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LEVELS OF NUTRIENT FORMS AND CHLOROPHYL A BIOMASS IN A HIGHLY POLLUTED BASIN, THE EASTERN HARBOUR OF ALEXANDRIA

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Abstract: Distribution of the different forms of nitrogen and phosphorus in the sewage polluted waters of the Eastern Harbour of Alexandria was studied during June 1985. Because of the high nutrient content ,the average concentration of phytoplankton biomass was 23 mg chl.a.m^{-3}. The average N:P ratios (by atoms) of the different components were as follows: NO3/PO4: 18.7; DIN/DIP: 33.7; DON/DOP: 13.44; TDN/TDP: 18.4; PN/PP: 10.9 and TN/TP: 13.5.

Introduction

The Eastern Harbour (E.H.) is a shallow semiclosed basin, average depth 6m,surface area 2.53x$10^6 m^2$, connected to the Mediterranaen Sea by two openings (Boughaz 1 and Boughaz 2), through which exchange of water takes place. The harbour receives annually about 5.5x$10^6 m^3$ of untreated sewage and waste water through several outfalls distributed along the southern coast (Figure 1). This volume is about 36% of the water volume of the harbour.

Material and Methods

Seven stations were selected to cover the different parts of the harbour (Figure 1). Fifteen surface and subsurface water samples were collected during June 1985. Determinations of dissolved inorganic forms of nitrogen ,phosphorus,reactive silicate and chlorophyll a were carried out according to Strickland & Parsons (1972). TP , TDP, TN and TDN were determined using the methods descibed by Koroleff (1977) and Valderrama (1981).

Results and Discussion

During June 1985, the average surface temperature was 27.0°C,due to the shallowness of the E.H. no thermal stratification was observed. The average surface salinity was 35.89‰with a horizontal gradient of only 0.5‰indicating a horizontal mixing . On the other hand, a pronounced vertical salinity gradient (about 2.5‰) was recorded at Boughaz 1 . Judging from the relative volumes of the harbour and sewage inflow,the residence time of the harbour water is less than three years. Despite the large amount of sewage discharged into the harbour , the surface water seems to be well oxygenated (average D.O. saturation 116%). The effect of the high organic load is mostly felt near the bottom, where the average saturation was 58% with lower values (31%)near the bottom . The pH of the E.H. was always in the alkaline side (average 8.13). The total suspended matter (TSM)was exceedingly high varying between 133mg/l and 44mg/l. However ,the POM was much lower constituting on the average 5.0% and 7.7% of the surface and bottom values of TSM. This may indicate that the TSM of the E.H. are mostly of lithogenic origin. The secchi disc readings varied between 1.0 and 3.5m at different stations . The concentrations of reactive silicate (average surface 9.38ug at/l) was highly correlated with salinity (r= -0.8493,p<0.001).

The phytoplankton biomass was extreemly high compared with other coastal areas of the Egyptian coast, the average chlorophyll a biomass was 23mg chl.a.m^{-3}. Values as high as 37mg chl.a.m^{-3} were recorded at stations directly affected by sewage discharge.

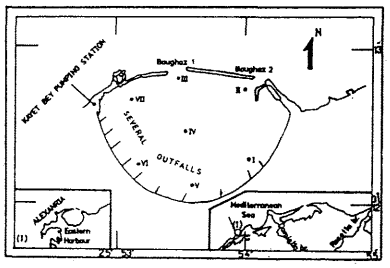

Figure 1. The study area showing stations sampled and sewage outfalls.

The average surface concentration of DIN was 8.56 ug at/l constituting 22% of TN. Nitrate constituted the larger part of DIN (average 56%),followed by ammonia (average 36%)and nitrite (8%). The relative abundance of the different nitrogen forms was as follows : NO3: 12.4%;NO2: 1.7%;NH3: 6.5%; DON:26.8% and PN:55.3%.

