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# Diatom Indices Used To Assess Water Quality For Al-Rumeytha River Water /Iraq

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***Abstract*:**
***Background:*** *The present research used diatoms as bioindicators to evaluate Al-Rumeytha River water quality in Al-Muthanna Governorate at three locations. The research ran from Autumn 2022 until Summer 2023. The quality of water was evaluated utilizing "Generic Diatom Index, Pollution sensitivity and Trophic Diatom" Index and physicochemical parameters .*
***Results:*** *Based on diatom indices, the Geometric Diversity Index (GDI) varied from 9.25 in site 1 to 17.38 in site 3, indicating moderate river pollution. The Pollution Sensitivity Index (IPS) varied from 6.15 in site 2 to 16.89 in site 3, suggesting moderate to severe river pollution. The Trophic Diatom Index (TDI) varies from (27.14) at site 2 to (83.63) at site 3 .*
***Conclusions:*** *Indicating that the river is oligotrophic to hypertrophic and that higher proof values indicate poor water quality. Water had few additives and was low-quality, indicating river water quality. Based on the results above, water quality was found to be in the range of oligotrophic to hypertrophic according to (TDI), moderate to good according to (GDI) index, and the assumption that the higher the confirmatory characteristics showed that the quality of water was low contaminated and suitable to be lived in. The lack of significant improvements in water quality and the presence of negative qualities indicate a deterioration in the overall water quality of a river.*
***Keywords:*** *River, Diatom, Diatom indices, Water quality*

## INTRODUCTION

Indeed, in Iraq and worldwide, rivers are one of the main sources of freshwater (Ewaid *et al*., 2019).water quality is vital for the development and survival of aquatic animals and plants in environments (Boyd, 2020). Notwithstanding, there are presented different types of normal and human pollutants. It is basic to continuously monitor water quality in rivers to evaluate the degree of contamination (Al-Ani *et al*., 2019). Diatoms are normal species that assume a significant part in freshwater environments. As a result, they are regarded as reliable indicators of recent and historical water quality and the environment. They are, therefore, thought to be trustworthy markers of the ecosystem and water quality in the past and present (*Lkr et al*., 2020).

Diatoms are easily collected and are highly sensitive indicators of physical, chemical and biological changes in water bodies. Their consistent presence in a wide range of aquatic environments makes diatoms valuable indicators of environmental change. In evaluating and tracking the quality of water, they are a fundamental instrument (Ewaid *et al*., 2019). Diatoms have been the subject of local research on water quality indicators in recent years. For example, Zainab *et al*., 2022 evaluated the Euphrates River's water quality. The Generic Diatom Index (GDI) and the Trophic Diatom Index (TDI) were used to evaluate the water quality. The diatom According to the diatom index data, the river is in a mesotrophic to oligo-mesotrophic condition, and the GDI shows that the water is moderately contaminated.

Neran et al., 2020 examined Um El-Naaj Marshes' water quality using diatoms as a bioindicator. Diatom index Trophic, diatom, and generic diatom indexes(Adnan *et al*., 2020). The presence of these suggests mesotrophic to eutrophic state.

Diatoms are (eukaryotic, unicellular, photosynthetic organisms with a variety of unique geometric shapes) (class: Bacillariophyceae), pennants and centric are two of the main orders into which diatoms are divided. Morphological attributes like size, shape, and ornamentation frustule are utilized to recognize diatoms. On artificial surfaces, diatoms can be found in two different forms: plankton, which floats freely, and benthic, which is fixed to a substrate (Abu-Hadal & Al Hassany, 2020).

Determination of water quality and detection of pollution in the water flow by means of diatoms decent capacity ((Martín et al., 2010) . Different investigations have been directed to evaluate the nature of water by inspecting phytoplankton, especially diatoms.

SPI and GDI were at first evolved as organic pollution indices, while TDI is an indicator of contamination with inorganic nutrients (Kelly & Whitton, 1995) . The GDI includes genera as its only reason for deciphering water quality, notwithstanding, species inside a variety could have different necessities concerning the quality of the water.

It is proposed that the following different indices be used instead of the GDI to approve the GDI's results (Taylor *et al*., 2007). The GDI classification is based on 44 genera, while the SPI includes the (s and v) values of nearly 1,300 taxa for assessment. It is the most complete index since it just requires distinguishing proof down to the genus level, the GDI is comparatively easier to utilize and can assist with giving an early evaluation of a system's trophic condition. Kelly and Whitton in 1995, created TDI, which is a reliable indicator of the level of both organic and inorganic pollution (Musa & Greenfield, 2018).

