

Physico-Chemical Evaluations And Trace Metals Distribution in Water-Surficial Sediment of Ismailia Canal, Egypt

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Abstract: Ismailia Canal is considered as one of the most important irrigation and drinking water resources. During drought period the water level decreased and 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, CO₃⁻, HCO₃⁻, Cl⁻, SO₄⁻, Ca²⁺, Mg²⁺, Na⁺, K⁺, NO₂⁻, NO₃⁻, NH₃, PO₄³⁻, TP and SiO₂). 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 studied. [Nature and Science 2010;8(5):198-206]. (ISSN: 1545-0740).

Keywords: Chemical evaluation, trace metals, water, 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 m³/sec. The total area surrounded the canal is about 108.200 fedden and transported 5.000.000 m³ 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 °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, CO₃⁻: nil – 15.1 mg/l, HCO₃⁻: 172 – 250 mg/l, SO₄⁻, 31.1 – 40.6 mg/l, NO₂⁻: 7.77 – 10.22 µg/l, NO₃⁻: 17.00 – 19.38 µg/l, NH₃: 1.03 – 1.94 mg/l and PO₄³⁻: 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 concern 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^{2-} , HCO_3^- , Cl^- , SO_4^{2-} , 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-Cablata 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°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°C . TDS were determined by filtrating a known volume of water sample with glass microfiber filter (GF/C) and evaporating at 105°C . TSS is direct obtain by subtracted of TS-TDS. Concentrations of CO_3^{2-} and HCO_3^- were measured titrimetric against $0.025\text{ N H}_2\text{SO}_4$, using phenolphthalein and methylorang indicator. Cl^- was determined by argenometric method. SO_4^{2-} 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 salphat 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), 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 ($31 - 35$, $30 - 34^\circ\text{C}$) for air and water respectively. The lowest in February ($18.5 - 21.0$, $20.0 - 26.0^\circ\text{C}$).

3.1.2 Transparency

The lowest values of transparency were showed

at sites receiving the effluent discharge of the companies e.g. V, VI (40, 30 cm) respectively during January. Also, the changes in visibility of canal is generally low due to shallowness and the drought period effect, the water level decrease and suspended organic-inorganic particles increase. This is agree 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 $\mu\text{mhos/cm}$ during the investigation period. The maximum values 392, 742 and 369 $\mu\text{mhos/cm}$ were recorded at 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 distribution 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 on the same area. The highest values of TS were found at VI during three months, and reached to 742.630 and 112 mg/l in February. 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 sites are around to 8 and the lower values recorded during February Table (1). This may be due to fermentation of the organic matter which increase during this month of the drought period and 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 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^{2-} and HCO_3^- results are present in Table (1). The CO_3^{2-} 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 its 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^{2-} 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 site VI showed the highest levels 62,60 and 124 mg/l during January, February and March respectively. Also, sulphate concentrations was 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 site VI. The high values of SO_4^{2-} and Cl^- at site VI are strongly attributed to effluent discharging from Abu Za'baal fertilizers company at this site. This results 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 site VI opposite to the discharge point of Abu Za'baal fertilizer company. Comparison of the present results with the reported by El-Hadad, (2005) for 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 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: early 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, macroalgae 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 $\mu\text{g/l}$ respectively. The maximum value of NO_3^- 516 $\mu\text{g/l}$ at site 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 $\mu\text{g/l}$ 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 $\mu\text{g/l}$ 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.

3.5.4 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 detrimt 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 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 studied trace metals in water are present in (Table 2). They declare that the ranges of 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 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 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 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 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 compared with other studies because of the lack in determinations in aquatic ecosystem researches.

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 ($\mu\text{g/g}$) 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 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 behaviour 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 sulphat 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.

4. 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.

