Soil Quality Assessment Using Geomatics Techniques For The Garraf River Basin

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Abstract: Overview of assessment in geographical areas (GIS) and model reviews, positioning (GNSS), positioning, this study was conducted for the purpose of estimating the soil quality of the Gharat River Basin in the north of Dhi Qar Governorate using geomatics techniques represented by geographic information systems (GIS), remote sensing (RS) and positioning systems (GNSS). Which is about (90 km) from the city center. In nature soils and the correlation (B / C) reached (R² = 0.907) for sand, while the clay was correlation with the range (B / R) and it was (R² = 0.763) in While the correlation between the silt and the band (B/R) was recorded (R² = 0.730), the ph record (7.8-8.42) as it was classified as a neutral slant to the basal and it was clear from the statistical analysis that there is a relationship with the range (C / B) as it reached (R² = 0.583). The results showed a decrease in the values of soil samples between (0.2 - 1.7%) and the results of the analysis. 0.114% -0.197% and the results of the statistical analysis showed the correlation of the range (C/NIR) and gypsum with a correlation value of (R² = 0.686) in the proportion of lime ranged between (64.5% -21.5%) and the statistical analysis showed a correlation between calcium carbonate and the relativity of the range (C / NIR) as recorded (R² = 0.513), the results of the analysis of samples from the study samples ranged between (26.86-395.55), and through the statistical analysis it was found that there is a relationship between the rate of sodium adsorption and the ratio of the bandwidth of the satellite visual correlation amounted to (R² = 0.736), and it ranged The electrical conductivity values for the soils of the study area (5.79 -44.2 dS.m⁻¹) and it was a correlation (G / R) and the correlation value was (R² = 0.602), the calcium values in the area. The study ranged between (400-1944 ppm) and the correlation numbering (R² = 0.640) and the rates of magnesium in the study table ranged, the correlation coefficient (R² = 0.602), the sodium record between (50-1307 ppm) and the correlation range was (C / NIR ) Correlation coefficient reached (R² = 0.920), calcium carbonate ratios were found in the study stations (64.5% -21.5%) and its ratio reached with the range (C / NIR) as the proportion of gypsum in the region was calculated. The correlation coefficient of gypsum and range (C / NIR) was calculated) where it reached (R² = 0.686), the sodium adsorption ratio (SAR) was calculated and meals were between (26.86-395.5) and there was an association with the range (B / R + NIR) as it was recorded (R² = 0.737)

1. Introduction

Remote sensing techniques (RS), through the use of satellite data in soil quality control, have contributed and played an active role in recent years by making a quantum leap in providing a huge amount of data and information to supply geographic information systems (GIS) with high accuracy, low cost and quick
results, as it shortened decades of years of work (Dekker et al. 1996). These techniques have the ability to vary the spatial quality of soil and water for large areas at the same time. Mostly, remote sensing of a basin for a specific water body is limited to satellites with high spatial resolution such as Landsat and with a limited spectrum. The results of an investigation in the observation of satellites to assess the soil quality of the Al-Gharraf River Basin in the north of Dhi Qar Governorate. The main objective is to prepare a graphic guide for indicators of estimating soil and water quality and their spatial distribution using Landsat 8 OLI visuals and comparing them with the site data in the same place and time and creating a cross-index with a statistical correlation between Laboratory results and space data.

2. Soil quality concept

It is the ability of the soil to work productively within the limits of the ecosystem naturally, seasonally, in order to maintain plant productivity, animal continuity, maintain or improve water and air quality, maintain human health, and the ability to maintain food security. Soil quality reflects the extent to which it performs the functions of preserving diversity. The biological, productive and the continuity of life on the surface of the planet, and it was mentioned when observing the surface of the soil with the naked eye or by analyzing photographs that many of its qualities and characteristics appear, and thus we can distinguish the presence of a defect or difference in its quality and functions, and from the criteria for changing the color of the soil, surface water runoff, the interconnection of its lower layers and the formation of basins in it. And the diversity of herbs and their response to plant diversity on them, and one of the physical criteria for monitoring water quality is the possibility of extending the roots of plants in them, as well as the movement of water inside them and the ability to filter them between their horizons, as well as examining the arrangement of their solid parts and the extent of variation in the interstitial spaces and examining the thickness and depth of the surface and the composition of its textures, porosity, density, texture and degree. The stability of its solid particles is one of these properties that are inferred as chemical indicators. Such as: pH, electrical conductivity and phosphorous concentration, as well as examining the concentrations of nutrients that help plants grow in them, or those polluting minerals such as heavy metals, and elements (Toth, 2007). The main objective of evaluating and evaluating soil and water is to improve sustainability for optimal use. There are a number of concepts related to the original evaluation framework (Al-Husseini, 2005)(developed by the Food and Agriculture Organization, 1976) during the last decades, which included other concepts related to environmental consequences towards more benefits and services related to general and secondary ecosystems.