The average surface concentrations of DIP (0.32 ug at/l),although comparatively low ,was about 10 times higher than that found in the Mediterranean waters off the Egyptian coast .On the other hand , the average TP amounted to 3.4 ug at/l. The contribution of the different forms of phosphorus in the E.H. was as follows: DIP: 9%; DOP: 22.4% and PP: 69.3%.

The ratio NO3/PO4 is very near to that usually found in normal waters,while the ratio DON/DOP is comparatively lower (Table 1) probably due to the presence of the high concentration of soluble organophosphorus compounds (e.g. detergents) contained in the waste water discharged into the harbour.

Table 1 . Nitrogen-phosphorus ratios (by atoms) in the surface and bottom waters of the Eastern Harbour of Alexandria.

	NO_3/PO_4	DIN/DIP	DON/DOP	TDN/TDP	PN/PP	TN/TP
Surface	16.07	26.75	13.08	17.12	8.30	11.02
Bottom	21.32	40.55	13.79	19.73	13.72	15.89
Average	18.70	33.65	13.44	18.43	10.86	13.46

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ORIGINS OF TRACE ELEMENTS IN A MAIN LAND-BASED SOURCE ON THE NORTH AFRICAN COAST, WEST OF THE NILE DELTA

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Umum drain is a big land-based source of fresh water to the coastal area between Alexandria and libian border. It contributes six million cubic meter/day. In order to define of future objectives in chemistry of the coastal area that surrounds its down stream part, it is very important first to know chemical characteristics, including trace elements of that huge land-based source and the factor/s that may control its characters.

The drain receives its water mainly from two sources. One from the river Nile indirectly, i.e. after passing through agricultural lands of Bohaira and part of Alexandria Provinces. The other from lake Mariut, which join the drain at its northern part before reaching the sea. The lake lies south of Alexandria City and its water is mainly an agricultural drained water from the other part of Alexandria Province, sufferring from intensive pollution. As it bears waste waters of domestic and industrial origins from the city of Alexandria. At present, the water effluent from the lake to the drain is at a rate of 540,000 m^3/day, which is planned to be at a rate of 1.14 million m^3/day in 1987. This will happend after changing the sewer system of Alexandria City to add extra 600,000 m^3/day of its content to the lake.

The chemical characteristics, studied in the present work for the lake effluents and the waters up stream and down stream of the discharge point are shown in table I. Their daily discharge amounts from the lake and from the drain to the sea and their proportions are shown in table II. The daily amounts of pollutant elements discharged from the lake and from the drain to the sea and their proportions, after the 1987 Plan, are shown in table III.

The important stricking feature can be noticed from table I, is that the level of the concentrations of most of the elements studied in the two sources of waters to the drain are more or less equals, except for the sewage elements, total suspended matters, phosphorous and nitrogenous compounds and dissolved manganese. These are considerably higher in concentrations in the lake effluent, and can be used as tracers for the drain water in the coastal area. Mn is one of the metal components forming the industrial wastes that disposed to the lake[1] . Table III, shows that in 1978, the amounts of the pollutants disposed by the drain are expected to increase by 52% over what are disposed now.

Reference : (1) Halim, Y. (1983). Med-Term Report, 1983. Aquatic Envioronmental Pollution Project EGY/73/058. Alexandria University.

Table I
Average (and range of)
Concentration of dissolved and particulate solids in the effluent from lake Mariut (S_e) and in Umum drain upstream (S_u) and down stream (S_d) of the discharge point.

