Estimation Of Water Quality Using Geomatics Techniques for The Garraf River Basin

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Abstract

This study was conducted for the purpose of estimating the soil and water quality of the Gharraf 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. The chemical analyzes of the water samples showed that the degree of interaction was between (7.84-7.7) and the electrical conductivity (dS.m⁻¹1.1-1.05), and the total dissolved substances were between (1106-1051ppm), and the mathematical statistical relationships were weakly correlated with the ratios of the visible space bands. pH, electrical conductivity and total dissolved materials. Calcium ratios in the study area ranged between (ppm 47.4-107) and there was a significant correlation with the range (B/R + B) with a value of (R² = 0.51), and the results showed the ratios of magnesium in the study area between (ppm 9.67 - 26.61.) Between it and the band ratio (B/R + B), a correlation relationship with a value of (R²=0.525), potassium recorded an average between (3.1-ppm 5.5), and there was a significant correlation between it and the band ratio (B/R + R) and it reached (R²=0.665). , found a statistical relationship between sodium and the ratio of the band (B/R + R)) and a significant correlation was recorded with a value of (R² = 0.527). - 102.52) And there was a correlation between the presence of chloride and the ratio of the range (B/NIR + G) as it was recorded (R² = 0.593), the bicarbonate recorded ratios between (ppm 1.8-2.7), and there was a statistical relationship between the bicarbonate and the ratio of the range (C / R). ) amounted to (R² = 0.573), nitrate values were recorded in the study area between (4 - 3.45 ppm) and there was a significant correlation between them and the range (B5) as it reached (R² = 0.581), sulfate values were recorded between (207.25 - 277.5 ppm) and through Statistical analysis found that there is a correlation between The presence of sulfate with the ratio (C + B + G + R + NIR) which amounted to (R² = 0.596), the sodium adsorption ratio (SAR) was calculated, as its values ranged between (3.192 - 0.147) and most of the statistical relationships were weakly related to the spatial ratios and were gradually The hardness values in the study area are between (99.7 - 198.1)

1. Introduction

As a result of the increasing numbers of population and cities and the development of agricultural, industrial and oil methods, waste and pollutants increased, which led to an increase in water pollution, erosion of river banks, the phenomenon of surface run-off in urban areas, the gradual decline of water, the deterioration of agricultural lands and the intensity of desertification, which was reflected in the deterioration and pollution of the environment (Al-Rawi, 2011). Standing on the merits of this problem to assess the quality of soil and water periodically to reach results as quickly as possible and
to predict the size of the environmental defect and emergency events, that the current use of on-site measurements in collecting samples and analyzing them in the laboratory for quality assessment is an accurate measure of a point for a specific time and place and does not give spatial views of time. Other or other areas for the quality of soil and water and for large areas (Bartholomew, 2003) that modern technologies have contributed and played an active role in the detection and monitoring of all environmental and climatic phenomena.

1.1 Water quality concept

Water is the most important and basic natural resource for human life, as it is the resource without which the wheel of life would have stopped. It is the main controller of human development and the economy and the main player in agriculture, industry and various other activities and various facilities that make the life of the planet sustainable. (ICMM, 2007) mentioned river water different tasks other than Human consumption, which is the receipt of sewage water by these rivers for disposal and for all human activities, and this constitutes a major and dangerous environmental problem that has exacerbated widely in recent decades, which is the result of the diversity of human activities such as agriculture, industry and domestic use as waste from factories and homes, as it is considered to have heavy water and is the main cause of pollution of rivers and flats Water and groundwater, between (Al-Hadithi, 1997) The reason for the poor quality of water in a way is to mix sewage water with river water without treatment or purification to reduce the damage caused by this, as it is mostly consumed fresh water that is polluted at a high rate and is considered one of the most dangerous waters. (1980, Smith) A wetland is a transitional area between land, soil and water, and this view represents the midway between land systems. The aquatic environment, as water is the main controller of this system in general and a specific factor for both plants and animals, and it is also subject to specific times throughout the year and varies in its impact from time to time.

