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Using Prat's index for the evaluation of the pollution in some Iraqi marshes water

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ABSTRACT - Water samples were collected from four sites with three stations at each site from some of the Iraqi marshes (Hor Al-Hammar, Abu-Zarek, Al-Eaz and Hor Auoda). Samples were analyzed for pH, dissolved oxygen, BOD, COD, TSS, nitrate, chlorides, iron, manganese, calcium, magnesium and sodium. Water quality was classified according to Prat's classification, and distribution coefficient (Kd) for transportation of pollutants between the liquid phase and the solid phase was used. The results indicated that pH and BOD values of water were ranging from excellent to acceptable; dissolved oxygen was excellent; Salinity and T.S.S was excellent and a good indicator for polluted waters; Nitrate was excellent to acceptable; Fe and Mn were acceptable to excellent. Results of Kd values showed that sediment had high concentration of iron and manganese than water which could provide water with iron and manganese.

INTRODUCTION

In the present days, various types of activities, including agricultural, industrial and transportation, produce a large amount of wastes and various types of pollutants. Soil, air and water have traditionally been used as sites for the disposal of all these wastes. For example, beef cattle in the United States are estimated to produce 92 million mt/year of manure, while dairy cattle produce 27 million mt/ year (Pescod, 1992). Some of this manure washed away into the nearby streams, and pollute rivers, lakes and soil.

The most common kinds of waste can be classified into four types: agricultural, industrial, municipal and nuclear (Chapra, 1997). Agricultural wastes include a wide range of organic materials (often containing pesticides), animal wastes, and timber by-products (Amer *et al*., 2002): industrial waste products may be in gas, liquid or solid form and they pose a hazard to the environment. Food processing plants produce both liquid and solid wastes. Another urban waste is municipal garbage. It contains paper, plastic and organic materials. Some of these can be recycled by composting or they may be burnt or disposed of in land fills.

In 1971, Prat *et at*. (1971) proposed an index for surface waters based on the water quality classification systems used in a number of different countries. Their index was found to be a possible tools for establishing a comparative inventory of the quality of water sources in a region or country, but they did not believe it should be used to make wastewater treatment decisions (Wayne, 1978).

The objective of the present study is to evaluate some marshes water pollution by using Prat's classification system for surface water quality, and transportation of pollutants between liquid and solid phase by using distribution coefficient (Kd).

MATERIALS AND METHODS

Water samples were collected from four locations with three station at each location from the southern Iraqi marshes (Hor Al-Hammar-1, Hor Al-Hammar-2, Hor Al-Hamar-3; Abu-Zarek-1, Abu-Zarek-2, Abu-Zarek-3; Al-Ezz-1, Al-Ezz-2, Al-

Ezz-3, Hor Auoda-1, Hor Auoda-2 and Hor Auoda-3) sampling was carried out during the summer of 2006.

Samples were analyzed for pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), nitrates, chlorides, iron, manganese, calcium, and sodium according to the methods mentioned in the standard methods (1995).

Prat's classification system was used for the determination of marshes water quality according to Ott (1978). Distribution coefficient (Kd) for transportation of pollutants between liquid phase (water) and solid phase (marshes sediments) was calculated according to the formula:

$$Kd = \frac{\text{Concentration of pollutant in solution (mg Kg}^{-1})}{\text{Concentration of pollutant in solid (mg Kg}^{-1})}$$

RESULTS AND DISCUSSION

Table (1) shows the chemical and biological analyses of the twelve stations in the Iraqi marshes waters, which including pH, D.O, BOD,COD, TSS, NO_3^-, Cl^-, Fe^{+2} and Mn^{+2}. The pH values of the studied waters were ranging between 7.2 (Location 3- Hor Auoda-2) and 8.2 (Location 2- Abu Zarek) with the mean values of 7.43, 8.00, 7.80 and 7.97 for the locations 1, 2, 3, and 4, respectively (Table 1), These waters are classified as an excellent to acceptable according to Prat's classification (Table 2).

