

# The occurrence and distribution of humic substances and nutrient salts in Alexandria Eastern Harbour (Spring 2004)

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## Abstract

Alexandria Eastern Harbour (EH) is a semi-enclosed bay covering an area of about 2.8 km<sup>2</sup> with an average depth of 5 m. The harbour is connected with the Mediterranean Sea through El-Boughaz and El-Silsila openings. The hydrography of Alexandria EH were studied in spring (May 2004). These include the hydrographic data (temperature, pH, oxidizable organic matter (OOM) and chlorophyll-a and the nutrient salts (ammonia, nitrite, nitrate, reactive phosphate and silicate) were measured in the water. The study also includes determination both fulvic acids in the surface water as well as fulvic acids and other humic substances in the sediment of Alexandria EH were determined at the first time. Primary production measured chlorophyll-a values ranged between 0.68 and 4.35  $\mu\text{g l}^{-1}$ . As a result of the extensive input of nutrients since a long time ago from the main pumping station at Kayet Bay as well as subsidiary 11 outfalls inside the harbour, the semi-enclosed nature of the harbour and the shallowness of the water, heavy algal blooms and domination of plankton existed. The OOM values showed a narrow range of variation between the surface and bottom water with a respective mean value 7.47 and 8.05 mg O<sub>2</sub>/l, respectively. High values of ammonia 4.84  $\mu\text{mol l}^{-1}$ , nitrate 1.5  $\mu\text{mol l}^{-1}$  were recorded in the surface water of the harbour. Both silicate and phosphate showed a narrow range of variation between the surface and bottom water of the EH. Fulvic acids ranged between 0.10 and 0.41 mg l<sup>-1</sup>, and between 0.24 and 0.69 mg g<sup>-1</sup> in the surface water and sediments, respectively. The high values of fulvic acids are characterizing the inshore shallow area of the harbour. In the sediments, the percentage of humic substances /organic carbon is of an average value 35.5 for the EH which means that humic substances in the sediment of Alexandria EH represent more than 1/3 organic carbon in the sediments. In the sediments, correlation analysis reveals the presence of a good relation between fulvic acids and humic substances.

## 1. Introduction

Humic substances (humic and fulvic acids) are the largest resource of organic carbon in the aquatic environments (Mantoura *et al.*, 1978). These compounds also interact with a number of organic and inorganic pollutants, altering the chemical behaviors, transport mechanisms and ultimate fates of these pollutants in the environment.

The major components involved in the evolution of humic substances are proteins, carbohydrates, lignins, fatty acids and a variety of organic acids. They constitute the bulk (50 to 80%) of the organic matter in natural waters, sediments, soils, peat bogs and other natural ecosystems. The organic carbon content of coastal water and sediments is usually resulted from the contribution of terrigenous nutrients (exogenic) and decomposition of authogenic plant and animal remains near the bottom of the water bodies through the action of bacteria further the biologically important element, carbon, nitrogen and phosphorous to return into the circulation in the overlying water. However, the concentration of organic carbon in the sediments reflects the high productivity of the water column by

stimulating the growth of phytoplankton especially in the coastal waters. The character of organic substances is affected particularly by oxygen content, bacterial activity and the chemical nature of the overlying water (Fragalla, 1995).

The present work aims at the examination of the distribution of temperature, chlorophyll-a, pH and oxidizable organic matter; humic substances (humic acids (HA) and fulvic acids (FA)) and nutrient salts (ammonia, nitrite, nitrate, reactive phosphate and silicate) in the bottom water and humic substances (HS) in the sediments of the Alexandria Eastern Harbour (EH) after closing most of the sewers (about 11 outlets had been closed) which were distributed along the coast of the harbour.

### 1.1. Area of Study

Alexandria Eastern Harbour is one of the most important areas of tourism, fisheries and several recreational and developmental purposes. It is a shallow, protected, semi-enclosed and circular basin, covering an area of 2.8 km<sup>2</sup> and a mean depth of 5 m (Figure 1). The deepest part of the area (12 m) is found near El-Boughaz inlet, the bottom slopes down

gradually towards El-Boughaz opening (Said and Maiyza, 1987). Alexandria EH occupies the central part of the coast of Alexandria and connected to the Mediterranean Sea through two openings, El-Boughaz (main) and El-Silsila. According to Nessim *et al.* (2007), till 2003, the basin receives a considerable high amount of domestic sewage water discharged directly from the main pumping station at Kayet Bay as well as subsidiary 11 outfalls inside the harbour for rain water discharge. The daily amount of unprocessed sewage discharged inside the harbour was estimated at 63.014 m<sup>3</sup> (Mehrem, 2002). The main activity in the EH is fishing and most of ships are using the EH as fishing boats. In addition, there are many private shipyards slip ways used for building and maintenance of fishing boats, yachts and leisure small boats. Accumulation of nutrient salts, organics and other elements in the sediments as well as diffusion from the sediments and pore waters to the overlaying water are expected. The

surficial sediments of the harbour are highly affected by the anthropogenic input and progressively undergo several changes in their characteristics. Current is generally flow from the open sea into the harbour through El-Boughaz opening and then flow a counter clockwise path to reach the sea again through El-Silsila outlet. Exceptions may be observed during the winter months, when the currents follow a clockwise direction (El-Sonbaty, 1997). Recently, Shreadah *et al.* (2006) studied the physicochemical characteristics of the EH. The hydrographic structure of Alexandria EH has been studied by El-Geziry and Maiyza (2006), while the zooplankton community in the harbour has been studied by Zakaria (2006) and the crustacean isopods by El-Sonbaty (1997) and nutrient salts, bacteria and their correlation coefficient between them have been studied by Mahmoud *et al.* (2006). The pore water chemistry was studied by Nessim *et al.* (2007).

