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Distribution dynamics of some heavy metal in water body of Damietta and Rosetta branches, River Nile, Egypt

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ABSTRACT

Water samples were collected from 24 locations during 4 seasons along the extends of Damietta and Rosetta branches during 2010-2011. The main objective of this study is to determine the factors affecting on the distribution dynamics of the investigated metals (Fe, Mn, Cu, Zn, CO, Ni, Pb and Cd) in the water samples from the two River Nile branches. The present results showed that, Rosetta branch was highly polluted by the effluents discharged to the branch from the drain and from industrial area at Kafr El-Zayat city. Also, the highest contents of heavy metals were recorded in the cold season. The results showed that there was high seasonal and regional fluctuation in concentrations of the metals depending on the quantity and quality of the discharged effluents.

Keywords: River Nile, heavy metals , water pollution, Rosetta and Damietta branches, drain effluents.

INTRODUCTION

The problem of the limited amount of water resources in Egypt acquires more importance with the growth of the overpopulation problem and the inability to implement the projects of increasing water resources of the River Nile due to safety consideration in the South of Sudan since 1983(Ahmed *et al.,* 1995). Rosetta branch can be divided into two ecological community, one of them represent almost fresh water community extending from bifurcation of the River at delta barrage until behind Edfina Barrage. The other one represent mixed water community (Saline to fresh water) extending from below Edfina Barrage until the outlet of the branch in the Mediterranean sea (Sayed 2002).

Damietta branch with the length 242 km has a great vital importance since it serves as a source of water for municipal, industrial, agricultural and feeding fish dispersed in the area between El-Serw to Farskour city (Elewa and Aly, 1999).

Number of studies have been conducted on the roles of heavy metals in the water environments of the River and the rivers (Ahmed, 2013; Ezzat *et al.*, 2012; Singh and Choudhjaryn, 2013; Abdo, 2002; Abdo *et al.*, 2017; Abdelsatar, 2017; Bauomy *et al.*, 2017; Haga, 2017).

The present study aims to investigat the distributions of some heavy metals in the water ecosystems of Damietta and Rosetta branches during the four seasons of 2010-2011.

MATERIALS AND METHODS

24 sampling sites were selected in Damietta and Rosetta branches (Table 1, Fig. 1), represented the different varieties of the water body along the extends of the branches to follow up the seasonal and regional changes of heavy metals water samples were collected from different stations by using poly-vinyl chloride van Dorn water sampler bottle from the above 24 station. Heavy metals were extracted from water samples using nitric acid digestion method according to America Public Health Association (APHA, 1998). The concentrations of heavy metals were measured after digestion by conc. Nitric acid. The levels of Fe, Mn, Cu, Zn, CO, Ni, Pb and Cd were determined using Atomic Absorption (Perkin Elmer 3110 USA) with graphite atomizer HGA-600.

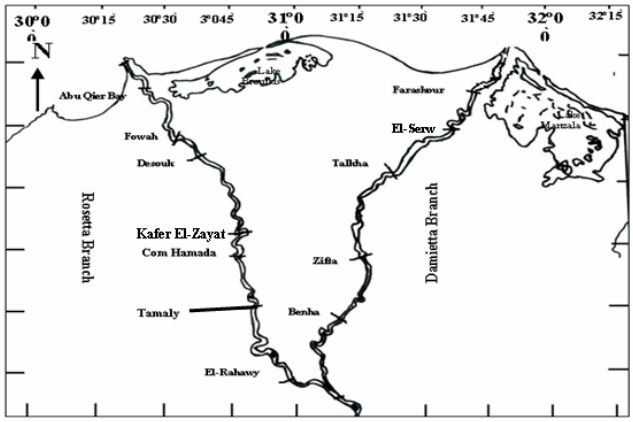

Fig. 1. Map of Damietta and Rosetta branches illustrates the selected stations

Table 1. Sampling sites at Damietta and Rosetta branches during 2010-2011.

