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Application of Organic Pollution Index (OPI) to assess the water quality of Al-Chibayish marsh, southern Iraq.

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Abstract:

The Organic Pollution Index (OPI) was applied for descriptive and quantitative assessment of the levels of organic contamination at six stations selected at Al-Chibayish marsh monthly during the period Augst, 2018 to July, 2019. Selected a set of physical and chemical variables affecting the organic pollution index (NO_2, NH_4, BOD_5 and PO_4). Results showed that the values of the pollution index ranged from 3.8 to 4.5 during the studied period. Generally, the value of OPI was (4.2) for Al-Chibayish marsh, which is classified as the second category (weak). Principal Component Analysis (PCA) showed that the most controlling factors in the organic pollution index were nitrite and ammonium ion followed by biological oxygen demand and active phosphate.

Keywords: Al-Chibayish marshes, Water Pollution, OPI.

Introduction

Preserving freshwater resources is an important priority in countries of the world and requires monitoring programs to protect their sources from pollution (Pesce and Wunderlin, 2000). In general, aquatic environments have a complex structure that requires careful exploitation in order to ensure the sustainability and continuity of the water system. Furthermore, the management of aquatic environments requires an understanding of the interrelationship between ecosystem characteristics and the ways by which a person can conduct his activities without changing the physical and chemical characteristics of aquatic environment (UNEP-GEMS, 2006). Water resources have received increasing attention from specialists in light of the increasing need to secure the requirements for the advancement of industrial, agricultural and environmental conditions and ensure the vocabulary of food security, accompanied by the deterioration of water quality as a result of continuous pollution in the sources of water systems (Al-Abadi, 2011).Marshes are of an important part of the area of southern Iraq and an important source of many water resources such as fisheries, reeds, agricultural and animal products. As a result of increasing human activities and the progress of civilization, pollution in the marshes has increased caused many changes in the environmental specifications of these areas and its revival (Jawad, 2008). Al-Chibayish marsh exposed to the discharge of untreated wastewater, which contains a lot of nutrients and toxic chemicals, a qualitative water evidence, has been used to describe the temporal and spatial variations of water quality according to different pollutants that reach water from different sources (Wang *et al*., 2008). The aim of the present study is to describe and quantify the levels of organic pollution of Al-Chibayish marshes using the Organic Pollution Index (OPI) to give a clear and expressive picture of the organic pollution of water and to determine the effective variables by calculating the index of organic pollution.

2-Materials and methods

Description the study area

Central marshes (Al-Chibayish) are bordered to the north by Amara road, Tigris river to the east, the Gharaf river to the west and the Chibayish road adjacent to the Euphrates river in the south. Al-Chibayish marsh is located at north of the Euphrates river and in the middle of the central marshes.

Before the desiccation, it was supplied with water from Tigris river but after the restoration in 2003, it became supplied from Euphrates River (IMOS,2006; Hussain, 2014). six stations were choosen six stations at Al-Chibayish marshes to collect water samples monthly from Augest, 2018 to July,2019 from a depth of 15 – 20 cm (Fig. 1).

Water samples were collected by using polyethylen bottles (5 liters) filled in full capacity, to prevent the affect of the transfer and movement of water to change their characteristics. Winkler bottles were used to collect water samples for measuring the (BOD_5) according to the APHA (2005) method. The distillation method was used to estimate the ammonium ion, while the colorimetric method was used to measure nitrite in water as described in (APHA, 2005). The Ascorbic acid method (Strickland and parsons, 1972) was used to determine the reactive phosphate in water samples.

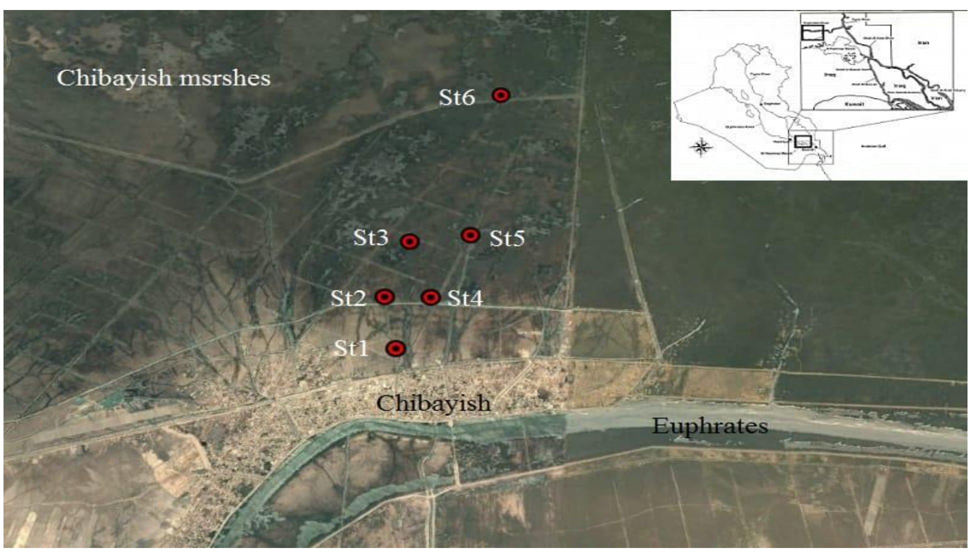

Fig 1: Map of the study stations.