Element	S_e Average (Range)	S_u Average (Range)	S_d Average
Chlorosity (g/l)	1.64(1.13 -3.60)	1.64 (0.85-2.51)	1.64
TSM (mg/l)	56.6 (10.0-95.0)	51.8 (4.3-96.5)	52.2
Phosphate(ug-at/l)	44 (1.2- 107.4)	4 (0.5- 20.0)	7.6
Total-P (ug-at/l)	96.8 (40.7-244.5)	15.4 (1.4-129.0)	22.7
Ammonia (ug-at/l)	37 (21.3-130.4)	25 (4.9-106.0)	26.0
Nitrite (ug-at/l)	13 (1.2 - 42.2)	3 (0.3- 6.9)	3.9
Nitrate (ug-at/l)	35 (11 - 56)	18 (8 - 39)	19.5
Total- N (ug-at/l)	85 (25.5-228.6)	46 (15.2 - 151.9)	49.5
Silicate (ug-at/l)	170 (52 - 315)	241 (117-477)	234.6
Dissolved (ug/l):			
Copper	5.6 (0.8 - 8.4)	5.9 (2.1 - 9.5)	5.9
Cadmium	0.63 (0.21 - 1.05)	0.86 (0.27-1.62)	0.86
Zinc	10.2 (5.2 - 12.7)	9.4 (2.8 - 18.1)	9.5
Iron	10.5 (5.1 - 22.9)	10.7 (3.1- 24.0)	10.4
Manganese	28.1 (0.7-100.8)	5.6 (1.7 - 22.5)	7.6
Particulate (ug/l):			
Copper	13.0 (6.5 - 21.4)	18.3 (6.3-25.5)	17.8
Cadmium	0.62 (0.25-1.42)	0.94 (0.65-1.21)	0.91
Zinc	28.9 (8.6 - 58.9)	32.8 (17.4-71.6)	32.4
Iron	307 (178- 478)	288 (109-552)	289.7
Manganese	87 (28 - 177)	128 (72- 280)	124.5

* Average of fourteen month observations taken before the 1987 Plan for changing the Alexandria Sewer System. .. Calculated.

Table II
The daily discharge amount of dissolved and particulate solids in the effluent (T_e) from lake Mariut and in Umum drain water down stream (T_d) of the discharge point and their ratios . (Before the 1987 Plan).

Element		T_e	T_d	% $\frac{T_e}{T_d}$
Discharged water(km^3)		540	6000	9.0
TSM	(Tonnes)	19.8	193.4	10.2
Chloride	(Tonnes)	885.6	9840.0	9.9
Silicate	(Tonnes)	2.57	39.41	7.0
Ammonia	(Tonnes	0.28	2.19	12.8
Nitrite	(Tonnes)	0.098	0.328	29.9
Nitrate	(Tonnes)	0.265	1.640	16.1
Total-N	(Tonnes)	0.642	4.159	15.5
Phosphate	(Tonnes)	0.760	1.459	52.1
Total-P	(Tonnes)	1.675	4.365	38.3
Manganese	diss.(Kg)	15.17	45.8	33.1
	part.(kg)	46.98	745.9	6.3
Iron	diss.(kg)	5.56	64.0	8.7
	part.(kg)	165.78	1738.2	9.5
Zinc	diss.(kg)	5.51	56.8	9.7
	part.(Kg)	15.61	194.7	8.0
Copper	diss.(kg)	1.94	23.2	8.4
	part.(kg)	7.02	106.9	6.6
Cadmium	diss.(kg)	0.35	5.05	7.0
	part.(kg)	0.34	6.47	5.1

Table III
Expected daily discharge amounts of pollutants in lake Mariut effluent (T_e) and in Umum drain water down stream (T_d) and their ratios, after the 1987 Plan.

Element		T_e	T_d	% $\frac{T_e}{T_d}$
Discharged water (km^3)		1140	6600	17.3
TSM	(Tonnes)	41.7	215.4	19.4
Chloride	(Tonnes)	1870	10824	17.3
Ammonia	(Tonnes)	0.591	2.504	23.6
Nitrite	(Tonnes)	0.207	0.436	47.5
Nitrate	(Tonnes)	0.559	1.951	28.9
Total-N	(Tonnes)	1.357	4.869	27.9
Phosphate	(Tonnes)	1.605	2.302	69.7
Total-P	(Tonnes)	3.531	6.209	56.9
Manganese,diss.	(Kg)	32.0	62.7	51.1