1.2 Problems causing low irrigation water quality

The irrigation water used for agriculture has become inconsistent with the standard specifications in most countries of the world, and this results in the transfer of toxic waste resulting from throwing waste and pollutants from various human activities to the running water, as it is subsequently transferred to agricultural lands and from there to plants, as humans and animals feed on them, and when they are transferred to the food chain, it is transferred to human cells, causing deadly diseases and weakening the immune system, and in addition to this, it leads to genetic changes in human cells that end in cancerous tumors and problems of the liver, kidneys and lungs, as discussed in the Rio Conference in Brazil 1992.

The problems related to the poor quality of irrigation water for use can be summarized:

1- An imbalance between nutrients in the soil

2- Living microorganisms in the soil are affected by the decomposing organic matter, causing negative disturbances in the nitrogen processes, namely nitrification, stabilization and transformation.

3- Accumulation of sediment, so it becomes a focus of sedimentation in the farm, such as Claypans, Hardpans and Limepans
4- Withdrawing quantities of harmful salts such as calcium carbonate when using pumps withdrawing from groundwater to irrigate with water of high salinity, which leads to the dissipation of soil characteristics and reduces its porosity, thus creating an impediment to drainage.

2. Materials and working methods

2.1 Study area and research

The study area is located within the administrative boundaries of Dhi Qar governorate and extends between longitude (31°00’00” – 32°00’00” N) and latitude (45°40’00” – 46°20’00” E), the Gharraf River occupies Wasit Governorate for a distance of (90 km). Its length is in the territory of Dhi Qar Governorate for a distance of (168 km) and is located on both sides of the river, starting from Al-Fajr district, passing through Qalaat Sukkar district and Al-Rifai district, as the study area ends in Al-Nasr district. The importance of the river strategically in that it supplies the cities it passes through and fills their need of water, starting from the upper district of the district south of Wasit Governorate to the outskirts of northern Nasiriya. In agricultural, industrial and other water uses (Al-Sahhaf) (2018)

2.2 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 sampling sites from the river And the soils adjacent to it, the location of the selected points was reached through a GPS device of the type (GARMIM 72), and the water samples were placed in clean, sterile, unused plastic bottles inside refrigerated containers until they are transported to the laboratory. The stations of the study area and according to the observed coordinates in conjunction with the passage of the satellite in the area within the area (Path167, Row38) and a visual capture to determine the exact location of the samples in the satellite visual and on the same day. It took place between 7:00 in the morning and 4:30 in the evening, on 10/10/2020, with moderate weather and a clear sky free of clouds and dust.

Table (1) shows the locations of water sampling

| station | sampling site | E   | N   |
|---------|---------------|-----|-----|
| Loc_01  | Al_Fajr       | 590787 | 3532154 |
| Loc_02  | Al_Fajr       | 592576 | 3530998 |
| Loc_03  | Al_Fajr       | 598393 | 3528445 |
| Loc_04  | Kalat Seker   | 600462 | 3526145 |
| Loc_05  | Kalat Seker   | 602363 | 3521365 |
| Loc_06  | Kalat Seker   | 603622 | 3517553 |
| Loc_07  | Al_Rifai      | 604402 | 3510336 |
| Loc_08  | Al_Rifai      | 604618 | 3503113 |
| Loc_09  | Al_Rifai      | 605139 | 3497376 |
| Loc_10  | Al_Nsar       | 606572 | 3490151 |
| Loc_11  | Al_Nsar       | 607111 | 3488073 |
2.3 Laboratory analyzes of soil and water samples

The chemical and physical analyzes of the samples of the study area were carried out in the Fadak laboratory of the upper holy shrine, according to the method of (Richard, (1954 and Jackson) (1958, and (1965, Black) and (Page et al., 1982) and in units of ppm estimation.

- Chemical analyzes of water samples
- electrical connection

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

- pH

The degree of reaction was estimated at the site using a pH meter.

- Calcium and Magnesium

The value of calcium and magnesium ions in water and soil samples was calculated by scaling method and using Fersnett (EDTA).