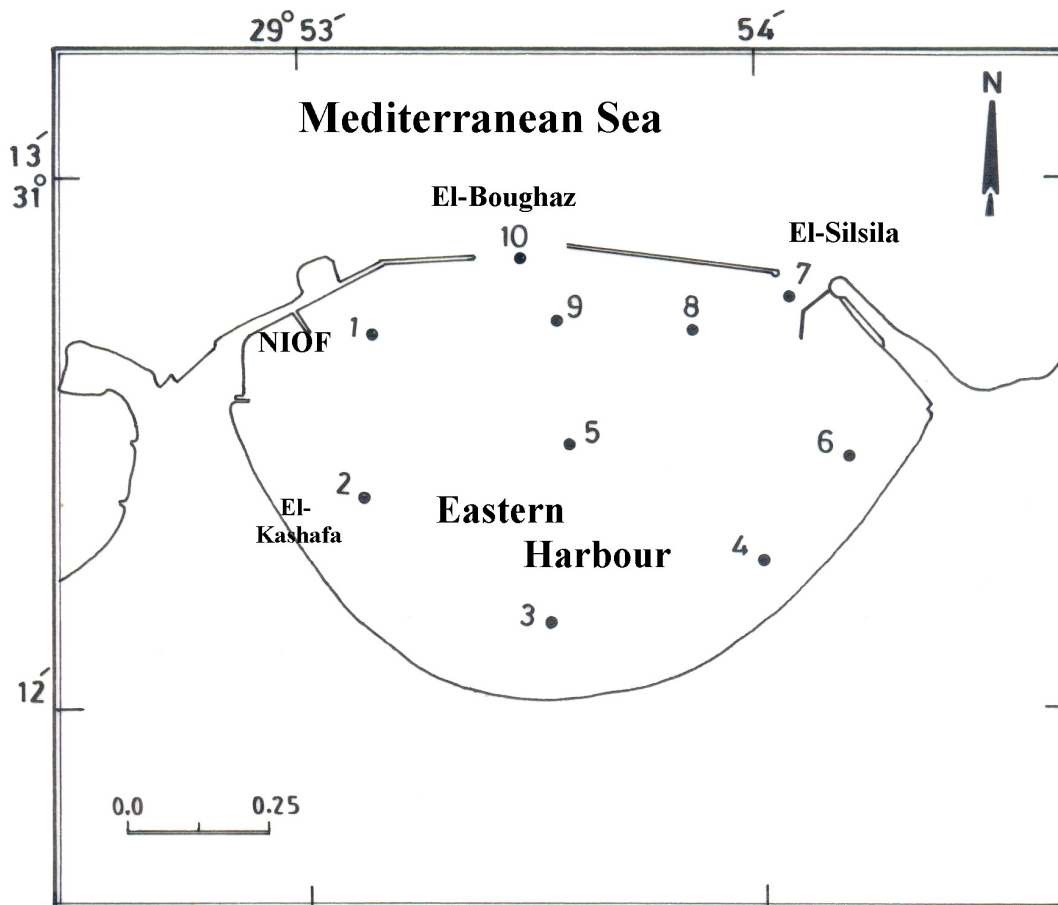


Figure (1): The study area, Alexandria Eastern Harbour and positions of the sampling stations.

## 2. Material and Methods

Sub-surface water samples (0.5 m depth) and near bottom water for nutrient salts was collected using a Nisken bottle twice on local motorboat from 10 locations covered the Eastern Harbour during spring, 2004. The locations were selected taking into consideration the different area of the harbour due to human activities. Water samples (surface and bottom) were stored at -20°C for nutrient salts analysis. Samples for measurements of oxidizable organic matter (OOM) were collected in brown bottles of 100 ml capacity. Water temperature was measured using a pocket thermometer. A portable digital pH meter of 0.01 unit accuracy (model 3410 Jenway) was used for pH measurements.

Sub surface water samples (about 0.5 m below the surface to avoid floating matter) were collected directly in a 5-liter polyethylene jerry cans previously cleaned. For chlorophyll-a, one liter polyethylene jerry cans surface water samples were collected at the same times. At the same stations, surficial sediments were collected utilizing a stainless-steel grab (Ekman Grab).

Nutrient salts in surface and bottom waters, including ammonia, nitrite, nitrate, reactive phosphate and silicate were determined spectrophotometrically according to the procedures mentioned Grasshoff (1976). Chlorophyll-a was determined according to Strickland and Parsons (1968) methods (using acetone

90%). (OOM) was estimated by boiling a known volume of water samples in presence of alkaline potassium permanganate and titrating the liberated iodine against standard thiosulphate solution (Ellis *et al* 1946). Surface water samples were used for the isolation of humic acids by classical procedure for XAD resin (Stuermer and Harvey, 1974 and 1977). Grab sediments were used for extraction of humic substances (humic acids (HA) and fulvic acids (FA)) from the same stations. Humic substances (HS) were extracted by 3 times successively shaking with 0.5 M NaOH solution and the humic acids were separated by acidification to pH one unit with HCl. The precipitated humic acids were recovered by centrifugation. The supernatant solution containing fulvic acids (Rashid and King, 1969 and Majumdar and Roa, 1978).

## 3. Results and Discussion

### 3.1. Water samples

#### 3.1.1. Hydrographical characteristics

The values of water temperature, pH and oxidizable organic matter (OOM) in the surface and bottom water and the concentration of chlorophyll-a in the surface water for all sample stations during the spring are shown in Table 1 and Figure 2.

Table (1): Water temperatures, pH, oxidizable organic matter and chlorophyll-a of surface (S) and bottom (B) waters in the Eastern Harbour Alexandria in spring 2004.

Station	Depth (m)	Type	Temp. (°C)	pH	OOM (mg O <sub>2</sub> /l)	Chl-a (µg/l)
1	2.5	S	22.63	8.30	9.77	0.70
		B	22.63	8.25	10.65	-
2	2.0	S	22.47	8.30	9.68	0.68
		B	22.17	8.22	4.27	-
3	2.0	S	22.67	8.34	8.32	4.35
		B	22.13	8.29	11.30	-
4	2.5	S	22.33	8.39	8.32	0.93
		B	22.30	8.21	5.33	-
5	7.0	S	22.27	8.41	7.36	1.51
		B	21.37	8.18	7.25	-
6	2.5	S	22.57	8.37	4.48	4.21
		B	22.10	8.26	9.60	-
7	7.0	S	23.47	8.41	7.15	3.49
		B	22.13	8.26	7.15	-
8	6.0	S	22.43	8.40	7.15	0.79
		B	21.74	8.22	8.64	-
9	12	S	22.10	8.38	7.04	1.20
		B	21.77	8.18	11.95	-
10	6.0	S	22.17	8.39	4.48	2.68
		B	21.30	8.23	4.48	-
Regional Average	4.95	S	22.51± 0.39		7.48 ± 1.90	2.05 ± 1.49
		B	21.97 ± 0.41		8.05 ± 2.80	-