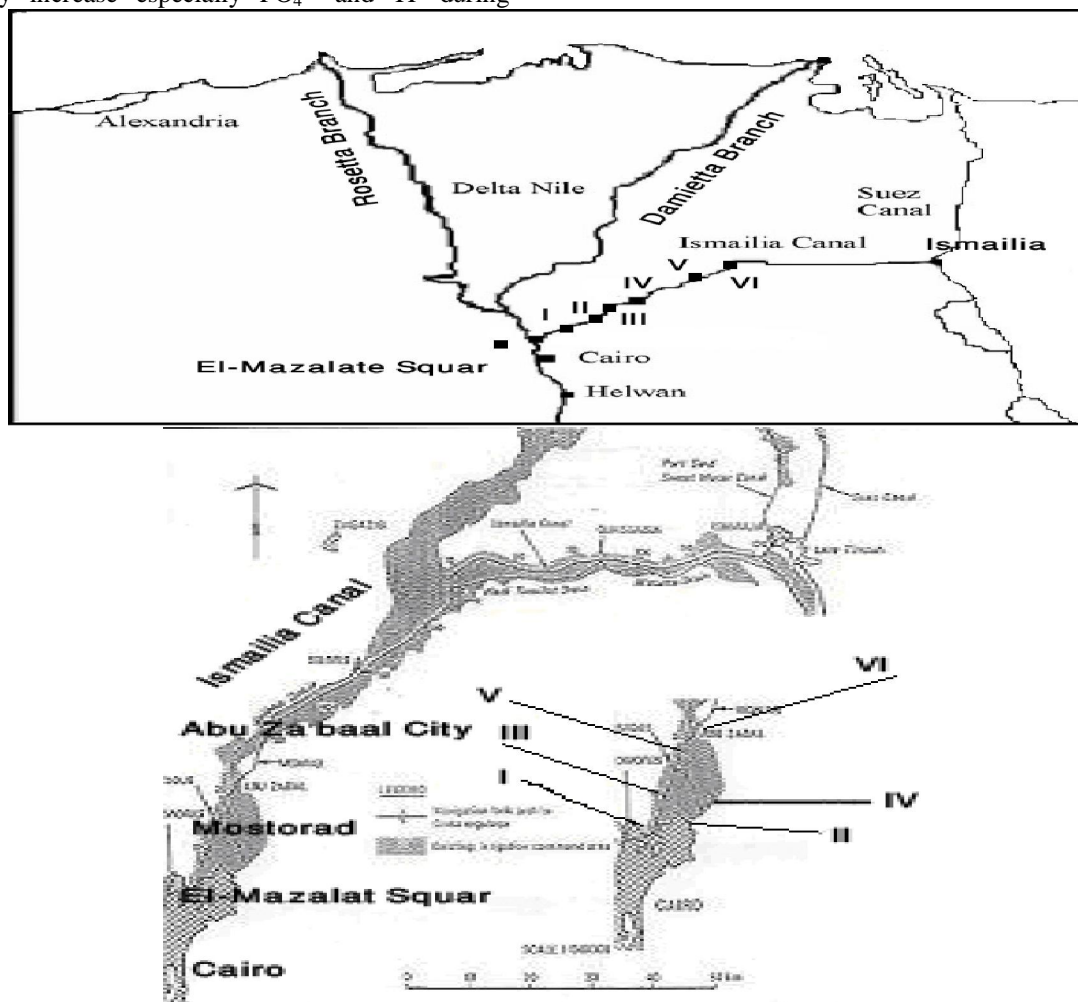


Fig. 1. The sampling locations of smailia Canal

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

Parameters	Month	January						February						March					
	Sites	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Air Temp. (°C)		19	23	20	20	25	24	19	20	19	18.5	18.5	21	35	35	32	32	35	31
Water Temp. (°C)		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 ²⁻ (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 ²⁻ (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 ³⁻ (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	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	0.001	0.001	0.001	0.003	0.003	0.001	0.001	0.001	0.001	0.002	0.002	0.0016	0.001	0.001	0.001
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	January						February						March					
	Sites	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Fe	183 48	253 52	217 64	1756 8	8112	1642 0	173 40	230 52	266 88	1566 4	1929 6	1844 4	139 00	201 92	1464 0	1460 0	2543 2	2068 0	
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	162 52	476 80	318 36	2103 2	1876 0	1149 6	187 88	360 96	369 08	2341 2	3338 8	1974 0	117 40	303 00	1867 2	1892 4	1712 8	2614 0	
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	

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