- Sulfates

  The determination of sulfate is done by measuring the degree of turbidity with a (Spectrophotometer)

- Sodium

  The value of the element sodium was estimated using a flame photometer.

- Chloride

  The chloride was calculated. The scaling method was estimated using silver nitrate standard solution and potassium chromate solution as a guideline.

- Sodium Adsorption (SAR)

  The sodium adsorption ratio was calculated according to the following equation.

  \[ \text{SAR} = \text{Na}/\sqrt{(((\text{Ca+Mg})/2)} \]

- Potassium

  Potassium element was calculated using a device (Flame photo mete).

- Nitrate

  Nitrate was estimated using a (Spectrophotometer).
2.4 Programming and satellite visual analysis

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 soil and water for the study area.

2.5 Satellite visual subtraction

The representative part of the study area was deducted from 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 progra.

![Figure 1: a picture showing the sampling stations from the study area](image)

2.6 Satellite image processing

Using special equations to treat reflection (Reflectance) using the program (ARC MAP 10.5) to process and correct the solar elevation angle in the real value as in the upper atmosphere, we get a visual processing and the value of one pixel and get rid of geometric distortions as a result of changes in the speed of the scanner and changes in its height, so it is represented as a real representation The study site (Daoud, 2015).
2.7 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 5 were used Scopes by 61 mathematical equations as follows.

\[
\begin{align*}
\text{C} & \text{ BAND 1} \\
\text{B} & \text{ BAND 2} \\
\text{G} & \text{ BAND 3} \\
\text{R} & \text{ BAND 4} \\
\text{NIR} & \text{ BAND 5}
\end{align*}
\]

\[
\begin{align*}
(C/B), (C/G), (C/R), (C/NIR), (B/C), (B/G), (B/R), \\
(B+NIR), (G/C), (G/B), (G/R), (G/NIR), (R/C), \\
(R/G), (R/B), (R/NIR), (NIR/C), (NIR/B), (NIR/G), \\
(NIR-R), (B+C), (B+G), (B-R), (B+NIR), (G+C), \\
(G+R), (G+NIR), (R+C), (R+NIR), (C+NIR), \\
(B+G+C), (B+G+R), (B+G+NIR), (B+R+NIR), \\
(B+R+C), (B+C+NIR), (G+C+R), (G+C+NIR), \\
(R+C+NIR), (G+R+NIR), (B+G+R+NIR), \\
(C+B+G+NIR), (C+B+G+NIR), (C+G+R+NIR), \\
(C+B+G+R+NIR), (C+B+G+R+NIR), (C+NIR+B)
\end{align*}
\]

Figure 2: is a picture showing the processing of satellite visuals using the ARCMAP program

Figure 3: symbols and equations relative to the bands used in the analysis of satellite visual Hasti, 2015
3. Results and discussion

- **pH water PH**

The Iraqi water in general is described as neutral water inclined to alkaline and the results showed that the water of the study area is neutral water with a slight basal slope and the results agree (Modher, 2017). The specifications of the World Health Organization (WHO) for drinking water, which set the permissible limit between (8.5-6.5)

- **Electrical conduction EC**

A measure of the susceptibility of an aqueous solution to the passage of electric current, and it depends on the presence of ions and temperature. The results showed that the electrical conductivity values of the river ranged between (1.06-1.08), which are in agreement with the results of (Modher, 2017), and it is within the range of potable water according to the standards of the World Health Organization (WHO). American salinity and FAO.

- **Calcium**

It is one of the main components of the Iraqi soil that resulted from the decomposition of sedimentary rocks and the most soluble in Iraqi waters. in the Organization (WHO).

- **Magnesium**

The results showed magnesium values between (9.67 - 26.61) and it is within the permissible limits as stated in the standards of the World Health Organization (W.H.O) as drinking water.

