Measuring The Water Pollution Of selected Sites In Al- Najaf Covenantate(TSS) And Using Remote Sensing Data

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Abstract . The current study was conducted in Najaf governorate within the Kufa district to measure the percentage of pollution (TSS) in the Euphrates River (Shat Kufa) and the length of about 25 km. The purpose of this study is to determine the estimated concentration of total suspended solid in the Shat Kufa by Landsat 8 OLI. The data was distributed by the United States Geological Survey (USGS) and downloaded from Earth Explorer website (2018-12-15) using remote sensing data, the study samples were collected from (10)(2018-12-22) starting from the north of Kufa - Zarka area to the south of Kufa bridge cement plant and a length of about 14.5 km. Most of the concentration of TSS spread across the northern and southern parts of the Shatt al-Kufa, as a result of cesspits, as well as the drainage of a number of waterways (the northern Kufa and Buhadi districts) directly to the Shat al-Kufa. The results of the analysis of correlation between reflectivity (r) for the degrees of remote sensing and TSS in the laboratory of the Department of Environment Faculty of Sciences University of Kufa band (4) Highest correlation and accuracy reached: \((r=0.917,R^2=0.840,\text{RMSE}=4.5225,\text{MRE}=1.1649)\) While the band (1) less coherent and accurate as it reached: \((r=0.562,R^2=0.316,\text{RMSE}=5.4683\text{ mg/l, MRE}=1.5739\%)\).

Key words: TSS، Shatt Al-Kufa، Remote sensing، Landsat imagery.

1.Introduction

Water is primary for existence on Earth, and any variance in the naturalist quality and allocation of water have ecological effects that can occasionally be devastating. In general, the humane need to safe drinking water that fundamental to health and must be ready to all [1]. Water are meeting an increasing worry through the action of pollutants due to the speedy growth of industrial and municipal labor because of the rising of people growth as well as the increase in territory drainage due to agrarian activities. Thus there have been rising concerns about the running of water quality all through the Globe [2]. In Najaf _ Iraq, Shatt Al- Kufa (Kufa River) is the great supply of water needed for drink, irrigation, industry and applications other. This river offering decreasing quantity and goodness of water because of the rapid evolution of industrial, agrarian and domestic activities. Water quality estimation is essential toblock and control river pollution and to fetch reliable information on the goodness of water for effective administration [3]. Remote sensing data have been more used for oversight the ecological, physical, and biological state of the seawater. Many studies own demonstrated which remote sensing imagery can be used for Total Suspended Solid (TSS) concentricity. The range of 0.4 to 0.85 \(\mu\text{m}\) is often chosen for seek aimed at
determining mode for estimation of water goodness parameters within the water column from remote sensing data [4].

The turnout of remote sensing technology offers an alternate way of pursuit spatial and temporal difference of TSS concentration. Utilizing technology remote sensing could reduce save time and cost and to estimate/map the TSS concentration is well. In this technicality, researchers have used several wavelengths, and then regarding it to the field, measuring TSS The fact that TSS rising the radiant emerging from the surface waters in the near infrared and visible region of the electromagnet spectrum has been renowned since the late 1970’s [5].

A number of researchers consummated that the TSS concentration is establish to be linear, and there is a curvilinear relationship between TSS and reflectance at green (0.5µm ) to red (0.6 µm ) of the visible spectrum [5][6][7][8][9][10]. and total suspended solid (TSS) as a focus measure of water quality [11][12][13][14][15].

2.Materials and methods

2.1 Study Area

Kufa is renowned to be one of driest and the hottest place in Iraq. It is located between 32° 04’ to 32° North longitude and 44° 26’ to 44° 23’ Eastern latitude [16], around 170 km south of Baghdad, the capital of Iraq, and 10 km of eastern north Najaf. Governorate It is place on the banks of the Shatt Al-Kufa who is branch from the Euphrates River. After city Al-Kufa , Euphrates river part into two rivers: Shatt Al– Kufa for a length and width of 73 km and about 100 m respectively, and Al-Abbasiyya. Rainfall water and stored water in container and reservoirs are the master source of water for Shatt Al-Kufa, and through the year, the water level is uneasy. The areas surrounding the river are known for agriculture, and some residential buildings are plased on the other side [17].