There was no study using this classification for the marshes water in Iraq, while there are some studies applying another classification such as Richards (1954), Ayers & Westcott (1985) by Ghliem (1997) and Al-Almeri (2007) who found that surface water quality was with mean values of dissolved oxygen for four locations: Hor Al-Hammar, Abu-Zarek, Al-Eaz and Hor Auoda which were 5.33, 9.00, 5.73 and 5.53, respectively, and classified as excellent. These results agree with the results of biological and chemical oxygen demand of the present study which were classified as an excellent to acceptable (BOD 50.87 to 3.47 mg l^{-1}; COD=10.00 to 20.00 mg l^{-1}). In spite of some stations which showed high values of BOD and COD such as location 2 (Abu Zarek 2) and location 1 (Hor Al-Hamar 3) and location 3 (Hor Auoda 3), but they remain as acceptable and there is no problem for using these waters in the course of irrigation. Some Arabic countries used a system for water quality of drains for both public health and for irrigation reuse such as Egypt, with BOD value of 6.0 mg l^{-1} classified as satisfactory and not polluted by law (48/82), and a minimum value of D.O of (2.0 mg l^{-1}) should be required for low dilution discharge into drains, to benefit from the self purification process for reducing pollution (Amer *et al*., 2000).

The main problem of water in the southern parts of Iraq is the salinity, this case is appeared in the chemical analysis of total suspended solids of the marshes water in Table (1). The values were between 4.0 mg l^{-1} (Location-2, Abu Zarek-3) and 199.0 mg l^{-1} (location 3-,Hor Auoda-3) with mean values of 15.33. 77.33, 137.33 and 88.33 mg l^{-1} for 1,2,3 and 4 locations, respectively. According to Part's classification, such waters may be classified as an excellent to slightly polluted.

Table 1: Chemical analysis of some Iraqi marshes water samples during summer 2006.

Index of quality	Location 1			Location 2			Location 3			Location 4		
	Hor Al-Hammar 1	Hor Al-Hammar 2	Hor Al-Hammar 3	Abu-Zarek 1	Abu-Zarek 2	Abu-Zarek 3	Hor Auoda 1	Hor Auoda 2	Hor Auoda 3	Al-Ezz 1	Al-Ezz 2	Al-Ezz 3
pH	7.50	7.50	7.30	8.20	8.10	7.70	8.10	8.10	7.20	7.90	8.10	7.90
Mean	7.34			8.00			7.80			7.97		
D.O ($mg\ l^{-1}$)	5.60	7.40	3.00	10.80	9.6	6.60	6.20	6.20	4.80	5.40	6.20	5.00
Mean	5.33			9.00			5.73			5.53		
BOD ($mg\ l^{-1}$)	1.30	1.60	1.00	2.60	5.40	1.10	2.40	2.30	3.00	0.40	1.20	1.00
Mean	1.30			3.47			2.57			0.87		
COD ($mg\ l^{-1}$)	10.00	10.00	30.00	10.00	10.00	10.00	10.00	20.00	30.00	20.00	10.00	10.00
Mean	16.67			10.00			20.00			13.33		
TSS ($mg\ l^{-1}$)	10.00	28.00	8.00	174.00	54.00	4.00	160.00	53.00	199.00	153.00	106.00	6.00
Mean	15.33			77.33			137.33			88.33		
NO^{-}_{3} ($mg\ l^{-1}$)	3.98	5.15	3.62	22.32	3.63	0.62	11.18	11.38	3.38	9.79	10.67	4.63
Mean	4.25			8.86			8.65			8.36		
CL^{-1} ($mg\ l^{-1}$)	2552.40	2127.00	3793.20	1134.40	1028.10	921.70	1276.20	1240.80	389.90	1311.70	1240.80	1382.60
Mean	2824.20			1028.10			968.97			1311.700		
Fe ($mg\ l^{-1}$)	0.206	0.276	0.276	0.345	0.621	0.414	0.069	0.207	0.276	0.345	0.345	0.414
Mean	0.253			0.460			0.184			0.368		
Mn ($mg\ l^{-1}$)	0.025	0.007	0.019	0.003	0.002	0.074	0.005	0.010	0.0147	0.007	0.009	0.008
Mean	0.017			0.026			0.010			0.008		

Table 2: Prat`s Classification System of Surface Water Quality.

