Impact of Drought Period on Water Quality and Trace Metals Distributions in Water and Sediment of Ismailia Canal, River Nile, Egypt

M. H. Abdo

National Institute of Oceanography and Fisheries
mh_omr@yahoo.com

Abstract: Ismailia Canal branched from River Nile is considered as one of the most important irrigation and drinking water resources in Egypt. During drought period the water level decreased and staining. This leading to the concentrations of the most physico-chemical parameters were increased. Physical parameters include (air and water temperatures EC,TS,TDS and TSS). Chemical parameters (pH, DO, BOD, COD, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, Ca^{2+}, Mg^{2+}, Na^+, K^+, NO_2^-, NO_3^-, NH_3, PO_4^{3-}, TP and SiO_2^-). In addition to some trace metals (Fe, Mn, Zn. Cu, Pb, Cd, Al, As, Ba, Co, Cr, Ni, Sb, Se, Sn, Sr, V and Mo) in water and surficial sediment of Ismailia Canal during drought period were measured.

[M. H. Abdo. **Impact of Drought Period on Water Quality and Trace Metals Distributions in Water and Sediment of Ismailia Canal, River Nile, Egypt.** *Life Sci J* 2013;10(4):485-492]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 63

Key wards: drought period, trace metals, water quality, sediment, Ismailia Canal.

1. Introduction

Ismailia Canal was constructed in 1862. It transports fresh water from River Nile in North Cairo at El-Mazalat square (mouth of canal) to El-Khanal Cities (Ismailia, Port Said and El-Suez) for water supply. The original canal dimensions average 2.1, 18 m depth and width respectively. It extends for about 128 km and has more than one regulator bridges constricted along the canal. The first is a head regulator at the mouth of the canal, the second at 13.8 km far from the canal mouth and the third at 75 km far from mouth of canal. The water canal discharge is 433.56 m^3/sec. The total area surrounded the canal is about 108.200 fedden and transported 5.000.000 m^3 per day for drinking, industrial and irrigation purposes. It is worthy to note that some factories are constructed on the two banks of the canal, discharging their wastes into the canal water, leading to change in the water quality of the canal **El-Hadad, (2005) and El-Sayed, (2008).**

Saad, (2003) reported that the current configuration of Nile Delta Lakes is changing rapidly, due to man's activities and natural processes. Most of their water supply comes from polluted agricultural drains several problems affect the conservation of the Nile Delta Lakes mainly pollution, land reclamation, intensive aquatic vegetation, over fishing and coastal erosion. Erection of Aswan High Dam accompanied by considerable increase in population and consequently in man's activities constitutes the main causes of pollution.

Water quality of Ismailia Canal from El-Mazalat square to El-Khosose city studied by **Abdo (1998)** and concluded that, there is an adverse effect of industrial wastes of different factories on two banks of canal on the distribution of the most physical and chemical parameters. Also, during drought period the values of some physical and chemical parameters were increased.

El-Hadad, (2005) studied the distribution and concentrations of Fe, Mn, Zn, Cu and Pb in water and sediment of Ismailia Canal and were found that the ranges of these metals in water are: Fe: 110 – 640, Mn: 40 – 360 µg/l, Zn: 1.8 – 54.8, Cu: 3.6 – 18.9 and Pb: 7.5 – 35.7 µg/l. In sediment: 7500 – 26900, 150 – 710, 31.1 – 78.5, 3.3 – 56.5 and 12.8 – 32.5 µg/g for the same metals respectively.

El-Sayed, (2008) determined that physical and chemical variables of Ismailia Canal water and recorded that the ranges of these variables were found to be water temperature: 16.5 – 34.6 ^{0}C, transparency: 50 – 140 cm, EC: 246 – 510 µmohs/cm. pH: 7.17 – 8.17, DO: 8.4 – 13.6 mg/l, BOD: 0.8 – 6.0 mg/l, COD: 4.2 – 35.6 mg/l, CO_3^{--}: nil – 15.1 mg/l, HCO_3^-: 172 – 250 mg/l, SO_4^{--}, 31.1 – 40.6 mg/l, NO_2^-: 7.77 – 10.22 µg/l, NO_3^-: 17.00 – 19.38 µg/l, NH_3: 1.03 – 1.94 mg/l and PO_4^{3-}: 30.6 – 90.2 µg/l.

The quality of water is now the concern of experts in all countries of the world. The water quality depends on the location of the source and the state environmental protection in a given area. Therefore, the quality and the nature of water may be determined by physical and chemical analysis **(Abdo, 2005).**

The contamination of soil, sediment, water resource and biota by heavy metals is one of the major concerns especially in many industrialized countries because of their toxicity persistence and bioaccumulation **(Iken et al., 2003).**

The aim of the present study is to determine the spatial and temporal distribution of physical variables (air and water temperatures, EC, Transparency, TD, TDS and TSS) chemical variables (DO, BOD, COD, pH, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, NO_2^-, NO_3^-, NH_3, PO_4^{3-}, TP and SiO_2^-) in addition to Fe, Mn, Zn, Cu, Pb, Cd, Al, Co, Ni, Cr, Ba, As, Sr, V, Sb, Se, Sn and Mo) in water and sediment of Ismailia Canal during three months of drought period to assess the environmental status of the water-sediment of Ismailia Canal.

