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Heavy Metals Contamination of a Mediterranean Coastal Ecosystem, Eastern Nile Delta, Egypt

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1. Introduction

Coastal Zone is "The scope of marine environment which covers territorial water, and the scope of land extending in wards that can affect or be affected by the marine environment. Half of Egypt's population lives in Egypt coastal zones, where sources of food, jobs and income are available. They depend mainly on traditional fishing and to a lesser degree on automation.

Coastal areas are characterized by high organic matter and nutrients from the continent, having fragile coastal ecosystem dependent on terrestrial conditions (Yáñez-Aracibia and Sánchez-Gil, 1988). Industrialization of coastal areas is very common in countries characterized by exploitation and importation economics, causing serious damage to coastal ecosystems, e.g. contamination of metals (Cardoso et al., 2001). Moreover, anthropogenic activities are known to have a wide range of potential effects of these coastal ecosystems, particularly from point and non-point sources of pollution.

The release of pollutants into coastal environment is a major human concern worldwide. These contaminants are known to readily accumulate in bottom sediments which serve as a repository of pollutants. Sediment contaminants could be released to the overlying water, resulting in potential adverse health effects to aquatic organisms (Daskalakis and O'Connor, 1995; Long et al., 1995; Argese et al., 1997; Ross and Delorenzo, 1997; Freret-Meurer et al., 2010). Among the adverse health effects associated with these contaminants are toxicity to the kidney, nervous and reproductive systems, as well as endocrine disruption and mutations (Collier et al., 1998; Nirmala et al., 1999; Ketata et al., 2007; Liu et al., 2008; Brar et al., 2009).

In addition, trace metals are known to bioaccumulate in edible aquatic organisms (e.g., mollusks), thus, representing a health risk to top predators, including humans (Fox et al., 1991; Renzoni et al., 1998; Huang et al., 2006; Díez et al., 2009).

The Egyptian coastline extends 3000 km along the Mediterranean Sea and Red Sea beaches in addition to the Suez and Aqaba gulfs. Natural conditions on Egyptian Mediterranean coasts differ significantly from those on the Red Sea coasts in terms of salinity, sea currents and temperature. Such difference has led to different biodiversity and ecosystems in each.

The Nile Delta coastal zone located along southeastern coastal area of Mediterranean Sea at unstable shelf of the northern section of Egypt (Fig.1). It is boarded by the north western

part of Suez Canal from the east and northern side of Manzala Lake from the south. It is considered as the most important vital area along the Mediterranean Sea. Many of the Egyptian coastal zones are subjected to variable significant environmental hazards including, loss of ecosystem quality, coastal erosion, seismic risk and over-exploitation. Moreover, it comprises a lot of land-use changes and modifications to development of future mitigation strategies. High profile example is the region of the eastern Nile Delta coastal ecosystem. It is one of the most beautiful recreation centers along coastal area of the Mediterranean Sea. In addition, it has several natural gas companies, recreational areas and fishing activities. A number of factors acting together on this zone has contributed to environmental and coastline changes. Natural processes and anthropogenic activities have to be considered as the most effective factors at the area of study. The pollution problems in the study sites are chiefly due to high quantity of domestic sewage and the virtually total absence of control on toxic components. Mistakes in their management can have catastrophic consequences for ecosystem integrity and human development.
Contamination by trace metals has not been extensively studied in the Egyptian coastal zones along the Mediterranean Sea which are subjected to intense discharges of pollutants. Therefore, it is important that sediment and water contamination by these pollutants be assessed for better management and protection of these valuable costal ecosystems at El-Gamil beach along the western coast of Port Said on the Mediterranean Sea. Especially, this study area represents a pronounced area for fishing, industrial development, urban extensions and more tourism activities along eastern Mediterranean Sea.

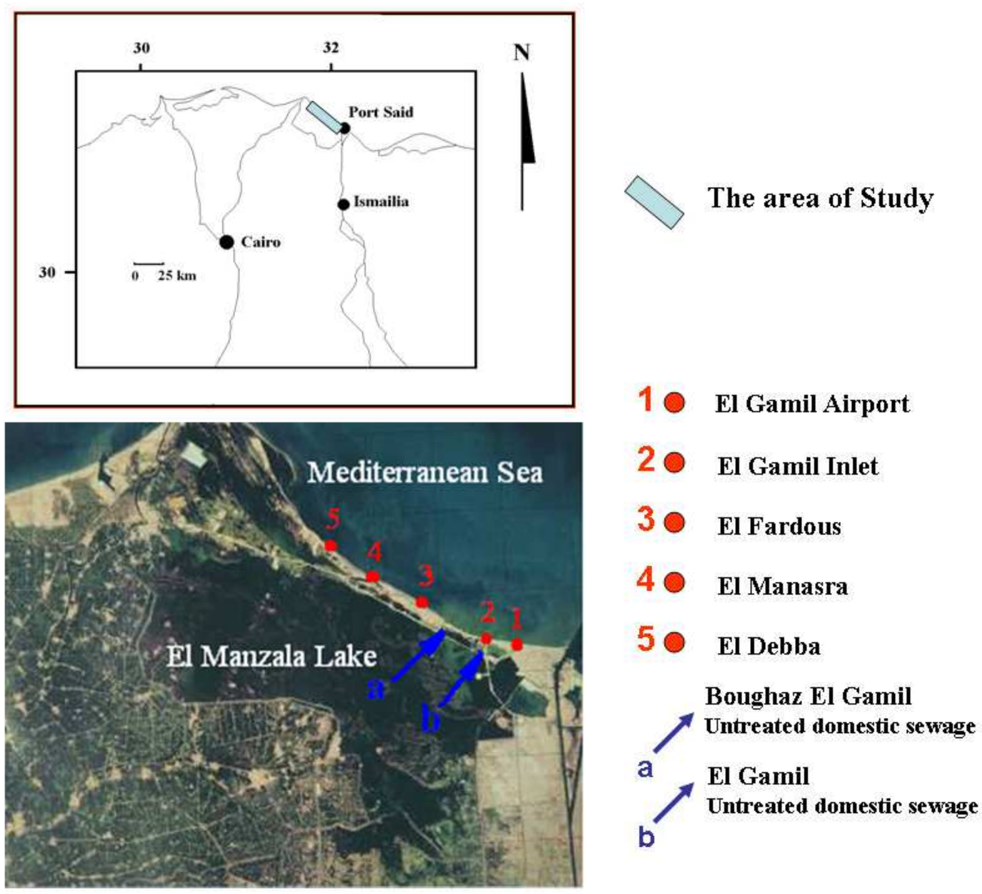


Fig. 1. Satellite image shows the location of the study area and the sampling sites

