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ECOLOGICAL STUDY ON WATER AND SEDIMENTS IN A SECTION OF THE RIVER NILE, ASWAN, EGYPT AS INDICATION FOR WATER QUALITY WITH THE EXISTENCE OF THE TOURISTS SHIPS FLOATING.

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ABSTRACT

A twelve month measuring of some ecological factors: physic-chemical, heavy metals, organic matters and chlorophyll-a, were conducted for water and sediments in three sites: Cataract Hotel (Site1), Delta Isis (Site2) and Sakara (Site3), moorages of floating tourism ships in River Nile of Aswan Governorate.

This study revealed that there is increasing in cadmium, lead, iron, zinc and phosphate and decreasing in dissolved Oxygen, in the three sites, than the permissible limit. According to law 48 (1982) for the protection of the River Nile and its tributaries from pollution, it is believed that there are a pollution of Nile water in three chosen sites may be due to many reasons discussed in details in this study.

Key words: River water and sediments- water quality- ships floating.

INTRODUCTION

Water pollution and wasteful use of freshwater threaten development projects. So the water treatment is very important to produce safe drinking water. Indeed, enrichment or deficiency of certain elements within soils or water may be responsible for certain diseases in plants, animals and humans. Elements such as Cd and Pb are usually described as potentially toxic and can be considered as probable etiological agents. Discharge of toxic chemicals and over-pumping of aquifers are two source for water pollution. Presence of some elements such as Copper, zinc, manganese and phosphorus with high concentrations make the water more pollutants and more toxic (Enderlein et al., 1996).The other different sources of pollution also may be derived from human activity as industrial wastewater and agricultural activities or from sewage and ship's wastes, which contribute most pollutants to the river (El-Sheekh, 2009). Several types of pollution were found in organic materials as well as major and trace metals. Organic pollution leads to disturbance of the oxygen balance and is often accompanied by severe pathogenic contamination (Bartram and Balance, 1996). Oil pollution may also come from barges, tankers and boats on river or canals, industrial wastes, garages, or any places using lubricating or fuel oils (El-Sheekh et al., 2000).

The rate of accumulation of heavy metals in Nile sediment depends on the physical and chemical conditions of the water body as well as the amount of industrial and sewage effluents flow to the River Nile (Elewa and Gohar, 1999; Abdo, 2004).

Analysis of river sediments is a good indicator of the river water quality. They are less variable than the overlying water column and act as traps for numerous compounds. Therefore, the analysis of river sediments permits us to detect pollution that could escape from water analysis. Today heavy metals have a great ecological significance due to their toxicity and cumulative behavior. The analysis of heavy metals in the sediments permits detection of pollutants that may be either absent or found in low concentrations in the water column (Binning and Baird 2001).

Aim of the work:

The present work is an attempt to provide complementary data on the elemental composition of river water and sediments of the Nile River in order to increase the awareness of pollution caused by some heavy metals that are exceptionally high in some sites. The impact of such heavy metals abnormality may extend to involve the water quality and food web, and hence the human health. In the study area, source(s) of the toxic metals could be natural or anthropogenic. The latter is represented by mining activities in addition, to some polluting industries such as the nitrogen fertilizer factory (kima) at Aswan. On the other hand, the natural sources of pollution are the drains of the Eastern Desert, especially during the seasonal flash floods. To achieve this aim, monthly determination of some ecological factors and heavy metals, as well as studying the aquatic physicochemical characters in the three investigated sites will be processed

MATERIALS AND METHODS:

Sampling:

Twenty four water and sediment samples were collected from three sites of river Nile in Aswan. The first site is located at Cataract hotel moorage (on the Eastern flank of River Nile). It was used as the most pure site non polluted (control) as it found south near Aswan reservoir and far away from most moorage. The second site is located at Delta Isis moorage (at the Western flank of River Nile), while the third site is located at Sakara moorage (Kima drainage). The sampling sites are given in Figure 1.

