLI satellite covering the study area. The compressed file of the satellite image contained eight spectral bands with spatial discrimination capabilities (30 m x 30 m) for each of the first, second, third, fourth, fifth and seventh spectral bands and (100 m x 100 m) for the tenth and first thermal bands, while it was (15 m x 15 m) for the eighth spectral band .

4 – Band Combinations

After correcting the OLI spectral bands, they were merged using ArcMap10.4.1 to obtain a single image of spectral bands 2, 4 and 7 in order to prepare them for digital processing and distinguishing land features and landmarks, as well as using them in the Supervised and unsupervised classification process.

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Thi-Qar Journal of agricultural research
ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 1 (2024) PP 434-439
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Locations				

5 – Laboratory work

Soil samples were taken from each site and at three depths and transported to the laboratory for physical and chemical analyses. The samples were allowed to air dry, ground, sieved with a 2 mm sieve and stored in nylon bags. Soil texture was estimated according to the method described in Black (1965), while organic matter was estimated according to Jackson (1958), and electrical conductivity was estimated according to the methods described in Page (1982) .

Results and discussion

1 – Size distribution of soil particles

The results in Table 1 and Figures 5, 6 and 7 show the volumetric distribution of soil particles for the study area sites. It is generally noted that there is a difference in the distribution pattern of soil particles (sand, silt and clay) within one soil site or between different soil sites. This is due to the variation in the sedimentary environment of the studied sites. It was noted that the clay and silt content was high in all sites compared to the small amount of sand in some sites. Silt particles dominated most sites, ranging between 206.90 - 703.20 g kg^{-1}, then clay, ranging between 202.80 - 659.20 g kg^{-1}, while sand ranged between 16.40 - 425.30 g kg^{-1}. Sites 3, 6, 8, 11, 12, 13, 17, 21 and 26 were characterized by a medium texture, with sand content ranging between 139.38 - 404.21, silt 410.30 - 703.20 and clay 210.20 - 291.90 g kg^{-1}, respectively. As for sites 4, 5, 7, 9, 10, 14, 15, 16, 18, 19, 22, 24, 25 and 28, the texture was medium fine, as the sand content ranged between 51.10 - 354.80, silt 264.67 - 538.01 and clay 322.61 - 353.73 g kg^{-1} respectively, while the texture of sites 1, 2, 20, 23 and 27 was fine, as the sand content ranged between 24.40 - 121.70, silt 315.70 - 384.60 and clay 537.40 - 649.70 g. kg^{-1}. To clarify the effect of spatial variation in the values of soil particles content, the results showed in the first section located east of the Shatt al-Arab River and represented by sites 1_12. The results showed that the soil textures were medium and medium-fine, with the exception of sites 1, 2 and 4, which were fine. The dominance of silt particles in this section ranged between 206.90 - 698.90 g kg^{-1}, then clay, which ranged between 80 - 659.20 g kg^{-1}, then sand, which ranged between 20.00 - 425.30 g kg^{-1}. In the second section, located west of Shatt al-Arab, represented by sites 13-28, the results showed that the soil textures were of medium fineness and that the clay and silt content was high in all sites compared to the small amount of sand. The dominance of silt particles in this section was between 208.00 - 703.20 g kg^{-1}, then clay, which ranged between 210.20 - 658.00 g kg^{-1}, then sand, which ranged between 16.40 - 416.10 g kg^{-1}.

Table 1. Some site characteristics of 30 cm depth in the sites study

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 1 (2024) PP 434-439
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