	No.	Code	Features of station	Position	
				Latitude	Longitude
Damietta Branch	1	D1E	Eastern bank at Benha City	30° 27.58\	31° 10.61\
	2	D1M	Main Channel at Benha City		
	3	D2E	Eastern bank at Zefta City	30° 43.08\	31° 24.31\
	4	D2M	The main Channel at Zefta city		
	5	D3W	At discharge point of cooling water of Talkha Electric Power Station	31° 04.00\	31° 24.31\
	6	D3M	The main channel at Talkha city		
	7	D4E	Eastern bank at El-Serw city		
	8	D4M	The main channel at El-Serw city	31° 14.43\	31° 14.43\
	9	D5W	Weastern bank at Faraskor city		
	10	D5M	In the main channel at Faraskor city	31° 21.35\	31° 46.95\
Rosetta Branch	11	R1up	In main channel (upstream of El-Rahawy Drain)	30° 12.44\	31° 01.99\
	12	R1M	In main channel at El-Rahawy		
	13	R1E	Eastern bank (downstream of El-Rahawy Drain)		
	14	R2E	Eastern bank at at Tamalay bridge	30° 30.46\	30° 50.03\
	15	R2M	The main channel at Tamalay bridge		
	16	R3W	Weastern bank at Kom Hamada city	30° 42.89\	30° 45.69\
	17	R3M	The main channel at Kom Hamada city		
	18	R4E	Eastern bank at Kafr El-Zayat city	30° 49.56\	30° 48.43\
	19	R4M	The main channel at Kafr El-Zayat city		
	20	R5W	Weastern bank at Dosouk city	31° 08.16\	30° 38.16\
	21	R5M	The main channel at Dosouk city		
	22	R6W	Weastern bank at Fauwa city	31° 12.00\	30° 33.17\
	23	R6M	The main channel at Fauwa city		
	24	El-Rahawy	At discharge point of El-Rahawy Drain		

D: Damietta branch R: Rosetta branch

Statistical analysis

One-way Anova analysis was applied to identify significant differences for all metals among different seasons and stations for water samples. Significance levels of tests were taken as $P<0.05$ and highly significance as $P<0.01$ person's correlation analysis was performed to evaluate the potential relationships between the measured variables. ANOVA tests and correlation coefficient (r) between the studied elements were undertaken using excel-stat software.

RESULTS AND DISCUSSION

The heavy metal concentrations in the two branches during the period of study depends mainly to thee fluctuation of the amount of the effluents discharged into the branches (Ibrahim and Omar (2013). Domestic effluents can contain fairly high concentration of Al, Cu, Fe, Pb, Zn and Ni. The seasonal variations of the distribution of the metals in the water (Table 2) show the higher concentration of Fe (611.4-1073.9 µg/L) measured during winter in Damietta and Rosetta branch may be due to the drought period with the decrease of the water level. The lowest values of 137.9-251.2 µ/g/L recorded during spring. This decrease in Fe content may be due to flourishing of phytoplankton and increase of dissolved oxygen leading to oxidation of Fe from Fe^{2+} to Fe^{3+} and precipitate to the sediment as $Fe(OH)_3$(Stumn and Morgan, 1970). The positive correlation between Fe-Mn (r = 0.72) Fe/Co (r=0.82), Fe/Zn (r=0.81), Fe/Ni (r=0.93) and Fe/Cd and Fe/Pb (r=0.78 and 0.72) during summer reveal that these heafy metals have the same source of water pollution.

Mn as Fe is considered to be an essential element in the biochemical cycle in water body. The present results of Mn revealed that the highest concentration of 162.3 µg/L recorded during winter in Rosetta branch in front of El-Rahawy drain which may be attributed the effects of the drought period in addition to the domestics, agricultural and industrial polluted effluents. These results agree with the finding by Abdo (2002), Abdelsatar and Elewa and Moustafa *et al.* (2010). The lowest value of Mn(16.3 µg/L) recorded in the hot seasons in both branches may be due to the adsorption of Mn salts on iron oxide and precipitate to the bottom other positive correlation between Mn and other metals during summer (r=0.53) with Cu, r=0.64 withZn r= 0.66 with CO (r=0.64-0.7) with Ni, Pb and Cd leading to the same source of pollution affecting these metals. The concentration of Cu show the highest value of 56.9 µg/L recorded in winter at station 18 and the lowest value 2µg/L recorded at station 23.