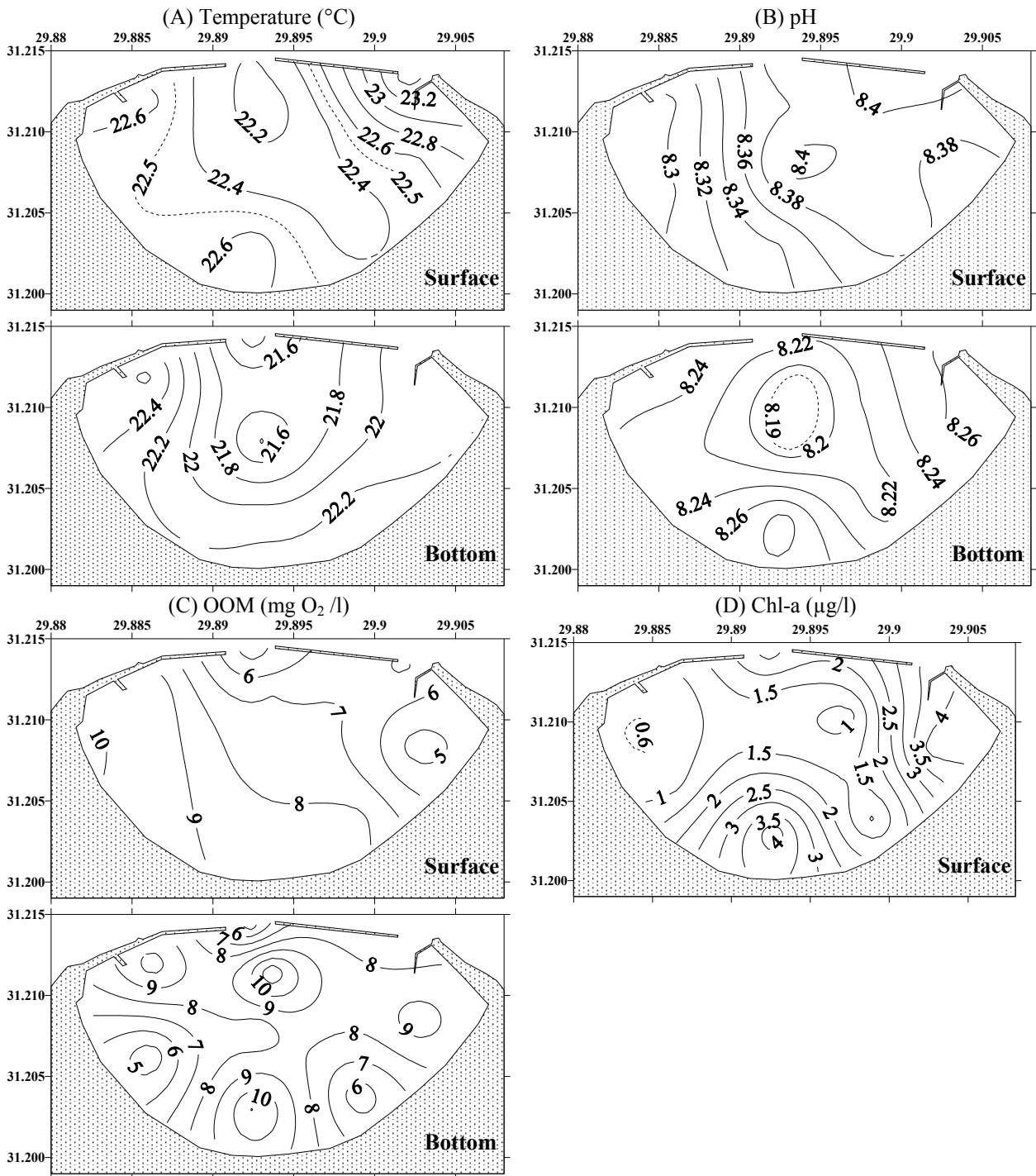


Figure 2: Horizontal distributions of (A) water temperature, (B) pH, (C) OOM and (D) chlorophyll-a of surface and bottom water of eastern Harbor in spring 2004.

### 3.1.1. 1. Water Temperature

The water temperature varied between 22.10 and 23.47°C in surface water with an average of  $22.51 \pm 0.40$  °C and between 21.30 and 22.63°C in the bottom water with an average of  $21.97 \pm 0.41$  °C. Surface water temperature was always higher than that of the bottom water at all stations of the EH. The horizontal distribution of temperature in the surface and bottom waters in the EH (Figure 2) showed a small increase in water temperature from the open sea towards the harbour via El-Boughaz (from 22.2 to 22.6°C in the surface water and 21.6 to 22.2°C in the bottom water). This trend is more or less reversed at El-Silsila opening. An increase of water temperature leads to a decrease in the solubility of oxygen in water, which leads to an increase of the metabolic activities of the microflora and fauna, which in turn results in higher biochemical Oxygen Demand (BOD) and local hypereutrophication (El-Nagar, 1993 and Aboul-Naga, 2001).

### 3.1.1. 2. pH

The pH values of the EH water lies at slightly alkaline side (8.30 – 8.41), (8.18 – 8.29) in the surface and bottom waters, respectively (Table 1). The surface water pH, as shown in Figure 2, slightly decreases from the sea shoreward, while the bottom water pH slightly increases with a very narrow range between 8.20 and 8.26 dominate the harbour (Figure 2).