No.	Soil Texture gkg^{-1}			class	Om gkg^{-1}	Ec dsm^{-1}
	clay	silt	sand			
1	538.4	384.6	77	C	8.7	26.5
2	540.5	337.8	121.7	C	3.7	7.66
3	210.2	435	354.8	L	11.2	3.33
4	562.7	263.8	173.5	c	6.1	5.65
5	337.7	453.8	208.5	SiCL	7.8	10.34
6	248.4	646	105.6	SiL	3.8	14.04
7	659.2	229	111.8	C	4.5	76.2
8	291.9	657	51.1	SiCL	15.1	42.2
9	306.2	672.8	21	SiCL	4	17.95
10	328.5	471.2	200.3	SiCL	6.7	43.9
11	284.1	639.4	76.5	SiL	2.1	12.62
12	291.6	656.3	52.1	SiCL	4.6	5.04
13	234.3	703.2	62.5	SiL	16.6	25.9
14	332.3	465.1	202.6	SiCL	4.7	22.81
15	387.4	290.5	322.1	CL	11.9	90.82
16	598.6	240.8	160.6	SiC	4.4	32.4
17	235.2	410.3	354.5	L	8.4	66.2
18	326	591.5	82.5	SiCL	6.5	37.5
19	403.4	576.4	20.2	SiC	6.4	21.52
20	615.8	359.8	24.4	C	4.2	39.1
21	248.4	646	105.6	SiL	4.2	41.6
22	658	229	113	C	8.1	40.72
23	537.4	384	78.6	C	2.8	29.31
24	486.8	408.2	105	SiC	5.9	29.6
25	553.2	308.2	138.6	C	12.5	40.92

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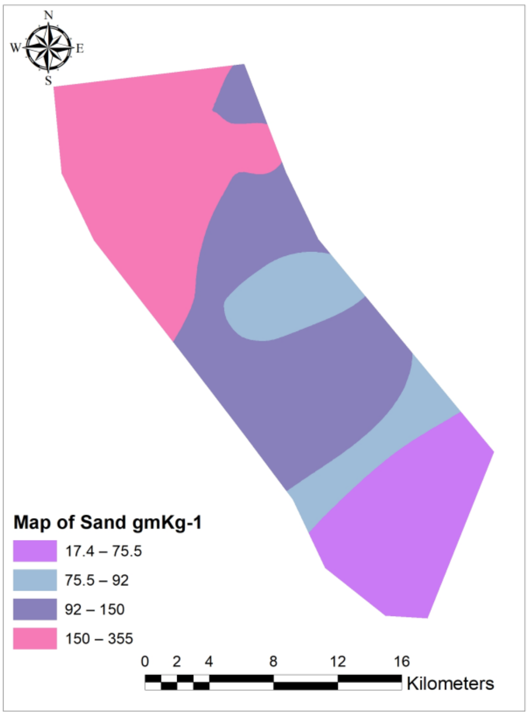
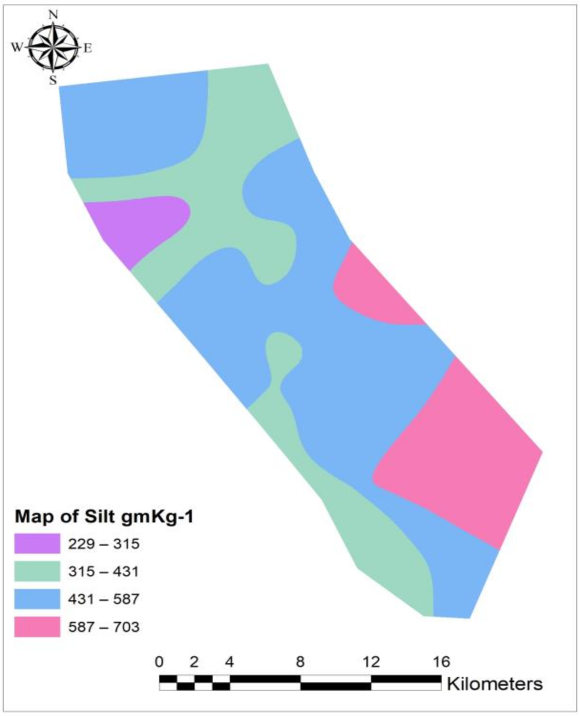
26	240.8	698.9	60.3	SiL	4.5	58.43
27	649.7	315.7	34.6	C	8.2	57.82
28	318.4	573.4	108.2	SiC	3.1	60.42