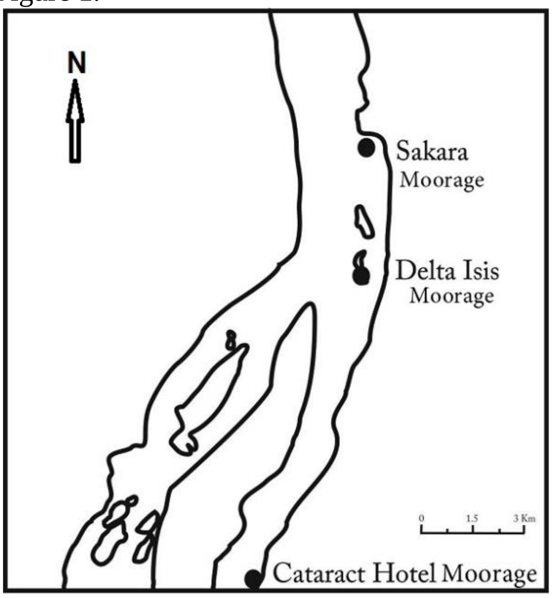

Fig. (1): Map showing the three studied sampling sites in the River Nile

Sampling was performed monthly during a period of one year, from February (2015) until January (2016) using standard Ekman grab with sample area 232cm^2 and length and width overall 24×22 cm for collecting sediment and water samples were put in bottles. Samples transferred carefully into suitable container then labeled.

At the three sites, monthly measurements of the air and water temperature, conductivity, hydrogen ion concentration, salinity and dissolved oxygen were recorded:. On the other hand, monthly measurements for each of water samples and sediment samples such as total dissolved salts (TDS), heavy metals (Cd, Pb, Fe, and Zn), calcium, magnesium, organic matters, phosphate and carbonate were recorded.

Temperature:

Air temperature was recorded by standard thermometer (0-100ºC) while water temperature was recorded by an electrode called lovi bond, Senso Direct, con200.

Conductivity, Salinity and Dissolved oxygen:

Water conductivity, Salinity and Dissolved oxygen were measured with an electrode called lovi bond, Senso Direct, con200.

Hydrogen ion concentration:

The pH was measured with an electrode called HANNA HI 8424 pH meter.

Total dissolved salts (TDS):

20g of the sediment sample was shaken with 100ml distill water for 5 hours at 1500 rpm then TDS in filtrate was measured by an electrode called HANNA HI99300 EC/TDS/Temperature..

Heavy metals measuring:

One gram of each sediment sample was digested with a mixture of 9ml conc. HCL and 3ml conc. HNO3 for 2-3hour at 60ºC. The mixture was heated on a water bath at 105ºC for 1 hour and then the temperature was raised to 140ºC. Heating was continued till near dryness. After cooling, 12.5 ml of 20% HCL was added and the mixture was re-warmed at

80ºC for 20 minute. The solution up to volume to 50 ml with distilled water. Heavy metals were determination in water samples collected according to method of preconcentration. 50 ml of each water sample was stored in a glass container and 0.5 ml of conc. Nitric acid was added to preserve the metals inside the samples. Heavy metals were determined in (mg/l) using flame atomic absorption model (Water Environment Federation 2012). All reagents used were of analytical grade (A.R). All standard metal solutions for atomic absorption spectrophotometric determinations were prepared from standard stock solutions by appropriate dilutions.

Calcium and magnesium +measuring:

5ml of digested sediment sample was titrated with EDTA (0.01 N) (Water Environment Federation 2012).

Carbonate measuring:

5ml of sediment extract titrated with HCL (0.01 N) (Water Environment Federation 2012).

Organic matters measuring:

A known weight of sample is placed in a ceramic crucible (or similar vessel) which is then heated to between 350 and 440 ºC overnight (Blume et al., 1990; Nelson and Sommers, 1996; ASTM, 2000). The sample is then cooled in a desiccator and weighed. Organic matter content is calculated as the difference between the initial and final sample weights divided by the initial sample weight times 100%.