Organic Pollution index

OPI index are used to assess the levels of organic pollution in rivers and lakes, which is an efficient method of chemical monitoring of water quality (Liu *et al*., 2011). The OPI was calculated based on Guasmi *et al*. (2010) as the average number of classes of four properties (BOD_5, NH_4, NO_2, PO_4). The class limits and the evaluation of organic pollution types were showed in Tables 1 and 2

Table 1: Class limits of pollutants (Leclercq,2001).

Classes	BOD_5 (mg/l)	Ammonium (mg N/l)	Nitrites (µg N/l)	Phosphates (µg P/l)
5	<2	<0.1	≤5	≤15
4	2-5	0.1-0.9	6-10	16-75
3	5.1-10	1.0-2.4	11-50	76-250
2	10.1-15	2.5-6	51-150	251-900
1	>15	>6	>150	>900

Table 2: Grid evaluation of organic pollution types (Leclercq,2001).

Limits	Organic pollution level
5.0-4.6	None
4.5-4.0	Weak
3.9-3.0	Moderate
2.9-2.0	Strong
1.9-1.0	Very strong

Statistical analysis

ANOVA test (one-way) was used by the application of the statistical analysis program Minitab version (16.1) to analyze the seasonal and spatial variations, the basic technique principal component analysis using XLSTAT 2015 to determine the most important water quality variables that affect the organic pollution index values.

Results and discussion

Seasonal variation was calculated in four periods, Autumn (September – November.), Winter (December-February), Spring (March-May) and Summer (June-August). Results showed the variables values of (OPI) different. Biological Oxygen Demand (BOD_5) values were fluctuated during the studied period, the highest value (6.9 mg/l) was recorded in November at station 2, while the lowest value (0.4 mg/l) recorded in February at stations 2 and 6 (Fig.1-A), significant differences ($P\leq0.05$) were also found among stations, The highest mean-value of (2.3 mg/l) at station 4 and lowest mean value (0.9 mg/l) at station 6. Significant differences ($P\leq0.05$) were found among seasons, The highest mean value (3.1mg /l) was recorded in summer, while the lowest mean value (1.46 mg/l) was recorded in spring. The ammonium values ranged from (17.4 mg/l) in August at station 1 to (0.6 mg/l) in May at stations 3 and 6 (Fig. 1-B). Significant differences ($P\leq0.00$) were found among stations, the highest mean value (7.9 mg/l) at station 6 and lowest mean value (1.8 mg/l) at station 5. Significant differences ($P\leq0.05$) were found among seasons, the highest mean value (5.9 mg/l) was recorded in Winter, while the lowest mean value (2.7 mg/l) was recorded in Autumn. Nitrite concentration ranged from (21.8 µg/l) in November at station 4 to (0.10 µg/l) in may at station 6 (Fig. 2-A). Significant differences ($P\leq0.05$) were found among stations, the highest mean value (7.67 µg/l) at station 4 and lowest mean value (0.3 µg/l) at station 6. Significant differences ($P\leq0.05$) were found among seasons, the highest mean value (11.3 µg/l) was recorded in Spring, while the lowest mean value (1.61 µg/l) was recorded in Summer.

The highest value of reactive phosphate (10.35 µg/l) was recorded in December at station 1, while the lowest concentration (0.13 µg/l) was detected in May at station 6 (Fig.2-

B). Significant differences ($P < 0.05$) were found among seasons, the highest mean value (3.85 µg/l) was recorded in Autumn, while the lowest mean value (1.09 µg/l) was recorded in Summer, furthermore significant differences ($P<0.05$) were found among stations, the highest mean value (5.85 µg/l) was recorded at station 1, the lowest mean value (0.43 µg/l) was recorded at station 6.

The annual rates of the OPI values in the study stations varied between the lowest value (3.8 Moderate) in the first and fourth station in winter and the highest value (4.5 Weak) in the fifth station in the both winter and spring. The overall average of all stations, which represents the status of Al-Chibayish, was recorded (4.2). Thus, Al-Chibayish marshes was classified under the second category as Weak Organic Pollution (Table 3). Statistical analysis showed a significant difference ($p\leq 0.05$) between stations. The lowest values were in the first and fourth station and the highest values (4.3 Weak) in the fifth station.

