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CONTRIBUTION OF SOME TRACE ELEMENTS FROM AN EGYPTIAN HUGE DRAIN TO THE MEDITERRANEAN SEA, WEST OF ALEXANDRIA

OSMAN A. EL-RAYIS[1] AND MAHA A. ABDALLAH [2]

[1] Department of Oceanography, Faculty of science, Alexandria University, Egypt
[2] National Institute of Oceanography and Fisheries, Alexandria, Egypt

Key Words: *Omoum Drain, agricultural drainage water, up- and down-stream, trace elements, Mediterranean Sea, Alexandria, Egypt.*

ABSTRACT

In 2003 the MAP Technical Report Series 141, has mentioned lack in data concerning flux of water, sediments and pollutants from North-African rivers and of course from the land based sources to the Mediterranean Sea.

In Egypt, Omoum Drain, after the construction of the Aswan High Dam and controlling of Nile River water flow, becomes one of the main land based sources regularly discharging its waters (flow rate 2547.7 x 10^6 m^3/year) directly to the Mediterranean Sea at EL-Mex Bay, west of Alexandria. At its downstream part and before reaching the sea its water mixes with water effluent (surplus water) from a neighboring sewage polluted lake called Lake Maryout, rate 262.8 x 10^6 m3 /year.

The present work is a monthly study for a year for level of concentrations of mainly some trace elements (nutrients and some heavy metals) in the proper water of the drain before mixing and in the effluent from the lake and calculations of both the concentrations and the corresponding expected loads of these elements contributed by the drain to the sea. The results revealed that the respective load to the sea for each of total suspended matter and for dissolved PO_4 -P, inorganic N, Fe, Mn, Cd, and Zn is 77380, 427, 4745,237,3.28,5.84,2.9 and 24 metric ton/year. The elements loaded by the lake effluent represent values ranged between 8 and 57.5% of the total load contributed by the drain to the sea. The plant nutrients (ammonia and reactive phosphorus) are of values exceeding 44%.

INTRODUCTION

Rosetta and Damietta Branches of Nile River beside agricultural drains are discharging to the Mediterranean Sea via several land based point sources at the North of Egypt and are contributing fresh and brackish waters and chemical elements to the Sea. El-Rayis and Saad (1984) ; Abdel-Moati, (1990) ; El-Rayis and Saad (1992) ; UNEP/MAP/MED POL (2003) have mentioned that the information about the amount of the inputs of these chemical elements from the land based sources to the Mediterranean Sea are still appear to be not sufficient for budget quantitative work.

Omoum Drain is an Egyptian huge agricultural drain opens directly to the sea at El-Mex Bay west of Alexandria (Fig. 1), Its average flow rate is ~6.6 million m^3/day (2547.7 x 10^6 m^3/year) all year around (El-Rayis and El-Sabrouti, 1997). The Drain water is slightly brackish (S‰ ~ 3.3, Hossam and Petras, 1998), and is composed mainly of agricultural.

*Corresponding author
E.mail: mahaahmed72002@yahoo.com

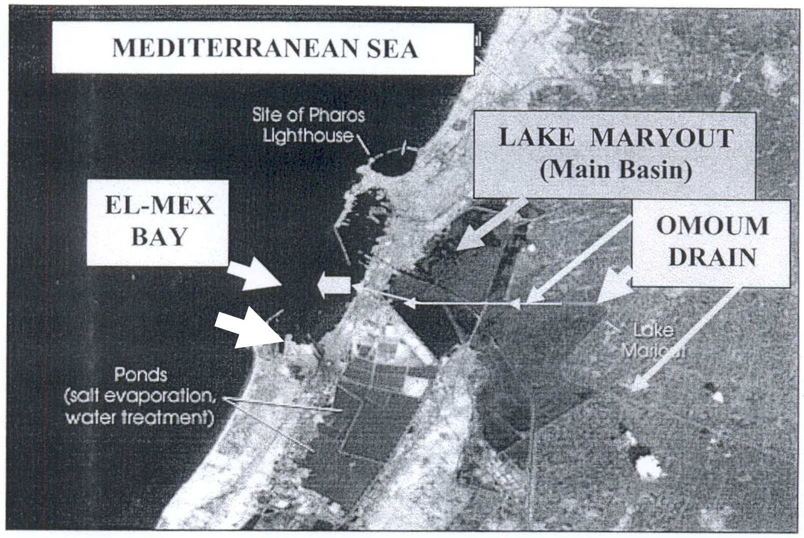

Fig. 1a – A space image of Alexandria City and its Lake Maryout (Main Basin), Omoum Drain, and Mex Bay