The current study chose diatoms because they mirrored the natural study region status. It is expected to use the records in the environment (Al-Rumeytha River) to assess its water quality and involve them in the control of Iraqi aquatic systems. Biological assessment changes in species diversity and abundance can indicate the overall health of the river. When as ecosystem certain species may be more sensitive to pollution than others, serving as bioindicators of water quality.

An environmental assessment of water quality for the Al-Rumeytha River in Iraq serves several keys of which:

Identification of Pollution Sources along the Al-Rumeytha River, understanding the sources of pollution is crucial for implementing targeted management strategies to mitigate contamination.

Evaluation of Ecological Impacts to assess the river's aquatic ecosystems, including changes in species composition, and biodiversity loss, by examining biological indicators such as plankton.

Scientific Knowledge Advancement: The research fills gaps in Al-Rumeytha River basin water quality assessment literature. The work advances riverine ecosystem science and informs future research by creating new data and insights, even with minimal data. This research used TDI, SPI, and GDI indices to define water quality by analyzing diatom community.

**The Study Area**

Al-Rumaytha River is situated 25 Km north of Samawa City. It enters the Rumatha region of the Directorate of Al-Hilal, which is 15 km west of Rumaytha City. The Al-Rumaytha River flows normally from the Al-Hilla River. It is the main water source for Al-Muthanna Province and has a complex organization of distributaries and branch canals. It extends about 30 km from the Al Hamza bridge to the Alnajame regulator (Ali Abdulhamza Obaid, n.d.)

For this study, three sampling algae sites were judiciously chosen along the Al-Rumaytha River within the Al-Muthanna province.

The exact geographical coordinates of these sites were accurately determined using a GPS device (Table 1)

1. Al-Arthiat Area: Situated about 8 km north of Al-Rumaytha's center, this area is marked by flourishing vegetation on riverbanks and adjacent agricultural fields.
2. Al-Rumaytha Center: Located at the heart of Al-Rumaytha, this site distinguishes itself with a dense population and notable water flow rate, making it significant for monitoring.
3. Al-Dyoalim Village: Positioned about 6 km from Al-Rumaytha's center in the northwest direction, this village area is characterized by the prevalence of agricultural fields and neighboring villages along the riverbanks. Notably, the presence of dense algae and aquatic life becomes

evident here, likely due to the slowed water flow rate. The specific geographical layout can be referenced in (Fig 1).

**Table 1. The study sites using a GPS device**

| Sites | Longitude | Latitude |
|---|---|---|
| S 1 | 21.30'945 E | 23.31'31 33 N |
| S 2 | 31.07'45 12 E | 6.70'31 31 N |
| S 3 | 45.33'45 14 E | 24.04'31 29 N |

