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A Study of Some Physicochemical Parameters and Heavy Metals in the Diwaniyah River / Euphrates, Iraq

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Abstract: ***Metals tend to accumulate in water and move up through the food chain. So, studies to ascertain the level of heavy metals in environment and determine potentially hazardous levels for human are necessary. Samples were monthly collected from three sites along the Diwaniyah River, during Autumn 2012 to Summer 2013. In this investigation, concentration of four heavy metals copper (Cu), zinc (Zn), cadmium (Cd) and lead (pb) in water and sediments have been determined. In addition, some physiochemical parameters of water were investigated. Heavy metal concentrations were measured by flame atomic absorption spectrometry. The results showed that the highest concentrations of heavy metals in water and sediment samples were related to pb and Zn. However, the observed heavy metals concentrations in water and sediments were below the recommended limits for WHO. The investigation showed elevating levels of heavy metals in environment. Thus, a serious notification to industrial and manmade pollution, which can lead to ecosystem and food chain contamination, is necessary.***

Keywords: Diwaniyah River, Limenological, Heavy metals, Water, Sediment.

1. Introduction

Environmental pollution is a worldwide problem, heavy metals belonging to the most important pollutants. The progress of industries has led to increased emission of pollutants into ecosystems. In natural aquatic ecosystem, heavy metals occur in low concentrations mainly due to weathering of soils and their associated bedrocks. In recent times however there has been an unprecedented increase in the level of these metals due to human activities. The occurrence of such metals in excess of natural load has become a problem of increasing concern not only to environmentalists but also to health practitioners.

The concern about heavy metals stems from their persistence in the environment as they are not easily degraded either through biological or chemical means unlike most organic pollutants. The discharge of various metal pollutants in to the aquatic environment as pointed out by [1,2] could damage the quality of the ecosystem thereby rendering water body unsuitable for its intended uses posing a serious health threat to the immediate population. Heavy metals do not exist in soluble forms for a long time in water; they are present mainly as suspended colloids are fixed by organic and mineral substances [3].

2. Materials and Methods

2.1. Study Area

Diwaniyah river (Shatt Al-Diwaniyah) is an extension of the Hilla river in the area stretching from the village of Sunnia which is north of the city, even the southern city of Diwaniyah, about 15 km inside the city (latitude and longitude coordinates are from 32˚ 02˙ 48.38˝ N, 44˚ 46´ 42.27´´ E to 31˚ 39´ 15.48´ N, 45˚ 01´ 53.42 ˝ E respectively).

For investigation of study, 3 sites were chosen along the Diwaniyah River as show in figure 1. The 1st site is before entrance the river to city, the 2nd site is in the mid of the city, and 3rd site is after the river passing the domestic wastewater treatment plant and factories (textile, and rubber factories).

Figure 1: The Study Sites

2.2. Sampling Strategy

Samples of water and sediment were collected from three different sampling sites along the river (study site). The samples were collected monthly (started with November 2012 and finished at August 2013). At each of the sampling sites triplicate samples were collected. Water samples were collected at the depth of 30cm below the surface using 1liter polyethylene bottles with screw caps which were acid washed and rinsed with distilled water prior to the sampling.

Samples were acidified with 1.5ml concentrated Nitric acid (HNO_3)/liter of sample, after air temperature (AT), water

temperature (WT), water flow (WT), transparences, dissolved O_2 (DO), pH (Digital Inolab 720, WTW-Germany) and conductivity (Model 340i/SET, WTW-Germany) (EC) measurements in the field and subsequently transported to the laboratory for analysis. Total dissolved solids (TDS) were determined by WTW multiple meter model 2005(origin Germany), total alkalinity (TA) and oxygen dioxide (CO_2) was determined according to the procedure [4], EDTA titrimetric method was used to determine total hardness as recommended by WHO [5]. Sediment samples (top 10cm) were collected using soil auger, kept on ice in polythene bag and transported to the laboratory [6]. Heavy metals (HMs) measured by flame atomic absorption spectroscopy type Shimadzu AA-6300 Japan according to method that described by APHA [7].

