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ASSESSMENT OF SOME HEAVY METAL POLLUTION IN WATER AND SEDIMENTS OF ISMAILIA CANAL, EGYPT

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ABSTRACT: Ismailia Canal is one of the most important branches of the Nile River in Egypt. It is the main source of drinking and irrigation water for many cities. Water and sediments samples were taken from 6 sites during 6 months of (Jan., Mar., May, July, Sept. and Nov.) 2017. The sites are: (I) El-Mazalat (at start of the canal), (II) Al- Ameriyah, (III) Mostourd, (IV) Abu-Zaabl, (V) Al-Monair and (VI) Belbies. The samples of water and sediments were chemically analyzed for detection of heavy metals *i.e.,* (Cu, Pb, Cd, Ni and Zn). Abu-Zaabl site was more pollution than the other sites. The contents in water were within the limits allowed by the World Health Organization **(WHO, 1995)**. Highest pollutions were sites III, IV and V.

Key words: Heavy metals, industrial pollution, sediment, Ismailia canal.

INTRODUCTION

The River Nile is the main water source for Egypt, securing sufficient water for Egypt's survival and economic development. Uncontrolled wastewater discharge into it can cause immediate and long-term water quality health hazards impacts on the users **(Ibrahim *et al.*, 2009).** Ismailia canal is one of the most important irrigation and drinking water sources in Egypt. It was constructed in 1862 to supply drinking water to villages on the Suez Canal zones and workers during digging the Suez Canal. Today its water is used for irrigation, domestic and industrial use and provides water for about 12 million Egyptians, including those living in the northern part of Great Cairo, (Shubra El-Kheima, El-Ameriyah, Mattaria, Musturod, Abu-Zaabl, Inchas, Belbeis, Abbasa, Abu-Hammad, Zagazig and El-Tal El-Kabeer), **(Geriesh *et al.*, 2008).**

It is about 128 km long, with 30 to 70 m width and 1 to 3 m depth, discharges about 5 million $m^3 day^{-1}$ of water for drinking and industrial purposes **(El-Haddad, 2005).** The canal has its inlet from the Nile at Cairo and runs directly to East Ismailia passing Kalioubeya and Sharkia Governorates **(Stahl and Ramadan, 2008).** Owing to industrial and agricultural activities, large amounts of untreated municipal and industrial wastewater as well as rural domestic wastes discharge into it **(Stahl *et al.*, 2009; Geriesh *et al.*, 2008)**.

The first source is the upstream portion of the Ismailia Canal from Cairo to Abu- Zaabl, includes the largest industrial zones in the region (Shubra El-Kheima, Musturod, Abu-Zaabl industrial zones) with activities of petroleum, petro gas, iron and steel, fertilizers, detergents and electric power station, the second source is the water treatment plants which caused dramatic changes. In addition to waste disposals, seepage from septic tanks of houses are major sources of contamination (**Mohamed *et al.,* 2014).**

Regular water quality monitoring is necessary to assess the quality of water **(Poonam *et al.,* 2013)**. Studies on heavy metals in rivers, lakes, fish and sediments represent major concerns **(Ali and Fishar, 2005).** Effluents discharged into Nile waters induce considerable changes in

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properties of its water and alters the environmental characteristics of river **(El-Sayed, 2011).** Heavy metals are serious pollutant because of their toxicity and persistence on living organisms **(Khalil *et al.,* 2007).** In the aquatic environment, elements are found in the various components of water, suspended solids, sediments and biota **(Shakweer and Abbas, 2005)**.

Water quality of Ismailia Canal from Shubra-El-Mazalat to El-Khosose city was studied by **Abdo (1998)** who concluded that, pollution was widespread in those areas.