The seasonal variations in OPI values were characterized for the six stations with different values. The lower OPI values in the spring might be attributed to the increased the consumption of nutrients by the phytoplankton and aquatic plants (Huq *et al*., 1978; Twomey and Jhon, 2001). on the other hand, it may be attributed to water flow increment that enter the marshes during the spring, which may disperse the potential pollutants in water. The spatial changes in the values of the index showed decreased in the first and fourth stations significantly. This explains the severity of the impact of these stations with organic pollutants that are directly discharged to the marshes without any treatment. Sewage stations in Al-Ghumaija and Al-Machri were also affected by liquid wastes of livestock due to near the residential for animal breeders to these stations, addition to being affected by agricultural fertilizers,There is a lack of aquatic plants and phytoplankton in these stations that consume nutrients as well as rainfall that dissolves atmospheric nitrogen and drifting chemical fertilizers, The reduction of nutrients concentrations due to their comsuption by phytoplankton and aquatic plants, particularly during blooming season which lead to elevate the values of OPI (Twomey and Jhon, 2001).

It was noted that the value of the index cannot be generalized to all stations, since each station has its own pattern in terms of the influence of the controlling factors and therefore its sensitivity to the evidence (Maitera *et al*., 2010).

In general, the value of the OPI for the marshlands was recorded (4.2) and this is classified under the category of weak organic pollution. The main reason for this is the effect of sewage plants that drain waste water to the marshes directly without treatment, as well as the low discharge of water entering the marshes from the Euphrates River, which was act to dilute the wastewater, that may have caused the low quality of the marshlands, which was once considered the pride of the central marshes, thus the marshes are classified as organic polluted marshes (Liu *et al*., 2010).

The results of the PCA analysis for Al-Chibayish marsh showed the agroup of environmental factors effect directly on values of OPI. nitrite and ammonium ion were the most variables responsible for the deterioration of water quality of the marshes, followed by the BOD_5. As phosphate effective, it is noted that all variables were inversely correlated with evidence of organic pollution index.

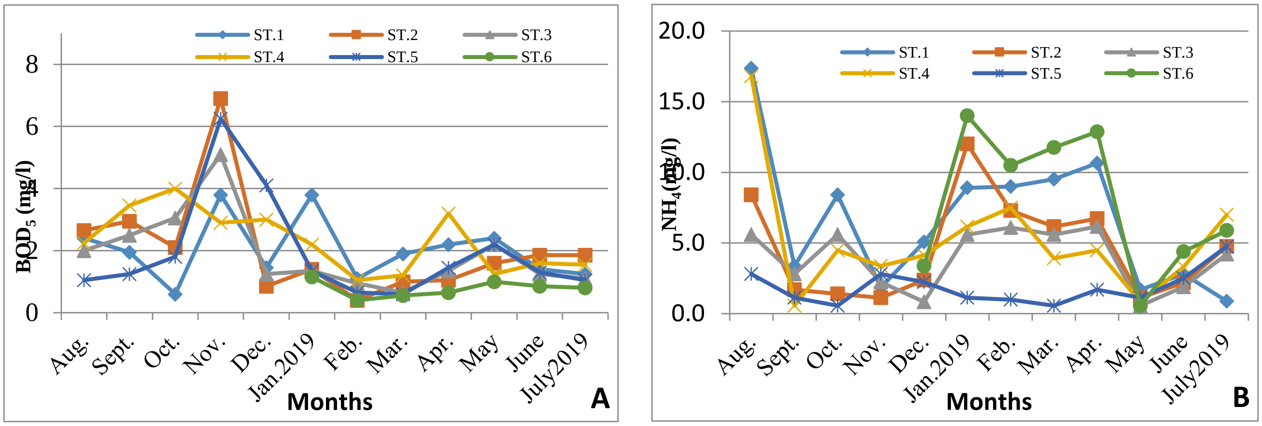

Fig. (1) A: Biological Oxygen Demand (BOD_5) and B: Ammonia(NH_4^+) concentrations (mg/l) at the study stations during Aug.,2018-July,2019.