3. Results and Discussion

The mean values ± standard deviation of physiochemical analysis of water samples obtained from the study sites are represented in table 1. Air and water temperatures were in the range 12-35 °C to 14-40.12 °C, respectively, Electrical conductivity was observed 940 µs/cm at site 1 during Jan 2013 and 1193 µs/cm at site 3 in August 2013 respectively, TDS ranged from 113 -1375 mg/L in sites 1 (during July) and 3 (during Aug.) respectively, these values increased in winter months and decreased in summer months [8, 9].

During the study period, the pH was in the ranges from 6.7 to 8.1, during September and April respectively, water flow ranged 21- 44Cm/min in site 3 and 1 during march and October respectively, turbidity ranged from 16 NUT – 52 NUT in site 2 and 3 during September and October respectively, and transparency ranged between 26 Cm -71 Cm in site 1 during July and March respectively.

The dissolved oxygen, and BOD_5 were 4.2 mg/L - 8.9 mg/L (in site 3 and 1 during Aug. and March), and 1.2 mg/L – 5.9 mg/L (during Feb. and Aug. in site 1 and 3) respectively, the values of BOD_5 and Dissolved oxygen that recorded were in limits recommended by EPA [10] for the rivers water. The carbon dioxide, Alkalinity, and total hardness values ranged between 121mg/L – 269 mg/L, 119 mg/L – 271 mg/L, and 275 mg/L – 546 mg/L during April and August in site 1 and 3 respectively.

As show in Table 2, the correlations among TDS, EC, air and water temperature was positive, Positive correlations were recorded between total alkalinity, dissolved oxygen and pH, Many studies have found that Iraqi water was slightly alkalinity [11-14]. The present study found high concentrations of total hardness in all sites during different months, with no significant difference among study sites while there were a negative correlation with dissolved oxygen and positive correlation with water and air temperature. The solubility of oxygen in an aquatic system is influenced the temperature and dissolved salts [15], so the correlation among dissolved oxygen and air temperature, water temperature, turbidity, total hardness, electrical conductivity, carbon dioxide and BOD5 were negative (Table 2).

Table 3; show the concentration of heavy metals in water and sediments in Euphrates River. The results of this study showed that the positive correlation between heavy metals in dissolved phases with air and water temperature, dissolved oxygen, BOD5 , turbidity, EC, CO_2, pH, Total hardness, alkalinity, and TDS while they have a negative correlations with other physiochemical parameters (Figure:3), that was agree with [16].

The concentrations of some heavy metals in water of Euphrates River were low according to WHO and USEPA guidelines, but there were high compared to other Iraqi aquatic systems [17, 18]. This difference with other Iraqi studies may be related to the difficulty of investigating heavy metals in toxic aquatic system, where heavy metal concentrations will be low. Moreover the many factors affect the concentrations, such as: the flow of the dredged materials from upper regions of the river, dilution and increase of water flow, direct drainage from farmlands, factories, sewage disposal plants, dissolution of sediments, increases in the numbers of phytoplankton in water, bioaccumulation, chemical adsorption on sediments and complexes with organic matter [19-21] 57-60. The concentration of heavy metals in all phases were Cd < pb < Cu < Zn, that means the source and fate of these metals are one [22, 23] and that were very clear in table 4, and figure 2.

Table 1: Physiochemical parameters of water in Euphrates River / Diwaniyah City, first line :(mode), second line: mean (±S.D).

