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Spatial Variability of Soil Salinity in Mid of Mesopotamian Plain by Remote Sensing

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Abstract: ***Shaikh Sa'ad project, in Wasit province, was chosen to conduct the current study, which located between the two longitudes: 15' 46° and 35' 46°E, and between the two latitudes: 30' 32° and 45' 32°N, where the Iraqi-Iranian borders bounded it at the north, the borders of Ali Al-Gharbi, Maysan province, at the east, Tigris river at the south, and Al-Jabbab river at the west. The project area was about 75000 ha. Vegetative spectral indices of the saline soils were evaluated through evaluating non-vegetative indices of the saline soils. Saline soils mappings were according to Kriging and Cokriging for the following laboratory measurement of soil salinity and the data from the satellite images. 1- Soil salinity mapping from laboratory measurements. 2- Soil salinity mapping from the satellite images. GIS program was used for conducting Geostatistics to account effective area, spatial reliability, and the number of representative samples. The results showed the higher Salinity Index (SI) with high significant positive correlation of 0.68 followed by Normalized Difference Snow Index (NDSI) with significant correlation which indicated that increasing soil salinity values led to increasing SI values. The results indicated that most of the study region lands were salinity affected and the SI values ranged from the lower value of 0.002 to the higher of 0.334. Normalized Difference Vegetation Index (NDVI) values ranged from the lower to higher values of 0.34 to 0.52, respectively. The results of Kriging's study explained the ESP value for the class E0 which occupied 2.22 with ratio of 0.002% while the larger area was for the class E3 of 53562 ha with a ratio of 55.1%. The results of Cokriging's study explained salinity values and horizontal readings for the class S0 which had an area of 0 ha with a ratio of 0% while the class S5 had the higher area of 64082 ha with a ratio of 65.92%, but Cokriging indicated that of the relationship between the salinity and NDVI for the class S0 had an area of 0 ha with a ratio of 0% while the class S5 had the higher area of 64257.9 ha with a ratio of 66.1%. Crokriging's results, between salinity values and SI, showed that the class S0 had an area of 0 ha with a ratio of 0% while the class S4 had a higher area of 64241.49 ha with a ratio of 66.08%. Also, the results showed, ESP values with EM38 horizontal readings, that class E0 had an area of 2.38 with a ratio of 0.002% while the class E3 had the higher area of 54425.3 ha with a ratio of 55.98%. The results, between ESP values and NDVI, showed that the class E0 had an area with a ratio of 0.008 while the class E3 had the higher area of 53690.1 ha with ratio of 55.23%. The results, between ESP values with Brightness Index (BI), showed that the class E0 had an area of 2.22 ha with a ratio of 0.002% while the class E3 had the higher area of 53562.03 ha with a ratio of 55.09%. The results showed that the Electrical Conductivity (EC) was a variable property from a horizon to other where the Coefficient of Variation (C.V) value of Ap horizon was 93.5%. The spatial reliability of EC 1.08 and the spherical model was the best to describe EC variation. In Ap horizon, ESP values ranged between 1 – 81, the lowest value was in the pedon 5 and the higher was in the pedon 9 of the Ap horizon. C.V value was 50.01%. The required representative samples ranged between 4 – 20 samples, the lower samples were for NDVI and the higher were for EC. NDVI had least variation, compared with EC, required a large number of samples ranged between 102 – 296 samples according to random selection. The smaller number of samples was for BI and the larger was for ESP. The results showed that, when geostatics was used, spherical model was the appropriate for most of studied properties with ratio of 71.5% followed by circular model of 28.5%.***

Keywords: Soil, Salinity, Shaikh Sa'ad, GIS , Al-Jabbab

1. Introduction

The soil salinity term for the level of dissolved salts in the soil solution, Soil salinity increases with the concentration of soluble salts, the seriousness of the salts in terms of its impact on soil properties Lead to the deterioration of its physical construction, And permeability The difficulty of movement of water and as well as The deterioration of its chemical building (Blake, 1965).

(F.A.O, 2011) indicated that 60-70% Soil of central and southern Iraq Seriously affected BY the accumulation of salts. AND THAT 20-30% of the remaining soil little affected by accumulation of salt, this marks the how dangerous posed to the natural resources in Iraq.