Determination of chlorophyll-a:

For the determination of chlorophyll-a µg/l, a known volume of water sample was collected (1 liter from the three sites. In the laboratory, water was filtrated by using ppt. The ppt was taken and extracted by 95% methanol, then heated in a water bath (Metzner et al., 1965; Marker, 1972) and finally centrifuged for about 15 minutes. The supernatant extract was measured against methanol blank at wave length of 644 and 633 nm by using T 70 UV/VIS Spectrometer. The content of pigment fractions (µg/ml algal) suspension can be calculated using the following equation (Metzner et al. 1965): Chlorophyll-a= $10.3E_{633}$-0.918 E_{644}

Statistical analysis:

Analysis of variance on spss software package (version 20) (SYSTAT statistical program) was used to test the present data. In the case of significant difference, the Multiple Range Comparison (Least significant difference; LSD) was selected from the postHoc window on the same statistical package to detect the distinct variance between mean. Stepwise multiple regressions were used to select the affected variable and calculate regression equation (Sparks, 2000). Probability value ≤ 0.05 were defined as significant through the study; however the value >0.05 were defined as non-significant. Probability value between 0.05 and 0.01 (both are included)

RESULTS AND DISCUSSION:

Water quality is defined in terms of the chemical, physical and biological contents of water. The water quality of rivers changes with the seasons. Important physical and chemical parameters that effect on the aquatic environment are temperature, pH, salinity and dissolved oxygen. Others are total suspended, dissolved salts and heavy metals. These parameters are the limiting factors for the survival of aquatic organisms (Lawson, 2011).

In Egypt, water pollution controls were initiated under Law 48, enacted in 1982. Under this law, allowable discharge limits are tied directly to stringent WQS (Water Quality System). According to law 48 (1982) for the protection of the River Nile and its tributaries from pollution these elements must not be more than the limits shown in table (1):

Table (1): The maximum limits according to law 48 (1982).

Cd	Pb	Fe	Zn	Ca	PO4	Dis. Oxygen	TDS	Salinity
0.01 mg/l	0.05 mg/l	1 mg/l	1 mg/l	50 mg/l	0.5 mg/l	≥5	≤500 mg/l	0.1 ppt

The concentration of cadmium, lead, iron, zinc and magnesium in addition to organic matters, TDS, calcium, phosphate and carbonate in sediment and water in three sites were monthly recorded

Cataract hotel moorage (Site 1):

Air temperature measured during sampling ranged between (16.9ºC) and (38.5ºC). Water temperature ranged between (13.8ºC) and (24.1ºC) and hydrogen ion concentration (pH) ranged from ranged between (7.68) and (8.9). Conductivity ranged between (241µs/cm) and (280µs/cm). The dissolved oxygen ranged between (0.58 ppm) and (4.97ppm). Salinity was the same all months (0.1), Table (2).

Table (3) shows that the high concentration for chlorophyll-a value in water, was 22.16 and 16.70 in months (Aug. and Sep, 2015), Total dissolved salt (TDS) in water was 149 in months (March and April 2015).The higher concentrations of Cadmium than permissible limit (>0.01) was found in months Mar, Sep., Oct., Nov., and Dec. 2.15. The higher concentration of Lead (pb) than permissible limit (0.05) was found in Nov. 2015 (0.52). The higher concentrations of iron (Fe) than permissible limit were recorded in all months except Feb. 2015, and the higher concentrations of Zn than permissible limit were recorded in all months except Mar., Apr., and May. Jun. and Jul., 2015. On the other hand, the higher concentrations than permissible limit were recorded in months Nov. and Dec., 2015 for PO4 (3.80). Mg and Ca concentrations in water not exceed the permissible limit in all months.

Regarding to the sediments, (Table 4), the concentration of organic matters (OM),total dissolved salt (TDS),Cadmium, Lead, Iron (Fe) is higher than permissible limit while Zinc, and Phosphate seems to be higher than permissible limit in months Apr., May, Aug., Sep for Zinc and Jun., Jul., Aug., Sep., Oct., for Phosphate. Mg and Ca concentrations in sediments not exceed the permissible limit in all months. Sediments collected in February, August, September (2015) and January (2016) had no carbonate concentration, but it recorded (21.00 mg/l) in July (2015).