### 3.1.1. 3. Oxidizable organic matter (OOM)

Oxidizable organic matter (OOM) of the surface water ranged between 4.48 and 9.77 mg O<sub>2</sub>/l, while the bottom water fluctuated from 4.27 to 11.95 mg O<sub>2</sub>/l, which is within the range of the results of Abou-Taleb (2004). The average values of OOM for both surface and bottom waters were  $7.48 \pm 1.9$  and  $8.05 \pm 2.8$  mg O<sub>2</sub>/l, showing no significant differences between the surface and bottom waters due to the shallowness of the harbour (Table 1). Horizontal distribution of OOM of surface water reveals a surface inflow taking place from the open sea to the harbour via El-Boughaz (in front of National Institute of Oceanography and Fisheries (NIOF)) (St. 1), while OOM of bottom water reveals an irregular trend. OOM are produced mainly through the decomposition of different effluents particularly domestic sewage introduced through land sources as well as the decomposition of plant organisms and particulate organic detritus at the bottom. Most of these substances are readily oxidized and are soon decomposed either through autolysis and/or bacterial action. Naturally, both mechanisms may act together, the extent of each varying according to the condition and the availability of necessary enzymes and bacteria.

### 3.1.1. 4. Chlorophyll-a

Chlorophyll-a is the essential pigment involved in light absorption and photochemistry in high plants and algae. Table (1) shows that chlorophyll-a ranged between a minimum of  $0.68 \mu\text{g l}^{-1}$  (in front of NIOF) and a maximum of  $4.35 \mu\text{g l}^{-1}$  in front of El-Kashafa, (Figure 1) which is probably due to the blooming of phytoplankton..

### 3.1.2 Nutrients

The surface (S) and bottom (B) waters values of ammonia, nitrite, nitrate, reactive phosphate and silicate are presented in Table 2 and the surface and bottom distribution are presented in Figure 3.

#### 3.1.2 .1. Ammonia (NH<sub>4</sub>-N)

Ammonia is the major nitrogenous product of the bacterial decomposition of organic matter and an important excretory product of invertebrates and vertebrates. In addition, ammonia is released during organic decomposition via sulfate reduction (Richards, 1965). The concentration of ammonia in Alexandria EH fluctuated between  $0.34$  and  $4.84 \mu\text{mol l}^{-1}$  and  $0.70$  and  $1.74 \mu\text{mol l}^{-1}$  in the surface and bottom waters, respectively. Thus, the concentration of ammonia decreases from surface water to bottom water at stations (2, 3, 4 and 5), which reflects the effect of discharged water through the harbour outlet. The surface distribution of ammonia showed outflow decrease from the EH through El-Boughaz (from  $4.0$  to  $0.3 \mu\text{mol l}^{-1}$ ). The same observations could be noticed in the bottom water distribution of ammonia but with a narrow range (from  $1.6$  to  $0.6 \mu\text{mol l}^{-1}$ ) through El-Boughaz and from  $1.2$  to  $0.8 \mu\text{mol l}^{-1}$  through El-Silsila opening (Figure 3).

#### 3.1.2 .2. Nitrite (NO<sub>2</sub>-N)

Nitrite forms a minor part of the total inorganic nitrogen. Nitrite concentration reached its maximum value of  $0.14 \mu\text{mol l}^{-1}$  in the surface water and  $0.20 \mu\text{mol l}^{-1}$  in the bottom water of the EH (Table 2), with a mean value of  $0.08 \pm 0.07 \mu\text{mol l}^{-1}$  and  $0.08 \pm 0.04 \mu\text{mol l}^{-1}$  for surface and bottom waters, respectively (Table 2). Distribution of nitrite in surface water Figure 3 reflect a decrease from the harbour through El-Boughaz and between  $0.14$  and  $0.18 \mu\text{mol l}^{-1}$  from the harbour through El-Silsila. On the other hand, a bottom water nitrite exhibits a gradual increase from  $0.07$  to  $0.18 \mu\text{mol l}^{-1}$  through El-Silsila.

#### 3.1.2 .3. Nitrate (NO<sub>3</sub>-N)

The concentration of nitrate in Alexandria EH surface water ranged between  $0.28$  and  $1.5 \mu\text{mol l}^{-1}$  and in bottom water between  $0.25$  and  $1.77 \mu\text{mol l}^{-1}$  with a mean value of  $0.76 \pm 0.48 \mu\text{mol l}^{-1}$  and  $0.77 \pm 0.45 \mu\text{mol l}^{-1}$ .

$\text{I}^{-1}$  for surface and bottom waters, respectively. The surface water nitrate distribution fluctuates between 1.4 and  $0.4 \mu\text{M l}^{-1}$  from the shore to open seaward. The

bottom water nitrate exhibits a high value (in front of NIOF and El-Silsila) and a gradual decrease towards open sea opening (Figure 3).