For many reasons, the most important of the nature of the climatic conditions,Random system of soil and water resources management Not based on periodic updating of the data relating to the activity of salinization.

(EtDouaik. Al, 2004) stressed the need to adopt surveys and maps related to the salinization To any area and diagnosis of farmland management systemsand integration with remote sensing data serve to distinguish and diagnose the type and capacity of salt spread in the soil through special spectral standards Represented in Salinity guide SI and Difference saline guide NDSI and Brightness guide BI.

Anderson and Croft, 2009 indicates how plants respond to the effects of soil salinity physiologic,they stressed the importance of the use of the radio field spectroscopy equipment to accuracy isolate the overlap and haunt the spectral data from satellites to Invest the electromagnetic energy from space and field in the soil surveys across all countries that suffer from this problem and this requires the concerted efforts of the countries and institutions within a unified style of work, It includes building a solid scientific base To document what is going through saline soils of the variations in the qualities and the nature of their formation during the time To manage it within the GIS software Within easy digital storage and handling and transformation of one formula for another.

Thenkabail,2000 identified Standards spectral vegetative functions as physical - vital task to determine class distribution of plants which is a variety of signs of value change with the chemical state of the soil and the stages of growth and health status of the plant.And has a mathematical equations contribute to the development of the numerical values of each pixel in the spatial data through subjecting certain spectral calculations imposed by the computational formula proposed standard spectral packages.

Weisz, 1993 pointed out that the method of Kriging technique is the most perfect in clarifying the spatial variability of the recipe and that this application requires precisely the spatial structure across the semi-variance function Semivariace and appropriate model for the recipe measured.

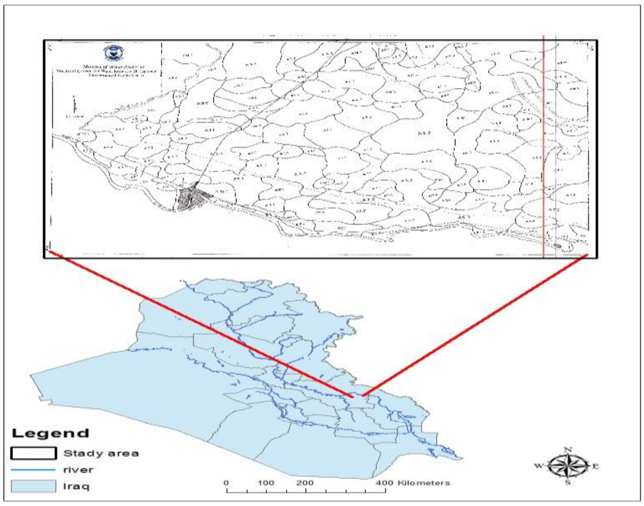
Webster and Oliver, 2001 said that this technology available in the GIS software provide predictive maps for the traits.Geographic Information Systems distinct from the rest of the information systems strongly analysis of information associated with the correct geographical locationas it inherited by some of its functions and this research aims to:

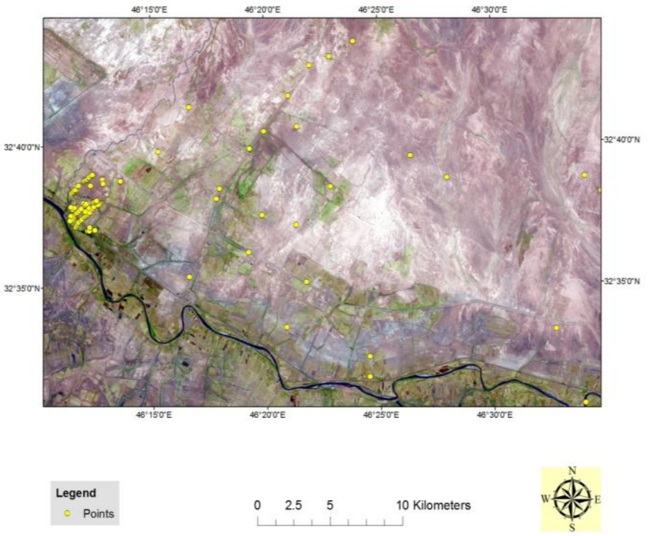
1. Understanding of the pattern and spatial distribution of soil salinity in the study area.
2. The relationship between soil salinity and satellite evidence.
3. Drawing soil salinity maps in Cokrging and Kriging waysfor use in saline soils management planning.