2. Materials and Methods

2.1 water-sediment samples collection and analyses:-

The present study was done during drought period (January, February and March 2007). The water and sediment samples were collected during three successive months of drought period. Six stations were selected along Ismailia Canal extended from El-Mazalat square to Abu Za'baal City. These stations are represented in Fig (1). The locations of these stations are:

Station I: The mouth of Ismailia Canal branched from River Nile at El-Mazalat square.

Station II: In front of the water inlet of El-Amyria drinking water purification station.

Station III: In front of El-Delta company for iron and steel production.

Station IV: In front of El-Cablate company for electrical wire production.

Station V: In front of Shiny company for ceramics production.

Station VI: At Abu Za'baal company for fertilizer and chemical products.

Water samples were collected at 60 cm depth (sub surface layer), using polyvinyl chloride Van Dorn bottle and kept in plastic bottle, preserved in an ice-box then returned immediately to the laboratory for analysis. Surficial sediment samples were collected using Eckman Dredge and kept in plastic bags. Then dried at 105 ^{0}C and preserved for analysis.

2.2 Field measurements:-

Air and water temperatures, electrical conductivity, as well as pH values were measured, using Hydrolab, Model "Multi 340I/SET". The transparency of water was measured in the field, using Secchi-disc (diameter 25 cm).

2.3 Laboratory analyses:-

Water samples for all selected parameter, were analyzed according to procedures specified in **APHA, (1998).** Total solids (TS) were measured by evaporating a known volume of well mixed sample at 180 ^{0}C. TDS were determined by filtrating a known volume of water sample with glass microfiber filter (GF/C) and evaporating at 105 ^{0}C. TSS is direct obtaining by subtracted of TS-TDS. Concentrations of CO_3^{--} and HCO_3^- were measured titrimetric against 0.025 N H_2SO_4, using phenolphthalein and methylorang indicator. Cl^- was determined by argenometric method. SO_4^{--} was determined using turbidimetric method. DO was determined by azide modification method. BOD by 5 days incubation method. COD was performed by potassium permanganate oxidation method. Ca^{2+} and Mg^{2+} were determined by EDTA titrimetric method. Na^+ and K^+ were measured directly using the flame photometer Model "Jenway PFP, U.K.". Concentrations of NO_2^-, NO_3^-, NH_3, PO_4^{3-} and SiO_3 were determined using the colorimetric techniques with formation of reddish purple azo-dye, Copper-Hydrazin sulphate reduction, phenate, stannous chloride reduction and molybdosilicate methods respectively. Total phosphorus (TP) was measured as reactive phosphate after persulphate digestion.

Total Fe, Mn, Zn, Cu, Ni, Co, Pb, Cd, V, Cr, Al, Sr, As, Sn, Ba, Sb, Mo and Se in water after digestion by conc. HNO_3. And in sediment after digestion according to **Jackwerth and Würfels, (1994),** were measured using Inductive Coupled Plasma Spectrometer "ICP, Model: Elan 9000, Perkin Elmer, USA".

2.4 Statistical Analysis

In order to study the different relationships among physical and chemical parameters of the area under investigation the correlation coefficient matrix (r) were calculated using the computer program EXCEL (Office XP).

3. Results and Discussion

The physico-chemical parameters are considered as the most important principles in the identification of the nature, quality and type of the water (fresh, brackish or saline) for any aquatic ecosystem **(Abdo, 2005).**

3.1 Physical measurements:-

3.1.1 Air and water temperatures

Temperature was the water quality indicator that exhibited little variance between the sites and months of water collection. The highest values were recorded during March (31 – 35, 30 – 34 ^{0}C) and the lowest in February (18.5 – 21.0, 20.0 – 26.0 ^{0}C) for air and water respectively.

3.1.2 Transparency

The lowest values of transparency were showed at sites receiving the effluents discharge of the companies e.g. stations V, VI (40, 30 cm) respectively during January. Also, the changes in visibility of the canal is generally low due to shallowness and the drought period effect, the water level decrease and suspended organic-inorganic particles increase. This is agreeing with that reported by **Abdel-Satar, (2008)** on Manzala Lake.

Electrical conductivity (EC)

EC is a good indicator parameter on the total dissolved ions in aquatic ecosystem. The EC values were ranged between 340 – 742 µmohs/cm during the investigation period. The maximum values 392, 742 and 369 µmohs/cm were recorded at station VI which may be receiving the effluents of Abu Za'baal Company. These results agree with that finding by **El-Sayed, (2008)** on the same area.

3.1.4 Solids (TS, TDS and TSS)

The distributions of TS, TDS and TSS in Ismailia Canal water are relatively increase during drought period due to the decay and degradation of the most microorganism species in the lower water level **(Abdo, 1998).** The present values of TS, TDS and TSS in Table (1) were found in the same ranges that recorded by **El-Hadad, (2005)** during winter season on the same area. The highest values of TS,TDS and TSS were recorded at station VI during three months, and reached to 742.630 and 112 mg/l in Februar, respectively. This mainly attributed to the waste water discharge of Abu Za'baal Fertilizers Company at this site.