Domestic waste waters released into the eatern Nile Delta ecosystem contain fairly high concentrations of metals as Al, Cu, Fe, Pb and Zn (Stephenson, 1987). These produced from household products such as cleaning materials, toothpaste, cosmetic and human faces. In addition, pollutants resulting from industrial, sewage, agricultural discharges, many types of industrial wastes and urban runoff caused many problems for the human bodies. Furthermore, most of the present freshwater discharged into the coastal zones of Mediterranean Sea is of drainage water, which has been used for irrigation, often contaminated with sewage or industrial waste, which reached to the sea via the Delta lakes (Dowidar, 1988). The present study aims at to assess environmental status, develop and establish database required to monitor the main environmental problem along the Nile Delta ecosystem.

2. Materials and methods

2.1 Sampling sites and measurements

The study area constitutes a small part of the low lands laying west of Port Said City vise El Gamil zone, extending west wards parallel to the Deltaic Coast-Mediterranean Sea. It is boarded by the Suez Canal from the east and by Lake Manzala from the south. It is situated at nearly about 13 kilometers west of Port-Said City and extending between Latitude 31°:10' - 31°:20' N and Longitude 32°:00' - 32°:20' E with about 24 km² coverage area. Five sites along the El- Gamil beach, including El Gamil airport (Site 1), El Gamil inlet (site 2), El Fardous (Site 3), El Manasra (Site 4) and El Debba (Site 5) were chosen for this study (Fig.1). General features of anthropogenic activities at the study area with emphasis on descriptive features of sampling sites are listed in table (1). Heavy metals (Fe, Mn, Cd, Zn, Cu and Pb) levels were measured in bottom sediment, surface water and bivalve samples collected from each site during December 2005 and August 2006.

Sampling sites	Coordinates of sampling sites	General features of anthropogenic activities
El-Gamil Airport	31° : 16': 56" N and 32° : 14': 36" E	- El-Gamil Airport.
El-Gamil Inlet	31° :17':25" N and 32° : 12 ': 35" E	- Boughaz El-Gamil " - El-Gamil and El-Abtal tourist villages - Standing apart breakwaters
El-Fardous	31° :18': 12" N and 32° : 10 ': 49" E	- Ashtoum El-Gamil - El-Maghraby and El-Fardous tourist villages. - Company of Natural gas Petroget
El-Manasra	31° : 19': 45"N and 32° : 8 ': 14" E	- Company of Petrobel Balaeim " Natural gas". - International Factory of pipelines Industry. - Electric station power. - Small urban. - Anti-fouling paints.
El-Debba	31° :21':28"N and 32° : 0.4': 50" E	- Small urban and Traffic highway

Table 1. Locations and descriptive features of sampling sites.

2.2 Bottom sediment, surface water and bivalve analysis

A total of 30 sediment samples were collected from the five selected sites along El-Gamil coast during December 2005 and August 2006. The sediment samples were collected by pushing a plastic core (12 cm in diameter) into the bottom sediment to a depth of approximately 5 cm, then put in plastic bags and transferred to the laboratory. Sediments were dried at 100 C° for 24hrs and kept in plastic bags until analysis. A representative 50 gm of sediment sample were repeatedly treated with hydrogen peroxide (30%) for removal of organic matter and loss in weight was determined and the organic matter free samples were treated by using dilute HCl to remove calcium carbonates and loss in weight was determined according to method described by Folk, 1974. The grain size analysis of the examined samples was done according to Friedman and Johnson 1982. Dry sand was fractioned by dry sieving using sieves with openings of 2, 1, 0.5, 0.25, 0.125, 0.063 and 0.032 mm and an electric shaker. The weight percentages of the different size classes were calculated in three replicates per site sampled.

To detect the heavy metal contamination in the sediment samples, an exact weight of dry sample (0.5 gm) of each sediment sample was completely digested for about 2hrs in Teflon vessels using a mixture of HNO_3, $HCLO_4$ and HF (3:2:1 v/v 10 ml) (triplicate digestions were made for each sample). The final solution was diluted to 25 ml with distilled de-ionized water (Oregioni and Astone, 1984).

A total of 30 surface water samples were collected at a depth of 0.5 m from the five selected sites along the El-Gamil coast during December 2005 and August 2006. Water samples were collected in one liter white polyethylene bottles, which were placed in an ice-box following collection, and transferred to the laboratory for storage at 4°C until analysis.

Specimens of the most commercial bivalve *Donax trunculus* were collected from the five sampling sites during December 2005 and August 2006 by obtaining individuals with standard lengths between 1 and 3 cm. Standard length and body weights were recorded for each specimens. Live samples were left in clean water for 30 minutes to purge their guts. Only the soft tissue was kept in plastic bags and frozen until analysis. The soft parts of *Donax trunuculus* were dried at 70°C for 12 hrs before analysis. Exact dry weight of sample (0.5 g) was digested in Teflon vessels with analar nitric acid (HNO_3), tightly covered and allowed to predigest overnight at room temperature. Complete digestion and preparation of bivalve sample for trace metal analysis were done according to (UNEP/FAO/IAEA/IOC, 1984).

Total concentrations of Fe, Mn, Zn, Cu, Pb and Cd metals in bottom sediment, surface water and bivale (*D. trunculus*) samples were analyzed using an atomic absorption spectrophotometer (AAS) (Perkin Elmer, Waltham, MA, USA, model 1200 A), at the El-Fostat Center, Cairo, Egypt, according to the Standard Method 3110 (APHA 1992). All analyses were carried out in triplicate. For each run, three "blanks" were analyzed using the same procedure to check the purity of reagents and any possible contamination. A similarity test was carried out through cluster analyses from simple Euclidian distance.