This study includes 10 selecting positions along the studying section of Shatt Al- Kufa s beginning from Al- Zerga unitel Cement factory Bridge as shown in Fig. 1.

![Figure 1. Location of the study area in Iraq and sampling locations](image-url)
2.2 Sampling collection and Landsat 8 image

Samples were collected on December 22/12/2018, where samples were collected for 10 stations of four variables at locations in the Euphrates River (Shat Kufa) at a depth of about (30) from the Zarka area and up to the bridge of the cement factory. Table (1) image), which was captured on December 15, 2018, obtained from the USGS website,

| Location Stations                  | Code Stations | x/m   | y/m   | PH  | Temp. | EC  | TDS  | TSS  | Cl  |
|-----------------------------------|---------------|-------|-------|-----|-------|-----|------|------|-----|
| Zirka area                        | S1            | 440485| 3551386| 7.8| 16°   | 894 | 581  | 10   | 700 |
| Al - Zarka Water Project          | S2            | 440983| 3550154| 7.7| 17°   | 1005| 653  | 20   | 600 |
| Agricultural house towards Zarka area | S3         | 442685| 3547150| 7.5| 16°   | 1952| 1269 | 20   | 1100|
| The Northern Incubator            | S4            | 442563| 3545953| 7.5| 18°   | 1439| 935  | 20   | 700 |
| The Kufa Water Project            | S5            | 443503| 3545314| 7.6| 17°   | 949 | 617  | 20   | 250 |
| Opposite Sikka Street             | S6            | 444159| 3544899| 7.5| 17°   | 915 | 594  | 10   | 500 |
| Near the Palace of Hospitality     | S7            | 444629| 3544347| 7.4| 17°   | 997 | 648  | 10   | 400 |
| The area of the animals            | S8            | 444753| 3543735| 7.1| 19°   | 1672| 1087 | 20   | 500 |
| Unit treatment of the volcanic station | S9         | 446017| 3542118| 7.2| 17°   | 1147| 746  | 30   | 650 |
| Cement Plant Bridge               | S10           | 448061| 3538978| 7.6| 16°   | 916 | 595  | 10   | 700 |

The quality of water of the Euphrates River (Shat Kufa) can be assessed in the study area to determine its suitability for the purpose of domestic uses according to the Iraqi Standards Standard, Table (2).

| Parameter       | Unit  | Limit  |
|-----------------|-------|--------|
| PH              | -     | 6.5-8.5|
| EC              | μs/cm | 2000   |
| TDS             | mg/l  | 1000   |
| TSS             | mg/l  | 10     |
| Cl              | mg/l  | 350    |

2.3 Regression Equation

Regression Equation was used to obtain resultant regression function to model the TSS(Figure 2-Figure 8) The independent variables are the reflectance and the dependent variables are TSS field values. Regression Equation used was linear model equation. The main formula for the resultant regression function is as follow
Explanation:

\[ y = ax + b \] 

\[ Y = \text{The dependent variable (field TSS)} \]

\[ A = \text{The constants} \]

\[ B = \text{The slope of regression} \]

\[ X = \text{The independent variables[19].} \]

### 2.4 conversion of pixel values to reflectance

Radiometric correction function was used to equalize the solar conditions in each region/pixel in the image to get the reflectance value by changing the value of Digital Number (DN) into the reflectance value. This was completed by algorithm formula accord to USGS (2016) as follows:

\[ \rho_x = M_\rho \cdot Q_{cal} + A_\rho \] 