2. Research Method

Project of Sheikh Saad in Wasit province, was chosen by the study area for the implementation of this study which is located between longitudes 46.15 and 46.35 east, and between latitudes 32.30 and 32.45 north, It is bordered to the north border region between Iraq and Iran, and the Middle District boundary to the western province of Maysan, on the south by the Tigris River to the west by the River Aljbab. Where confined to its territory in the eastern part of the Wasit province, which is an extension of the project north of Kut, estimated project area boundaries (75,000) thousand hectares as in Figure (1).

It was obtained satellite image through the Internet and format compressed from the official website Geological Survey US (USGS Global Visualization Viewer) and the track (167) and row (37) of the satellite (Lansat8) by sensor Oil for the year 2015 and took a snapshot dated 05.23.2015 for implementation of the study .Satellite image has been converted from a compressed format to format single spectral packages an extension (Tiff) using software (ERDAS Imaging 9.1) to study the statistical relationship between salinity data with the spectral values visible space used during the study period.As well as the vegetative and salt evidence as in Figure 2.





3. Methods and Means of Data Collection First: laboratory

104 sites superficial were selected 25-0 estimated by some soil characteristics, as follows:
Electrical conductivity estimated in the dough saturated extract

The device EC-meter according to the page et, al 1982
And the calculation of ESP by estimating Ca, Mg, Na to calculate the SAR and then ESP account, according to Abu Sharar equation 1976.

(1) ESP=6.28+(0.64*SAR)

Second, the evidence and indicators based on remote sensing data:
a- estimate spectral evidence vegetative saline soils: was estimated spectral parameters of the satellite image of the satellite and sensor LS8 OLI as follows:

(1) The difference vegetative guide: (NDVI) Normalized Difference Vegetation Index, according to Rouse equation 0.1973:

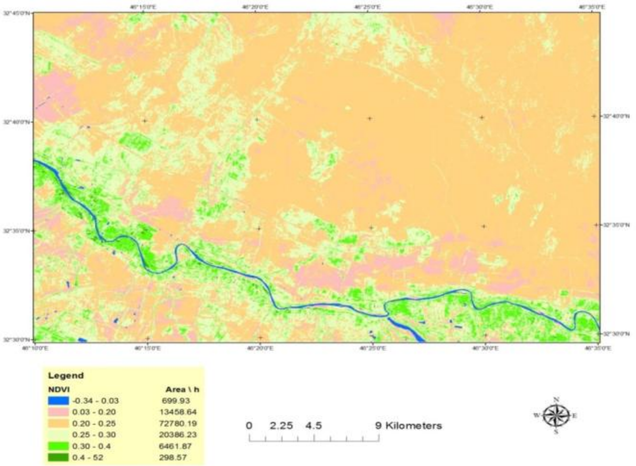
(2) NDVI = (B4-B3) / (B4 + B3) ....

(2) vegetation guide amended soil (SAVI) Soil-Adjusted Vegetation Index, according to the Huete, 1988equation:
(3) (SAVI) = (1 + L) * B4-B3) / (B4 + B3 + L) ....

b- estimate spectral evidence of no vegetative soil salt.
The most important non-vegetative spectral standards that are appropriate to the study of soils saline soils are:
1. salinity SISalinity Index: Khan guide 0.2005.
(4) Salinity Index (SI1) = B1 * B3) 0.5
2. different natural salinity guide (NDSI) Normalized Difference Salinity Index, according to Khan et, al 2005equation.
(5) NDSI = (B3-B4) / (B3 + B4) ....
3. Brightness guide (B1) Brightness Index, according to equation (Zhang, ET.AL (2002).
(6) b1 = [(b3) 2+ (B4) 2] 0.5 ....