3. Results and discussion

A similarity test established that sites 2 and 3 were highly similar, as well as sites 4 and 5, which were equally similar. Site 1 presented a similarity index closer to sites 2 and 3 than to the others. This test verified that El Gamil Beach can be divided into two areas. Sites 1, 2 and 3 represent the first area, and sites 4 and 5, the second.

The sediment at the five selected sites showed a highest percentage of very fine and fine sand coupled with low percentage of coarse fraction (Table 2). The maximum percentage of organic matter content was recorded at both sites of El-Gamil inlet and El Fardous with values of 4.13 ± 1.3 % and 4.23 ± 1.77 %, respectively. The high percentage of organic matter in the two mentioned sites can be attributed to the discharge of sewage wastes into the Mediterranean Sea through El Gamil outlet and Ashtoum El Gamil outlet along El Manzala Lake. Furthermore, the untreated domestic sewage discharged into the sea from four touristic villages in this coastal area *vise*: El Gamil, El Abtal, El Maghraby and El Fardous. The calcium carbonate content was very high at El Gamil airport with value of 27. 53 ± 5.10 %, while it was very low (3.03 ± 1.18%) at El Debba. The high values of calcium carbonate content at site (1) can be attributed to the accumulation of tremendous amounts of shell fragments blanketing the bottom sediment at El Gamil airport.

In the sediment samples, the concentration of heavy metals was higher during winter (Table 3). Even though there was variability among sites, the overall concentration range for a particular metal was relatively narrow, with no values that appeared to be unusual. Generally, in the sediment samples the heavy metals distribution followed the decreasing order of Fe> Mn> Zn> Pb**>** Cu> Cd. Moreover, El Manasra site suistained the heighest values of heavy metal contaminations recorded during the present study. This can be explained by the increasing industrial activities at this site. So, these high contaminants were associated with natural gas companies, pipeline industries and an electric power generating station operating at this area.

Sample number	Site	O.M.%	$CaCO_3$ %	Coarse trun. %	Fine trun. %	Phi (Φ)	Wentworth Mz
1	El-Gamil Airport	2	27.40	0.11	99.4	2.5	Fine sand
2		1.90	22.50	1.5	98.71	2.7	
3		2	32.70	0.06	98.06	2.8	
1	El-Gamil Inlet	3.60	7.40	0.92	97.1	3.2	Very fine sand
2		3.20	4.90	0.15	97.77	3	
3		5.60	7.30	0.13	96.25	3.06	
1	El-Fardous	2.20	6.70	0.13	98.72	2.6	Fine sand
2		5.50	2.80	0.16	98.18	2.9	
3		5	4.30	0.10	99.41	2.7	
1	El-Manasra	3.60	7.50	0.83	97.73	2.7	Fine sand
2		4.60	3.40	0.11	97.85	2.5	
3		3.40	2.50	0.10	98.50	2.8	
1	El-Debba	2.40	2.40	1.64	98.98	2.7	Fine sand
2		2	4.40	0.54	98.82	2.7	
3		3.10	2.30	0.35	99.07	2.7	

Notes: O.M: Organic matter; $CaCO_3$: Calcium carbonate; Coarse trun.: Coarse truncation; and Fine trun.: Fine truncation.

Table 2. The physical and chemical properties of sediment during summer 2006

Metal	Season	Sites									
		El-Gamil Airport Site (1)		El-Gamil Inlet Site (2)		El-Fardous Site (3)		El-Manasra Site (4)		El-Debba Site (5)	
		Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.
Fe (µg/g)	Winter	1936.5	45.2	1927.1	48.5	1865.7	38.3	1968.7	76.2	2030	4.8
	Summer	1830.4	68.8	1837.6	47.1	1748.2	44.1	1888.6	145.7	1918.7	24.7
Mn (µg/g)	Winter	200.8	16.5	204.2	13.5	213.5	8.3	254.3	16.6	229.4	32.7
	Summer	197.2	12.8	202.9	4	191.4	4	217.8	33	208.3	8.1
Cd (µg/g)	Winter	2.1	0.4	2	0.11	1.8	0.3	2.3	0.46	2.2	0.05
	Summer	1.9	0.41	1.4	0.23	1.8	0.3	2	0.57	1.9	0.2
Zn (µg/g)	Winter	33.9	3.4	34.6	2.1	33.1	1.3	42.2	1.5	36.9	5.5
	Summer	30.4	2.4	32.4	2.9	28	3.7	36.6	6	32.5	0.94
Cu (µg/g)	Winter	4	3.1	4.2	3.4	6.7	2.3	9.4	0.4	8.7	1
	Summer	6.6	1.6	5.7	1.1	6.6	1.6	9.4	1	7	1.3
Pb (µg/g)	Winter	23.8	4.1	18.4	2.5	20.2	4.1	22.8	3.4	24.8	1.3
	Summer	20.6	5	18.8	2.4	20.4	4.5	24.4	7.5	21	3.1

Note: ± S.D.: Standard deviation.