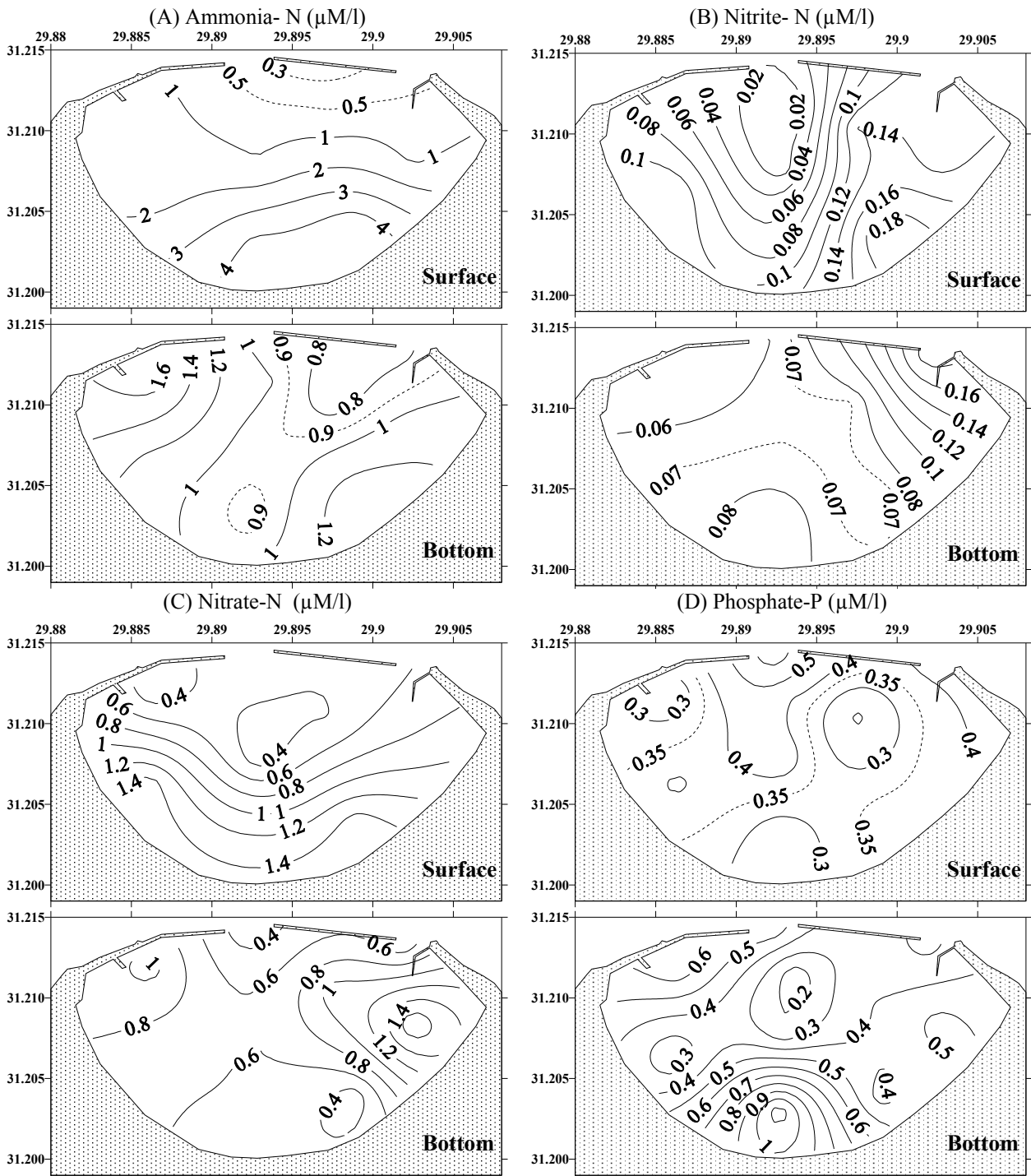


Figure 3: Horizontal distributions of (A) ammonia, (B) nitrite, (C) nitrate and (D) phosphate of surface and bottom water of eastern Harbor in spring 2004.

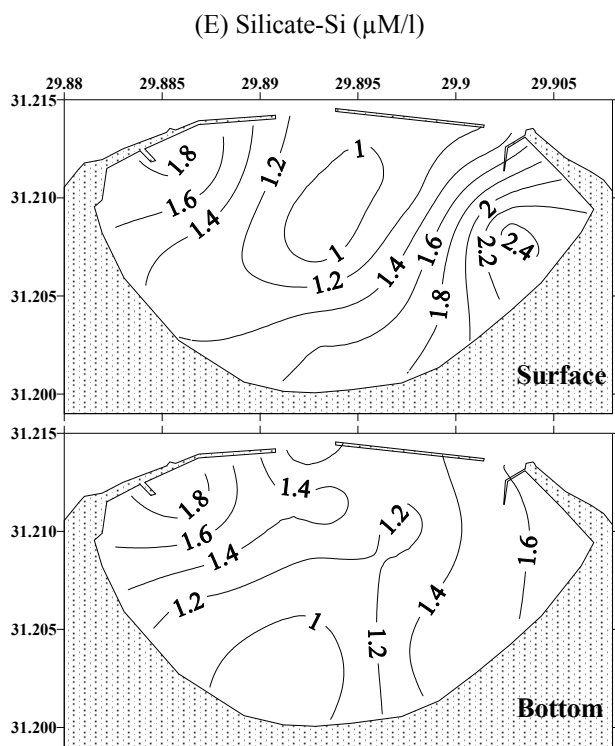


Figure 3 cont.: Horizontal distributions of (E) silicate of surface and bottom water of eastern Harbor during spring 2004.

3.1.2.4. Reactive phosphate ( $PO_4\text{-P}$ )

The phosphate concentration in the EH water showed a narrow range of variation between the surface and bottom water with a mean value of  $0.38 \pm 0.13 \mu\text{mol l}^{-1}$  and  $0.45 \pm 0.31 \mu\text{mol l}^{-1}$ , respectively. According to Stirn (1972), the phosphate content is around  $0.3 \mu\text{mol}$

$\text{l}^{-1}$  in the euphotic layer of a productive temperature coastal water. As shown in Figure 3, the surface water phosphate concentration exhibits a narrow range of variation from  $0.3$  to  $0.4 \mu\text{mol l}^{-1}$  in the harbour basin, while the bottom water exhibits a high concentration of  $1.1 \mu\text{mol l}^{-1}$  in the mid-shore of the harbour which gradually decreases to  $0.4 \mu\text{mol l}^{-1}$  through El-Boughaz and El-Silsila opening. Nehring (1987) found that, a continuous decrease in water and salt concentrations led to an increase in the phosphate concentrations in a stagnant water mainly due to phosphate remobilization from the sediments in the presence of hydrogen sulphide.

3.1.2.5. Silicate ( $SiO_4\text{-Si}$ )

Similar to phosphate, silicate showed a narrow range of variation between the surface and bottom waters of the EH. It ranges between  $0.81$  and  $2.48 \mu\text{mol l}^{-1}$  with a mean value of  $1.42 \pm 0.51 \mu\text{mol l}^{-1}$  and between  $0.83$  and  $1.79 \mu\text{mol l}^{-1}$  with a mean value of  $1.33 \pm 0.31 \mu\text{mol l}^{-1}$  in the surface and bottom waters, respectively (Table 2). The surface water silicate reveals high values in front of NIOF and station 6 and a gradual decrease to the open seaward through El-Boughaz and El-Silsila opening, while the bottom water silicate reveals the same trend of the surface but with a narrow range of graduation. Silicate concentrations in a marine water are controlled with uptake by heavy diatom blooms and the input of drainage water. The concentration of silicate in the EH water is low as compared with that of eutrophication in Iskenderum Bay, northeast Mediterranean ( $8.0\text{-}11.0 \mu\text{g l}^{-1}$ ) (Yilmaz *et al.*, 1992).