C: mapping soil salinity using ways of Kringing and Kokriging following data:
1. Drawing soil salinity maps from laboratory measurements.
2. Drawing soil salinity maps of the vertical and horizontal EM38 data.
3. Drawing soil salinity maps from satellite imagery data.
4. The use of GIS software for statistical analysis Geostatics to calculate the distance and reliability affecting the spatial and the number of representative samples.And the use of autocorrelation Varigram scheme which represents the relationship between the semi-variance function and the distance.Which determines a correlation between the character and the distance is calculated based on the equation(Nasser and Almrzuk 1989).

As the: N = number of samples required Ta = T value based on the degree of freedom contrast X = average.and using a GIS program and through the use of technology and KrigingGeostatics.As draws relationship with the distance to see the distance influential Range.As for obtaining samples and depending on the technique that takes into account the spatial coherence,As it has been to focus on the distance influential in the calculation of the number of samples representing the path of the study were divided as the longest distance on the distance influential Range.



4. Results and Discussion

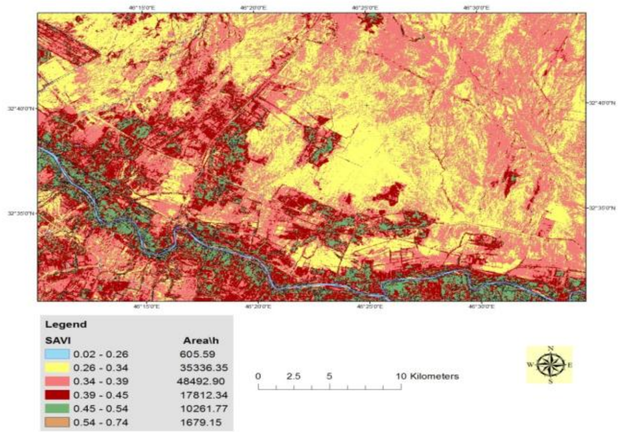
Guide vegetation difference (NDVI) Normalized Difference Vegetation Index:

Results of the study in Figure (3) indicated that most of the study area is influenced by salinityAnd it represented the presence of six varieties ranging salinity of less valuable guide values (-0.34-0.03)Low class NDVI filled an area of 699.93 hectares and 0.16%.While higher class NDVI filled an area of 298.57 hectares and 0.26%The results indicated that the third and fourth categories occupied the post of larger space where an estimated 93,146.42 hectares and by 81.56% indicate they saline soils. The rate of the soil vegetation directory (SAVI) Soil Adjusted Vegetation Index:

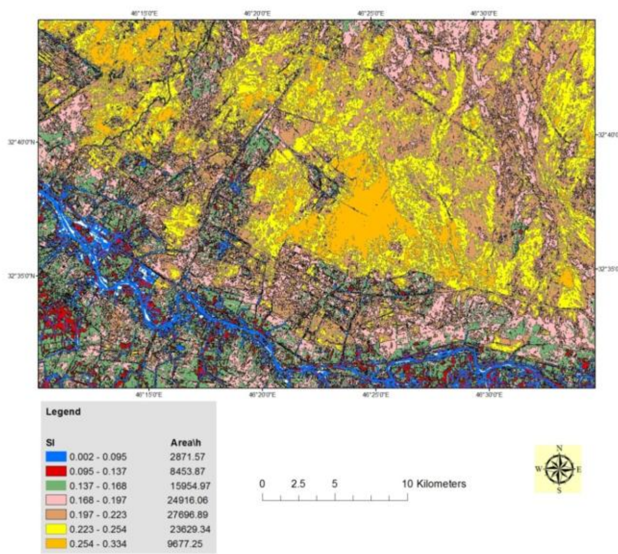
Results of the study (Figure 4) that most of the study area affected by salinity and it represented the presence of six varieties manual salinity values ranged from less valuable (0.26-0.02) to a higher value (0.74-0.54).

Item little SAVI filled an area of 605.59 hectares and 0.52%

Class of Higher sixth SAVI filled an area of 1679.15 hectares and 1.47%The results indicated that the Class II and III occupied the post more spaceIt estimated at 83829.25 hectares and by 73.40% and turned out to be saline soil.