3.2. Chemical variables:-

3.2.1 Hydrogen ion concentration (pH)

The pH of Ismailia Canal water at most stations are around to 8 and the lower values recorded during February Table (1). This may be due to fermentation of the organic matter which increases during this month of the drought period and this coincident with **Abdel-Satar, (2008)** for Lake Manzalah. The minimum value of 3.9 and acidity 150 mg/l were recorded at station VI representing and good evidence on the effect of the effluent of Abu Za'baal Fertilizers Company at this site.

3.2.2 Carbonate and bicarbonate:-

CO_3^{--} and HCO_3^- results are present in Table (1). The CO_3^{--} were not detected during February at all sites and the HCO_3^- were increased at all sites during this month. This mainly attributed to the presence of high amount of organic matter during drought period, especially during February and it's accessible to bacterial decomposition and fermentation, where the HCO_3^- is the final product of the decomposition. These results agree with that reported by **Ali, (2008)** on the Manzalah Lake. The ranges of CO_3^{--} and HCO_3^- were found to be ND – 14.2, 162 – 222 mg/l respectively.

3.2.3 Chloride and sulphate

Concentrations of chloride varied between 30 – 40 mg/l at all sites during three months, where station VI showed the highest levels 62,60 and 124 mg/l during January, February and March respectively. Also, sulphate concentrations were taken the same behavior of chloride. The sulphate concentrations ranged between 21.0 – 36.6 mg/l at all sites during three months, where the maximum values 39, 156 and 38 mg/l were recorded at the same station VI. This may be attributed to the effluents discharging from Abu Za'baal Fertilizers Company at this station. These results are coincident with that finding by **Elewa et al., (2001).**

3.3 Calcium and magnesium

The monthly variations of Ca^{2+} and Mg^{2+} in Ismailia Canal water during drought period are present in Table (1). The ranges of Ca^{2+} and Mg^{2+} concentrations were found to be 31 – 36 and 11 – 20 mg/l respectively at different sites during three months. The highest values of Ca^{2+}: 44, 64, 38 and Mg^{2+}: 22, 58 and 18 mg/l at station VI opposite to the discharge point of Abu Za'baal fertilizer Company. The comparisons of the present results with the reported by **El-Hadad, (2005)** on the same area were showed similar levels during winter (2005) and the lower values were recorded during other seasons. This mainly attributed to the lower and staining of Ismailia Canal water during drought period, the death and decaying of most phyto-zooplanktons may be leading to facilitate in the liberation of different ions **(Abdo, 1998 and El-Hadad, 2005).**

3.4 Dissolved Oxygen (DO), Biochemical (BOD) and Chemical Oxygen Demand (COD):-

DO, BOD and COD were ranged between 6 – 10, 2.8 – 5.2 and 6 – 16 mg/l during three months of drought period, respectively. Generally the DO at all selected sites of canal water were within the guideline values cited by **USEPA, (1999)** for the protection of aquatic life [for warm water biota: early life stages = 6 mg/l, other life stages = 5.5 mg/l]. For cold water biota: charley life stages = 9.5 mg/l, other life stages = 6.5 mg/l. BOD and COD values were in agreement with these obtained by **El-Hadad, (2005).** He reported that the BOD and COD were varied in the ranges of 2.4 – 3.6 and 8.0 – 19.2 mg/l respectively during winter season.

3.5 Nutrient salts

Nitrogen and phosphorus limit the growth of terrestrial plants, phytoplankton, macro-algae and vascular plants in fresh water and marine ecosystem, and silicon additionally limits the growth of diatoms **(Rabalais, 2002).**

3.5.1 Nitrite and Nitrate

NO_2^- and NO_3^- concentrations were found slightly variations at different locations and during three collection months, Table (1). NO_2^- and NO_3^- were ranged between 9 – 18 and 20 – 52 µg/l respectively. The maximum values of NO_3^- 516 µg/l at station VI during February, mainly related to the waste water of Abu Za'baal fertilizers Company discharge at this site.

3.5.2 Ammonia

Ammonia-N accounted for the major proportion of total soluble inorganic nitrogen. It fluctuated in the ranges of 0.108 – 0.50 mg/l during drought period at different sites. The values of ammonia at different sites of Ismailia Canal (Table 1) were within chronic guide lines recommended by **USEPA (1999)** at pH 8, ammonia (1.27 – 8.41 mg/l).

3.5.3 Ortho and total phosphate

Ortho-P and Total-P values exhibited local variations with interrupted monthly trends and total-P increase during February, while ortho-P increase during January. The ranges of ortho and total-P were found to be 23 – 165.5 and 109 – 1478 µg/l respectively at different sites. The high values of TP at all sites of Ismailia Canal during February could be attributed to the lower and staining water during this month may be facility the death and decaying of the most microorganism in column water, which leading to liberation different ions especially ortho and total-P. This interpretation was supported by **Nesbeda, (2004)** showing that phosphorus enters the lakes through anthropogenic sources, such as fertilizer runoff into either inorganic or organic fractions. Also the maximum values of ortho-P were reached to 607, 3503, 605, 713, 4415 and 879 µg/l at site VI opposite to the discharge point of the Abu Za'baal fertilizers Company. These results coincide with that reported by **Abdel-Satar, (2005)** on the River Nile at the Sugar Integrated Industries Company.