	Site.1	Site.2	Site.3
Water temperature	12-34	12-35	12.3-34
°C	21.8±7.5	21.98±7.496	21.783±7.049
Air temperature	14-39	14-39.5	15.5-40.12
°C	25±7.7	25.375±7.652	26.55±7.519
Water flow	25.5-44	25-41	21-37
	34±6.1	33.28±5.343	28.74±5.44
Turbidity	25-49	16-50	31-52
NUT	37±7.8	36.42±9.77	41.548±7.45
Transparency	20-71	28-66	24-60
Cm	46.8±17.7	44.85±13.45	40.83±13.30
EC µs/cm	940-1133	1009-1178	1018-1193
	1028±62.8	1111±60.13	1119. ±60.53
TDS mg/L	113-1043	901-1365	900-1375
	880±247.9	1089±153.47	1099±167.6
pH	7.5-8.1	7.5-8.1	6.7-81
	7.8±0.24	7.8±0.21	25.8±32.88
Total hardness	275-546	331-516	305-522
mg($CaCO_3$)/L	411±79.5	409.92±53.86	401.41±68.08
CO_2 mg/L	121-201	126-245	135-269
	163.3±25.3	176.42±38.22	188.08±42.59
Total alkalinity	119-185	121-179	119-271
mg($CaCO_3$)/L	141.2±25.2	144.92±17.56	175.58±52.6
O2 mg/L	5.2-8.9	4.9-7.9	4.2-8
	7.4±1.11	7±0.881	6.5167±1.01
BOD_5 mg/L	1.2-4.9	1.6-5.2	2-5.9
	2.04±1.06	±1.041	2.742±1.13

Table 2: The correlation among physiochemical parameters of water during the period of study

WT	0.98	1.00										
WF	0.05	0.12	1.00									
TUR	0.57	0.57	0.32	1.00								
TRANC.	-0.68	-0.66	-0.21	-0.60	1.00							
pH	0.43	0.39	-0.21	0.33	-0.29	1.00						
TH	0.65	0.64	0.02	0.36	-0.65	0.35	1.00					
EC	0.64	0.62	0.11	0.38	-0.39	0.38	0.27	1.00				
CO2	0.62	0.58	-0.19	0.38	-0.54	0.64	0.70	0.39	1.00			
TALKA	0.15	0.10	-0.44	-0.01	0.14	0.81	0.05	0.25	0.45	1.00		
O2	-0.75	-0.70	-0.13	-0.61	0.84	-0.47	-0.74	-0.59	-0.72	-0.12	1.00	
BOD5	0.82	0.79	-0.06	0.55	-0.62	0.54	0.71	0.56	0.81	0.33	-0.87	1.00
TDS	0.39	0.36	-0.04	0.26	-0.04	0.41	0.05	0.57	0.41	0.43	-0.30	0.43	1.00
	AT	WT	WF	TUR	TRANC.	pH	TH	EC	CO2	TALKA	O2	BOD5	TDS

Table 3: Mode (first line), Average ± S.D (second line) of different phases of heavy metals in Euphrates River / Diwaniyah City

Element	Site.1				Site.2				Site.3			
	Water		Sediment		Water		Sediment		Water		Sediment	
Cd	Dissolved µg/L	Particulate µg/g	Exchangeable µg/g	Residual µg/g	Dissolved µg/L	Particulate µg/g	Exchangeable µg/g	Residual µg/g	Dissolved µg/L	Particulate µg/g	Exchangeable µg/g	Residual µg/g
	ND-1.05	2.94-9.15	0.09-2.7	0.68-4.56	ND-1.9	3-10.9	0.94-2.6	0.079-6.34	0.038-1.9	4.41-8.9	0.55-5.97	1.29-8.22
	0.4675±0.37	4.9583±1.841	1.36±1.07	2.39±1.66	0.7092±0.6153	5.9992±2.5725	1.73±0.89	3.03±2.42	1.0532±0.63579	6.265±1.409	2.91±2.38	5.09±3.02
Zn	2.01-10.51	35.21-400	6.55-12.65	20.05-36.25	5.62-15.98	40.19-150.3	9.2-18.06	42.5-73.21	8.3-16.4	109.11-211.1	5.6-16.31	23.89-81.59
	7.7658±2.2027	75.369±102.43	9.52±2.83	27.39±6.77	11.465±3.1279	72.9142±34.1678	15.04±3.96	53.67±13.49	12.345±2.8933	131.0925±29.7693	10.16±4.64	54.64±27.06
Pb	0.5-1.32	4.12-9.55	0.46-1.75	13.1-23.53	ND-2.9	5.99-13.11	0.81-2.08	15.94-27.19	1.98-7.12	15.77-48.19	1.28-2.79	17.93-30.51
	0.9583±0.2501	6.7317±1.976	0.92±0.58	18.73±4.52	1.0708±0.7774	8.8558±2.0053	1.43±0.54	21±4.65	4.7517±1.9283	35.7125±11.5101	1.89±0.73	23.44±5.34
Cu	2.45-4.01	27.13-41.12	4.9-1.75	17.52-22.37	2.71-5	28.5-44.41	5.75-9.78	21.53-35.39	4.12-12.45	40.98-69.19	8.84-13.9	25.15-36.26
	3.3458±0.584	32.2017±3.5069	6.91±1.34	20.02±2.11	3.6942±0.8148	35.6583±4.4763	7.74±1.73	28.19±5.67	8.0858±2.5553	57.6542±9.4757	12.21±2.31	30.27±4.66

