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Using Diatom Indices to Evaluate Water quality In Abu-Zirig Marsh Thi-Qar Province /south of Iraq

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Abstract:

The study attempts to assess water quality in Abu-Zirig Marsh which used epiphytic Diatom community for assessing water quality. Many of Diatom indices {Trophic diatom index (TDI), Diatom index (DI), Generic diatom index (GDI) have been used to give qualitative information about the status of the freshwater ecosystem(good, moderate, high pollution). In this study, the epiphytic diatoms on both host aquatic plants *Phragmites australis* and *Typha domengensis* were collected from Abu-Zirig Marsh within Thi-Qar Province at three sites in Autumn, 2018 and winter, 2019. Epiphytic diatoms were Identified by the preparation of permanent slides method, some species of epiphytic diatom showed dominance such as *Cyclotella meneghiniana, Gomphonema angustatum, Cocconies placentula, Cymbella affinis, Navicula cryptoephala, Nitzschia linearis, N. dissipata, Surirella ovalis*. Abundant diatoms indicated trophic conditions of the Marsh. The results of diatom indices revealed that IPS (10-12.5) is a moderate pollution condition of marsh, DI (2.9-3.4) range from high to moderate pollution condition, TDI (47.2-60.8) indicates trophic condition ranging from (oligo-mesotrophic to eutrophic) condition of marsh while GDI a range between (11.6-13.7) moderate pollution condition, the aim of the study that is about evaluating water quality of Abu-Zirig Marsh by using Diatom indices (IPS,DI,TDI and GDI), as well as due to scarce local previous studies of epiphytic diatoms and used as bio-indicator of water quality in Abu-Zirig Marsh, therefor suggested this study .

Key words: Abu-Zirig Marsh، Epiphytic diatom, Diatom indices, Water quality.

Introduction:

The Marshes in Southern Iraq, identified as the Mesopotamian marshlands were previously the largest wetlands in the Middle East before their drought in (1992) (1). Nowadays the Marshes represent more than 15,000 km^2 across two large rivers, Tigris and Euphrates (2). Mesopotamian marshes are a distinct ecosystem with their unique biodiversity of flora and fauna. Also, the marshes act as a natural filter for contaminants coming from the Tigris and Euphrates rivers (3). Abu-Zirig Marsh is a natural depression located in the south and south east of Al Islah town, and to the northeast of the Al-Fahud City and around 30 km^2 east of Nasiriyah. The major source of water in the marsh is out of the Shatt Abu-Lihia (Bottom section of the Gharraf River), (4). Former studies involved; phytoplankton and their relationship with physical-chemicals parameters to monitoring the restoration process of Abu-Zirig Marsh (5) and about seasonal variation and diversity of epipelic algae (6).

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Diatom groups are used as bio-indicators for evaluating water quality of the marsh (7). Several local studies deal with epiphytic algae such as (8, 9, 10, 11, 12, 2, 13) which include species identification and counting frustule of diatoms as well as the study of their distribution. Diatoms (class: Bacillariophyceae) are eukaryotic, single-cell, photosynthetic and contain different distinct geometric shapes. Diatoms are classified into two main orders: 1) centric and 2) Pennants. The identification of Diatom depends on morphological figures such as shape, size, and ornamentation frustule. Diatoms are either plankton (floating free) or benthic (attached to a substrate) in nature that can be found on the artificial surfaces (12). Diatoms are distinguished by their capacity rapidly to respond to environmental changes, deterioration of water quality, nutrients, acidification and metals are thus used to monitor ecological status, for those reasons used as an index for monitoring water quality (14). The study aims to use epiphytic diatom indices (IPS, DI, TDI, GDI) to evaluate water quality of Abu-Zirig Marsh, the study performed about

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epiphytic diatoms due to their dominance in aquatic environment of Iraq (8).