Table 3. Mean concentration of the total heavy metals in sediment samples during winter and summer (2005-2006)

	Fe	Mn	Cd	Zn	Cu	Pb	O.M.%	$CaCO_3$%	Sand %	Silt %
Fe	1									
Mn	0.847	1								
Cd	0.288	0.309	1							
Zn	0.782	0.981	0.219	1						
Cu	0.438	0.749	0.735	0.724	1					
Pb	0.427	0.714	0.788	0.684	0.996	1				
O.M.%	-0.317	0.11	-0.479	0.166	0.091	0.091	1			
$CaCO_3$%	-0.174	-0.373	0.138	-0.285	-0.235	-0.176	-0.694	1		
Sand %	0.238	0.157	0.955	0.024	0.562	0.62	-0.528	0.052	1	
Silt %	-0.341	-0.193	-0.904	-0.04	-0.499	-0.554	0.559	0.021	-0.983	1

Table 4. Correlation coefficient matrix between heavy metals, organic matter (O.M.), Calcium carbonate ($CaCo_3$), and grain size in sediment samples during summer 2006

Metal	Season	Sites									
		El-Gamil Airport Site (1)		El-Gamil Inlet Site (2)		El-Fardous Site (3)		El-Manasra Site (4)		El-Debba Site (5)	
		Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.
Fe (μg/L)	Winter	786	14.4	793.3	17	744	19	834.6	50	841.3	14
	Summer	872.6	27	832	24.9	822.6	14.7	846.6	30.2	896	15
Mn (μg/L)	Winter	170	11.1	174.6	7.5	168.6	20.8	162	15	171.3	7.5
	Summer	198	5.2	190.6	9	180	7.2	169.3	13	187.3	6.4
Cd (μg/L)	Winter	2.4	0.3	2.4	0.11	2.7	1.5	3.1	0.2	2.8	4.2
	Summer	2.6	0.2	0.8	1.3	2.7	0.11	2.6	0.2	2.4	0.2
Zn (μg/L)	Winter	281.3	21.5	287.3	16.7	242.6	6.4	277.3	16.2	269.3	18.5
	Summer	300	17.4	271.3	17.2	283.3	16.2	294.6	32.5	282.6	20
Cu (μg/L)	Winter	15.3	2.3	14	2	16	2	21.3	1.1	17.3	4.1
	Summer	13.3	3	12.6	2.3	14	2	19.3	1.1	18.6	1.1
Pb (μg/L)	Winter	34.6	7	31.3	5	35.3	6.1	44	2	50	2
	Summer	42.6	8	40	6	41.3	6.4	50.6	4.1	56	7.2

Note: ± S.D.: Standard deviation.

Table 5. Mean concentration of total heavy metals in water samples during winter and summer (2005-2006).

Metal	Season	Sites									
		El-Gamil Airport Site (1)		El-Gamil Inlet Site (2)		El-Fardous Site (3)		El-Manasra Site (4)		El-Debba Site (5)	
		Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.	Mean	±S.D.
Fe (μg/g)	Winter	52.8	0.5	53.1	1.3	57.2	3.6	55.2	2	47.2	2.5
	Summer	66.4	1.7	61.8	0.9	57.2	4.1	60.7	3.3	59.3	4.2
Mn (μg/g)	Winter	4.8	0.3	6.8	0.3	6.4	0.1	8.4	1.2	7.6	0.6
	Summer	7.6	0.4	6.8	0.4	6	0.5	7.1	1.2	6.3	1.4
Cd (μg/g)	Winter	2	0.1	2.1	0.15	1.6	0.3	2.4	0.3	2	0.3
	Summer	2	0.3	2.2	0.2	2.4	0.3	2.1	0.1	2.1	0.1
Zn (μg/g)	Winter	34.4	0.7	27.1	5.2	25.2	1.5	22	1.9	26.8	3.2
	Summer	36.4	3.8	34.8	0.8	32.8	0.7	33.4	0.5	32.9	0.1
Cu (μg/g)	Winter	3.6	0.2	3.8	0.3	4.8	0.3	3.6	0.2	3.2	0.2
	Summer	4.4	0.6	4.2	0.5	4	0.1	4.3	0.1	4.1	0.1
Pb (μg/g)	Winter	6.8	1.7	6.6	0.6	5.6	0.9	6.8	1.7	7.2	0.1
	Summer	9.2	0.2	9	0.3	8.8	0.3	9	0.2	8.9	0.1

Note: ± S.D.: Standard deviation.

Table 6. Mean concentration of total heavy metals in *Donax trunculus* samples during winter and summer (2005-2006).

Classification of pollution level of each element according to the American rules for sediment, in conformity to the lowest effect (LEL), heavily polluted category (HPC) and sever effect level (SEL). Judging by the present results, El Gamil beach can be considered a non–metal–polluted area, according to the pollution levels determined by the international rules (Ontario Ministry of the Environment-OME and United States Environmental Protection Agency – EPA).

Correlation coefficient matrix between heavy metals, organic matter, calcium carbonate and grain size of the sediment collected during August 2006 was statistically calculated (Table 4). The correlation coefficient matrix between heavy metal concentrations and physico-chemical characteristics of the sediment samples of El Gamil beach varied between negatively and significantly ones. Strong positive correlations were noticed between Cd and sand ($r = 0.995$); and Cu and Pb ($r = 0.996$). While, inverse correlations between Cd and silt ($r = -0.904$); and sand and silt ($r = -0.983$) as shown in figures 2, 3, 4, and 5 respectively.

The concentrations of heavy metals were higher in the summer than in the winter in the surface water samples collected during the present study (Table 5). Even though there was variability among sites, the overall concentration range for a particular metal was relatively narrow, with no values that appeared to be unusual. Not surprisingly, Fe concentrations were the highest, ranging from 822.6 ± 14.7 µg g^{-1} at El Fardous to 896 ± 15 µg g^{-1} at El Debba. Cd concentrations were the lowest and ranged from 0.8 ± 1.3 µg g^{-1} at El Gamil inlet to 2.7 ± 0.11 µg g^{-1} at El Fardous.

The concentrations values of heavy metal (µg g^{-1} dry wt) in the soft tissue of *Donax trunculus* are shown in table (6). The concentrations of heavy metals were higher in the summer than in the winter in the bivalve samples collected during the present study, and with the decreasing order of Fe> Zn> Pb> Mn> Cu> Cd. Based on the data given in table (6), it seems that the observed variation in metal levels in *Donax trunculus* at different sites can be attributed to two mechanisms. The first is the availability of different metals in different sites, which in its turn depends on the pollution sources that usually vary among different sites. The second is the animal involves different uptake and retention mechanisms which may also vary with physiological and environmental factors (Byran, 1973) or even with the sexual state of the animal (Alexander and Young, 1976). Generally, the values of heavy metals concentration varied with insignificant range in both seasons and among sampling sites due to similar conditions affecting these sites. The highest concentration level of Zn (36.4 ± 3.8 µg g^{-1}) and Cu (4.8 ± 0.3 µg g-1) metals in the analyzed species are less than the maximum permissible levels (MPLs) of 100 µg g-1 and 10 µg g-1 for Zn and Cu, respectively. The (MPLs) of 2 µg g-1, and 5 µg g-1 declared by WHO 1982 and WHO 2006 for Cd and Pb, respectively are much lower than those detected in the soft tissues of D. trunculus with 4.8 ± 0.3 µg g-1 for Cu and 9.2 ± 0.2 µg g-1 for Pb. Donax trunculus inhabiting El Gamil beach along the western coast of Port Said on the Mediterranean Sea are more likely to be toxic for public health.