El-Haddad, (2005) studied the distribution and concentrations of Fe, Mn, Zn, Cu and Pb in water and sediment of Ismailia Canal and found ranges as follows in water: Fe: 110 – 640, Mn: 40 – 360, Zn: 1.8–54.8, Cu: 3.6 – 18.9 and Pb: 7.5 – 35.7 µg L^{-1}. In sediment: 7500–26900, 150 – 710, 31.1 – 78.5, 3.3 – 56.5 and 12.8 – 32.5 µg g^{-1} for the same metals, respectively.

MATERIALS AND METHODS

Six water and sediment samples were collected during six months (Jan., Mar., May, July, Sept. and Nov.) during 2017 from six different sites of Ismailia Canal (Map 1). Details of samples sites are presented in Table 1.

Three replicates of water samples were taken at each site kept refrigerated and transferred cold to the laboratory for analysis. Also three replicates of sediment samples were taken by core sampler **(Boyd and Tucker, 1992)**, kept in clean plastic bags and chilled on ice box for transport to the laboratory for analysis. Water and sediment analyses were carried out according to standard methods for examination of water and waste water **(APHA, 2012).** Analyses included soluble Cu, Pb, Cd, Ni, and Zn in water and total in sediments.

Inductively Coupled Plasma-Emission spectrometry (ICP-OES) (model Perkin Elmer optima 3000, USA) was used for measurement of the metals.

RESULTS AND DISCUSSION

Heavy Metals in Water

The following five heavy metals of Cu, Pb, Cd, Ni and Zn were detected in the six months at all collection sites (Table 2).

Contents of elements were in the following order: For copper element (Cu): VI >V > III > IV > II > I. For lead element (Pb): III > IV > V > VI > II > I. For cadmium element (Cd): IV and V > III and VI > I and II. For nickel element (Ni): V > IV > III > VI > II > I. For zinc element (Zn): IV > VI > III , II and V > I.

The concentration levels of all studied heavy metals were within the limits allowed by the World Health Organization **(WHO, 1995)** as shown in (Appendix 1).

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 water. Total heavy metals in aquatic ecosystems can reflect the present pollution status of these areas **(Haiyan and Stuanes, 2003).**

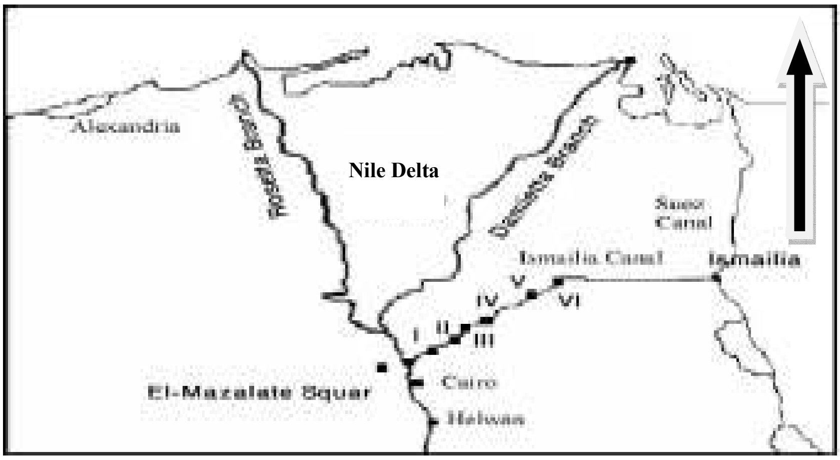
Heavy metals in Sediments

The results obtained for the sediment analysis are shown in (Table 3). The contents varied widely and among different sites especially for Cu, and Zn. The pattern was as follows for sites of the water: For copper element (Cu): IV > III > V > VI > II > I. For lead element (Pb): III > IV > V > VI > II > I. For cadmium element (Cd): IV and III > V > I I and VI > I. For nickel element (Ni): IV > III > V > II > VI > I. For zinc element (Zn): IV > V > III > VI > II > I.

Highest values indicating pollution were in the industrial zones of Mostourd (site III), Abu-Zaabl (site IV), and Al-Monair (site V).