3. Materials and working methods

3.1 Study area and research

The study area is located within the administrative boundaries of Dhi Qar Governorate and extends between longitude (31°10′00″ _ 32°00′00″ N) and latitude (45°40′00″ _ 46°20′00″ E), and the study area is located on both sides of the Garraf River starting from Al-Fajr District, passing through Qalaat Sukkar and Al-Rifai district, as the study area ends in Al-Nasr district, and accordingly, the study area will be along the river basin, 60 km north of the center of Dhi Qar governorate.
Figure 1: A map (1) of the Republic of Iraq, indicating the location of the study site in the satellite video captured on 10/10/2020

Figure 2: A map (2) The study site in the satellite video captured on 10/10/2020

3.2 work supplies

This stage includes collecting information and previous studies, preparing and preparing maps and satellite visuals related to the study area and capturing satellite visuals from the official website.
https://earthexplorer.usgs.gov for the Landsat8 satellite for the study area according to the coordinates that were determined on the ground in the locations of soil sampling adjacent to the river.

Table (1) showing soil sampling locations

| station | sampling site    | E       | N       |
|---------|------------------|---------|---------|
| Loc_01  | Al_Fajr          | 595478  | 3533653 |
| Loc_02  | Al_Fajr          | 600676  | 3527146 |
| Loc_03  | Kalat Seker      | 603730  | 3519452 |
| Loc_04  | Al_Rifai         | 605495  | 3507009 |
| Loc_05  | Al_Rifai         | 604834  | 3499835 |
| Loc_06  | Al_Nsar          | 606904  | 3491712 |

3.3 Physical and chemical properties of soil

After drying the soil samples for the study area and preparing them in the laboratory, the saturated paste was made with a ratio of water (1-1) for each sample, three replicates, six samples, and a total of 18 samples were prepared for analysis. In the method of Richard (1954), Jackson (1958), Black (1965), Page et al. (1982), and in units of ppm.

A - physical properties

It includes the size distribution of soil particles, and the relative distribution of soil particles was estimated by the condensate method, as stated (Bouyoucos, 1962)

b- Chemical properties

First - electrical conductivity (EC)

The electrical conductivity value was calculated using an electrical conductivity device (EC-meter)

Second - pH

The degree of reaction was estimated using a pH meter from the saturated paste extract

Third- Determination of calcium and magnesium ions

Calcium and magnesium ions were determined in soil and water samples by slaking with Fresnité (EDTA)

Fourth - Sodium (Na)
The sodium ion concentration was measured using a flamephotometer

**Fifthly - Organic matter (OM)**

The organic matter was estimated by the oxidation method of organic carbon with potassium dichromate solution in an acidic medium, and then the titration was carried out using Moore's salt, and it was detected by the ferroin index.

**Sixth- (aqueous calcium sulfate)**

Calcium sulfate aqueous was determined laboratory and expressed as a percentage.

**VII- (Calcium Carbonate)**

Calcium carbonate was determined laboratory and expressed as a percentage.

**Eighth- Calculation of the sodium adsorption rate SAR**

The sodium adsorption ratio was calculated according to the equation used to calculate the SAR of the water samples.

3.4 **Programming and satellite visual analysis**

3.4.1 **Using the thematic digital environment in Arc Map 10.5**

The GIS program (GIS PROGRAM) was used to create digital thematic maps, ARC MAP version 10.5, and it is one of the widespread programs used in geographic information systems, as it provides great possibilities for supplying and processing digital data and obtaining high-accuracy data in monitoring, guessing, inference and inference. And one of its most important features is that it provides great possibilities in classifying and building thematic maps with a high level of accuracy and speed at the same time, and working in this environment includes producing maps suitable for evaluating the soil for the study area (Daoud, 2015).