On the other hand the concentration factor of metals is considered as an indicator of heavy metals accumulation in the tissues of aquatic organisms in relation to their concentration in the ambient water (Sultana and Rao, 1998). The concentration factor values for the studied metals in *Donax trunculus* are delineated in table (7). For *Donax trunculus*, Cd gave the highest accumulation rate in the animal tissue with C.F. values ranging between 833.33 and 592.59 in winter and 2750 and 769.23 in summer. The order of C.F. in the soft tissues of *Donax trunculus* was Cd> Cu> Pb> Zn> Fe> Mn, respectively. This order indicates that *Donax trunculus* can be used as good indicator for the toxic metals as Cd and bio-indicator for essential metals as Cu.

Metal	Sites	Seasons					
		Winter			Summer		
		Mean concentration of water	Mean concentration of *Donax trunculus*	C.F.	Mean concentration of water	Mean concentration of *Donax trunculus*	C.F.
Fe	El-Gamil Airport	786	52.8	67.17	872.6	66.4	76.09
	El-Gamil Inlet	793.3	53.1	66.93	832	61.8	74.27
	El-Fardous	744	57.2	76.88	822.6	57.2	69.53
	El-Manasra	834.6	55.2	66.13	846.6	60.7	71.69
	El-Debba	841.3	47.2	56.10	896	59.3	66.18
Mn	El-Gamil Airport	170	4.8	28.23	198	7.6	38.38
	El-Gamil Inlet	174.6	6.8	38.94	190.6	6.8	35.67
	El-Fardous	168.6	6.4	37.95	180	6	33.33
	El-Manasra	162	8.4	51.85	169.3	7.1	41.93
	El-Debba	171.3	7.6	44.36	187.3	6.3	33.63
Cd	El-Gamil Airport	2.4	2	833.3	2.6	2	769.2
	El-Gamil Inlet	2.4	2	833.3	0.8	2.2	27.50
	El-Fardous	2.7	1.6	592.5	2.7	2.4	888.8
	El-Manasra	3.1	2.4	774.2	2.6	2.1	807.6
	El-Debba	2.8	2	714.3	2.4	2	833.3
Zn	El-Gamil Airport	281.3	34.4	122.3	300	36.4	121.2
	El-Gamil Inlet	287.3	27.1	94.32	271.3	34.8	128.3
	El-Fardous	242.6	25.2	103.8	283.3	32.8	115.7
	El-Manasra	277.3	22	79.33	294.6	33.4	113.4
	El-Debba	269.3	26.8	99.51	282.6	32.9	116.4
Cu	El-Gamil Airport	15.3	3.6	235.3	13.3	4.4	330.8
	El-Gamil Inlet	14	3.8	271.4	12.6	4.2	333.3
	El-Fardous	16	4.8	300	14	4	285.7
	El-Manasra	21.3	3.6	169	19.3	4.3	222.8
	El-Debba	17.3	3.2	184.9	18.6	4.1	220.4
Pb	El-Gamil Airport	34.6	6.8	196.5	42.6	9.2	215.9
	El-Gamil Inlet	31.3	6.6	210.8	40	9	225
	El-Fardous	35.3	5.6	158.6	41.3	9	217.9
	El-Manasra	44	6.8	154.5	50.6	8.9	175.8
	El-Debba	50	7.2	144	56	8.9	158.3

Note: C.F.: Concentration factor.

Table 7. Concentration factor of metals in the soft tissue of *Donax trunculus* during winter and summer 2005-2006.