Table (2): Concentrations ( $\mu\text{ mole/l}$ ) of ammonia, nitrite, nitrate, phosphate and silicate of surface (S) and bottom (B) waters in the Eastern Harbour Alexandria in spring 2004.

Station	Type	$NH_4\text{-N}$	$NO_2\text{-N}$	$NO_3\text{-N}$	DIN- N	$PO_4\text{-P}$	$SiO_4\text{-Si}$
1	S	1.24	0.06	0.29	1.59	0.25	1.90
	B	1.74	0.05	1.06	2.85	0.68	1.79
2	S	1.50	0.12	1.49	1.74	0.41	1.25
	B	1.12	0.07	0.65	1.84	0.20	1.17
3	S	4.24	0.07	1.21	5.52	0.25	1.57
	B	0.85	0.09	0.58	1.52	1.10	0.83
4	S	4.84	0.20	1.50	6.54	0.38	1.77
	B	1.39	0.06	0.30	1.75	0.36	1.57
5	S	1.10	0.01	0.28	1.39	0.45	0.81
	B	0.91	0.07	0.60	1.58	0.22	1.11
6	S	0.80	0.13	0.88	1.81	0.38	2.48
	B	1.11	0.12	1.77	3.00	0.54	1.57
7	S	0.46	0.13	0.58	1.17	0.41	1.23
	B	0.77	0.19	0.84	1.80	0.27	1.59
8	S	0.66	0.14	0.40	1.20	0.18	1.07
	B	0.70	0.07	1.08	1.85	0.39	1.11
9	S	0.54	0.00	0.40	0.94	0.39	0.99
	B	1.02	0.07	0.58	1.67	0.14	1.53
10	S	0.34	0.02	0.60	0.96	0.66	1.13
	B	0.96	0.06	0.25	1.27	0.57	1.05
Regional Average	S	$1.57 \pm 1.61$	$0.08 \pm 0.07$	$0.76 \pm 0.48$	$2.42 \pm 2.02$	$0.38 \pm 0.13$	$1.42 \pm 0.51$
	B	$1.06 \pm 0.31$	$0.08 \pm 0.04$	$0.77 \pm 0.45$	$1.91 \pm 0.56$	$0.45 \pm 0.31$	$1.33 \pm 0.31$

### 3.1.3. Fulvic acids in surface water of Alexandria EH

Fulvic acids representing the dissolved organic matter in natural water, is a complex assemblage of decay plant and soil materials and of the polymeric compounds produced by random combination of these various biomonomers. It is largely composed of a variety of carbohydrates, sugars, free and bound amino acids, nitrogenous compounds held together, lignins and their derivatives and fatty acids. (Plavsic *et al.*, 1991) In Alexandria EH, fulvic acids in the surface water ranged between 0.10 and 0.41 mg l<sup>-1</sup> with a mean value of 0.23±0.1 mg l<sup>-1</sup>. The high values of fulvic acids taking place through the harbour shore and the values decrease towards the open seaward (Figure 4). According to Hayes (1998), aquatic humic substances (fulvic acids and humic acids) may be found in groundwater, rivers water, lakes, bogs, swamps and seawater. The source of humates may be autochthonous or allochthonous that is the humates may be formed from phytoplankton and the plankton populations in the water or they may be leached into the aquatic environment from terrestrial plants, leaf litter, soil, or subsurface deposits. Relatively undisturbed marine environments have humic and fulvic acids formed almost entirely from native phytoplankton. Inland surface waters contain major contribution from allochthonous sources. Mixing of the two types of materials may occur, as in river estuaries (Figure 5).

## 3.2. Sediment samples

### 3.2. 1. Fulvic acids and humic substances

The surface sediments of Alexandria EH are rich in sand, which is of biogenic origin, in addition to shells and their fragments, resulting in an average CaCO<sub>3</sub> content of ~70%. (Abu-Taleb 2004). The fulvic acids in the surface sediments of the harbour ranged between 0.24 and 0.69 mg g<sup>-1</sup> with a mean of 0.52±0.14 mg g<sup>-1</sup>, while the humic substances (fulvic and humic acids) ranged between 1.09 and 2.19 mg g<sup>-1</sup> with a mean of 1.67±0.36 mg g<sup>-1</sup> (Table 3). Humic substances in Alexandria EH are characterized by the low value of the fulvic acid fractions. The mean FA/HS ratio for the EH is ~30.6%, and it varies between 22% and 37.5%. No definite trend has been observed for humic substances distribution but fulvic acid proportion increases in the humic substances which may be given as a result of an increasing probability of condensation and polymerization processes in the sediments. (Rashid 1985).

Fulvic acid distribution in the sediments exhibits the same trend of its distribution in the surface water but in high values (0.24 and 0.65 mg g<sup>-1</sup>). The high values of fulvic acids in the sediments of the harbour present along the shore of the basin are mainly due to the accumulation of humic substances from the inland flow present along the EH.

Humic substances distribution in the sediments of the EH varies between 1.4 and 2.0 mg g<sup>-1</sup>, high in the shores and decrease from the shore to open seaward. It exhibits the same horizontal distribution of fulvic acids in the surface water and fulvic acids in the sediments of the Alexandria EH (Figure 4).

Using the concentration of fulvic acids in the water and sediments, we calculated the concentration factor (CF equivalent to: concentration in sediment / concentration in water). It could be seen that CF ranges between 1.68 and 3.6 with an average of 2.31 ± 0.61 (Table 3).

### 3.2. .2. Humic substances and organic carbon content in the sediments of the Eastern Harbour

The organic matter in the harbour sediments shows a relative narrow range where the values vary from 3.0 to 7.6% with an average value of 4.44% (Nessim *et al.*, 2007). According to Younes (2005), the organic carbon content of the Eastern Harbour Sediment exhibit a least average value of 0.47%, while the Western Harbour average was 2.04% and the Abu-Qir Bay average was 1.94% and El-Max Bay average was 0.83%. Whatever is the total organic carbon in the sediments, the extractable organic matter is an important parameter, and it may reflect the degree of association between the organic matter and mineral support as well as the nature of the organic matter (Cauwet, 1985).