Results of the study (Figure 5) that most of the study area is influenced by salinity and it represented the presence of seven varieties. less valuable guide to salinity (0.095-0.002) to a higher value (0.334-0.254).Class of Higher seventh SI filled an area of 9677.25 hectares by 8.4.The results indicated that the fifth and sixthtwo varieties occupied the post of largest area was estimated at 51,326.23 hectares and by 44.94% and turned out to be saline soil.

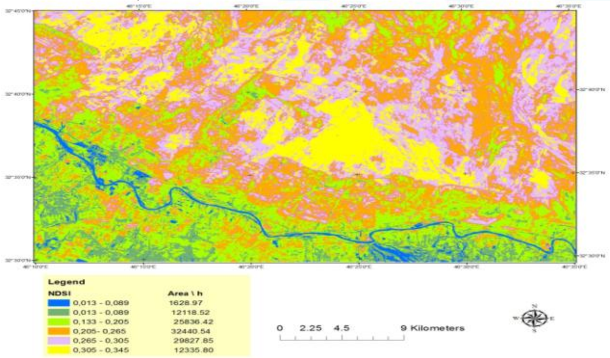


Results of the study (Figure 6) indicated that most of the study area affected by salinity and it represented the presence of six varieties.Guide values ranged (0.345-0.305)

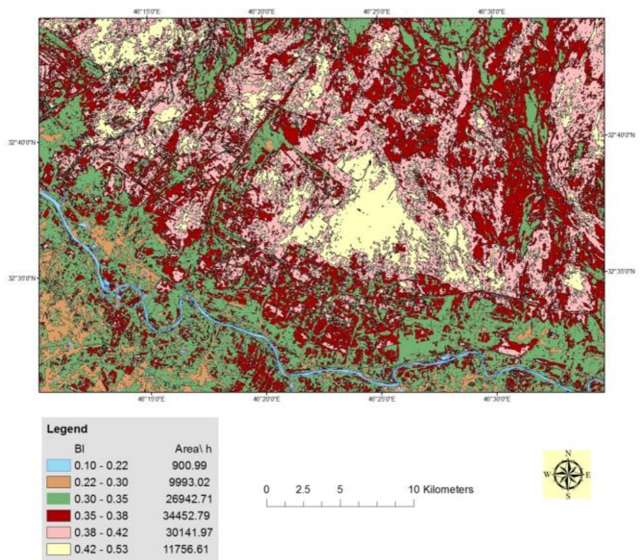
Little class NDSI filled an area of 1628.97 hectares and 1.4%,

Class of Higher sixth NDSI filled an estimated area of 12,335.80 hectares and increased by 10.80%

The results indicated that the fifth and sixth two varieties occupied the post of largest area estimated 61,268.39 hectares and by 53.64% and turned out to be saline .



soil. Results of the study (Figure 7) that most of the study area is influenced by salinity and it represented the presence of sixth varieties. Guide values ranged from less valuable (0.10-0.22-) to a higher value (0.53-0.42).Class few brightness filled an area of 900.99 hectares and by 0.7%While high-brightness product was the sixth held an estimated area of 11,756 hectares and 10.2%The results indicated that the fourth and fifth categories, who occupied the post of more space, as estimated surface area of 64,594.76 hectares a rate of 56.56%, which is a saline soils.



Production of Maps for salinity spatial change and mutual sodium ratio usingkriging and cokriging ways:

The spatial variability map of soil salinity EC using the method of kriging:
Kriging results of a study of salinity indicate that concerning the product SO it occupies a zero hectares and a percent of 0%.While the class S5 is Higher space which reached 63,838 hectares, and by 65.67% percent.

Regarding varieties S0 and S1 and S2 the total area is 989.33 hectares and 1.01% percent which is less than the critical limit for electrical conductivity EC is 16-1DS.M.