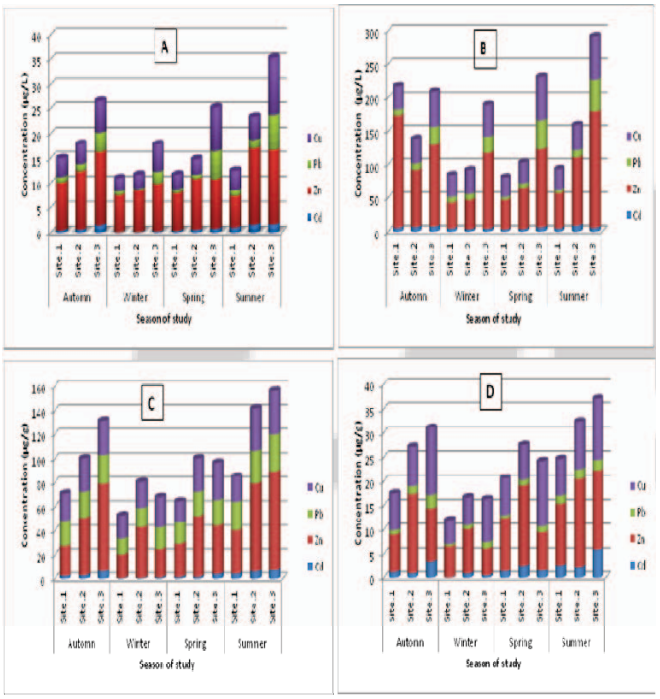

Figure 2: The mean of Seasonal variation of Dissolved (A), Particulate (B), Exchangeable (C), and Residual (D) heavy metals in study sites

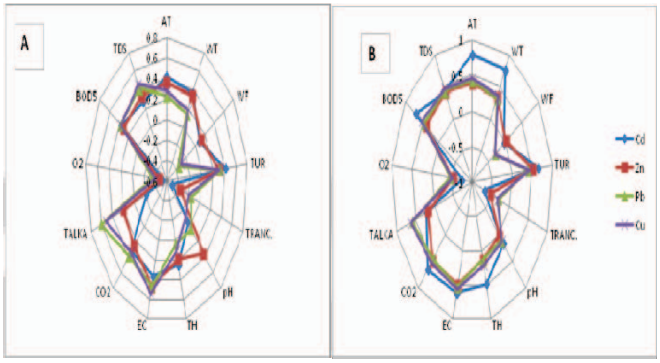

Figure 3: The correlation between dissolved (A), Particulate (B) heavy metals and physiochemical properties in water during the period of study

Table 4: The correlation between particulate and dissolved heavy metals in period of study

Cd Diss	1							
Cd Parti	0.566284	1						
Zn Diss	0.682515	0.66217	1					
Zn Part.	0.36451	0.193174	0.326444	1				
Pb Diss	0.624618	0.336094	0.503229	0.459793	1			
Pb Part.	0.459987	0.241264	0.426779	0.426568	0.961602	1		
Cu Diss	0.607253	0.299806	0.491973	0.456734	0.970438	0.956628	1	
Cu Partic	0.461781	0.297996	0.422281	0.50834	0.91414	0.949575	0.920813	1
	Cd Diss	Cd Parti	Zn Diss	Zn Part.	Pb Diss	Pb Part.	Cu Diss	Cu Partic

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