Humic substances/organic carbon ratio (according to the values determined by Younes, 2005) reveals the ratio of 35.5% for the EH which means that humic substances in the sediments of Alexandria EH represent more than 1/3 organic carbon in the sediments. Kemp (1971) showed that humic substances account for 60-70% of the organic matter in Lake Ontario sediments, while Aboul-Naga (1990) found that humic substances did not exceed 38% of organic carbon in surface sediments from Lake Edku.

### 3.2. 3. Correlation Matrix

In the sediments, correlation analysis reveals the presence of a certain relation between fulvic acids and humic substances with a high value of (r = 0.91, n = 10 p < 0.05). Fulvic acids and humic substances in the sediments of the EH reveal a good agreement with temperature (r = 0.581 and 0.812 respectively, n = 10 p < 0.05), ammonia (r = 0.79 and 0.768 respectively, n = 10 p < 0.05), silicate (r = 0.723 and 0.760 respectively, n = 10 p < 0.05) and a moderate correlation with pH, nitrite, nitrate and any relation with OOM and phosphate. In the sediments, the significant correlation indicates that due to the increase of temperature the decomposition increase due to bacterial action leading to the fulvic acids content and humic acids content and respectively ammonia content in the sediments.





Table (3): Concentrations of fulvic acids (FA) in surface water (S), fulvic acids and humic substances in sediments, fulvic acids / humic substances ratio and concentration factor of fulvic acids in the eastern harbour during spring 2004.

Station	Type	Water	Sediments		
		FA (mg/l)	HS mg/g	FA / HS Ratio	CF
1	S	0.41			
	B	0.69	2.19	31.50	1.68
2	S	0.26			
	B	0.51	1.87	27.30	1.69
3	S	0.20			
	B	0.44	1.51	29.00	2.10
4	S	0.36			
	B	0.62	2.00	31.00	1.72
5	S	0.10			
	B	0.37	1.16	32.00	3.60
6	S	0.22			
	B	0.64	1.92	33.70	2.78
7	S	0.22			
	B	0.60	1.84	32.60	2.73
8	S	0.12			
	B	0.24	1.09	22.00	2.00
9	S	0.22			
	B	0.50	1.69	29.60	2.27
10	S	0.21			
	B	0.54	1.44	37.50	2.57
Average	S	0.23 ± 0.10			
	B	0.52 ± 0.14	1.67 ± 0.36	30.62 ± 4.12	2.31 ± 0.61

## References

- Aboul-Naga, W.M.: 1990, Study of humic substances in Lake Edku and their effect on water chemistry. Ph.D. Thesis, Faculty of Science, Alexandria University, Egypt, 205 pp.
- Aboul-Naga, W.M.: 2001, Eutrophication in Lake Mariut, Egypt. *Arab Gulf Journal of Scientific Research*, 19 (3): 150-158.
- Abou-Taleb, A.E.A.: 2004, Assessment of some heavy metals and their accumulation in some marine organisms in Alexandria coastal environment. M.Sc. Thesis, High Institute of Public Health, Alexandria University, Egypt, 260 pp.
- Cauwet, G.C.: 1985, Dynamique de la matiere organique dans les milieux marins et polyhalins; son role dans processus geochemiques. These d'Etat, Universite Perpignan, 178 pp.
- El-Geziry, T.M. and Maiyza, I.A.: 2006, The hydrographic structure of Alexandria Eastern Harbour. *Egyptian Journal of Aquatic Research*, 32, special issue, 69-73.
- Ellis, M.M.; Westfall, B.A. and Ellis, D.M.: 1964, determination of water quality. U. S. Dept. Int. Fish. and Wildlife service, Research report No. 9, 122p
- El-Nagar, M.F.: 1993, Biological implication of some cellular products naturally occurred in marine algae. M.Sc. Thesis, High Institute of Public Health, Alexandria.
- El-Sonbaty, S.F.: 1997, Studies on some crustacean isopods in the Eastern Harbour of Alexandria. M.Sc. Thesis, Faculty of Science, Alexandria University, Egypt.