Delta Isis Island moorage (Site 2):

Air temperature measured during sampling ranged between (19.5ºC and (40.5ºC) (2015). Water temperature ranged between (17.2ºCand (24.2ºC. The hydrogen ion concentration (pH) ranged between (7.66 and (8.77). Conductivity ranged between (246µs/cm and (280µs/cm). The dissolved oxygen ranged between (0.7 ppm and (4.93 ppm. Chlorophyll-a in water ranged between (0.01 mg/l and (11.20 mg/l). Salinity was the same all months (0.1), Table (5).

Table (2): Monthly fluctuation of ecological factors in (site1) Cataract hotel during the period of investigation.

Month	Site 1					
	Temperature (˚C)		pH	Cond. s/cm)(µ	Diss.Oxygen(ppm)	Salinity
	Air	Water				
Feb.2015	16.9	13.8	8.81	241	4.74	0.1
Mar.	33	17.5	8.39	242	4.97	0.1
Apr.	28.7	17.8	8.13	249	4.04	0.1
May	31	19.8	8.2	254	3.03	0.1
Jun.	36	20.5	7.75	256	2.6	0.1
Jul.	37.5	23.6	7.68	274	0.58	0.1
Aug.	37.8	23.3	7.8	275	0.75	0.1
Sep.	38.5	24.1	7.8	278	0.86	0.1
Oct.	35.5	24	7.8	280	0.97	0.1
Nov.	27	21.1	7.8	267	1.06	0.1
Dec.	31	21.1	7.86	264	0.9	0.1
Jan.2016	18	17.9	8.9	243	1.18	0.1

Table (3): Monthly fluctuations of Chlorophyll-a, TDS, heavy metals, calcium and phosphate in water in (site1) Cataract hotel moorage.

month	chl-a	TDS	Cd	pb	Fe	Zn	Mg	Ca	PO4
Feb.2015	0.13	145.00	0.00	0.00	0.00	1.10	23.52	24.00	0.00
Mar	0.02	149.00	0.19	0.00	7.00	0.63	23.04	28.00	0.06
Apr	0.80	149.00	0.00	0.00	6.20	0.66	13.20	24.00	0.29
May	1.74	145.00	0.00	0.00	6.33	0.80	12.00	28.00	0.00
Jun	7.30	141.00	0.00	0.00	9.70	0.73	9.10	32.00	0.00
Jul	9.80	141.00	0.00	0.00	9.70	0.70	9.60	32.00	0.00
Aug	22.16	143.00	0.00	0.00	11.96	3.21	7.20	32.00	0.44
Sep	16.70	144.00	0.10	0.00	7.42	3.20	14.00	20.00	0.00
Oct	4.75	144.00	0.11	0.00	7.42	1.11	14.40	20.00	0.00
Nov	0.62	145.00	0.05	0.52	11.91	1.11	8.40	28.00	3.80
Dec	0.31	143.00	0.20	0.00	8.51	1.21	12.00	28.00	3.80
Jan.2016	0.02	145.00	0.00	0.00	6.12	1.13	14.40	24.00	0.00

Table (4): Monthly fluctuations of organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment in (site1) Cataract hotel moorage.