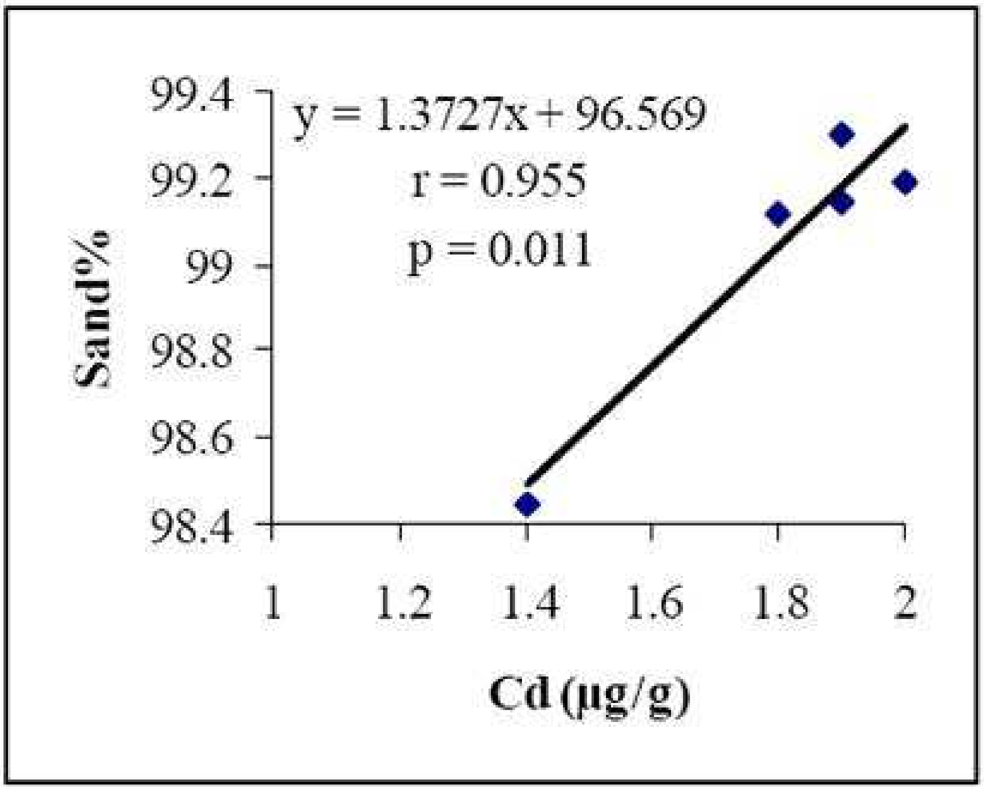


Fig. 2. Correlation between Cd and sand% in sediments

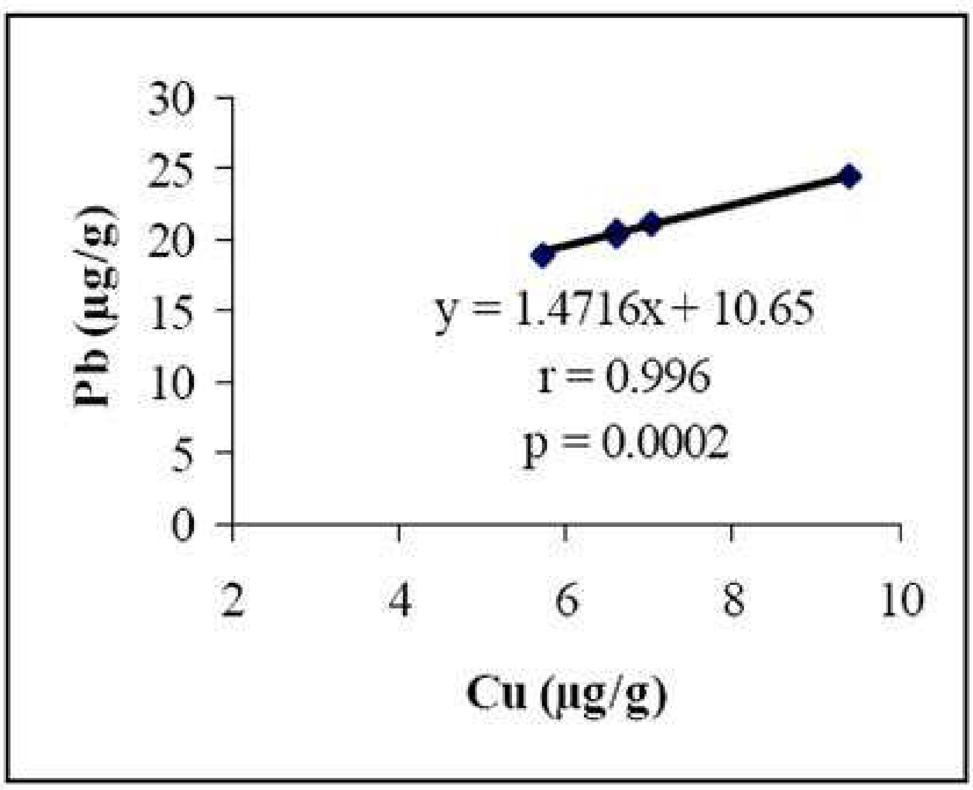


Fig. 3. Correlation between Cu and Pb in sediments

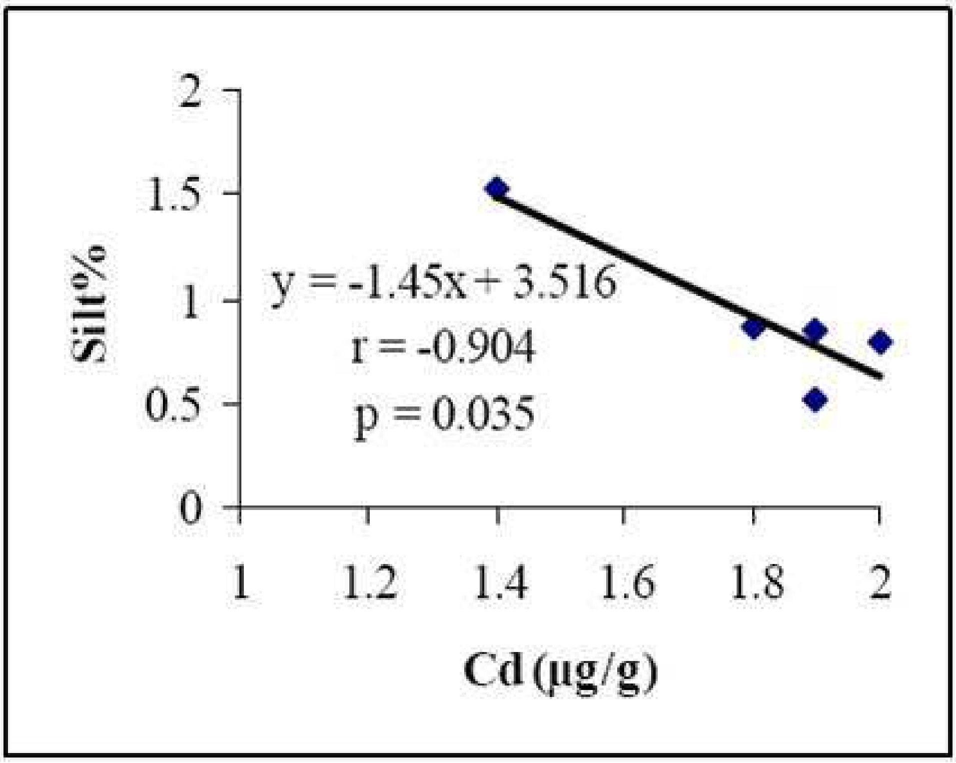


Fig. 4. Correlation between Cd and silt% in sediments

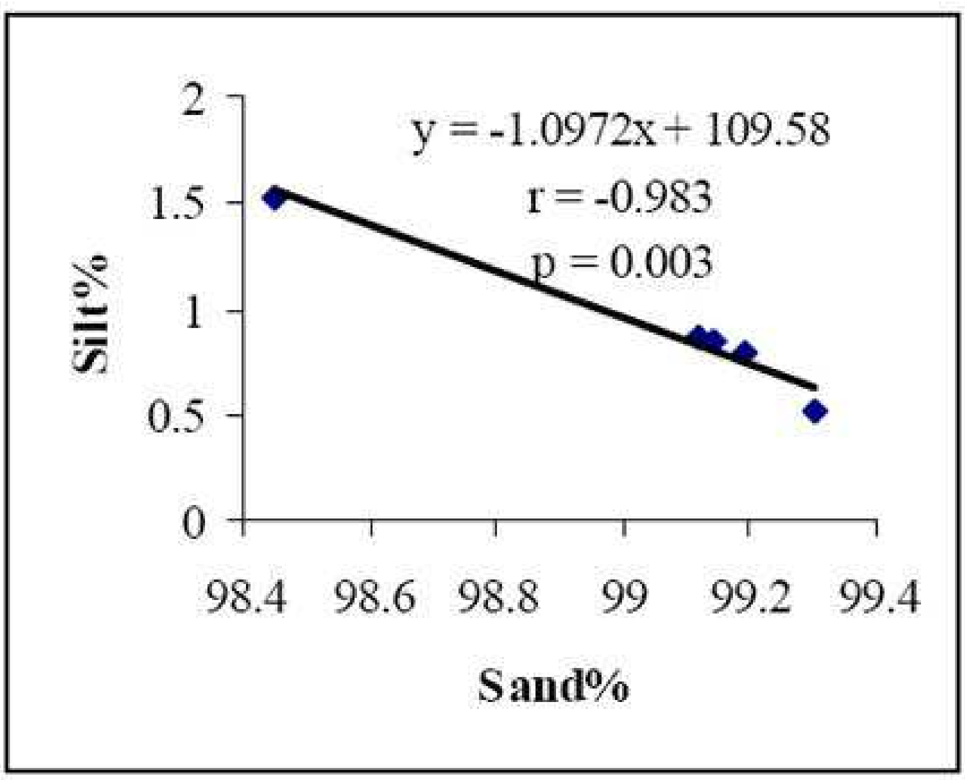


Fig. 5. Correlation between sand% and silt% in sediments

4. Conclusion

Nearly 40% of industrial development activities are practiced in Egyptian coastal zones, in addition to a number of urban and tourism development activities. Furthermore, coastal zones monopolize the seaports infrastructure, in addition to agricultural and land reclamation sectors, as well as a developed road network capable of accommodating all development aspects. The coastal zones attract increasing numbers of migrating workers from other areas and Governorates. Tourism development represents one of the main activities in Egypt's coastal zones, particularly in terms of beach development regarded as the basis of international tourist attraction.

The quality of marine and coastal environments and their environmental resources along the Nile Delta ecosystem are threatened by a number of hazards related to internal development inside the country whose impacts are carried to coastal zones via the river Nile, agricultural drainage system and air (land sources).

Results of the present study indicate El Gamil beach along the western coast of Port Said City on the Mediterranean Sea is considered a non metal polluted area, suggesting regular monitoring of metals in the sediments, water and marine organisms should be undertaken, due to the rapid growth of area. Different types of pollutants, including agricultural, industrial, organic compounds and domestic discharge were identified by analyzing bottom sediment, surface water and bivalve sampling collected from the study area of heavy metals. Contaminants originating from agricultural and domestic sources were detected along the El Fardous and El Gamil inlets. Industrial pollutants were detected at the El Manasra and El Fardous sites. These contaminants were associated with natural gas companies, pipeline industries and an electric power generating station. The proximity