Zn is an essential element in human growth and it's a plant micronutrient, being an important constituent in the formation of enzymes and in nucleic acid formation (APHA, 1998). The increase of Zn concentration 121.3 µg/L in Rosetta branch during winter at station 13 may be the discharge of the effluents from El-Rahawy drain. On the other hand, the decrease of Zn to 9.7 µg/L in Damietta branch during summer may be attributed to the adsorption of Zn on $Fe(OH)_3$ and MnO_2 to precipitate. This results was conformed with the positive correlation of Zn with Mn (r=0.64), Zn/Cd (r=0.87) Zn/Pb (r=0.62) Zn/Ni (r=0.83) and Zn/Co (r=0.79). The increase of Pb to 219.7 µg/L at station 18 during Autumn due to the polluted effluents compared with the lowest value of 4.2 µg/L recorded at station 4 during winter. The higher value of Pb during Autumn may be due to the higher load of suspended matter inflow in the effluents of industrial wastes poured at Kafr El-zayat industrial area. At the related to the precipitation of Pb salts at high pH values in the form of $PbCO_3$. The increase of Cd concentrations (2.6-3.9 µg/L) during winter season may be due to the disposal of the polluted effluents gives higher chances to accumulate Cd in the water. Thus, the correlation coefficient of heavy metals with each other are depend on the nature of the

effluents discharged and the distribution dynamics of different metals to react in the water and the deposition and adsorption process on surface of suspended particles.

Long term studies the water of the two branches indicate that Fe and Pb contents fluctuated between 79-296 and 2-734 µg/L for Damietta 1997 and Rosetta 1999 respectively and Pb content 5-119 and 76-206 µg/L (Table 3). This long term studies revealed the fluctuation of heavy metals content with time may be due to the effects of the discharged effluents into different localities.

Table 2. Heavy metals concentration (µg/g) in the sediments of Damietta & Rosetta branches

		Min.	Station	Season	Max.	Station	Season
Fe	D	137.9	3	Spring	611.4	5	Winter
	R	251.2	18	Spring	1073.9	13	Winter
Mn	D	16.29	2	Summer	74.26	7	Winter
	R	16.27	22	Autumn	162.3	13	Winter
Cu	D	5.6	2	Summer	23.6	5	Winter
	R	2.1	23	Winter	56.9	18	Winter
Zn	D	9.7	4.14	Summer	50.5	8	Aut./winter/spring
	R	16.2		Spring/Aut.	121.3	13	Winter
Co	D	3.0	6	Summer	9.3	1	Summer
	R	3.2	12	Summer	18.7	13	Winter
Ni	D	7.6	10	Summer	42.6	3	Winter
	R	9.5	21	Winter	96.5	13	Winter
Pb	D	4.2	4	Winter	80.2	8	Aut./spting
	R	7.0	21	Aut./wint/spring	219.7	18	Autumn
Cd	D	0.56	6	Spring	2.6	1	Winter
	R	0.86	12	Sum./spr.	3.9	20	Winter

D: Damietta branch R: Rosetta branch

Table 3. Long term studies of heavy metal concentration in water (µg/L) in Damietta and Rosetta branches

	Present work		**Coher**	**Addo 1999**
	Damietta	**Rosetta**	**Damietta**	**Rosetta**
Fe	138-611	251-1074	79-296	2-734
Mn	16-74	16-162	72-711	28-230
Cu	6-24	2-57	13-89	2-88
Zn	10-51	16-121	80-296	2-734
Pb	4-80	7-220	5-119	76-206
Cd	0.6-2.6	0.9-4	2-15.3	8-138

Conclusion

The heavy load of the effluent wastes especially from El-Rahawy drain and at Kafr El-Zayat resulting in increase of the levels of the studies heavy metals in the water body. Thus, the aquatic chemistry of the metals in water environment of the two branches depend on the distribution dynamics of these metals and on the interaction between these metals and on the aquatic environment.

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