Month	OM	TDS	Cd	pb	Fe	Zn	Mg	Ca	PO_4	CO_3
Feb.2015	4.31	165.00	0.03	0.53	31.55	0.35	8.64	8.00	0.00	0.00
Mar	1.85	163.00	0.03	0.13	29.82	0.53	8.40	10.00	0.00	9.00
Apr	0.43	125.00	0.06	1.13	34.25	1.30	7.20	4.00	0.00	13.80
May	0.66	163.00	0.06	1.22	34.10	1.10	9.60	20.00	0.00	9.00
Jun	1.31	171.00	0.05	2.30	33.31	0.58	6.00	26.00	2.40	9.00
Jul	1.61	171.00	0.05	2.95	33.69	0.56	6.00	26.00	41.25	21.00
Aug	0.90	152.00	0.06	3.13	29.38	1.24	6.00	20.00	2.40	0.00
Sep	0.91	152.00	0.04	1.63	29.10	1.01	4.80	16.00	14.80	0.00
Oct	0.74	152.00	0.03	0.96	32.18	0.72	4.80	16.00	14.87	15.00
Nov	0.75	289.00	0.03	0.60	16.94	0.34	20.40	34.00	0.00	9.00
Dec	0.57	231.00	0.06	1.13	34.21	0.30	12.00	32.00	0.00	12.00
Jan.2016	0.36	165.00	0.05	1.01	32.38	0.20	8.40	12.00	0.00	0.00

Table (5): Monthly fluctuation of ecological factors in (site2) Delta Isis during the period of investigation.

Month	Site 2					
	Temperature (ºC)		PH	Cond.(μs/cm)	Diss. Oxygen (ppm)	Salinity
	Air	Water				
Feb.2015	19.5	17.2	8.77	252	4.21	0.1
Mar.	39	19.6	8.72	250	4.93	0.1
Apr.	30	19.2	8.5	252	4.06	0.1
May	31.5	19.7	8.13	252	2.8	0.1
Jun.	36.5	22	7.71	254	2.1	0.1
Jul.	39	24.2	7.67	277	1.15	0.1
Aug.	40.5	24.1	7.66	275	0.87	0.1
Sep.	38.8	24.1	7.7	278	0.94	0.1
Oct.	37.5	24	7.74	280	1.01	0.1
Nov.	28	21.6	7.71	270	0.7	0.1
Dec.	31	22.2	8.03	274	1.08	0.1
Jan.2016	19.8	18.4	8.4	246	1.33	0.1

Table (6) shows that total dissolved salt in water ranged between (142 mg/l) in both June and July (2015) and (156 mg/l) in December (2015). Cadmium value in water is higher than permissible limit in all months; Lead is absence in water during the period of investigation. Iron value is higher than permissible limit in all months except Feb. and Dec. 2015. Zinc value is higher permissible limit in Feb. and Aug., 2015 and Jan., 2016. Ca AND Mg values not exceeds permissible limit during the period of investigation. P2o5 value exceeds permissible limit in Feb., May, Nov. and Dec., 2015.

Sediment chemical analysis (Table 7) indicates that the higher concentration of organic matte (3.44 mg/l) is recorded in Feb., 2015 while the highest value of total dissolved salt (1257 mg/l) is recorded in JAN., 2016. Cadmium, Lead and Iron, values exceed permissible limit in all months; zinc values exceed the permissible limit in Feb., Aug. 2015 and Jan.2016. Ca concentrations exceed permissible limit in Jun., Jul and Dec. 2015.PO4 exceeds the permissible limit in Feb., May. Nov. and Dec. 2015. No Carbonate concentration in January (2016) but it reaches up to (15 mg/l) in all of February, March, July, August and December (2015).

Table (6): Monthly fluctuations of chlorophyll-a, TDS, heavy metals, calcium and phosphate in water in (site2) Delta Isis moorage.