distribution of sand
Figure 6.
distribution of silt

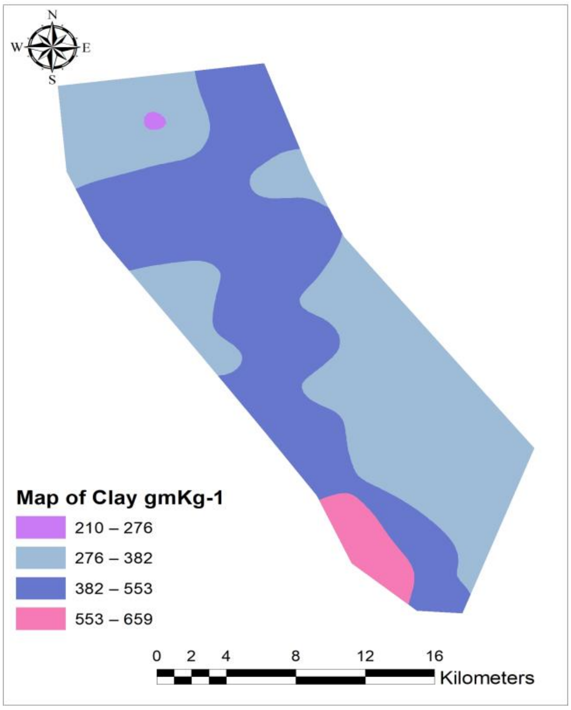


Figure 5. Spatial

Spatial

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Figure 7. Spatial distribution of clay

Due to the presence of more than one source of sedimentation in the study area, this led to a difference in the content of soil particles (sand - silt - clay), as there are two sources of sedimentation in the study area, one from Iraqi lands represented by Shatt al-Arab and the other source coming from Iranian lands represented by Karkheh River. When flooding, each river transports erodible materials from its basin and then continues to transport them to the topographically low areas, as the ability of Karkheh River to transport a coarser river load than Shatt al-Arab River due to the difference in the speed of the rivers at the borders of Basra and Khuzestan provinces (Vanessa and Cecile, 2007) and (Sadkhan, 2009). The intensity of the speed of the transporter decreases the further we move away from the flood source, so the coarse particles are deposited close to the flood source and the medium particles are a little further away, while the clay part continues to move until the end of the water movement and may collect in depressions (Al-Aqidi, 1986). As for the effect of the pedogenic factor on the soil properties and development, the above results show that there is a weakness in the activity of pedogenic processes due to the nature of the environmental conditions prevailing in the soil sector due to the low rates of precipitation, in addition to the short period of time for the deposition of these soils due to the prevalence of drought and the lack of movement of colloids throughout the soil sector. By studying the volume distribution of soil particles, it can be concluded that the texture of the soils in the study area ranged from fine to medium texture with some medium textures .

2 – Electrical conductivity

The results in Table 1 and Figure 8 show the electrical conductivity values of the study area sites. The soil sites showed a variation in salinity content between the study area sites, as the Survey staff (2003) Soil classification was adopted regarding the soil salt content. It is noted that the electrical conductivity values of the study area sites fall between non-saline soils to highly saline soils and ranged between 3.33 - 90.82 dSm^{-1}. The lowest electrical conductivity appeared at site 4 with a value of 3.33 dSm^{-1} belonging to the Kutuf Al-Anir section located east of Shatt Al-Arab, while the highest electrical conductivity appeared at site 15 with a value of 90.82 dSm^{-1} belonging to the Kutuf Al-Anir section located west of Shatt Al-Arab, as it is clear that there is an effect of spatial variation and the

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type and degree of agricultural investment on the electrical conductivity values, while the electrical conductivity values for sites 2, 3, 4, 5, 6, 11 and 12 were between low-salinity to medium-salinity soils, as they ranged between 3.33 - 14.04 dSm^{-1}. The reason for the decrease in their values is that they are cultivated soils with continuous vegetation cover or previously cultivated, and also the irrigation and plowing process