to various anthropogenic sources of pollutants warrants a continue monitoring program in the Egyptian coasts along Mediterranean Sea for inorganic and chemical organic compounds in sediments, water, and biota in order to have an effective coastal management program to protect the ecological integrity of this valuable ecosystem and the health of humans associated with it. The reported results could be considered as documentation of a good understanding to assess the ecosystem status of the concerned sites, and might be useful to researchers interested in the cotastal zones of Mediterranean Sea. Farther environmental studies are required to assess and improve the development planning and economic activities along of study area and its vicinity.

5. References

Alexander, G., Young, D. (1976). Trace metals in Southern California mussels. Marine Pollution Bulletin 7, 7-9.

APHA (1992). *Standard Methods for the examination of waters and wastewaters.* 16^{th} ed., (Washington, DC; American Public Health Association).

Argese, E., Ramieri, E., Bettiol, C., Pavoni, B., Chiozzotto, E., Sfriso, A. (1997). Pollutant exchange at the water /sediment interface in the venice canals. Water, Air, and Soil pollution 99, 255-263

Brar, N.K., Waggoner, C., Reyes, J.A., Fairy, R., Kelley, K.M. (2009). Evidence for thyroid endocrine disruption in wild fish in San Francisco Bay, California, USA. Relationships to contaminant exposures. Aquatic Toxicology doi:10.101 /j.aquatox. 2009.10.023.

Bryan, G. (1973). The occurrence and seasonal variation of trace metals in scallops *Pecten maximus* and *Chlayms opercularis.* Journal of Marine Biology Association, Vol. 53, Pp. 145-166.

Cardoso, A.G.A., Boaventura, G.R., Filho, E.V.S., Brod, J.A. (2001). Metal distribution in sediments from the Ribeira Bay, Rio de janeiro, Brazil. Brazilian Chemical Society 12 (6), 767-774.

Collier, T.k.,Johnson, L.L., Stehr, C.M., Myers, M.S, Stein, j.e. (1998). A comprehensive assessment of the impacts of contaminants on fish from an urban waterway. Marine Environment Research 46, 243-247.

Daskalakis, K.D., O'Connor, T.P. (1995). Normalization and elemental sediment contamination in the coastal United States. Environmental Science and Technology 29, 470-477.