Heavy metals accumulate more in sediments than water, since the sediments act as reservoir. **Hamed (1998)** stated that heavy metal pollution was mooted in waters of Damiette Nile branch and **Nguyen *et al.* (2005)**, noted heavy metal pollution in some waters of lakes.

Contents don't exceed the guidelines for **USEPA** (**1997**) except for Pb, which exceeded them. However contents in sediments exceeded than acceptable guidelines cited by **Salmons and Förstner (1984) and USPHS (1997)** as shown in Appendix 2.



Map 1. The water and sediment sampling locations of Ismailia Canal

Table 1. Details of surface water and sediment sampling location of Ismailia Canal

Sample ID	Site	Source of pollution	Latitude	Longitude
I	El-Mazalat	unpolluted area (control)	30° 06′ 30″	31° 15′ 10″
II	Al-Ameriyah	industrial outlets (water purification station)	30° 06′ 41″	31° 16′ 22″
III	Mostourd	industrial outlets (activities of petroleum, petro gas)	30° 09′ 55″	31° 17′ 36″
IV	Abu-Zaabl	industrial outlets (Abu Zaabl fertilizer factory)	30° 16′ 28″	31° 22′ 44″
V	Al-Monair	industrial outlets (Aluminum Sulfate factory)	30° 16′ 49″	31° 23′ 07″
VI	Belbies	municipal sewage outlets	30° 24′ 57″	31° 34′ 33″

Table 2. Average contents of heavy metals in Ismailia canal water (μg L^{-1}) collected from 6 different sites (site I to site VI)

Sample ID	Site	Cu	Pb	Cd	Ni	Zn
I	El-Mazalat	32	4	1	7	8
II	Al-Ameriyah	34	5	1	8	9
III	Mostourd	41	14	2	11	9
IV	Abu-Zaabl	35	9	5	12	13
V	Al-Monair	48	8	5	13	9
VI	Belbies	58	7	2	9	11
LSD (0.05)		15	6	2	2	3

Table 3. Mean values of heavy metals concentration of Ismailia canal sediment (mg Kg^{-1})

Sample ID	Site	Cu	Pb	Cd	Ni	Zn
I	El-Mazalat	75	7	1	19	88
II	Al-Ameriyah	79	8	2	27	129
III	Mostourd	100	135	4	47	201
IV	Abu-Zaabl	104	100	4	58	247
V	Al-Monair	94	24	3	37	235
VI	Belbies	84	19	2	24	155
LSD (0.05)		9	52	1	27	101