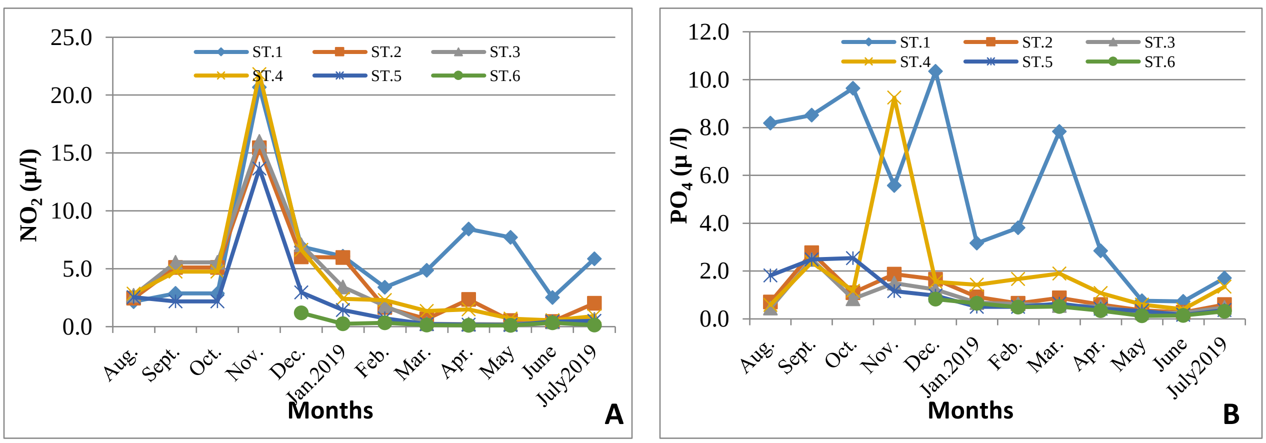

Fig. (2) A: Nitrite(NO_2^-) concentration and B: Reactive Phosphate(PO_4^{-3}) concentration (µ/l) at the study stations during Aug.,2018-July,2019.

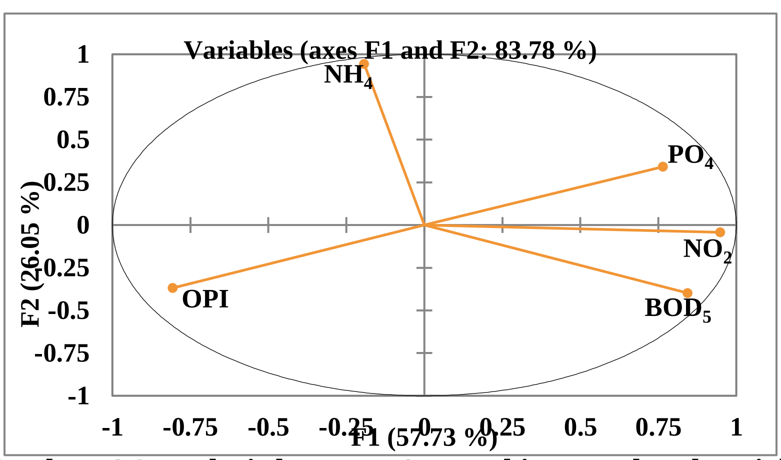

Fig 3. The PCA analysis between OPI and its correlated variables.

Table 3: Organic pollution index (OPI) and taxonomic categories of study stations in Al-Chibayish marshes.

Stations	Season	OPI Values	Descriptions
Station 1	Autumn	4.0	Weak
	Winter	3.8	Moderate
	Spring	4.2	Weak
	Summer	4.3	Weak
Station 2	Autumn	4.0	Weak
	Winter	4.2	Weak
	Spring	4.3	Weak
	Summer	4.2	Weak
Station 3	Autumn	3.9	Moderate
	Winter	4.4	Weak
	Spring	4.3	Weak
	Summer	4.3	Weak
Station 4	Autumn	3.9	Moderate
	Winter	3.8	Moderate
	Spring	4.3	Weak
	Summer	4.3	Weak
Station 5	Autumn	4.2	Weak
	Winter	4.5	Weak
	Spring	4.5	Weak
	Summer	4.3	Weak
Station 6	Autumn	-	-
	Winter	4.1	Weak
	Spring	4.3	Weak
	Summer	4.3	Weak
General rate of marsh Al-Chibayish		**4.2**	**Weak**

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تطبيق دليل التلوث العضوي (OPI) لتقييم نوعية مياه هور الجبايش جنوب العراق

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الملخص:

طبق دليل التلوث العضوي للتقييم الوصفي والكمي لمستويات التلوث العضوي لستة محطات في اهوار الجبايش أثناء الفترة الممتدة من شهر اب ، 2018 ولغاية تموز، 2019. قيست مجموعة من المتغيرات (NO_2, NH_4,BOD_5 and PO_4) المؤثرة على دليل التلوث العضوي. وكانت التغيرات واضحة لدليل التلوث العضوي في محطات الدراسة حيث تراوحت بين (3.8 – 4.5) .اما المعدل العام لقيمة الدليل سجل (4.2) لأهوار الجبايش وبذلك يصنف ضمن الفئة الثانية (ضعيف)، أظهرت نتائج تحليل المكونات الأساسية (PCA) أن اكثر العوامل المتحكمة بمستوى دليل التلوث العضوي هي النتريت وايون الامونيوم ثم المتطلب الحيوي للاوكسجين و الفوسفات الفعالة.

الكلمات المفتاحية: أهوار الجبايش، نلوث المياه، OPI