Materials and Methods:

Samples of epiphytic diatoms were collected monthly for two seasons (Autumn, 2018 to Winter, 2019) from three sites (Table 1) selected along Abu-Zirig Marsh in Thi-Qar Province (Fig.1) for each host aquatic plant *(Phragmites australis* Trin. ex. , *Typha domengensis* Pers), [**Site1**: Inlet of Marsh, described as site inlet water to the marsh from Shatt Abu-Lihia with high recharge, Commonly aquatic plants in site *Typha australis*, *Ceratophyllum demersum* **Site2**: Center of Marsh**,** it's about 3km from the first site, describe with intensity aquatic plants such as; *T. australis*, *P. australis.* Also, present aquatic birds and buffalo animals. **Site3**: [Outlet of Marsh], near The Shrine of Mr. Ywshe, it's about 5km from the second site, commonly aquatic plants *T. australis*, *P. australis.* The samples were put in polyethylene containers with small amount of water environment and 5-10ml of 4% formalin were added to solution in the field until arrival to laboratory (1). For qualitative analysis; weight 10g of host plants were cut into small parts 2-3 cm and shaken with 50-100ml of environment water then scrapped surface plant by smooth brusher or the blade isn't sharp then samples were preserved in plastic containers with 1ml of Lugol solution.(12) (15). For quantitative analysis includes separate diatom cells from host plants *(P. australis, T. domengensis*),then putting the sample of diatom cells in cylinders of (100ml) for 10-15 days with 1ml of Lugol solution for precipitation, then keep precipitating (20-30ml) in containers with added drops of Lugol solution (16).prepared of permanent of epiphytic diatom for identification by the light microscope 100x (8). To identify epiphytic diatoms depended on key references (1, 10, 12, 17 and 18).

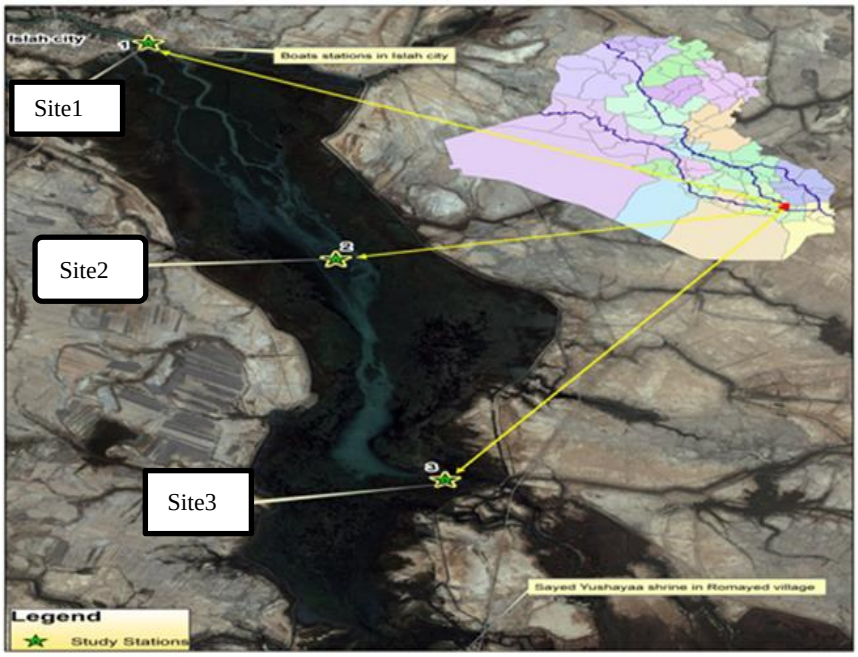

Figure 1. Image of the sites in Abu_Zirig Marsh Southern Iraq (Google Map).

Table 1. The geographical position of the study sites.