Díez, S., Delgado, S., Aguilera, I., Astray, J., Pérez-Gómez, B., Torrent, M., Sunyer, J., Bayona, J.M. (2009). Prental and early childhood exposure to mercury and methylmercury in Spain, a high-fish-consumer country. Archives of Environmental Contamination and Toxicology 56, 615-622.

Dowidar, M. (1988). Productivity of the southeastern Mediterranean. In national and man made hazard, El-Sabh, M.I. and Murty, T.S., eds., 477-498.

Folk, R. (1974). Petrography of sedimentary rocks. Herrphill, Texas. P. 182.

Fox, G.A., Collins, B., Hayakawa, E., Weseloh, D.V., Ludwig, J.P., Kubiak, T.J., Erdman, T.C. (1991). Reproductive outcomes in colonial fish-eating birds: a biomarker for occurrence and prevalence of bill defects in young double-crested cormorantsin the Great Lakes, 1979-1987. Journal of Great Lakes Research 17, 158-167.

Freret-Meurer, N.V., Andreata, J.V., Meurer, B.C., Manzano, F.V., Baptista, M.G.S., Teixeira, D.E., Longo, M.M. (2010). Spatial distribution of metals in sediments of the Riberia Bay, Angra dos Reis, Rio de Janeriro, Brazil. Marine Pollution Bulletin 60: 627-629.

Friedman, G., Johnson, K. (1982). Exercises in sedimentology. John Wiley & Sons, Inc, USA.

Huang, X., Hites, R.A., Foran, J.A., Hamilton, C., Knuth, B.A., Schwager, S.J., Carpenter, D.O., 2006. Consumption advisories for salmon based on risk of cancer and noncancer health effects. Environmental Research 101, 263-274.

Ketata, I., Smaoui-Damak, W., Guermazi, F., Rebai, T., Hamza-Chaffai, A. (2007). In situ endocrine disrupting effects of cadmium on the reproduction of Ruditapes descussatus. Comprative Biochemistry and Physiology C146, 415-430.

Liu, J., Goyer, R.A.,Waalker, M.P. (2008). Toxic effects of metals. In : Klaasen, C.D.(Ed.), Casarett and Doull's Toxicology. The Basic of Science of Poisons. McGraw-Hill, New York, pp.931-979.

Long, E.R., Macdonald, D.D., Smith, S.L., Calder, F.D. (1995). Incidence of adverse biological effects within ranges of chemical concentration in marine and estuarine sediments . Environmental Management 19, 81-97.

Nirmala, K., Oshima, Y., Lee, R., Imada, N., Honjo, T., Kobayashi, K. (1999). Transgenertaional toxicity of tributyltin and its combined effects with polychlorinated biphenyls on reproductive processes in japanese medaka (Oryzias latipes). Environmental Toxicology and Chemistry 18, 717-721.

Oregioni, B. and Astone, S. (1984). The determination of selected trace metals in marine sediments by flameless/ flame-atomic absorption sepctrophotometry. IAEA Monaco Laboratory, Internal Report.

Renzoni, A., Zino, F., Franchi, E. (1998). Mercury levels along the food chain and risk for exposed populations. Environmental Research 77, 68-72.

Ross, P., Delorenzo, M.E. (1997). Sediment contamination problems in the Caribbean islands: research and regulation. Environmental Toxicolology and Chemistry 16, 52-58.

Stephenson, M. (1987). The environmental requirements of Aquatic plants publication No. 65-Appendix A., agreement no. 8-131-499-9. A report prepared for the state Water Resources Control Biard, State of California. Sacramento, California.

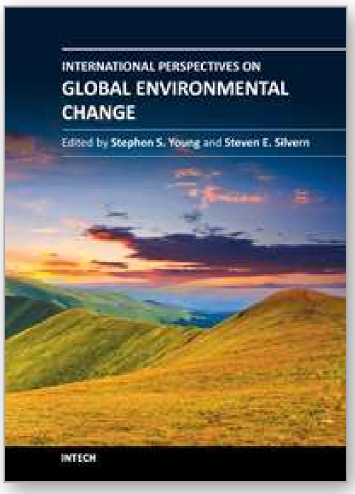
Sultana, R., Rao, D. (1998). Bioaccumulation patterns of Zinc, Copper, Lead and Cadmium in Grey Mullet, *Mugil cephalus* (L.) from harbour waters of Visakhapmum, India. Bull. Environ. Contam. Toxicol., Vol. 60. Pp. 949-955.

UNEP/ FAO/ IAEA/ IOC, (1984). Sampling of selected marine organisms and sample preparation for trace metal analysis. Reference methods for marine pollution studies. Review 2:19.

WHO (1982). Toxicological evaluation of certain food additives, WHO Food Addit. Ser. No. 17, World Health Org., Geneva, Pp. 28-35.

WHO (2006). Joint FAO/WHO Expert Committee on Food Additives. Meeting (67th: 2006: Rome, Italy) Evaluation of certain food additives and contaminants: sixty-seventh report of the Joint FAO/WHO Expert Committee on Food Additives. (WHO technical report series; No. 940).

Yáñez- Arancibia, A., Sánchez-Gil, P. (1988). Ecologia de los recursos demersales marions, first edicao. AGT Editor S/A Mexico, D, P. 189.



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Environmental change is increasingly considered a critical topic for researchers across multiple disciplines, as well as policy makers throughout the world. Mounting evidence shows that environments in every part of the globe are undergoing tremendous human-induced change. Population growth, urbanization and the expansion of the global economy are putting increasing pressure on ecosystems around the planet. To understand the causes and consequences of environmental change, the contributors to this book employ spatial and non-spatial data, diverse theoretical perspectives and cutting edge research tools such as GIS, remote sensing and other relevant technologies. International Perspectives on Global Environmental Change brings together research from around the world to explore the complexities of contemporary, and historical environmental change. As an InTech open source publication current and cutting edge research methodologies and research results are quickly published for the academic policy-making communities. Dimensions of environmental change explored in this volume include: Climate change Historical environmental change Biological responses to environmental change Land use and land cover change Policy and management for environmental change