Where:

\[ \rho_x = \text{TOA (Top of Atmospheric) planetary reflectance, without correction for the solar angle.} \]

\[ M_\rho = \text{Band-specific multiplicative rescaling factor from the metadata.} \]

\[ A_\rho = \text{Band-specific additive rescaling factor from the metadata.} \]

\[ Q_{cal} = \text{Quantized and calibrated standard product pixel values (DN).} \]

TOA reflectance was corrected based on the sun angle following formula as follow:

\[ \rho_x = \frac{\rho_x}{\sin(\theta_{SE})} \] 

where:

\[ \rho_x = \text{TOA planetary reflectance} \]

\[ \theta_{SE} = \text{Local sun elevation angle[20]} \]
3. Result and Discussion

**Figure 2.** Scatter plot of band 1 vs field TSS (mg/l)

**Figure 3.** Scatter plot of band 1 vs field TSS (mg/l)

**Figure 4.** Scatter plot of band 1 vs field TSS (mg/l)

**Figure 5.** Scatter plot of band 1 vs field TSS (mg/l)
Figure 6. Scatter plot of band 1 vs field TSS (mg/l)

Figure 7. Scatter plot of band 1 vs field TSS (mg/l)

Figure 8. Scatter plot of band 1 vs field TSS (mg/l)

Where the correlation $r$ and the coefficient of determination ($R^2$) between reflectivity and laboratory concentration TSS (mg/l) extends between (0.562-0.917) (0.316- 0.840), respectively. Band4-red is the highest correlation ($r = 0.917$) and $R^2 = 0.840$). At the same time, band1-Ultra-blue is less correlated ($r = 0.562$) and the coefficient of determination ($0.316 = R^2$) In the table 2.

Table 3. Relationship between TSS field concentration and reflectivity r band1-band7 for sample locations

| No. bands       | Regression Equation | Correlation Coefficient(r) | Coefficient of Determination($R^2$) |
|-----------------|---------------------|----------------------------|-----------------------------------|
| band1-Ultra-blue| $y = 866.78x - 56.378$ | 0.562                      | 0.316                             |
| Band 2-Blue     | $y = 1710.7x - 131.87$ | 0.734                      | 0.539                             |
| Band3-Green     | $y = 1096.4x - 44.11$ | 0.747                      | 0.558                             |
| Band4-red       | $y = 884.33x - 17.282$ | 0.917                      | 0.840                             |
The spatial distribution of TSS in the study area (Shat Kufa) for each band (1-7) appears to be similar, but varies in quantity from one item to another, where the TSS distribution is concentrated in the edges of the Kufa, South of the south and decline in the center of the Kufa, as a result of wastewater and drainage of a number of mazasl directly to the Shuf Kufa. Table (4) and Figure9 The upper boundary (TSS) band (4,5,6,7) above the upper limit band (1,2,3) because of its lower water penetration, so its sensitivity (TSS) is greater, so it is good for studying the surface plankton of the water, while at the same time the upper boundary (TSS) band (3) 1,2) due to The ability to penetrate the water less.

| No. bands        | MAX     | MIN     | MEAN     | STD.    |
|------------------|---------|---------|----------|---------|
| band1-Ultra-blue| 37.5081 | 8.8122  | 14.6963  | 2.7452  |
| Band 2-Blue      | 42.0612 | 0.0025  | 13.1334  | 4.8248  |
| Band3-Green      | 66.9669 | 1.7675  | 17.2085  | 6.3520  |
| Band4-red        | 82.6784 | 6.5845  | 18.1168  | 9.1398  |
| Band5-NIR        | 87.8933 | 0.0032  | 16.7349  | 18.9967 |
| Band 6-SWIR 1    | 105.0056| 0.0042  | 17.3272  | 20.4383 |
| Band7-SWIR2      | 148.6575| 0.0105  | 18.3044  | 22.5547 |
3.2 Accuracy Assessment

Use the accuracy assessment measurements: Root Mean Square Error (RMSE), and the mean relative error (MRE) the following equations:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (tss_{est}-tss_{meas})^2}{N}}$$  \hspace{1cm} (4)

$$MRE(\%) = \frac{1}{N} \sum_{i=1}^{N} \left| \frac{tss_{est}-tss_{meas}}{tss_{meas}} \right| \times 100$$  \hspace{1cm} (5)

where $x_{meas,i}$ and $x_{esti,i}$ are the measured and estimated values, respectively, and $N$ is the number of samples.