5.3.4 Reactive silicate

Silicate fluctuated between 2.45 – 7.70, 1.44 – 4.00 and 3.12 – 4.00 mg/l during January, February and March months respectively, (Table 1). The lower values of silicate were recorded during February compare with other months is related to the silicate consumption by diatoms which bloom at low temperature and water level **(Wetzel, 2001).**

3.6 Trace metals

Trace metals are considered harmful to environment and belong to one of the most toxic groups of water pollutants. There has been increasing concern and more stringent regulation standards pertaining to the discharge of heavy metals to the aquatic environment, due to their toxicity and deter mint to living species including humans. Heavy metals are non-degradable and can accumulate in living tissue **(Ikem et al., 2003).**

3.6.1 Trace metals in water

To assessment the water quality of Ismailia Canal water the eighteen trace elements were determined in the water and sediment of the canal. There are some detected trace elements in Ismailia Canal water e.g. Fe, Mn, Zn, Cu, Cd, Pb, Al, As, Ba and not detected elements e.g. Co, Ni, Cr, Sr, V, Sb, Sn and Mo during three months at all collection sites (Table 2).

The concentrations of the studied trace metals in water are present in (Table 2). They declare that the ranges of the detected trace elements were found to be Fe; 0.19 – 0.30, Mn; 0.10 – 0.18, Zn; 0.040 – 0.095, Cu; 0.005 – 0.0161, Pb; 0.0150 – 0.029, Cd; 0.001 – 0.003, Al; < 0.1 – 0.8, As; < 0.01 – 0.100 and Ba; < 0.0005 – 0.002 mg/l during investigation period at all sites.

The concentration levels of all studied heavy metals are within permissible limits of the **WHO, (1995)** except for Al, Mn, and Zn up to 0.2, 0.1 and 0.05 mg/l respectively.

Generally, the main natural source of heavy metals in water is weathering of minerals **(Klavins et al, 2000).** Industrial effluents and non-point pollution sources, as well as changes in atmospheric precipitation can lead to local increase in heavy metals concentration water. Also, total heavy metals concentrations in aquatic ecosystem can mirror the present pollution status of these areas **(Haiyan and Stuanes, 2003).**

3.6.2 Trace metals in sediment

The analysis of heavy metals in the sediment permits detection of pollutants that may be either absent or in low concentrations in the water column **(Binning and Baird, 2001).** The accumulation of metals from the overlying water to the sediment is dependent on a number of external environmental factors such a pH, EC, the ionic strength, anthropogenic input, the type and concentration of organic and inorganic ligands and the available surface area for adsorption caused by variation in grain size distribution **(Awfolu et al., 2005).**

The determination of eighteen trace elements in Ismailia Canal sediment during three months of drought period revealed that Mo, Sb, Se and Sn were not detected, but Fe, Mn, Zn, Cu, Pb, Cd, Al, Ba, As, Co, Cr, Ni, Sr and V were detected as present in Table (3).

The ranges of thirteen elements were detected in sediment were varied between, Fe; 8112 – 26688, Al; 11496 – 47680, Mn; 169.6 – 780.00, As; 115 – 350, Ba; 109.2 – 332.0, Sr; 66 – 223.6, Zn; 28 – 193.2, V; 18 – 169.2, Cr; 12 – 118, Pb; 10 – 43.2, Co; 2 – 36.4, Cu; 16.2 – 73.2, Ni; 2.8 – 74 and Cd; 1.6 – 9.2 mg/kg during drought period at all sites, Table (3).

In view of the concentration levels of the studied trace elements, the highest values were Fe, Al at all station. This may be attributed to the fact that Fe, Al are the most abundant elements in earth crust and is also confirmed with that reported by **Abdel-Satar, (2005)** on the River Nile sediment. The concentration levels of Fe, Mn, Zn, Cu and Pb were found in the same ranges determined by **El-Hadad, (2005)** on the same area. Also, the values of Ni, Co and Cd in Ismailia Canal sediment were taken in the same ranges of Nile sediment determined by **Abdel-Satar, (2005).** The other studied elements Ba, As, Sr, V and Cr were measured in canal sediment and can not compare with other studies because of the lack in determinations in aquatic ecosystem researches on this area.

The heavy metals concentrations of Zn, Ni, Cu, Pb and Cd from the Ismailia Canal sediment compared with the probable-effects-level (PEL) guidelines for toxic biological effects established by **USEPA, (1997),** sediment-quality guidelines cited by **Salomons & Förstner, (1984),** and **USPHS, (1997)** in Table (4).

Table (4): Sediment- quality guidelines of trace elements (µg/g) measured in fresh water sediments.

Metal	USEPA (1997)		Salomons & Förstner, (1984), USPHS (1997)	Present trace metal levels
	TEL	PEL		
Zn	124	271	< 100	28 – 193.2
Ni	15.9	42.8	45 – 65	2.8 – 74
Cu	18.7	108	45 – 50	16.2 – 73.2
Pb	30.2	112	20 - 30	10 – 43.2
Cd	0.68	4.21	1	1.6 – 9.2

The previous Table (4) revealed that, these elements in Ismailia Canal sediments did not exceed the PEL guidelines for **USEPA, (1997)** except for Ni. On the other side the sediment concentrations of these elements showed higher level than acceptable guidelines cited by **Salomons & Förstner, (1984),** and **USPHS, (1997).**

4. Statistical analysis

Correlation coefficient "r" is one of the most important statistical test to evaluate the strength or weakness relationships among physical and chemical parameters as well as trace metal concentrations determined in the this study.