month	Chl-a	TDS	Cd	pb	Fe	Zn	Mg	Ca	PO4
Feb.2015	0.01	146.00	0.00	0.00	0.00	1.12	23.52	24.00	0.11
Mar	0.01	148.00	0.22	0.00	8.69	0.70	28.08	26.00	0.00
Apr	0.40	144.00	0.00	0.00	9.27	0.79	12.00	20.00	0.00
May	8.91	144.00	0.10	0.00	7.14	0.88	4.80	32.00	0.12
Jun	7.50	142.00	0.30	0.00	7.20	0.90	7.20	28.00	0.00
Jul	11.20	142.00	0.30	0.00	7.21	0.92	7.20	28.00	0.00
Aug	3.95	142.00	0.00	0.00	7.34	1.30	12.00	20.00	0.00
Sep	4.10	144.00	0.10	0.00	8.70	0.96	10.00	26.00	0.00
Oct	5.24	144.00	0.16	0.00	8.75	0.96	10.80	26.00	0.00
Nov	1.02	144.00	0.00	0.00	6.84	0.79	7.20	32.00	1.12
Dec	2.57	156.00	0.00	0.00	0.00	0.93	19.20	20.00	1.10
Jan.2016	0.16	146.00	0.24	0.00	7.43	1.12	10.80	24.00	0.00

Table (7): Monthly fluctuations of organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment in (site2) Delta Isis moorage.

month	O.M	TDS	Cd	pb	Fe	Zn	Mg	Ca	PO4	CO3
Feb.2015	3.44	195.00	0.04	0.41	17.20	0.39	14.64	18.00	9.67	15.00
Mar	2.65	124.00	0.03	0.42	16.40	0.37	2.88	12.00	0.00	15.00
Apr	1.69	312.00	0.02	0.47	33.98	0.58	7.44	3.60	0.00	12.00
May	1.30	312.00	0.02	0.50	33.10	0.61	7.44	32.00	0.00	12.00
Jun	1.10	283.00	0.02	0.65	17.05	0.93	0.40	80.00	12.40	15.00
Jul	2.50	283.00	0.03	0.93	17.05	1.80	20.40	80.00	12.40	15.00
Aug	1.20	183.00	0.03	0.07	17.08	0.27	4.80	36.00	12.40	15.00
Sep	0.88	143.00	0.04	0.06	18.43	0.27	6.00	10.00	13.60	12.00
Oct	0.50	143.00	0.06	0.84	21.99	0.26	6.00	10.00	13.62	12.00
Nov	0.67	203.00	0.03	0.19	16.73	0.33	12.00	22.00	0.00	9.00
Dec	0.93	1257.00	0.02	0.34	17.08	1.03	30.00	90.00	0.00	15.00
Jan.2016	0.99	195.00	0.04	0.05	19.15	0.24	14.40	24.00	0.00	0.00

Sakara moorage (Site 3):

This site was most polluted one as it is near (Kima brad age) and near ships and boats moorages. Air temperature Measured during sampling ranged between (19ºC) in January (2016) and (44ºC) in July and August (2015).Water temperature ranged between (17.1ºC) January (2016) and (25.5ºC) in both September and October (2015). The hydrogen ion (PH) concentration ranged between (7.5) in August (2015) and (8.36) in January (2016). Conductivity ranged between (250 µs/cm) in August (2015) and (316 µs/cm) in October (2015).The dissolved oxygen ranged between (0.65ppm) in August (2015) and (3.46ppm) in April (2015). Salinity ranged between (0.1) in May, Jule, September and December (2015) and (0.3) in April (2015) (table8).

The highest Chlorophyll-content (9.54) in water is recorded in Aug. 2015. Total dissolved salt in water changes in a narrow range (147 to 166). Cadmium value in water exceeds permissible limit in Mar., May, Sep., Oct., Nov. 2015 andJan.2016. Water is pure from Lead in this site.Fe content exceeds the permissible limit in all months except in Feb., 2015. Zn content exceeds the permissible limit in Apr., May. Jun., Jul., Aug., Sep. and Oct. 2015. Mg and Ca concentrations in sediments not exceed the permissible limit in all months. PO4 content exceeds in Feb., Mar., Apr., Nov., Dec., 2015 and Jan., 2016 (table 9)

In regarding to sediments, the highest content of organic matter (30.40) and total dissolved salt in sediment is recorded in Jan.2016. Cadmium and Fe content is higher than permissible limit in all months while Lead exceeds the permissible limit in all months except Aug., Sep., and Oct., 2015. Zinc value is higher than permissible limit in Apr., *May*,Aug., Sep., Oct., Dec. 2015 and Jan.2016. Magnesium and calcium value is under the permissible limit in all months. Phosphate value is higher than permissible limit in Jun., Jul., Aug., Sep. and Oct., 2015. Carbonate value ranged between (0 mg/l) in January (2016) and (21 mg/l) in both April and May (2015) (table12).