As for the rest of the varieties S6.S5.S4.S3

The total area of 96,221.99 hectares and a percentage of up to 98.98% of the total area, which is above the critical limit for electrical conductivity of a soil saline and the reason is because the soils study area are soils saline barren and where large areas is planted, while the remaining space was occupied by some crops and neighboring regions of the Tigris River for being non-saline soil planted as in Figure (8). The spatial change map of the ESP using the Kriging method:

The results of the Kriging study indicates that The percentage of mutual sodium ESP for the E0class served as an area of 2.22 hectares and by 0.002%, while the E3Class is higher space and up to 53,562 hectares, and by 55.10%, while in regard to the E0 and E1 and E2varietiesthe total area is 33,533.22, and by 34.49%, which is less than the critical limit mutual sodium ratio ESP. the rest of the E5, E4, E3, E2varieties the total area is 63,676 hectares and by 65.50% of the total area which is above the critical limit for mutual sodium. Mutually sodium soil with A high proportion. The reason is that the soil of the study area is barren and saline soils where large areas were uncultivated,The remaining space was occupied by the soil with a ratio of less than 15% of ESP, especially adjacent to the Tigris River to the soil as the soil is saline as in Figure (9).

Map for Spatial covariance of soil salinity EC with the natural green cover guide NDVI usingCokrigking method.

The results of the Cokrigking study between salinity and the natural green coverguide.For the class S0 occupies zero hectare and 0% while the class S5 is higher space which reached 64257.9 and by 66.10% and regarding S0 and S1 and S2 the total area is 968.38 hectares and is 0.99%, which is less than the critical limit for electrical conductivity EC is 16ds.m while as for the rest of the S6.S5.S4.S3 varieties the total area is 96,242.38 hectares and a percentage of up to 99.00% of the total area, which is above the critical limit for the salinity of the soil, a saline barren where large areas were uncultivated, the remaining spaces of some crops adjacent to the Tigris River and the areas it has occupied as a non-saline soil as in Figure (10),It is almost similar to the varieties of salinity and area occupied in the way of the kriging EC method alone.

Map for Spatial covariance of soil salinitywith SI guide usingCokrigking method:
The results of the Cokrigking study between salinity and the natural green coverguide.For the class S0 occupies zero hectare and 0% while the class S4is higher space which reached 64241.49 and by 66.08% and regarding S0 and S1 and S2 the total area is 4839.52 hectares and is 4.97%, which is less than the critical limit for electrical conductivity EC is 16DS.m while as for the rest of the S6.S5.S4.S3 varieties the total area is 93253.16 hectares and a percentage of up to 95.92 %of the total area, which is above the critical limit for the salinity of the soil, a saline barren where large areas were uncultivated, the remaining spaces of some crops adjacent to the Tigris River and the areas it has occupied as a non-saline soil as in Figure (11), It is somewhat different from the varieties of salinity and area occupied in the way of the Cokrigking EC method alone.

The spatial reliability and obtaining samples:
The results as shown in Table (1).It is noted that whenever a significant change will be the largest number of samples and whenever a little change there will be less number of samples,This is consistent with what was discovered by (Nelson, and Warrick 1985) and (Mohaimeed, 1999).

The number of samples required for the study area ranged from 4-20 samplesas it was the lowest number of samples to NDVI guide and most number for the EC,It turns out that guide NDVI less change compared with the ECsalinity,while required many more samples between 296-102 samples in the case of relying on random Law,As it was the lowest number of samples to guide B1 and the most number is ESP's,the results indicated that the percentage of appropriate model for most of the traits is spherical. When using of geological statistic and by 71.5%;Followed by circular model and 28.5%.

5. Conclusions

Possible to summarize the most important conclusions of this study, including as the following:

1) The existence of spatial changes in ESP, EC which is important for the work of survey and classification of the soil, especially in defining the boundaries between units of soil salinity.
2) The spherical model is appropriate for most soil traits when using of Geological statistics and by 71.5%, followed by circular model by 28.5%, while the rest of the models did not any of them apply to the soil traits and that is because it did not give a good representation to the function of the contrast.
3) Qualities that have reliable spatial number of samples less depending on the semi-contrast migraine scheme is required, while it required a large number of samples in the case of relying on random law.
4) It is found that by using the Cokrigking the fourth trait was the highest area of the values of salinity which reached 64,241.49 hectares and by 66.08% compared with the normal kriging, thefifth class was High salinity , The recommendations can be summarized as follows:
5) The need to rely on geological of statistics in determining the reliability of spatial traits to be used more broadly in soil science applications, rather than relying on random order to minimize mistakes and cost obtaining samples.area of 27,696.89 hectares and by 24.25%.

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