Condition	Excellent	Acceptable	Slightly Polluted	Polluted	Heavily Polluted
Index of Quality	1	2	4	8	>8
pH	6.5-8.0	6.0-8.4	5.0-9.0	3.9-10.1	10.1 >3.9 to>
(%) Dissolved Oxygen	88-112	75-125	50-150	20-200	<20 to>200
5-Day Biochemical Oxygen Demand (ppm)	1.5	3.0	6.0	12.0	>12.0
Chemical Oxygen Demand (ppm)	10	20	40	80	>180
Suspended Solids (ppm)	20	40	100	278	>278
Nitraes (ppm)	4	12	36	108	>108
Chlorides (ppm)	50	150	300	620	>620
Iron (ppm)	0.1	0.3	0.9	2.7	>2.7
Manganese (ppm)	0.05	0.17	0.5	1.0	>1.0

Table 3: Distribution Geologist (kd, $L.Kg^{-1}$) for iron and copper in the studied locations.

Location	Stations	Kd_{Fe}	Kd_{Mn}
Location 1	Hor Al-Hammar 1	0.436	14.265
	Hor Al-Hammar 2	0.569	4.325
	Hor Al-Hammar 3	0.497	25.111
	Mean	0.501	14.567
Location 2	Abu Zarek 1	0.746	90.947
	Abu Zarek 2	1.337	21.424
	Abu Zarek 3	0.902	19.893
	Mean	0.995	44.088
Location 3	Hor Auoda 1	0.150	38.256
	Hor Auoda 2	0.443	24.485
	Hor Auoda 3	0.587	24.964
	Mean	0.393	29.235
Location 4	Al-Ezz 1	0.728	13.040
	Al-Ezz 2	0.746	22.194
	Al-Ezz 3	0.954	22.956
	Mean	0.809	19.397

Ott (1978) mentioned that water with high TSS caused problems for irrigation and public use and must be diluted with excellent water or may be used for tolerant plants.

The high values of TSS agreed with the high concentrations of chlorides in the present study and is classified as heavily polluted (Table 1). Pescod (1992) indicated that waters of the arid and semiarid regions had high values of TSS and TDS (total dissolved salts).

Results in Table (1) showed that nitrate concentrations in the studied waters were between 4.25 and 8.86 mg l^{-1} which may be classified as an excellent to acceptable according to Prat's classification. Mahida (1981) suggested that the source of nitrogen in water are plants and animals which changed to ammonium NH_4^+ and nitrate by ammonification and nitrification process and microorganisms play important roles in these processes. Results of heavy metals analyses (Fe and Mn) indicated that iron concentrations were 0.253, 0.460, 0.184, and 0.368 mg l^{-1} for locations 1,2,3 and 4, respectively which were classified as acceptable (Table 2), while the concentration of manganese were 0.017, 0.026, 0.010 and 0.008 mg l^{-1} for locations 1,2,3 and 4, respectively and classified as excellent (Table 2). Results indicated that there is no problem of heavy metals (Fe and Mn) in the studied waters and may be used for irrigation.

In order to evaluate the transportation and movement of iron and manganese between waters and sediments, distribution coefficient (Kd) was used, and the results are presented in Table (3). The mean values of Kd for the iron and for the four the locations selected were (0.501, 0.995, 0.393 and 0.809)$\times 10^{-4}$ LKg^{-1}, While the mean values of Kd for the manganese were (14.567, 44.088, 295, and 19.397)$\times 10$ LKg^{-1}.It is apparent from the present study that the solid phase (sediments) have a higher concentration of iron and manganese than the liquid phase (water) and the sediments may provide the water with a high concentration of Iron and manganese.

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استخدام دليل Prat's لتقييم تلوث بعض مياه اهوار العراق

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المستلخص جمعت نماذج المياه من أربعة مواقع وبثلاث محطات مختلفة لكل موقع من أهوار العراق. حللت نماذج المياه والتي تضمنت (pH والأوكسجين المذاب و BOD و COD و TSS) والنترات والكلورايد والحديد والمنغنيز والكالسيوم والمغنسيوم والصوديوم). صنفت نوعية المياه وفقاً إلى مفهوم دليل Prat. كما استخدم مفهوم معامل الانتشار (Kd) لانتقال الملوثات بين الطور السائل الصلب. أوضحت النتائج بأن قيم pH وBOD والملوحة والـ T.S.S. (ملوثة إلى ممتازة) والنترات مقبولة إلى ممتازة والحديد والمنغنيز مقبولة إلى ممتازة, كما بينت النتائج بان قيم Kd كانت عالية المحتوى بالحديد والمنغنيز وتجهيز المياه بهذين العنصرين من رواسب الأهوار إلى المياه السطحية الحدودية.