The obtained results of correlation coefficient "r" revealed that water temperature showed positive correlations ($n = 10$, $P < 0.05$) among different physical and chemical parameters e.g. EC, TS, TDS, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, NO_3^-, PO_4^{3-} and SiO_3^- (r = 0.56, 0.53, 0.57, 0.51, 0.52, 0.49, 0.60, 0.46, 0.52 and 0.63 respectively). It's showed that the important role of water temperature in the distribution of physical and chemical parameters in aquatic ecosystem. The negative correlation coefficient "r" between transparency with TS, TDS and TSS (r = -0.85, -0.84 and -0.79) represented the inverse relationship between transparency and different solids forms. TS was found positive correlations with TDS and TSS (r = 0.99 and 0.93) revealed that the strong interrelationship among these solids. pH was controlled in the distribution of CO_3^{2-} and HCO_3^- related to through the positive correlations of pH with CO_3^{2-} and HCO_3^- (r = 0.5 & 0.79). Both of (Cl^-, SO_4^{2-}) and (Ca^{2+}, Mg^{2+}) were similar behavior through the high significant correlation "r" at ($n = 10$, $P < 0.05$) (r = 1.0 and 0.98 respectively). The obtained results coincide with that finding by **Abdel-Satar, (2008)** on Manzalah Lake. Cl^- & SO_4^{2-} fulfilled a significant positive relationship with Ca^{2+} and Mg^{2+} (r = 1.0, 0.98 and 1.0, 0.99) but CO_3^{2-} and HCO_3^- with two cations were negative correlations (r = -0.45, -0.59 and -0.83, -0.87), this means that Ca^{2+}, Mg^{2+} may be present in chloride or sulphate salts and not found as carbonate or bicarbonate salts in Ismailia Canal water. Also, the present results coincide with that reported by **Elewa *et al.*, (2001)** on River Nile. Nutrient salts; NO_2^-, NO_3^-, NH_3, PO_4^{3-}, TP and SiO_3^- through the statistical analysis "r" declared that high significant correlation between NO_3^- and PO_4^{3-}, TP and SiO_3^- (r = 0.99, 0.96 and 0.68) respectively, as well as PO_4^{3-} with TP (r = 0.98) revealed the strong relationship between ortho and total phosphate.

The correlation coefficient among eighteen trace elements showed a positive correlation between Fe and Mn in water and sediment (r = 0.57 and 0.83) ($n = 10$ at $P < 0.05$) indicating that the association of two elements originates from a common source during transportation and/or depositional reactions. The positive correlation between concentrations of Mn/Zn, Mn/Cu, Mn/Pb and Mn/Al (r = 0.97, 0.66, 0.36 and 0.49 respectively) indicates Mn oxide or hydroxide as part from the suspended matter plays an important role in the distribution dynamic of total trace metals in the canal water. These results agree with that reported by **Abdel-Satar, (2008)** on Manzalah Lake. For other trace element concentrations in water and sediment were positively correlated with each other e.g. Fe, Mn, Cu and Pb (r = 0.62, 0.95, 0.58 and 0.72 respectively) revealing that the concentrations of these elements are dependent on each other. The other relationships among other trace elements (Ni, Co, Cr, Sr, V, Sb, Sn and Mo) were found not significant may be related to these elements were not detected in Ismailia Canal water and sediment.

5. Conclusion

From previous discussion mentioned we can concluded that, the water quality parameters were slightly increase especially PO_4^{3-} and TP during drought period. The point discharged of Abu Za'baal fertilizers company (VI) act as source of pollution in the Ismailia Canal. The order of detected trace elements in water and sediment were arranged from high to low concentrations as follows:

Al > Fe > Mn > As > Zn > Pb > Cu > Cd > Ba and Al > Fe > Mn > As > Ba > Sr > Zn > V > Cr > Pb > Co > Cu > Ni > Cd respectively.

The correlation coefficient showed that the strong inter-relationships among physical, chemical and trace metal concentrations measured in the Ismailia canal water and sediment.