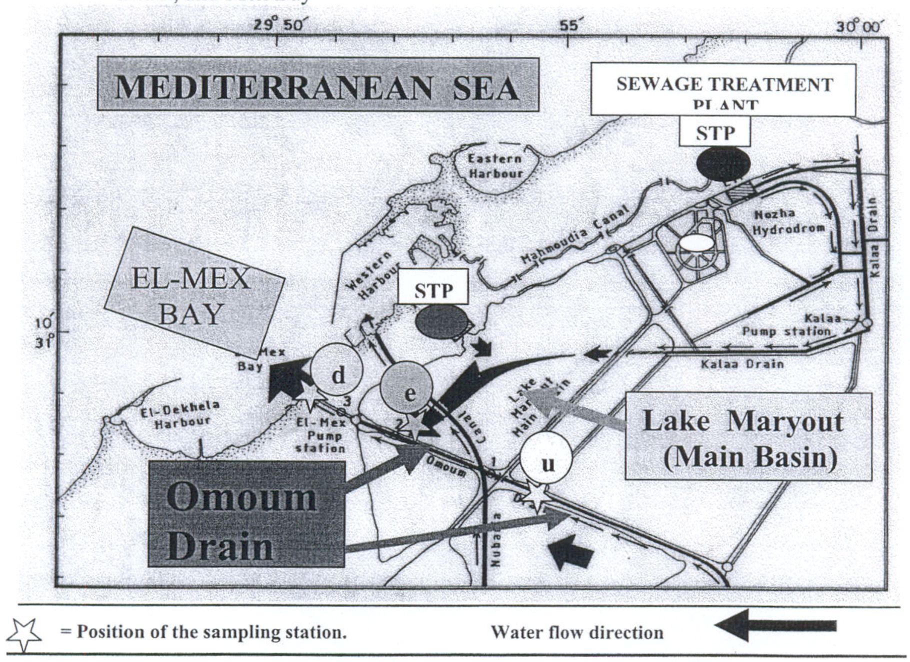

Fig. 1b – Study area showing Omoum Drain, Lake Maryout and its surplus water effluent to the downstream part of the drain before pumping to the sea at El-Mex Bay besides positions of the sampling stations (u and d are up- and down-.stream respectively and e = Lake effluent).

drainage water drained from cultivated fields at the northwest part of the Nile Delta (Bohaira and a part of Alexandria Provinces). The drain- during its way down to the sea- is bordering Lake Maryout (Main Basin) at its west side. This lake is lining Alexandria City at its southern side. The bank between the drain and the lake, however, contains several breaches that allow for surplus water from the lake to flow and mix with the drainage water in the drain before discharging to the sea. The surplus water from the lake is flowing at a rate of ~ 720,000 m^3/day, derived mainly from discharges of wastewaters of two Alexandria primary treatment sewage plants (Eastern and Western Treatment Plants, EL-Rayis *et al,* 1998). The wastewater in the overflowing water from the lake (site e, Fig.1b) constitutes 71 % and after mixing with the agricultural drainage water at the downstream part of the drain at site d constitutes about 10.8 %. These calculations are depending on the volumes of each of the discharged wastewater from the treatment plants, agricultural drainage waters contributed to the lake from Kalaa Drain, and the flowing rate at the upper part of Omoum Drain). The dilution factor (8.2) for the polluted effluent is then calculated using the following equation:

Dilution factor (n) = the ratio of the daily volume of the proper drainage water (at the upstream of Omoum Drain) with respect to that of the lake effluent (after El-Rayis and Saad, 1999).