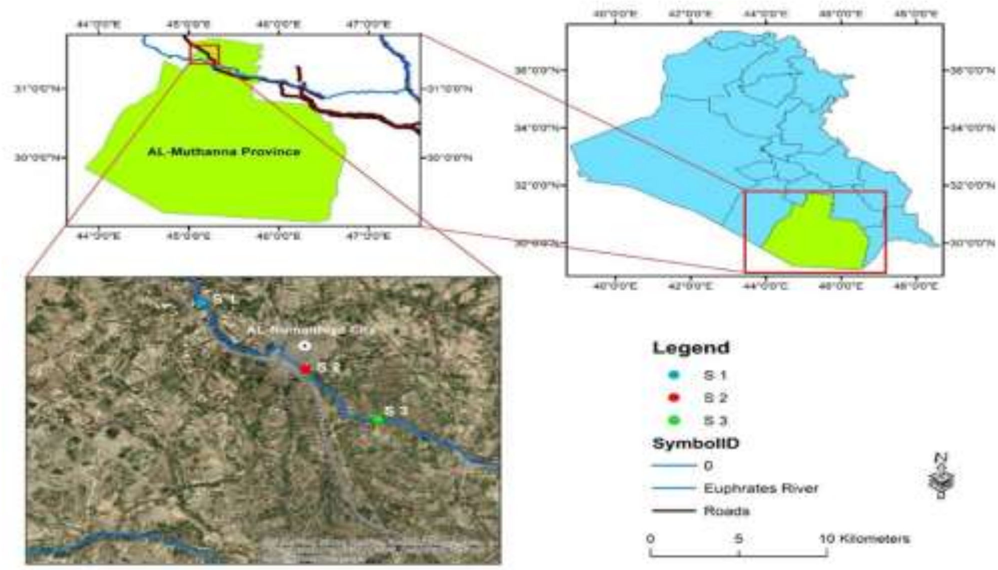


**Fig 1: Map showing selected sites in the Al-Rumaytha River.**

**Sampling**

Seasonal algae samples were collected from three locations (Figure 1) from autumn 2022 to summer 2023 using phytoplankton net (20 μ) and 1-liter plastic bottles, containing tiny drops of Lugol's for qualitative and quantitative analysis. The research collects diatoms in cylinders (1000 mL) from three replicates per location for 10-15 days with 1ml of Lugol's solution for precipitation, then stores the precipitate (20-30 ml) in containers with a few drops. Label container samples with date and place. Prepare permanent slides for microscopy diatom identification ((Al-Saedy *et al.*, n.d.)

Physical and chemical measurements were taken from each site's subsurface water samples in clean polyethylene bottles (5L). A Hydrolab Quanta Multiparameter meter (Standard Methods for the Examination of Water and Wastewater Part 4000 INORGANIC NONMETALLIC CONSTITUENTS, 1999) monitored temperature, EC, DO, and pH in situ. Water samples were collected and filtered (0.45 µm pore size) for analyzing total dissolved nutrients (nitrate, nitrate, and phosphate) at each location (Apori *et al.*, 2024).

**Diatom indices**

1. Trophic indices

1.1. Trophic Diatom Index (TDI): The 86 diatom taxa diagnosed obtained from sample collection and used as indicators were selected based on their ability to tolerate inorganic nutrients. (Kelly & Whitton, 1995).

Index determined using equation and Table 2:

“$\boldsymbol{TDI} = \Sigma\ [\boldsymbol{AjS\ jVj\ /\ AjVj\ X25}]\ \boldsymbol{-25}$”

**Aj**: “abundance of species j in the sample.

**Sj**: species sensitivity to nutrient j in the sample, values range from 1 for low nutrient concentrations to 5 for high ones.

**Vj**: value of the index [1-3]”

**Table 2. TDI values.**

| “Degree of Pollution | “Index value |
|---|---|
| Oligotrophic state | TDI < 35 |
| Oligo-mesotrophic State | TDI (35-50) |
| Mesotrophic State | TDI (50-60) |
| Eutrophic State | TDI (60-75) |
| Hypertrophic State” | TDI > 75’ |

1.2. Generic Diatom Index (GDI): This index is defined by the equation (Lecointe *et al.*, 1993) and (Table 3) as follows:

$$GDI=[\Sigma AjSjVj/AjVj]\ x4$$

**Aj:** “abundance of the species in the sample.
**Sj:** sensitivity of the species to nutrients [1-5].
**Vj:** index value [1-3]’

**Table 3. GDI values.**

| “ Quality of water | Value of (GDI) |
|---|---|
| High | (17.5- 20) |
| Good | (14 -17.5) |
| Moderate | (10.5 -14) |
| Poor | (7 -10.5) |
| Bad | < 7” |

2. Pollution index:
2.1. The Pollution Sensitivity Index: IPS was calculated using the equation of Prygiel & Coste (1993).

$$IPS=(\Sigma AjSjVJAjVj \times 4.75) - 3.75$$

**Aj**: “Abundance or abundance ratio of the species appears in the sample.
**Sj:** Sensitivity of species to nutrient ranges between (1to 5).
**Vj:** Value species range from (1to 3) shown in special tables.
The pollution sensitivity index values range from (4 to 20)”

**Table 4. IPS Values.**

| Quality of water | IPS value |
|---|---|
| High | (17 -20) |
| Good | (13-17) |
| Moderate | (9-13) |
| Poor | (5-9) |
| Bad | <5 |

**Statistical analysis**

Data was analyzed using SPSS (version 26, SPSS Inc. Chicago, Illinois, USA). Descriptive statistics (mean, standard deviation), Statistical analysis was carried out using One-way ANOVA at $p \leq 0.05$, and differences were compared by using least significant difference (LSD). The relationship between studied parameters was determined by Pearson's correlation coefficient (r).