![Figure 3 Satellite image of the study area on 10/10/ 2020](image-url)
Satellite visual deduction 3.4.2

The representative part of the study area was deducted in the satellite visual for accuracy, ease of handling, high data volume reduction, and ease of performing the necessary digital data processing operations in the Arc Map program.

Figure(4) An image showing the study site on the satellite image

3.4.2 Equations of ratios of satellite visual bands

The data for multispectral (bands) for the study area is processed using one-way equations between the bands from mathematical transactions between a certain number (bands) to obtain updated digital images showing us the characteristics of the study area, and in this study the use of 5 ranges with 61 mathematical equations as follows
Figure 4: of symbols and equations for relative bands used in satellite visual analysis (Hasti ,2015)

3.4.3 Working in the Microsoft office program

In our study, it was approved using the Excel program within the Microsoft Office version of 2010 to collect the database and make the calculations and corrections entrusted to the study and the calculations related to the results of laboratory analyzes and prepare them for statistical transactions and the formation of a concordant evidence with the satellite visual data obtained as a result of making the calculations according to the equations and evidence obtained From the ARCMAP10.5 program and the satellite visualization parameters of LANDSAT 8

3.4.4 statistical analysis

The SPSS statistical program (IBM SPSS Statistics 19) was used to calculate the correlation between the laboratory data (terrestrial) and the values of the visual (spatial) ranges, with the use of Microsoft Excel to make and find the linear equations for the study

4. Physical and chemical properties of the soils of the study area

4.1 soil texture

It means the relative distribution of the aggregates of the breeding joints (sand, silt and clay) and it is responsible for the extent of its smoothness or roughness. It is characterized by the peculiarity of stability and does not change easily over time as in chemical characteristics and it takes hundreds and
perhaps thousands of years to change, soil texture has a great influence on the movement of water and air. Inside the soil, the coarse-textured soil has little effect on the movement of water and air in the soil, unlike the soil with a silty clay texture, which contributes to preventing and slowing the movement of water and air within the soil. The soil of the study area was characterized by the similarity of its texture to a large extent. In the first, second, quarter and sixth sites, the soil was mixed, in the third site it was sandy mixture, and in the sixth site it was alluvial for the soils of the study area.

A - The results of the statistical analysis indicated that there is a correlation between sand and the relative range (B/C), as it was recorded (R² = 0.907) as shown below:

![Graph showing (sand) values with band ratio (B/C)](image)

Figure(5) (Graph showing (sand) values with band ratio (B/C))

B - The results of the statistical analysis indicated that there is a correlation between the clay and the relative range (B/R), as it was recorded (R² = 0.763) as shown below:

![Graph showing the values of (clay) with the ratio of the band (B/R)](image)

Figure(6) A graph showing the values of (clay) with the ratio of the band (B/R)

C - The results of the statistical analysis indicated that there is a correlation between the silt and the relative range (B/R), as it was recorded (R² = 0.730) as shown below.
A Figure(7) graph showing the values of (silt) with the ratio of the band (B/R)

4.2 Soil reaction degree (PH)

The results showed through the analyzes that the soils of the study had a neutral interaction degree inclined to the base and ranged between (8.42-7.8) and through the statistical analysis there is a correlation between them and the relativity of (C/B) range with a value of (R² = 0.583) as shown below

Figure(8) Graph showing the values of (PH) with range ratio (C/B)

4.3 electrical connection

The results of the soil samples in the study area indicated to the electrical conductivity, as its values ranged from (5.79-44.2 ds. m⁻¹) and the reason is due to the presence of factors affecting soil salinity such as high ground water and components of the original material and the lack of cultivation in the area and the lack of
maintenance or reclamation. The results of the statistical analysis showed a correlation relationship between electrical conductivity and band relativity (G/R) as shown below:

![Graph showing electrical conductivity values with band ratio (G/R)](image)