MATERIAL AND METHODS

Surface water samples were monthly collected for a year 2004-2005 from the upstream part (site u) of Omoum Drain before mixing with the effluent from the lake and from the lake effluent itself to the drain (site e, Fig.1). In these samples the concentrations of the following elements were determined: N-forms (NO_3, NO_2, NH_4 and TN), P-forms (DIP and TP) and the metals Cu, Zn, Cd, Fe and Mn (in their dissolved state). Both chlorosity (Cl_v) and total suspended matter (TSM) contents were also measured in the water sample using the conventional Mohar's method and gravimetry respectively. The nutrients were determined colorimetrically using a spectrophotometer (Shumadzu double beam UV-150-02) according to APHA (1995) and Koroleff's methods cited in Grasshoff (1976). The trace metals in 2-5 liter filtered water samples were pre-concentrated first using chelating resin according to the procedure mentioned by Abdullah and Royle (1974) before measuring using flame-atomic absorption spectro-photometer (AAS-Varian Techtron-Model 10 plus). The values are expressed as (µg/l).

Precision of metal analysis represented by coefficient of variation (C.V) is 21, 23 and 25% for dissolved Cu, Cd and Zn respectively. Recovery from metal free waters using standard addition technique is about 95% of the standard values of trace metals.

The values of the studied elements in the downstream part of the drain are calculated using the conventional dilution equation:

$$Sd = [Su + (Se/n)] / [1 + (1/n)]$$

where Sd, Su and Se are the concentrations of the element in the down-stream and in the upstream or proper drain and in the effluent from the lake, respectively. While (n) is the dilution factor calculated above (8.2), which is the ratio of the volumetric flow of water in Omoum Drain before mixing with that of the effluent.

RESULTS AND DISCUSSION

The concentrations of the studied nutrients and trace metals as well as Cl_v and TSM in the effluent (Se) of Lake Maryout and in the upstream part of Omoum Drain (Su) and that calculated in the down-stream part of the discharge point (Sd) are listed in Table (1).

Table (1): Average concentration of studied elements in the lake effluent and in Omoum Drain upstream and downstream of the discharge point after 1993.

Element	Unit	Lake effluent (Se)* measured	Omoum Drain		Permissible level (Law 4/ 1994)
			Upstream part (Su)*,measured	Downstream part (Sd)*,calculated	
Flow rate (m^3/d)		720,000	5,930,000	**6,650,000**	
Cl_v	**mg/l^{-1}**	1226±24	1675±76	**1626.2**	**-**
TSM	"	48.0±26	30.0±7	31.95	60
DIP	**mg P/l^{-1}**	1.63±0.6	0.18±0.0	0.34	1.63
TP	"	2.79±1.0	0.54±0.2	0.78	-
NH_4	**mg N/l^{-1}**	6.48±4.5	0.58±1.2	1.22	3
NO_2	"	0.06±0.0	0.06±0.0	0.06	-
NO_3	"	0.94±0.8	0.67±0.6	0.69	9
DIN	"	7.48±3.6	1.31±0.4	1.97	-
TN	"	35±6.0	16.9±8.0	18.87	-
DIN/DIP		4.59	7.28	5.79	
Fe	**mg/l^{-1}**	0.0129±6.5	0.0096±5.0	$9.9X10^{-3}$	1.5
Mn	"	0.0028±2.3	0.0012±0.8	$1.4x10^{-3}$	1
Cu	"	0.0029±1.5	0.0025±1.2	$2.5x10^{-}3$	1.5
Cd	"	0.0012±0.6	0.00117±0.4	$1.2x10^{-3}$	0.05
Zn	"	0.0177±12	0.0091±5.8	$10.03x10^{-3}$	5

*Average of successive twelve month
The values at the downstream part are calculated according to the dilution equation.

The daily total load of each of these elements contributed by the lake (Te) and that discharged to the sea (Td), in addition to their ratio are shown in Table (2). The abundance of the concentration level for each of the studied elements in each of the upstream part of the drain (proper agricultural drainage water), and in the effluent from the lake besides those in Nile River water (as background levels, after El-Rayis and Saad 1992; Awad, 1993) are shown in Fig 2.

From Table (1), it is easy to notice that most of the concentration levels of the trace elements in the lake effluent are quite close to their counterparts in the upstream part of the drain.