RESULTS

**A- physico-chemical parameters**

In this research, Table 5 shows physico-chemical characteristics as yearly rates. Temperature ranged 20.32°C.pH of water samples were 7.45. The dissolved oxygen content was 11.114 mg. L-1 . Nitrate levels were 4.864 mg. L-1. The nitrite rise is 2.396 mg. L-1 . Phosphorus was 1.576 mg.

**Table 5: Range of mean values of Physicochemical Parameters in Al-Rumeytha River during the study period.**

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| parameters | Mean± St |
|---|---|
| Temperature | 20.32 ±5.59 |
| pH | 7.45±0.387 |
| E .C | 1985.93±645.04 |
| Turbidity | 17.099±14.77 |
| DO | 11.114±0.458 |
| $PO_4$ | 1.576±0.285 |
| $NO_2$ | 2.396±0.302 |
| $NO_3$ | 4.863±0.928 |

**B- Trophic Indices**

Trophic Diatom Index (TDI): used for monitoring diatoms in aquatic ecosystems, as they are very sensitive to changes caused by a variety of factors other than nutrients (Kelly & Whitton, 1995). TDI's recent results ranged from the lowest rate (47.77) in Autumn to the highest rate (56.74) in spring, while the lowest value (27.14) in site 2 and the highest value (83.63) in site3 (Figure 2).

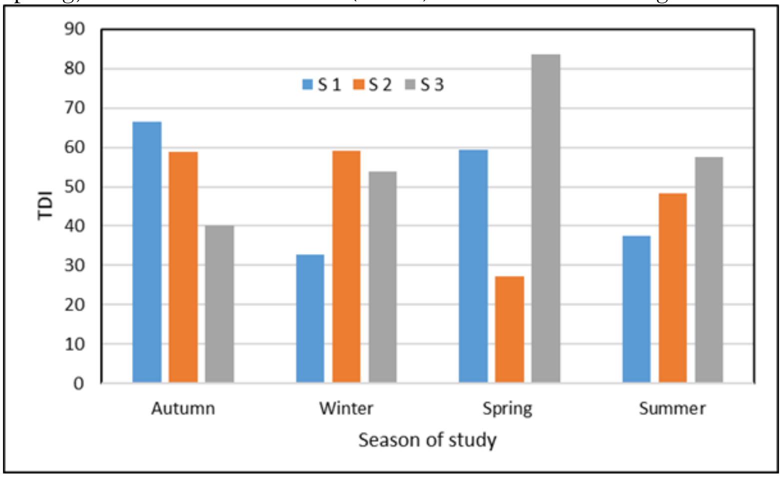


**Fig.2 Seasonal Variations for Trophic Diatom Index values in Al-Rumaytha river water.**

**General Diatoms Index (GDI):** is a successful instrument for stream checking, as the diatom local area is delicate to changes in non -nutritional variables (Hassan & Shaawiat, 2015).The current study showed that the mean value of (GDI) ranged from (11.64) in Winter to (13.07) in Spring, index values ranging between (9.25) in site1 and (17.38) in the site 3 (Figure 3).

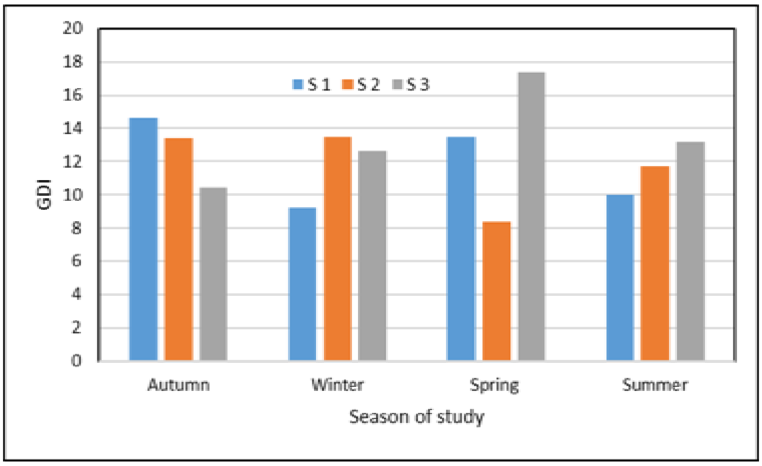


**Fig.3 Seasonal Variations for General Diatoms Index values in Al-Rumaytha river water.**

**Pollution Sensitivity Index (PSI)**

According to the IPS values, the results demonstrated that the Al-Rumaytha river was oderate to good .The mean value ranged between (6.15 in site 2) and (16.89 in site 3) (Fig. 4) .The statistical study shows favorable relationships between IPS, GDI, and TDI and temperature, pH, NO3, and DO. Positive connections exist between TDI, IPS, and GDI.