**Figure(9) Graph showing electrical conductivity values with band ratio (G/R)**

### 4.4 Organic matter

The results showed that the soil content of the study area was poor of organic matter, as it ranged from (0.2-1.7 ppm) due to the lack of vegetation cover, dryness of the soil and lack of interest in it from an agricultural point of view. NIR) has a value of (R² = 0.785) as shown below:

![Graph showing material value with band ratio (C/NIR)](image)

**Figure(10) Graph showing material value with band ratio (C/NIR)**

### 4.5 Calcium

It is one of the nutrients necessary for plant growth, and it is present in the soil in high proportions and varies according to the quality of the soil and the material of the origin. It is found in three forms, namely calcium, which is not ready for absorption, exchanged and dissolved. In general, Iraqi soils are considered calcareous soils with a high content of calcium. The study area indicated that the value of calcium ranged between (400-1944) ppm, and the statistical analysis indicated that there is a
relationship between calcium and the range ratio (NIR/R) with a value of \((R^2 = 0.639)\) as in the figure below.

![Graph showing calcium values with band ratio (NIR/R)](image)

**Figure(11)** Graph showing calcium values with band ratio (NIR/R)

### 4.6 Magnesium

One of the main reasons for its existence is irrigation water and groundwater, and it is also found in the form of magnesium sulfate salts in the soil and is characterized by its high solubility \((262 \text{ g/ liter})\). A correlation relationship between magnesium and the band ratio (G/R) amounted to \((R^2 = 0.602)\), as shown in the figure below.

![Graph showing magnesium values with band ratio (G/R)](image)

**Figure(12)** Graph showing magnesium values with band ratio (G/R)

### 4.7 Sodium

It has a direct effect on the growth of most agricultural crops, as it acts as a divider for soil aggregates, reducing its ability to transport water and air, and this results in a mass structure that makes it difficult for the roots to extend into the soil or to form a suitable mulch for seed germination. The sodium ion is present in the soil solution for several reasons, including the type of the original substance that constitutes the soil, or from irrigation water or ground water, the values of sodium in the soils of the study area ranged between \((50-1307 \text{ ppm})\), and the statistical analysis indicated that there is a correlation.
between the values of sodium and the range \((C/NIR)\), as the value of the correlation ratio reached \((R^2 = 0.920)\) as in the figure below

\[
y = 2045.8x - 2963.9 \\
R^2 = 0.9202
\]

**Figure (13)** Graph showing sodium values with band ratio \((NIR / C)\)

### 4.8 Calcium carbonate

Lime has physical, chemical and fertility effects on the soil. From a physical point of view, it affects the volume distribution of soil separations from its presence, which increases the proportion of sand and silt, making the texture more coarse. The results of the soil of the study area showed that the proportion of calcium carbonate in the soil ranges between \((64.5\% - 21.5\%)\). The statistical analysis also showed a correlation between calcium carbonate and the relative range \((C/NIR)\), as it was recorded \((R^2 = 0.513)\) as in the figure below

\[
\text{Caco3} = 187.59(C/NIR) - 147.59 \\
R^2 = 0.5131
\]

**Figure (14)** Graph showing calcium carbonate values with band ratio \((C/NIR)\)
4.9 hydrated calcium sulfate

The results of the analysis of the soils of the study area showed the percentage between (0.114%-0.197%) for the presence of gypsum, which means that it is a non-gypsum soil, and one of the reasons is the abundance of calcium carbonate in the soils of the study area, as the carbonate and sulfate ions compete for the calcium ion, so it is lime or gypsum and beet. The results of the statistical analysis: There is a relationship between the range (C/NIR) and gypsum with a correlation value (R² = 0.686), as shown below.

\[
y = 0.0238(x) + 0.0303 \\
R^2 = 0.6867
\]

**Figure(15)** Graph showing calcium sulfate values with range ratio (C/NIR)

4.10 Sodium adsorption ratio

Increasing the sodium ion in the soil has a direct impact on its efficiency and quality, as it leads to poor soil construction and disintegration and the destruction of the structure of its composition. It works on the dispersal of soil particles and the lack of porosity, and then poor ventilation and the passage of water and nutrients inside it, which weakens the activity of microorganisms and plant growth, and the results of the analysis showed. The soil samples of the study area showed that (SAR) values ranged between (26.86-395.55), and through the statistical analysis it was found that there is a relationship between the sodium adsorption rate and the satellite visual bandwidth ratio (B/R + NIR) with a correlation value of (0.736)