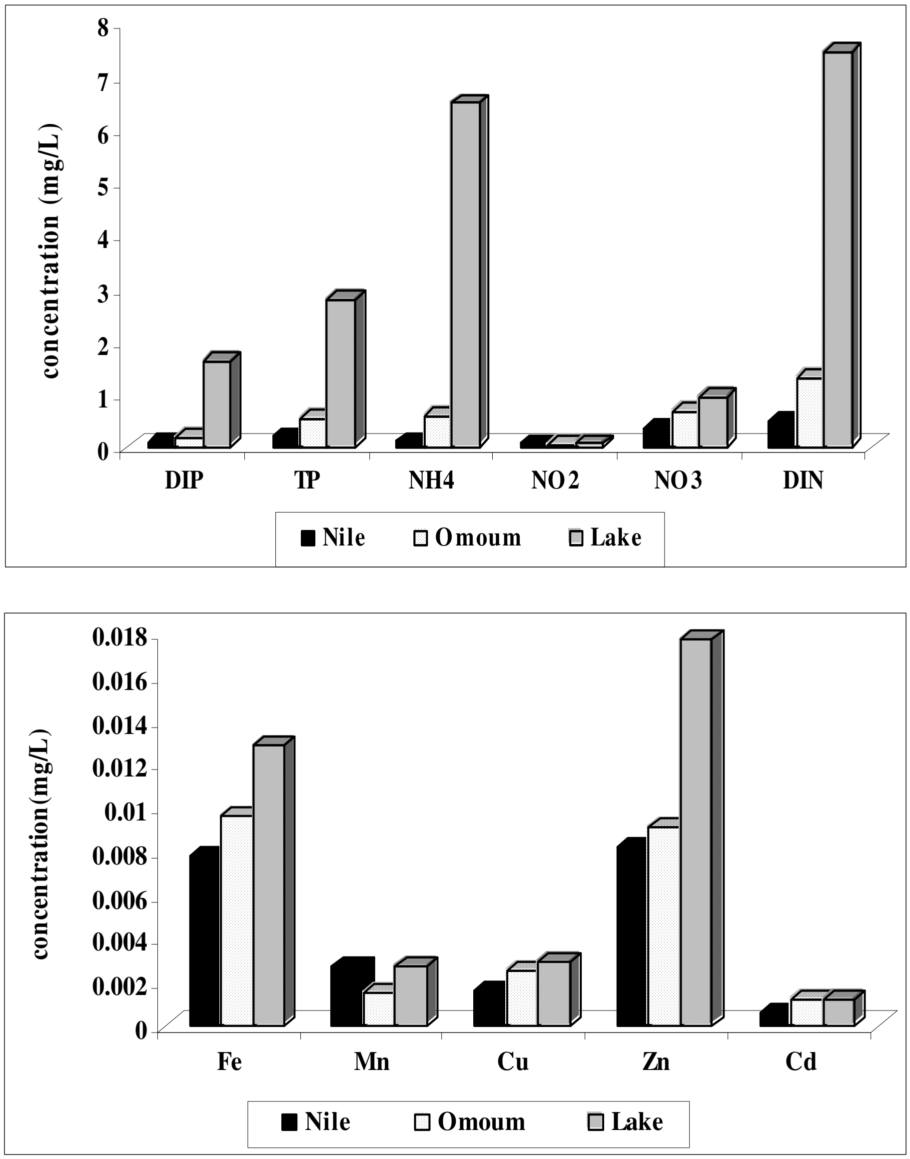

Fig. 2: A comparison between the concentration levels of the studiedelements in the upstream part of the Omoum Drain, the lake effluent and of the River Nile water (as background).

(proper agricultural drainage water), with the exception of the plant nutrients (P and N), Zn and TSM. These are of concentration level considerably higher than those in the proper drain water (9, 5.2, 11.2, 57, 1.9 and 1.6 respectively). At the same time the elements DIP, TP, NH_4, DIN, Zn and TSM are more than those in the proper Nile River water (El-Rayis and Saad 1992; Awad, 1993) by 18.8, 13.2, 58.9, 14.9, 2.2 and 3.3 times respectively. Table (2) shows that, the lake contributes between 8 and 57.5% of the total amount of the elements discharged to the sea. It shows as well, that NH_4 and DIP are the most polluting elements in the discharge. Obviously the high concentration level of each of N and P compounds in the lake effluent reflects the role of disposal of the wastewater effluents from the two Alexandria treatment plants.