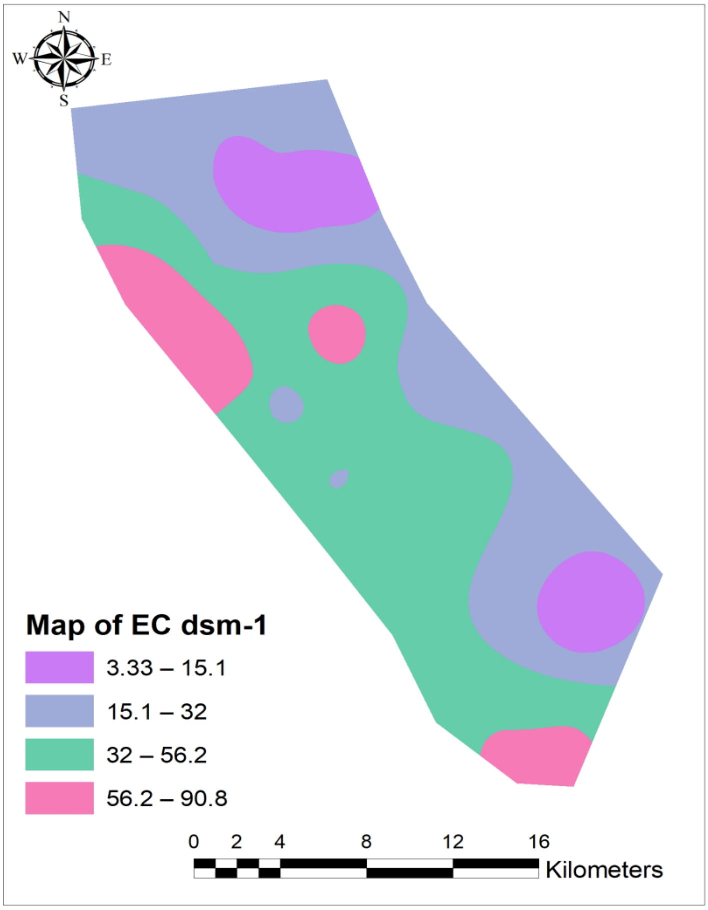

Figure 8. Spatial distribution of EC

plays a role in washing salts downwards and limiting the activity of the capillary property that encourages the salinization process (Al-Atab, 2008). The rest of the sites did not show a specific pattern in their salt content according to the variation of their spatial location. The electrical conductivity results of sites 1, 8, 9, 13, 14, 16, 23 and 24 showed that they are located between medium to high salinity soils with a range of 8.13 - 32.40 dSm^{-1}. This is due to the occurrence of a similar overlap in the result of the effect of the factors causing salinization represented by the level of critical groundwater, the type of agricultural investment and the texture of the soil sector. As for the rest of the sites, they are located within the highly salinity soils, ranging between 22.62 - 90.82 dSm^{-1}. The reason for the high salinity in these sites is their location in uncultivated fallow areas and the absence of vegetation cover or its very low level within these selected sites. The variation in salinity content from one site to another showed most of them an increase in the surface depth and decreases with depth. This is due to the effect of the climate factors in the study area, as the evaporation values were high

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from the soil surface despite the distance of the groundwater from the soil surface in most sites, and the groundwater was close to the soil surface in the previous seasons and in turn transported the salts to collect at the soil surface with the approach of the groundwater level to the soil surface due to the activity of the capillary property and during the wet and dry climate cycles and flood seasons (Al-Ani et al., 2000) .

3 – Organic matter

The results in Table 1 and Figure 9 show the distribution of soil organic matter content for the study area sites. In general, there is a decrease in the organic content rate in the study area, as the values ranged between 2.1 - 16.6 g kg^{-1}. This is due to the lack of vegetation cover and agricultural investment, and the decomposition of organic matter under the dry conditions that characterize the climate of the study area and the nature of the root systems (Al-Rawi, 2003). As for the effect of spatial variation in the organic content of the study area sites, sites 3, 8, 13, 15 and 25 showed the highest organic content of 11.2, 15.1, 16.6, 11.9 and 12.5 g kg^{-1}, respectively, due to their location within areas with vegetation cover for continuous investment in sites close to the Shatt al-Arab and invested in the cultivation of palm trees and economic crops, or their location within the dried marshlands, which led to an increase in their organic matter content. The rest of the sites showed a clear decrease in their organic content with a value not exceeding 5.80 g kg^{-1} due to the lack of vegetation cover due to low rainfall rates, high salinity, lack of agricultural exploitation, and decomposition rates of organic matter. In general, there are slight differences in the distribution of organic matter between most sites in the study area. This may be due to the lack of vegetation cover as well as the prevailing dry climatic conditions that help oxidation processes occur due to high temperatures. The changes in the values of organic matter content are clear and decrease with depth, especially when moving from the surface depth to the lower depths. The studied soils are poor in their organic matter content, like the soils of arid and semi-arid regions (Al-Atab et al., 2013) .