Table (8): Monthly fluctuation of ecological factors in (site3) Sakara during the period of investigation.

Month	Site 3					
	Temperature (ºC)		PH	Cond.(µs/cm)	Diss.Oxygen (ppm)	Salinity
	Air	Water				
Feb.2015	19.8	17.5	7.95	262	3.02	0.2
Mar.	37	20.1	7.98	305	3.32	0.2
Apr.	30	19.9	7.82	306	3.46	0.3
May	35.5	20	8.27	277	2.86	0.1
Jun.	36.5	22	7.6	261	1.8	0.2
Jul.	44	24.5	7.54	256	0.7	0.1
Aug.	44	24.4	7.5	250	0.65	0.2
Sep.	41.5	25.5	7.55	283	0.72	0.1
Oct.	38.8	25.5	7.63	316	0.76	0.2
Nov.	28.5	21.6	7.77	272	1.26	0.2
Dec.	31	21.5	7.89	272	0.99	0.1
Jan.2016	19	17.1	8.36	274	1.33	0.2

Table (9): Monthly fluctuations of Chlorophyll-a, TDS, heavy metals, calcium and phosphate in water in (site3) Sakara moorage.

month	Chl-a	TDS	Cd	pb	Fe	Zn	Mg	Ca	PO4
Feb.2015	0.04	156.00	0.00	0.00	0.00	0.77	24.48	16.00	2.10
Mar	0.11	160.00	0.37	0.00	9.03	0.73	23.04	28.00	2.05
Apr	0.66	166.00	0.01	0.00	9.10	1.36	14.40	20.00	1.12
May	1.36	166.00	0.11	0.00	7.30	1.31	2.40	36.00	0.00
Jun	2.45	160.00	0.01	0.00	7.50	1.30	2.40	20.00	0.00
Jul	4.18	151.00	0.00	0.00	7.70	1.10	15.60	20.00	0.00
Aug	9.54	151.00	0.00	0.00	7.71	1.13	15.60	20.00	0.00
Sep	7.33	150.00	0.20	0.00	7.50	1.10	9.60	24.00	0.00
Oct	6.89	148.00	0.21	0.00	7.47	1.09	9.60	24.00	0.00
Nov	0.47	148.00	0.07	0.00	6.70	0.43	7.20	32.00	9.25
Dec	2.33	147.00	0.00	0.00	5.59	0.70	14.40	20.00	9.25
Jan.2016	0.19	156.00	0.07	0.00	7.61	0.77	10.80	28.00	2.50

Table (10): Mean and standard deviation (SD) of ecological factors at the three sites during the whole period of investigation.

Sites	Temperature (ºC)		Hydrogen ion (pH)	Conductivity (Cond) (µs/cm)	Dissolved oxygen(Do) (ppm)	Salinity
	Air	Water				
Site(1)&Site(2)	NS	NS	NS	NS	NS	NS
Site(1)&Site(3)	NS	NS	**	**	NS	**
Site(2)&Site(3)	NS	NS	**	**	NS	**

*: the mean difference is significant at the 0.05 level.
**: the mean difference is significant at the 0.01 level.
NS: the mean difference is not significant.

Table (11): LSD multiple comparisons between ecological factors at different sites during the period of investigation.