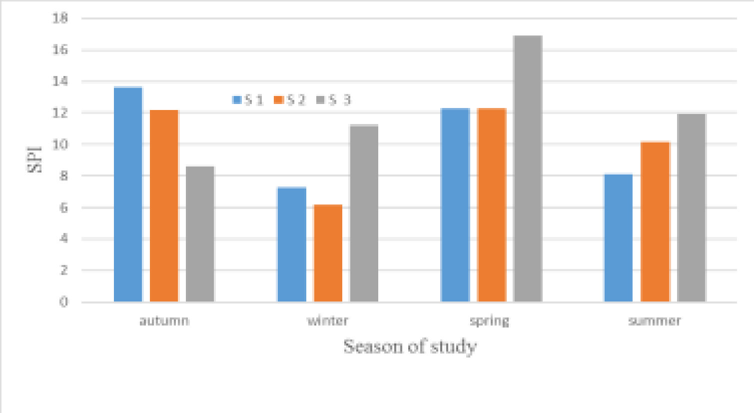


**Fig.4 Seasonal Variations for Pollution Sensitivity Index values in Al-Rumaytha river water.**

**Discussion**

**A- physic-chemical parameters**

Water quality depends on temperature, which impacts gas and salt solubility and aquatic creature behavior, physiology, and distribution (Apori *et al.*, 2024). pH of water samples was slightly neutral according to criteria proposed by Reid, many studies in Iraqi inland water recorded the buffer capacity of water such as (Salman et al., 2013), dissolved oxygen readings were greater than in the Al-Bayati (2016) investigations. Nitrate levels were higher at all locations owing to increasing agricultural activities and sewage wastes dumping into research sites, the greatest nitrate content was attributable to excessive irrigation after fertilizing agricultural fields(Tesoriero *et al.*, 2013).Concentrations Nitrite may rise owing to decreasing algal and aquatic plant consumption or nitrogenous pollutant fluxes (Al-Hamdani *et al.*, 2012).High water levels may cause the maximum phosphorus content, which is caused by over irrigation after fertilizing agricultural land((Yisa & Jimoh, 2010)

**B- Trophic Indices**

**Trophic Diatom Index (TDI)**

In current study, TDI values are lowest than those found by (Lkr *et al.*, 2020).The results show that Al-Rumaytha river has a level of (oligotrophic to hypertrophic) and water quality of (medium to good), which is in agreement with ((Al-Fanharawi, 2017).

**General Diatoms Index (GDI)**

According to the results the water quality of the Al-Rumaytha River is classified as moderate to good or poor to good, based on the range of values, as compared to the index values identified by the Iraqi Ministry of Environment and Water. Good water quality with low or no pollution was indicated by higher values of GDI (Hassan & Shaawiat, n.d.)

**Pollution Sensitivity Index (PSI)**

According to the IPS values and environmental changes (rainfall, reduced temperatures and increased concentration of nutrient), the affect establishment of sensitive and tolerant species. Moderately polluted waters are often associated with untreated municipal, industrial or agricultural discharges. Diatom communities at these sites tend to be species-poor, with taxa indicative of medium to high nutrient levels (Rivera-Rondón & Catalan, 2020).

## CONCLUSION

Al-Rumaytha river water was classified as high pollution, oligo-trophic to hypertrophic and moderately polluted according to diatom indices IPS, TDI, and GDI respectively. According to the findings, water quality at site 3 was oligotrophic to hypertrophic (TDI) and moderate to excellent (GDI) throughout spring.

## DECLARATIONS :

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**Competing interests' statement**

The authors approved that there is no conflict of interest from any parties upon publication of this manuscript .

**Ethics statement**

All authors approved that this research followed the journal's ethical guidelines, as indicated on the journal's author guidelines page .

**Author contributions**

All the authors contributed equally to designing research, data collection, data acquisition, data analysis, reporting, and manuscript preparation.

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**Data availability**

Datasets related to this article will be available upon request to the corresponding author.

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