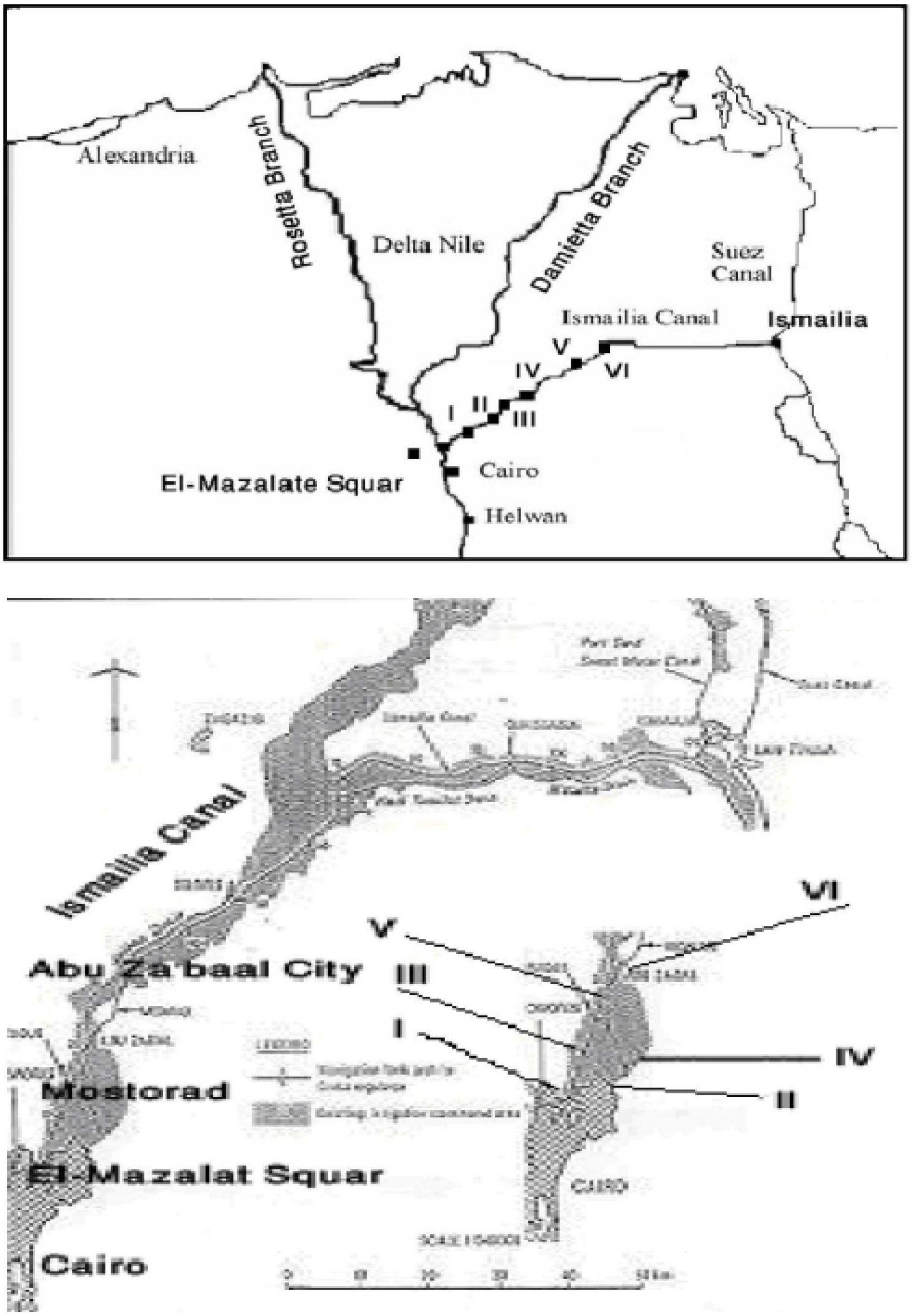

Fig. 1. The sampling locations of Ismailia Canal

Table (1): Physicochemical parameters of the Ismailia Canal water during January, February and March 2007.

Parameters (Month / Sites)	January						February						March					
Sites	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Air Temp. (^0C)	19	23	20	20	25	24	19	20	19	18.5	18.5	21	35	35	32	32	35	31
Water Temp. (^0C)	22	24	23	23	24	23	19.5	20	20	20	20.5	26	32	33	31	31	35	30
Transparency (cm)	70	80	60	70	40	30	90	60	94	65	65	60	90	65	75	60	80	60
EC (µmohs/cm)	340	341	346	348	358	392	358	375	361	360	367	742	342	347	346	343	350	369
TS (mg/l)	252	222	222	288	232	398	272	300	256	270	262	742	260	276	232	260	290	300
TDS (mg/l)	208	212	218	230	208	304	234	266	224	219	216	630	240	220	200	220	260	264
TSS (mg/l)	44	10	4	58	24	94	38	34	32	51	46	112	20	56	32	40	30	36
pH	8.3	8.1	8.2	8.2	8.1	7.3	7.5	7.9	7.4	7.4	8.0	3.9	8.2	8.3	8.4	8.5	8.2	8.0
CO_3^{--} (mg/l)	ND	14.2	14.2	10.2	ND	ND	ND	ND	ND	ND	ND	ND	4.84	4.84	2.42	2.42	ND	ND
HCO_3^- (mg/l)	203	162	186	195	162	162	226	227	219	203	203	150 Acidity	220	180	180	180	196	211
Cl^- (mg/l)	38	40	38	40	38	62	36	36	34	34	32	60	30	30	30	30	30	124
SO_4^{--}(mg/l)	29.7	31.2	32.0	36.6	29.1	39	28.9	36.6	33.7	32	35	156	25	25	23	21	23	35
Ca^{2+} (mg/l)	32	33	34	32	32	44	32	34	36	36	34	64	32	32	31	31	31	38
Mg^{2+} (mg/l)	11	12	12	15	18	22	20	20	19	19	21	58	15	16	17	17	16	18
DO (mg/l)	10	9	8	8	8	7	8	8.4	7.2	8	7.2	6	8	8	8	8	7.6	8
BOD (mg/l)	3	4	4	4.4	4.6	3.3	2.8	5.6	3.6	3.6	5.2	2.4	4.4	4.4	4.4	4	4.4	4.4
COD (mg/l)	16	8	16	16	13	13	8	8	6	8	8	8	8	8	8	8	8	8
NO_2^- (µg/l)	12.2	18	16	15	9	12	16	17	10	11	12	15	12	11	10	9	10	11
NO_3^- (µg/l)	43	23	27	28	22	23	30	25	20	26	24	516	21	52	50	32	20	28
NH_3 (mg/l)	0.40	0.50	0.50	0.41	0.40	0.43	0.18	0.36	0.45	0.11	0.12	0.19	0.15	0.18	0.14	0.15	0.26	0.29
PO_4^{---} (µg/l)	76.6	99.1	118.5	165.5	131.2	607	30.6	36	37	23	43	3503	25	49	34	38	54	605
TP (µg/l)	160	109	207	427	167	713	147.8	1107	445	556	1177	4415	215	213	195	244	191	879
SiO_2^- (mg/l)	7.70	5.70	3.4	2.73	2.45	5.5	1.7	1.6	1.52	1.44	2.31	4.0	3.43	3.55	3.12	3.20	3.5	4.0