- **potassium**

The results showed the amount of potassium in the river water samples was between (1.2-5.5), which is considered suitable for drinking water according to the specifications of the World Health Organization (WHO), and it is present in lower percentages than sodium, due to the scarcity of its spread, low solubility in water and high stability in the soil (Al-Hayek, 1989)

- **Sodium**

It is one of the most abundant elements in nature. It is a highly soluble alkaline in water. It is a single positive ion (WHO, 2003) Na +. The main source is from the melting of feldspar rocks found in the river basin during weathering processes, especially clay (Al-Mousawi, 2016). The results showed in The study area ranges from (4.4-91.1), which is within the permissible limits and according to the specifications of the World Health Organization (WHO), which is (200 ppm) as a maximum.

- **Chlorine**

The results showed the values of chlorine in the study area ((76.75 - 102.52) and it is within the permissible limits for drinking water as stated in the specifications of the World Health Organization (W.H.O).
- **Sulfates**

A negative divalent ion (SO₄), whose main source is the melting of gypsum rocks, clays and sewage waste in rivers and water bodies, has a significant impact on the formation of permanent hardness. The results showed the amount of sulfate present in the river water ranged between (277.55-207.25) and is within the limits set by the World Health Organization (W.H.O) for drinking water specifications.

- **nitrates**

The results showed that the percentage of nitrates present in the river water samples ranged between (3.45 - 4), which is in accordance with the standards set by the World Health Organization for drinking water (W.H.O).

- **Sodium adsorption ratio**

The results showed that the rate of sodium adsorption (3.192-1.147), which is within the excellent level, as stated in the classification of irrigation water according to (FAO) standards.

- **Calcium**

The results of the statistical analysis showed that there is a relationship between the presence of calcium and the range (B/R+B) as it reached (R² = 0.510) as shown below.

![Figure 4: Relationship between the presence of calcium and the range](image)

- **Magnesium**

The results of the statistical analysis of the river water samples showed that there is a relationship between magnesium and the ratio of the range (B / R + R), as it was recorded (R² = 0.525) as shown below.
It was found that there is a relationship between potassium and the band ratio (B / R + R) with a value of \( R^2 = 0.665 \)

\[
\begin{align*}
\text{As shown below}
\end{align*}
\]

\[
\begin{align*}
\text{Figure 5: relationship between magnesium and the ratio of the range (B / R + R)}
\end{align*}
\]

- potassium

The results showed that there was a relationship between sodium and the ratio of the band (B/R + R), as its value was \( R^2 = 0.527 \), as shown below

\[
\begin{align*}
\text{Figure 6: relationship between potassium and the band ratio (B / R + R)}
\end{align*}
\]
Figure 7: relationship between potassium and the band (B/R + R), as its value was \( R^2 = 0.527 \)

- Sulfates

The results showed that there was a correlation between sulfate and the band ratio (C+B+G+R+NIR) as its value was \( R^2 = 0.596 \), as shown in the figure below.

Figure 8: correlation between sulfate and the band ratio (C+B+G+R+NIR)

- Chloride

The results of the statistical analysis of the river water samples showed a statistical relationship between chloride and the band ratio (B/NIR + G), as it was recorded \( R^2 = 0.593 \) as shown below.
The results of the statistical analysis showed that there is a relationship between the presence of nitrates and the range (B5) with a value of ($R^2 = 0.581$), as shown below:

**Figure 10**: relationship between the presence of nitrates and the range (B5) with a value of ($R^2 = 0.581$).

- Sodium adsorption ratio

No significant relationship was found between the SAR value and the relative bands of the satellite visuals, and most of the relationships were weakly related.

4. Conclusions

It is possible to use satellite visuals from the Landsat 8 OLI satellite to predict indicators of soil and water quality and purity standards, and compare and interpret them mathematically for basins, rivers, lakes and various areas on the surface of the earth. Water quality indicators are closely related to the reflection ranges in Landsat 8 OLI and are mathematically weighted, as they can be used to estimate water quality for the Graf River Basin and for all seasons. All water quality parameters can be calculated using satellite visuals and using all Landsat 8 OLI bands that can be linked to water quality.
indicators and standards, especially the new bands developed to obtain better and more accurate indicators that were not used in Landsat-7.

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