3.3 Results Accuracy Assessment

The accuracy assessment indicates that band 4 has the smallest deviation in the estimation of TSS image: RMSE=4.5225, and MRE % = 1.1649 mg/l. Meanwhile, band with the highest deviation in
estimating TSS is band 1 RMSE=5.4683, MRE % = 1.5739 mg/l. This can be caused by the penetration ability and susceptibility to materials of TSS or object of water.

Table 5. the accuracy results TSS( estimation (mg/l)

| No. bands    | RMSE   | MRE %  |
|--------------|--------|--------|
| band1-Ultra-blue | 5.4683 | 1.5739 |
| Band 2-Blue  | 4.9785 | 1.3724 |
| Band3-Green  | 4.8684 | 1.4304 |
| Band4-red    | 4.5225 | 1.1649 |
| Band5-NIR    | 5.1198 | 1.2266 |
| Band6-SWIR 1 | 4.7445 | 1.464  |
| Band7-SWIR2  | 4.7376 | 1.3111 |

Figure 10. Estimated vs. Measured TSS Band 1
Figure 11. Estimated vs Measured TSS Band 2
Figure 12. Estimated vs Measured TSS Band 3
Figure 13. Estimated vs Measured TSS Band 4
4. Laboratory results

1. **(PH)** The pH values in the study area fall within the permissible limits of the Iraqi standard for domestic purposes (8.5) and Table (2), ranging from 7.1 to 7.8.

2. **(TSS)** Ranging between (10 - 30) mg/l All sites except S1, S6, S7 and S10 were recorded, which exceeded the range of the tests within the Iraqi standard for household purposes (10) mg/l according to Table (2). This increase in TSS values is attributed to the increase in agricultural waste flowing into the Euphrates River through the dams, as well as the wastewater discharges that flow directly into the Euphrates River, observed through field visits.
3. **EC** The results of the chemical analysis of the waters of the Kufa Shattah Table (1) and Figure (18) show that the values of (EC) in the study area (2000 s / cm3μ, according to Table (2). Sites (S9, S8, S4, S3, S2) recorded an increase in EC values during that month. This is due to the increase in the number of mazasl (the northern Kufa district and the Bawdari district) which flow directly into the Euphrates River.

4. **TDS** Ranging between (581-1269) mg / l All sites except S3 (S8), which is within the scope of the survey within the Iraqi standard for household purposes (1000) mg / l, were recorded according to Table (2).

5. **CL** The results of the chemical analysis of the waters of the Kufa Shattah Table (1) and Figure (18) show that the values of (CL) in the study area, Ranging between (250-1100) mg / l All the sites except S5, which exceed the range of surveys within the Iraqi standard for household purposes, were recorded at 350 mg / l according to Table 2. This increase in CL values is due to the increase of agricultural waste flowing into the Euphrates Through the façades and sewers.
5. Conclusion

The study was carried out on the Euphrates River (10 stations) where the relationship between TSS (laboratory size) and the (1) (7) r (band) was studied from Landsat 8 image. Analysis of the correlation between reflectivity (r) for the remote sensing data and TSS), the band (4) is the highest correlation with (r = 0.917, R² = 0.840, TSS> 80 mg / l) and regression equation y = 884.33x - 17.282 The distribution of TSS on the Euphrates River from the north to the south is very different from the TSS measured at the station sites (10)) (RMSE=4.5225mg/l ,MRE =1.1649%.

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