Table (2): Monthly variations of studied trace metals of Ismailia Canal water (mg/l) during January, February and March 2007.

Parameters (Month / Sites)	January						February						March					
Sites	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Fe	0.26	0.28	0.37	0.25	0.19	0.24	0.25	0.27	0.28	0.23	0.29	0.26	0.30	0.25	0.21	0.20	0.27	0.25
Mn	0.12	0.18	0.17	0.15	0.100	0.14	0.15	0.17	0.16	0.11	0.13	0.12	0.10	0.15	0.13	0.12	0.11	0.16
Zn	0.06	0.09	0.085	0.075	0.05	0.07	0.07	0.095	0.095	0.050	0.040	0.040	0.05	0.075	0.065	0.06	0.055	0.08
Cu	0.018	0.019	0.009	0.008	0.005	0.007	0.017	0.019	0.019	0.015	0.014	0.014	0.015	0.017	0.0161	0.016	0.015	0.018
Pb	0.028	0.029	0.019	0.018	0.015	0.017	0.027	0.029	0.010	0.016	0.016	0.018	0.025	0.027	0.021	0.020	0.020	0.020
Cd	0.003	0.003	0.002	0.0018	0.0015	0.0018	0.003	0.003	0.001	0.0016	0.0016	0.0018	0.0025	0.0027	0.0016	0.0016	0.0015	0.0018
Al	0.8	0.6	< 0.1	< 0.1	< 0.1	0.6	0.209	0.409	0.312	0.29	0.396	0.682	< 0.1	0.4	0.2	< 0.1	< 0.1	< 0.1
Co	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.002	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.002	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005
As	< 0.01	< 0.01	< 0.01	0.039	0.026	0.025	0.051	0.058	0.118	0.118	0.068	0.069	0.061	0.068	< 0.1	0.080	0.1	0.09
Sr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Se	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table (3): Monthly variations of studied trace metals of Ismailia Canal sediment (mg/kg) during January, February and March 2007.

Parameters (Month / Sites)	January						February						March					
Sites	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Fe	18348	25352	21764	17568	8112	16420	17340	23052	26688	15664	19296	18444	13900	20192	14640	14600	25432	20680
Mn	644.8	683.6	611.2	514.0	192.8	197.2	411.2	780.0	731.6	317.2	446.84	400.8	169.6	598.4	535.2	504.8	226.8	645.6
Zn	59.2	119.2	65.2	73.6	38.4	36.8	118.4	141.6	134.4	51.6	193.2	28.0	71.6	28.0	48.0	74.0	66.8	69.2
Cu	31	60	28.3	45	16.2	19.6	32.1	27.6	27.8	30.2	19.8	13.2	29.7	33.5	26.3	52.2	15.0	25.6
Pb	31.6	10.0	36.8	25.2	15.6	18.4	36.0	43.2	12.0	18.8	16.8	14.8	18.8	14.8	17.2	13.2	14.0	14.8
Cd	3.6	2.4	1.6	4.8	5.2	6.0	2.80	2.04	2.52	3.40	2.56	3.60	3.6	9.2	4.8	4.0	7.6	4.0
Al	16252	47680	31836	21032	18760	11496	18788	36096	36908	23412	33388	19740	11740	30300	18672	18924	17128	26140
Co	6.0	6.0	16.8	6.4	2.0	4.0	4.0	11.6	16.4	23.2	2.0	26.0	34.0	30.4	35.2	25.2	23.6	36.4
Ni	30.0	40.4	36.0	38.4	30.4	30.4	44.8	57.2	61.2	2.8	56.8	58.4	58.4	74.0	59.6	62.0	52.4	59.2
Cr	12.0	44.8	76.8	40.4	32.8	14.8	81.6	66.4	118.0	21.2	51.6	29.2	34.8	79.2	53.6	88.0	52.8	50.0
Ba	132	332	169.2	130.4	110.8	174.8	135.2	213.6	197.2	212.8	179.6	137.6	109.2	207.2	200.4	208.4	168.4	191.2
As	160	350	180	150	120	190	166	225	210	230	200	150	115	218	220	225	210	212
Sr	77.6	223.6	200.4	124.4	70.8	66.0	92.4	126.8	175.6	214.8	107.2	87.6	96.8	108.8	109.6	79.6	84.4	128.4
V	125.6	169.2	118.8	57.6	43.2	42.4	44.0	30.8	24.4	168.0	26.0	14.0	18.4	24.8	152.8	151.6	107.2	111.2
Sb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Se	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