No.	Sites	The coordinates	
		Longitude (eastwards)	Latitudes (northwards)
1	Inlet of marsh	46 °14' 212"	31° 02' 113"
2	Center of marsh	46° 37 ' 881 "	31°07 ' 285 "
3	Outlet of marsh	46°38 ' 560 "	31° 04' 599"

Trophic Indices:

1. Diatomic index (DI): DI is calculated according to Descy's list (19) which consists of 106 species by as following :

$$DI = \sum \mathbf{Aj} \times \mathbf{Ij} \times \mathbf{Vj} / \mathbf{Aj} \times \mathbf{Vj}$$

Aj: Relative abundance of the species j present in the sample.
Ij: Sensitivity index of the species.
Vj: Value of Index.
Calculated value of the DI index was varied from 1 to 5, Table 2. In order to simplified interpretation of the result, the following quality classes adopted:

Table 2. The values of diatom index and their interpretation.

Value of diatom index	Interpretation values
4.5	Best biological quality, no pollution
4-4.5	Almost normal quality (Slight changes in the community, slight pollution)
3-4	Most important changes in the community, decreases of the sensitive species, moderate pollution or significant eutrophication
2-3	Resistant species dominant, decreases or disappearance of the sensitive species (reduced diversity), high pollution
1-2	The market dominance of a few resistant species (many species disappear), very high pollution

2. Trophic diatom index (TDI): Calculated TDI based on 86 diatom taxa chosen for their indicator value (tolerance to inorganic nutrients), and identification easily (20).

Index calculated by Table 3 and equation:

$$TDI = \sum(AjS\ jVj\ /\ AjVj\ X25) - 25$$

Aj: Abundance or proportion of species j in sample

Sj: Species sensitivity to nutrient j in the sample (1-5) values range from 1for sites with very low nutrient concentrations to 5 for sites with very high nutrient concentrations

Vj: Value of Index (1-3)

Table 3. The values for TDI ranged from 0-100.

Pollution Degree	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

3.Generic Diatom Index (GDI): This index explains by equation (21) and Table 4, as follows:

$$GDI=(\sum AjSjVj/AjVj)x4$$

Aj: Abundance or proportion of species in the sample.

Sj: Species sensitivity to nutrients (1-5)

Vj: Value of the index (1-3).

Table 4. The values of Generic Diatom Index (GDI).

Water Quality	Value of (GDI)
High	17.5- 20
Good	14 -17.5
Moderate	10.5 -14
Poor	7 -10.5
Bad	< 7

Pollution Index:

The Pollution sensitivity index (IPS):

IPS was estimated based on equation applied by (22):

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

Aj: Abundance or the ratio of the species appears in the sample.

Sj: Sensitivity species to nutrient ranges (1-5) show in special tables.

Vj: Value species range from (1-3) shown in special tables.

The Pollution sensitivity index values ranging from (4-20),Table 5 .

Table 5. Values of the pollution sensitivity index.

Water Quality	Value index IPS
High	17 -20
Good	13-17
Moderate	9-13
Poor	5-9
Bad	<5

Results and Discussion:

Epiphytic diatoms use to monitoring water quality of Abu-Zirig Marsh as indices [Diatom index (DI), Trophic diatom index (TDI), Generic diatom index (GDI)and Pollution sensitivity index (IPS)].Table 6 Show the results of Pollution Sensitivity Index (IPS) from10 to12.5 , and Generic diatom index (GDI) from11.6-13.7 moderate pollution state at three sites during the period study, due to change environmental such as, rainfall, low temperature and increase nutrient concentration that effect on founding sensitive and tolerant species (23). While, DI showed high pollution level 2.9 in two seasons at site1 due to the increase in discharge water from the Shatt Abu-Lihia (Bottom section of the Gharraf River), agriculture activity in some surrounding regions. But sites 2,3 showed moderate pollution 3-3.4 during the same period due to more clear changes in diatom community and disappearance and decreases of the sensitive species (19). As winter, 2019 recorded the highest value of (TDI) 60.8 (eutrophic state) in sites 2 due to appear some geneses *D. vulgare* referred to water quality ranging from Mesotrophic to Eutrophic, species *G. parvulum* indicates the ability to tolerate water rich in nutrients highly associated with low DO concentration which may cause the dominance of tolerance species and decrease or disappearance sensitive species, *N. palea* was also present in the largely detected nutrient-rich water (24). Values of (TDI) in other sites ranged between 47.2 to 55.8 (oligo-mesotrophic to mesotrophic) in both seasons due to the domestic waste disposal in the sites, agriculture activity in some surrounding regions, increase nutrient concentration (8, 25).