**Figure(16)** Histogram showing SAR values with Band Ratio (B/R+NIR)
Table (2) spectral indices of the elements of soil analysis in the study area

| Adjective | mathematical model                                      | R²  |
|-----------|--------------------------------------------------------|-----|
| Sand      | Sand = -1.0469(B/C) + 441.89                           | 0.907|
| Clay      | Clay = 452.57(B/R) - 300.25                            | 0.763|
| Silt      | Silt = -918.57(B/R) + 1331.4                           | 0.730|
| pH        | PH =1.9861(C/B) + 6.0347                               | 0.583|
| EC        | Ec = -87.168(G/R ) + 123.89                            | 0.602|
| Ca        | Ca = -4460.6(NIR/R ) + 1595.7                          | 0.639|
| Mg        | Mg = -3208.2(G/R ) + 4559.7                            | 0.602|
| Na        | Na = 2045.8 (C/NIR) - 2963.9                           | 0.920|
| CaCO₃     | Caco3 = 187.59(C/NIR ) - 147.59                         | 0.513|
| CaSO₄.2H₂O| CaSO₄.2H₂O =0.0238(C/NIR ) + 0.0303                     | 0.686|
| SAR       | SAR = 953.08(B/R+NIR ) - 944.95                         | 0.736|
| OM        | OM=10.188(C/NIR) - 9.1542                              | 0.785|

5. Conclusions

It is possible to use the satellite visuals from the satellite (Landsat 8 OLI) to predict indicators of soil quality and purity standards, compare and interpret them mathematically and the different areas on the surface of the earth. Soil quality indicators are closely related to the reflection ranges in (Landsat 8 OLI) and are mathematically weighted, as they can be used to estimate soil quality for the Garraf River Basin and for all seasons. The first four bands obtained from the Landsat-8 (OLI) satellite visuals (the first coastal band, the second blue band, the third green band, and the fourth red band) with their groups and band ratios closely related to soil quality standards and indicators. There is a clear effect of the falling rays on the target as it increases or decreases the reflectivity and has different results.

References

[1] Al-Husseini, Iyad Kazem Ali 2005. Study of the characteristics of some dried Hammar marsh soils in southern Iraq. Master's thesis, College of Agriculture. Baghdad University. The Republic of Iraq.
[2] Daoud, Jumaa Muhammad, Foundations and applications of remote sensing, 2015. The Egyptian Arabic Republic
[3] FAO, 1976.A framework for land evaluation. FAO Soil bulletin 32
[4] Rome. Italy
[5] Toth, G. E. - Soil Quality in the European Union. - In: Toth, G., Montanarella, L. and Rusco, E. (Eds.), (2008): JRC Scientific and Technical Reports. - Threats to Soil Quality in Europe, 11-19
[6] Black, C. A. 1965. Methods of Soil Analysis. amer. Soc. Agron. Inc., USA. pp. 1572
[7] Richards, L.A. 1954. Diagnosis and Improvement of Saline and Alkaline Soil. USDA. Hand Book 60 USDA, Washington, DC. USA.p. 17-21
[8] Page, A.L., R.H. Miller and D.R. Keeny. 1982. Methods of soil analysis part 2,2nd(ed). Agron Pub.9, Madison, Wisconsin, USA. P.403-429
[9] Ayers, R. S. and D.W. Westcot, 1985, Water Quality for Agriculture. Irrigation and drainage paper (29 Rev.1). FAO. Rome Italy, pp.1-13
[10] Richards, L.A, 1954, Diagnosis and improvement of saline and alkali soils. U.S. Dept. of Agri. Handbook No.60., pp.69-82
[11] Altovisiki, M. E., 1962,: Hand book of hydrogeology. Geogoelitzet, Moscow, USSR (In Russian), 614p
[12] Hasti Shwan Abdullah , Submitted to the Faculty of Engineering of the University of Sulaimani in Partial Fulfilment of the Requirements For the Degree of Master in Science of Water Resources Engineering
[13] Dekker and Rounsevell, M.D.A. (1976). Land-use and climate change within assessments of biodiversity change: A review. Global Environmental Change, 19,306-315