- Faragalla, H.M.: 1995, Sediment-water interface chemistry in the Eastern Harbour, Alexandria. M.Sc. Thesis, Faculty of Science, Alexandria University, Egypt.
- Grasshoff, K.: 1976, Methods of sea water analysis. Verlag Chemic Weinheim, New York.
- Hayes, M.H.B.: 1998, Humic substances: Progress towards more realistic concepts of structure, pp. 1-27, in "Humic Substances Structures, Properties and Uses", eds. Davis, G.; Ghabbour, E.A.; Khairy, Kh.A, R.S. C, Cambridge CB4, OWF, UK, pp. 259.
- Kemp, A.L.W.: 1971, Organic carbon and nitrogen in the surface sediments of Lake Ontario, Erie and Huron, *Journal of Sedimentology and Petrology*, 41: 537-548.
- Macolady, D.L.: 1998, Perspectives in Environmental Chemistry. New York, Oxford, p. 230.
- Mahmoud, Th. H.; El-Nagar, M.M.A.; Abd El-Halim, A.M. and El-Shenawy, M.A.: 2006, The correlation coefficients between some hydrographic parameters, nutrient salts and bacteria in the Eastern Harbour, Alexandria, Egypt. International Conference on Aquatic Resources, Needs and Benefits, Sept. 18-21, Alexandria, Egypt.
- Majumdar, S.K. and Roa, C.V.N.: 1978, Physicochemical studies on enzyme degraded fulvic acid. *Journal of Soil*, 29: 489-497.
- Mantoura, R.F.C.; Dickson, A. and Riley, J.P.: 1978, The complexation of metals with humic material in natural waters. *Estuar. Coast. Mar. Sci.*, 6: 387-408.
- Meherm, M.: 2002, Assessment of the state of pollution by antifouling paint in marine environment of Alexandria coastal region. Ph. D in Maritime Transport Technology (Environmental protection) Arab Academy for Science and Technology and Maritime Transport.
- Nehring, D.: 1987, Temporal variations of phosphate and inorganic nitrogen compounds in Central Baltic deep waters. *Limnology and Oceanography*, 32: 494-499.
- Nessim, R.B.; Tadros, H.R.Z. and Abou-Taleb, A.E.: 2007, Pore water chemistry of Alexandria Eastern Harbour. MEDCOAST, Alexandria, Egypt, pp. 873-884.
- Plavsic, M.; Cosovic, B. and Miletic, S.: 1991, *Analytica Chimica Acta*, 255: 15
- Rashid, M.A.: 1985, Humification- A Major Biogeochemical phenomenon. In: *Geochemistry of Marine compounds*. Springer – Verlag, New York, Berlin, Heidelberg, Tokyo, 300pp.
- Rashid, M.A. and King, L.H.: 1969, Molecular weight distribution measurement from marine clays on the Scottian Shelf. *Geochim Cosmochim Acta*, 33: 147-151.
- Richards, F.A.: 1965, Dissolved gases other than carbon dioxide. In: Riley, J.P. and Skirrow, G. (eds.), *Chemical Oceanography*, Vol. 1, Academic Press, London and New York, pp. 197-225.
- Said, M.A. and Maiyza, I.A.: 1987, Effect of the domestic sewage discharge of the hydrographic regime of the Eastern Harbour of Alexandria. *Bull. Inst. Oceanogr. & Fish.*, AREB (2): 1-20.
- Shreadah, M.: 1982, Studies on the chemical composition of the EH water, Alexandria. M.Sc. Thesis, Faculty of Science, Alexandria University, Egypt.
- Shreadah, M.A.; Said, T.O.; Younis, A.M. and Farag, R.S.: 2006, Physico-chemical characteristics of the semi-closed areas along the Mediterranean coast of Alexandria, Egypt. *Egyptian Journal of Aquatic Research*, 32, Special Issue, pp. 38-48.
- Stevenson, F.J.: 1994, Humus chemistry, composition and reactions. 2<sup>nd</sup> ed., Wiley, New York.
- Stirn, J.: 1972, Possibilities for constructive use of domestic sewage. in: Ruivo, M. (ed.) *Marine Pollution and Sea Life*. Fishing News, London, pp. 517-519.
- Strickland, J.D.H. and Parsons, T.R.: 1968, A practical handbook of sea water analysis. *Bulletin of Fish Research Board of Canada*, pp. 167-311.
- Stuermer, D.H. and Harvey, G.R.: 1974, Humic substances from sea water. *Nature, London*, 250: 480-482.
- Stuermer, D.H. and Harvey, G.R.: 1977, The isolation of humic substances and alcohol-soluble organic matter from seawater. *Deep-Sea Res.*, 24: 303-309.
- Yilmaz, A.; Basturk, O.; Saydam, C.; Edjer, D.; Yilmaz, K. and Hatipoglu, E.: 1992, Eutrophication in Iskenderum Bay, Northeast Mediterra. In: Vollenweider, R.A., Marchetti, R. and Viviani, R. (eds.), *Marine Coastal Eutrophication*, Elsevier.
- Younes, A.M.M.: 2005, Speciation of organic compounds in semi-closed areas along the Mediterranean coast of Alexandria. M.Sc. Thesis, Faculty of Science, Al-Azhar University, 224 pp.
- Zakaria, H.Y.: 2006, Zooplankton community in the Eastern Harbour of Alexandria. *Egyptian Journal of Aquatic Research*, 32, Special Issue, pp. 196-209.

## تواجد وتوزيع المواد الدبالية والأملاح المغذية في الإسكندرية الميناء الشرقي (ربيع 2004)

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المعهد القومي لعلوم البحار والمصايد - الاسكندرية

يعتبر الميناء الشرقي بالإسكندرية خليج شبه مغلق ويغطي مساحة تبلغ حوالي 2.8 كم مربع، بمتوسط عمق 5 متر. الميناء يرتبط بالبحر المتوسط من خلال فتحة البوغاز و السلسلة. تم دراسة المتغيرات الهيدروغرافية في الميناء الشرقي بالإسكندرية في فصل الربيع (مايو 2004). وتشمل هذه البيانات الهيدروغرافية للمياه درجة الحرارة ودرجة الحموضة و المواد العضوية والكلوروفيل-أ والأملاح المغذية (الأمونيا والنترت ، والنترات والفوسفات والسيليكات المتفاعلة). و اشتملت الدراسة ايضا تعيين احماض الفولفك في المياه السطحية للميناء بالاضافة الى تعيين أحماض الفولفك وغيرها من المواد الدبالية في الرسوبيات للمرة الاولى. تراوحت قيم الكلوروفيل كإنتاجية للواد الغذائية الأولية بين 0.68 و 4.35 ميكروجرام /لتر ، ونتيجة للمدخلات واسعة النطاق من المغذيات منذ زمن طويل من محطة الضخ الرئيسية في خليج قايتباى فضلا عن المصببات الفرعية داخل الميناء (11 مصب) و الطبيعة شبه المغلقة من الميناء مع ضحالة المياه المثقلة بالطحالب والعوالق. وأظهرت قيم المواد العضوية مجموعة ضيقة من التفاوت بين المياه السطحية ومياه القاع مع قيمة كل منها 7.47 يعني O<sub>2</sub> و 8.05 ملغم / لتر ، على التوالي. القيم العليا للأمونيا 4.84  $\mu\text{mol}$  ل - 1 ، نترات 1.5  $\mu\text{mol}$  ل - 1 سجلت في السطح المياه من الميناء. كلا السيليكات والفوسفات أظهرت مجموعة ضيقة من التفاوت بين المياه السطحية والمياه القاعية. الأحماض Fulvic تراوحت ما بين 0.10 و 0.41 ل مغ - 1 ، وبين 0.24 و 0.69 مغ ز - 1 في المياه السطحية والرواسب ، على التوالي. وقيم عالية من الأحماض fulvic هي التي تميز المنطقة الضحلة القريبة من الشاطئ من الميناء. وفي الرواسب ، كانت النسبة المئوية للمواد الدبالية / الكربون العضوي هو بقيمة متوسطها 35.5 وهو ما يعني أن المواد الدبالية في الرسوبيات الاسكندرية تمثل أكثر من 1 / 3 الكربون العضوي في الرواسب. ويكشف تحليل الارتباط وجود علاقة جيدة بين fulvic الأحماض والمواد الدبالية في الرواسب.