Table 6. Values of diatom indices and pollution indices applied during the present study at Abu-Zirig marsh in seasons Autumn2018 and Winter2019.

Season	Sites	Pollution index		Diatom indices					
		SPI	Pollution state	DI	Pollution state	TDI	Pollution State	GDI	Pollution State
Aut. 2018	1	10.1	Moderate	2.9	High pollution	47.8	Oligo-mesotrophic	11.7	Moderate
Win.2019	1	10	Moderate	2.9	High pollution	47.2	Oligo-mesotrophic	11.6	Moderate
Aut2018	2	10.4	Moderate	3	Moderate	49.6	Oligo-mesotrophic	11.9	Moderate
Win.2019	2	12.5	Moderate	3.4	Moderate	60.8	Eutrophic	13.7	Moderate
Aut2018	3	10.4	Moderate	3	Moderate	49.5	Oligo-mesotrophic	11.9	Moderate
Win.2019	3	11.6	Moderate	3.2	Moderate	55.8	Mesotrophic	12.9	Moderate

Conclusion:

The results reveal that the diatom indices IPS (moderate pollution), DI (high to moderate pollution), TDI (oligo-mesotrophic to eutrophic), GDI(moderate pollution) can evaluate water quality and trophic status (TDI) by application in ecosystem due to tolerance and sensitive species of diatom.

Authors' declaration:

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are mine ours. Besides, the Figures and images, which are not mine ours, have been given the permission for re-publication attached with the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee in University of Baghdad.

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استخدام الأدلة الحيوية الدايتوميه لتقييم نوعية المياه في هور أبو زرك / جنوب العراق

ليلى سامي ابوهدل **جنان شاوي الحساني**

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الخلاصة:

تتضمن الدراسة الحالية تقييم نوعيه المياه في هور ابو زرك باستعمال مجتمع الدايتومات الملتصقة على النباتات لتقييم نوعيه المياه.استعملت الأدلة الحيوية الدايتوميه {دليل الدايتوم الأغتذائي(TDI)،دليل الدايتوم (DI)، دليل الدايتوم العام (GDI)} لإعطاء المعلومات النوعية عن حاله المسطح المائي العذب(جيد ،متوسط ،عالي التلوث). خلال الدراسة جمعت الدايتومات الملتصقة على نباتي القصب والبردي من هور ابو زرك داخل مدينة ذي قار بثلاث مواقع في فصلي الخريف 2018والشتاء2019 وشخصت بطريقه تحضير السلايدات الدائمة، أظهرت النتائج سيادة بعض الانواع من الدايتومات *Cyclotella meneghiniana, Gomphonema angustatum, Cocconies placentula, Cymbella affinis, Navicula cryptoephala, Nitzschia linearis, N. dissipata, Surirella ovalis.* وفره , الدايتومات تكشف الحاله الاغتذائيه للهور حيث كانت قيمه IPS(10-12.5)متوسطة التلوث ،DI(2.9-3.4)من عالي الى متوسط التلوث،TDI(47.2-60.8)والذي يظهر الحالة الأغتذائيه للهور بين (oligo-mesotrophic-eutrophic) أما GDI(11.6-13.7)كان متوسط التلوث خلال الدراسة. أثبتت النتائج قدرة ألاله الحيوية الدايتوميه (DI,IPS,TDI,GDI) في تقييم نوعية المياه في هور ابو زرك . نتيجة الى قله الدراسات المحلية عن الطحالب الملتصقة على النباتات واستخدامها كدليل حيوي لتقييم نوعيه المياه في هور ابو زرك ،اقترحت هذه الدراسة .

الكلمات المفتاحية: هور أبو زرك، الدايتومات الملتصقة، أدلة الدايتومات ،نوعية المياه.