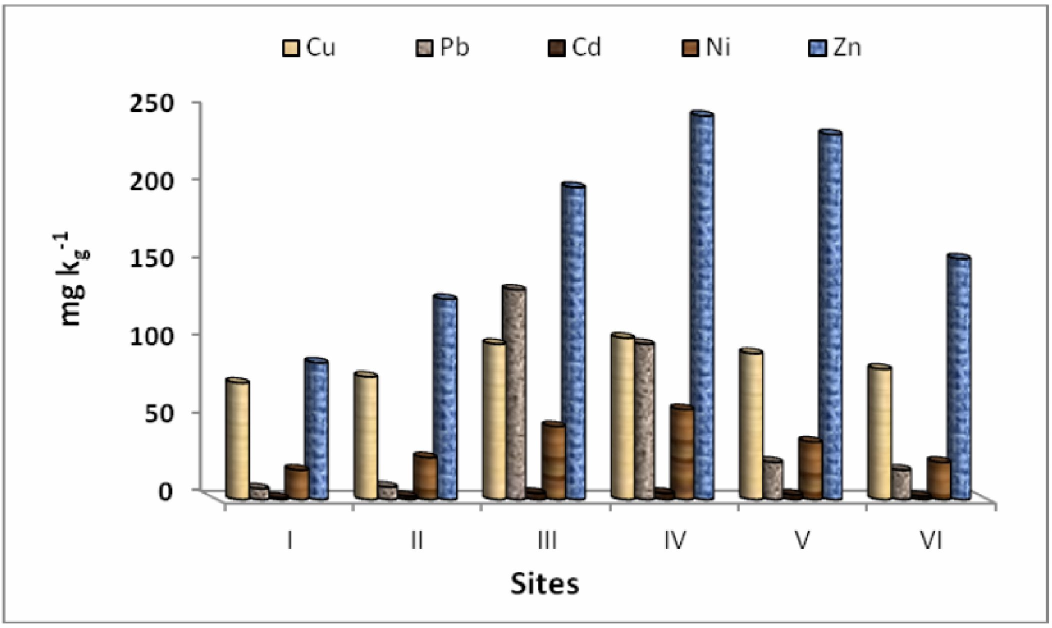


Fig. 1. The concentration of elements in the sediment samples of the study area (mg Kg^{-1})

I,II,III,IV,V and VI are samples site; El-Mazalat, Al-Ameriyah, Mostourd, Abu-Zaabl, Al-Monair and Blbies, respectively.

Conclusion and Recommendation

The elements Cu, Pb, Cd, Ni and Zn were highest in Abu-Zaabl (site IV). In this location, a fertilizer factory discharges its waste water in the canal. Pb was highest in Mostourd (site III), while the lowest was in El-Mazalat followed by Al-Ameriyah then Belbies (sites I, II and VI).

Thus, Ismailia Canal which is the main source of freshwater for several governorates, cities and villages is exposed to pollution in its water due to different wastes that discharge into it. Water quality may be used for irrigation.

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APPENDIX

Appendix 1. Guidelines of water quality regarding metal contents (WHO, 1995)

	Mg l^{-1}
Aluminum, Al	0.2
Barium, Ba	0.7
Cadmium, Cd	0.003
Cobalt, Co	nil
Chromium, Cr	0.05
Copper, Cu	1
Iron, Fe	0.3
Manganese, Mn	0.1
Nickel, Ni	0.02
Lead, Pb	0.01
Zinc, Zn	3

Appendix 2. Sediment quality guidelines for heavy metals (mg Kg^{-1}) measured in fresh water sediments

Metal	USEPA (1997) Probable effects level	Salomons and Förstner, (1984), USPHS (1997)	Present metal level (mg l^{-1})
Zn	271	<100	121 – 247
Ni	42.8	45-65	19 – 58
Cu	108	45-50	75 – 104
Pb	112	20-30	7 – 135
Cd	4.21	1	1 – 4

تقييم التلوث ببعض المعادن الثقيلة في المياه والرسوبيات بترعة الإسماعيلية، نهر النيل، مصر

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تم جمع ستة عينات من المياه ورواسب قاع القناة خلال ستة أشهر (يناير ومارس ومايو ويوليو وسبتمبر ونوفمبر) في عام ٢٠١٧ من ستة مواقع مختلفة من ترعة الإسماعيلية بغرض تقييم تأثير الصرف الصناعي على المياه والرواسب، المواقع المختارة تشمل (I) مدخل ترعة الإسماعيلية بشبرا المظلات، (II) الأميرية، (III) مسطرد، (IV) أبو زعبل، (V) المنير و(VI) بلبيس، تم تحليل عينات الماء والرواسب كيميائياً للكشف عن المعادن الثقيلة (النحاس، الرصاص، الكادميوم، النيكل، الزنك)، أوضحت النتائج أن تركيز جميع العناصر المدروسة في المياه في الحدود المسموح بها مع وجود بعض الاختلافات من موقع إلى آخر، كانت أعلى قيم للمناطق الملوثة هي المواقع الثالث والرابع والخامس بالمقارنة مع الموقع الأول.

المحكمـــــون:

١- أ.د. علـــي أحمـــــد عبـــدالســـــلام أستاذ الأراضي المتفرغ – كلية الزراعة بمشتهر – جامعة بنها.

٢- أ.د. أيمن محمود حلمي محمد أبو زيد أستاذ ورئيس قسم الأراضي – كلية الزراعة – جامعة الزقازيق.