References

1. **Abdel-Satar, A. M. 2005.** Quality of River Nile sediments from Idfo to Cairo. Egyptian J. of Aquat. Research, 31(2): 182 – 199.
2. **Abdel-Satar, A. M. 2005.** Water quality assessment of River Nile from Idfo to Cairo. Egyptian J. of Aquat. Research. 31(2): 200 – 223.
3. **Abdel-Satar, A. M. 2008.** Chemistry of major ions, nutrient salts and heavy metals in Lake Manzalah. Egypt. Egyption J. of Aquat. Research. 34(2): 130 - 148.
4. **Abdo, M. H. 1998.** Some environmental studies on the River Nile and Ismailia Canal in front of the industrial area of Shoubra El-Kheima. M. Sc. Thesis, Fac. of Sci., Ain Shams Univ., Cairo, Egypt.
5. **Abdo, M. H. 2005.** Physico-chemical characteristics of Abu Za'baal Ponds, Egypt. Egyptian J. of aquatic research, 31(2): 1 – 15.
6. **Ali, M. H. H. 2008.** Assessment of some water quality characteristics and determination of some heavy metals in Lake Manzalah, Egypt. J. Aquat. Biol & Fish. 5(3): 17 – 30.
7. **American Public Health Association (APHA) 1998.** Standard methods of the examination of water and waste water, New York.
8. **Awofolu, O. R.; Mbolekwa, Z.; Mtshemla, V. and Fatoki, O. S. 2005.** Levels of trace metals in water and sediment from Tyume River and its effects on an irrigated farmland, water SA, 31(1): 87 – 94.
9. **Binming, K. and Baird, D. 2001.** Survey of heavy metals in the sediment of the Swarkops River Estuary, Port Elizabeth South Aferica. Water SA, 27(4): 461 – 466.
10. **Elewa, A. A.; Shehata, M. B. and Abdo, M. H. 2001.** Effect of thermal pollution of Shoubra El-Kheima Electric station on River Nile water quality. The Second International Conference and Exhibition for Life and Environment. 3-5 April, 2001, Alexandria.
11. **El-Haddad, E. S. M. 2005.** Some environmental studies on water and sediment of Ismailia Canal from El-Mazallat to Anshas Region. M. Sci. Thesis, Fac. of Sci., Al-Azhar Univ.
12. **El-Sayed, S. A. 2008.** Microbiological studies on Ismailia Canal, River Nile, Egypt. M. Sci. Thesis, Fac. of Sci. Al-Azhar Univ.
13. **Haiyan, W. and Stuane, A. O. 2003.** Heavy metal pollution in air-water-soil-plant system of Zhuzhou City, Human Province, China. Water, Air and Soil Pollution. 147: 79 – 107.
14. **Iken, A.; Egiebro, N. O. and Nyavor, K. 2003.** Trace elements in water, fish and sediment from Tuskegee Lake, South Eastern, USA. Air, Water and Soil Pollution. 149: 51 – 75.
15. **Jackwerth, E. and Würfels, M. 1994.** "Der Druchaufsche B-Apparative Moglichkeiter, Problem and Anwendungen" in M. Stoeppler (ed.), Probennahme and Aufschlu B, Springer-Verlage, Berlin, pp. 121 – 138.
16. **Klavins, M., Briede, A., Rodinov, V., Koborite, I., Parele, E. and Klavina, I. 2000.** Heavy metals in Rivers of Latvia, Sci. Total Environ. 262: 175 – 184.
17. **Nesbeda, R. H. 2004.** Sedimentological and geochemical characterization of east pond, Belgrade Lakes Watershed, Central Maine, Thesis for Honors in Geology, Department of Colby College Faculty of the Geology, Waterville, Maine, 114pp.
18. **Rabalais, N. N. 2002.** Nitrogen in aquatic ecosystems, Royal Swedish Academy of Sciences. Ambio, 31(2): 102 – 122.
19. **Saad, M.A.H. (2003).** Impact of diffuse pollution on the socio-ecnomic development opportunities in coastal Nile Delta Lakes, Difffuse Pollution Conference Dublin 2003.
20. **Salmons, W. and Förstner, U. 1984.** Metals in the Hydrocyle, Springer-Verlage, Berlin, 349pp.
21. **US. Environmental Protection Agency, (USEPA) 1997.** The incidence and severity of sediment contamination in surface waters of the United States, volume 1-national sediment survey: Washington, D. C., Report 823 – R – 97 – 006, various pagination.
22. **USEPA, 1999.** National recommended water quality criteria-correction-United State Environmental Protection Agency EPA 822-Z-99-001; 25pp. (http://www.epa.gov./ostwater/pci/revcom).
23. **USPHA, 1997.** Toxicological profile for zinc and lead on CD-ROM. Agency for Toxic Substances and Disease Registry. U.S. Public Health Service.
24. **Wetzel, R. G. 2001.** Liminology; Lake and River Ecosystem; Aeademic Press, San Diego, CA.
25. **WHO, 1995.** World Health Organization for inorganic constituents of health Significant and European Economic Community Standard for Parameters and Goals New York, 1271.

9/24/2013