Table (1) also shows that, the DIN/DIP ratio in the lake effluent (4.59) is considerably lower than that in the proper drain water (7.28). The normal N/P ratio in the human excrement is almost 5.3 (Wetzel, 2001). On the other hand, the level of NO_3 and NO_2 in the lake effluent is considerably low (for example it is lower than the DIP). Elimination of these inorganic N compounds especially NO_3, from such aquatic medium (oxygen depleted) is expected which is mostly due to de-nitrification processes and formation of molecular N_2O and N_2 (Carpenter and Capone, 1983 and Yoshida, 1988).

Table (3) showed the change in current load of some studied elements from the drain to the sea before and after the construction of the treatment plants in 1993. It is easy to notice that there is an increase in the load contributed to the sea for each of DIP, NH_4, NO_2 and DIN. The increase is several times that in the discharged waters previously recorded before 1993 by El-Rayis and Saad (1992). The increase in the level of PO_4 and DIN species after 1993 is

often due to release of these plant nutrients by oxidation of organic matter of the raw wastewater during the primary treatment processes inside the treatment plants and aeration process before discharging into the lake and thence to the drain. The level of the pollutants in the current land based (Omoum Drain) with respect to that of the permissible level in such

source according to the Egyptian law (4/1994) for environmental protection is also shown in Table (1). The impacts of this land based source on the quality of the neighboring Mediterranean Sea coastal waters (at El-Mex Bay, surface area 19.4 km^2) need to be studied and assessed. Such impact will be the subject of the forthcoming paper.

Table (2): Calculated daily load (after 1993) of pollutants discharged with the effluent (e) from Lake Maryout and with the Omoum Drain down-stream part (d) and their percentage ratios.

Element	**Unite**	**Effluent load (Te)**	**Load at the Downstream of Omoum Drain(Td)**	**Te-load / Td-load %**
Flow rate (m^3/d)		**720,000**	**6,650,000**	10.8
Cl_v	**ton/d**	882.7	**10814.2**	8.16
TSM	"	34.56	**212.5**	16.26
DIP	"	1.17	**2.61**	**44.83**
TP	"	2.01	**5.19**	38.74
NH_4	"	4.66	**8.1**	**57.53**
NO_2	"	0.04	**0.40**	10.0
NO_3	"	0.68	**4.59**	14.81
TN	"	25.20	**125.48**	20.08
Fe	**kg/d**	9.29	**65.83**	14.11
Mn	"	2.02	**9.31**	21.69
Cu	"	2.09	**16.62**	12.57
Cd	"	0.86	**7.98**	10.77
Zn	"	12.74	**66.69**	19.10

Table (3): Load (ton/day) of some constituents contributed by Omoum Drain to the sea before and after the construction of the Alexandria two sewage treatment plants in 1993.

Constituent	Before 1993*		After 1993**		State after 1993
	Before 87	**After 87**	(1995)	**(2005)**	
Flow rate ($x10^6$) (m^3/d)	6.350	6.650	6.650	**6.980**	**Increase**
Cl_v ($x10^3$)	9.84	10.824+	10.81+	**10.40+**	~ Constant
TSM (x10)	19.32	21.54+	21.25	**9.7**	Decrease***
DIP	1.459	2.302	2.61	**4.19+**	**Increase**
TP (Diss.) **TP (Diss. + Part)**	4.363 -	6.209 -	4.31 5.19	- **5.69+**	Variable
NH_4-N	2.19	2.50	8.10	**10.41+**	**Increase**
NO_2-N	0.33	0.44	0.40	**1.46+**	**Increase**
NO_3-N	1.64	1.93	4.59+	**3.08**	**Increase**
DIN	4.16	4.87	13.09	**14.95+**	**Increase**
TN (Diss. + Part)	-	-	125.5+	**38.12**	Decrease***

* After El-Rayis and Saad (1992)   ** Present work   + ve is a maximum value
*** The noticeable decrease in the TSM load obviously reflects the role of the primary treatment process for the raw sewage wastes in the treatment plants.

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