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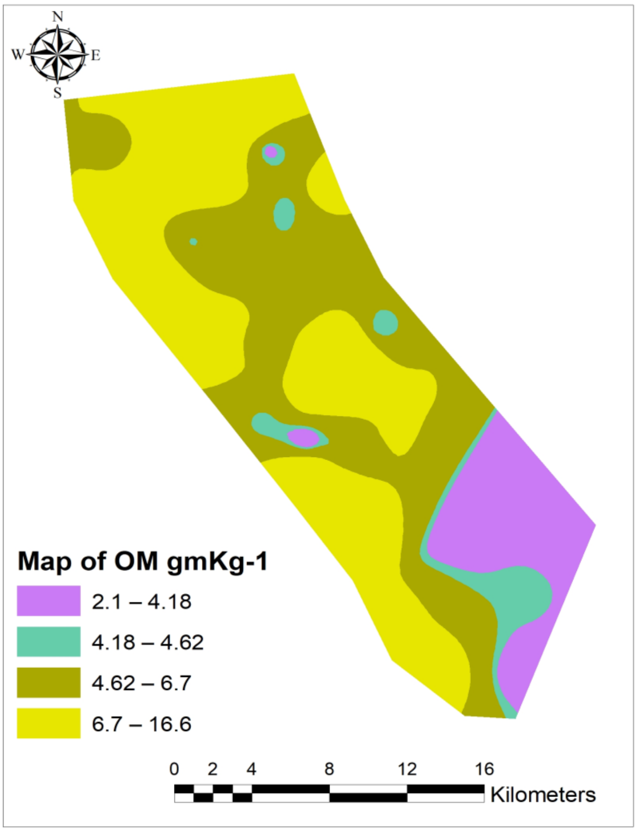

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https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

Figure 9. Spatial distribution of OM

ii. References

Soil Survey Staff. (2003). Soil Taxonomy. Abasic system of soil classification for making and interpreting soil survey. 2nd edition. Agriculture Handbook No. 436. USDA.

Van derknijff ,J,M. 2000 . European Commission Soil Erosion Risk Assessment In Europe Directorate General JRC European Soil Bureau .Soil Erosion Risk Assessment in Europe .p 38 .

Habib ,H. and Al-Shaihabi ,O. 2012 . Improvement of Soil Physical Properties at B'lay Area in south Syria to Limit Land degradation .

Rasham, M. H. (2012) Agriculture and water resources file. Publ.online.http://jcoagri.uobaghdad.edu.iq/uploads/Latest%20Issue/2015/1/9.pdf.

Black, C.A. (1965). Method of soil analysis , Am . Soc . of Agronomy No . 9 part I and II .

Jackson , M . L . (1958) .``Soil chemical Analysis `` . printice – Hall . Inc . , Engle wood cliffs . , N . Y

Page , A . L . ; Miller, R . H . and Keeney, D . R . (1982) . Methods of soil analysis , part (2) 2nd ed . Agronomy g – Wisconsin , Madison ,Amer . Soc . Agron . Inc . Publisher.

Vanessa Mary An Heyvaert and Cecile Baeteman .(2007). Holocene sedimentary evolution and palaeocoastlines of the Lower Khuzestan plain (southwest Iran). Marine Geology 242 : 83–108 .

Sadkhan, Muqdad Taher (2009). A sedimentary, hydrographic and mineralogical study of the confluence of the Karun River with the Shatt al-Arab and the surrounding areas. Master's thesis, College of Science, University of Basra.

Al-Aqidi, Walid Khalid (1986). Soil Science/Soil Survey and Classification. University of Mosul.

Al-Atab, Salah Mahdi Sultan (2008). Variation in soil properties and classification in some areas of Basra Governorate. PhD thesis - College of Agriculture - University of Basra.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 1 (2024) PP 434-439

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

Al-Ani, Abdullah Najm, Dakhel Radi Nadwi and Talib Akab Hussein (2000). Study of the physical and chemical properties of some soils of the marshes in Iraq. Iraqi Journal of Agriculture, 5.

Al-Rawi, Muthanna Khalil (2003). Characterization and distribution of parent materials of some sedimentary soils and their effect on soil properties. PhD thesis. College of Agriculture, University of Baghdad, Iraq.

Al-Atab, Salah Mahdi, Mohammed Ahmed Kazem and Hussein Abdul Nabi (2013). Variation of some physical and chemical properties of soils of Kutuf and river basins in Abu Al-Khaseeb district in Basra Governorate. Basra Research Journal. Volume 38, Issue 1: 221-237.