Site	Temperature (ºC)		Hydrogen Ion Mean± SD	Dissolved Oxygen (ppm) Mean± SD	Conductivity. (µs/cm) Mean± SD	Salinity Mean± SD
	Air Mean± SD	Water Mean± SD				
Sites (1)	30.91±7.28	20.38±3.19	8.08±0.42	2.14±1.66	260.25±14.64	0.10±0.00
Sites (2)	32.59±7.23	21.36±2.48	8.06±0.43	2.10±1.52	263.33±13.23	0.10±0.00
Sites (3)	33.80±8.41	21.63±2.89	7.82±0.28	1.74±1.11	277.83±21.07	0.18±0.06

Table (12): Monthly fluctuations of organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment in (site3) Sakara moorage.

month	O.M	TDS	Cd	pb	Fe	Zn	Mg	Ca	PO_4	CO_3
Feb.2015	2.67	408.00	0.02	0.18	17.09	0.91	6.00	10.00	0.00	9.00
Mar	0.60	129.00	0.02	0.05	17.10	0.54	4.80	20.00	0.00	15.00
Apr	0.80	154.00	0.06	0.62	33.94	3.33	8.40	20.00	0.00	21.00
May	0.82	154.00	0.03	0.60	33.54	3.10	8.40	22.00	0.00	21.00
Jun	1.32	108.00	0.03	0.02	34.10	0.92	4.80	44.00	6.40	15.00
Jul	1.78	108.00	0.04	0.02	34.19	0.92	4.80	44.00	7.30	15.00
Aug	4.65	108.00	0.04	0.00	33.40	1.10	28.80	44.00	7.20	15.00
Sep	2.15	147.00	0.06	0.00	27.10	1.90	7.20	16.00	6.70	9.00
Oct	1.31	147.00	0.06	0.00	27.10	1.91	7.20	16.00	6.75	9.00
Nov	1.32	408.00	0.01	0.08	17.07	0.91	25.20	54.00	0.00	12.00
Dec	2.67	408.00	0.02	0.08	17.07	1.23	28.80	48.00	0.00	12.00
Jan.2016	30.40	1428.00	0.03	0.18	17.09	1.50	32.40	136.00	0.00	0.00

DISCUSSION:

From Figure(2), it is clear that the hydrogen ion concentration (pH) in the three sites of this study lies on the alkaline side and ranged between (7.5 in and 8.9). PH of three sites of this study is in the normal limit according to law 48 (1982) for the protection of the River Nile and its tributaries from pollution (must be 7 to 8.5).Conductivity in the three sites is high and ranges between (241 µs/cm and 316 µs/cm). This is due to presence of industrial and human wastewaters. However, not all industrial activities will increase water conductivity (Horne & Goldman, 1994).

Dissolved oxygen in the three sites ranges between (0.58 mg/l in July 2015 and 4.97 mg/l in March 2015). These values depend on the physical, chemical and biochemical activities in the water body, and their measurement provides a good indication of water quality. Changes in dissolved oxygen concentrations can be an early indication of changing conditions in the water body (Bartram & Balance, 1996). Sediment and soil are composed of mineral constituents, organic matter, living organisms and heavy metals. Some of these heavy metals occur naturally in sediment, which are formed by geological processes (Moor et al., 2001). In this study Cadmium was more than the permissible limit as there was pollution resulting from Kima drainage. This agrees with (Kazantzis 1987) who said that cadmium in water in high value resulting from pollution from fossil fuel, fertilizer and industrial processes such as cement manufacturing. Iron in water in high resulting from the floating ships and maintenance work of floating ships (Fig.3). Zinc is an essential element for all living organisms but the high level of zinc may be harmful (National irrigation water quality program, 1998). Chemical industry is responsible for more than 60% of heavy metal discharges. This agrees with (El Sheekh, 2009) in site (3) Sakara moorage (Kima drainage).

Low Mg and Zn concentrations in the surface water may be related to the contribution of phytoplankton, pH and dissolved oxygen concentrations because of the increased consumption of these elements by the phytoplankton (Emerson & Lewis 1939).

Pb values in water were more than permissible limit in this study due to engine boats (Saeed and Shaker 2008). The high concentration of Zn in water may be due to considerable amounts of zinc leached from protection plates of boats containing the active zinc as mentioned by Hamed (1998). By comparing the accumulation of heavy metals in water and sediments, it can be concluded that

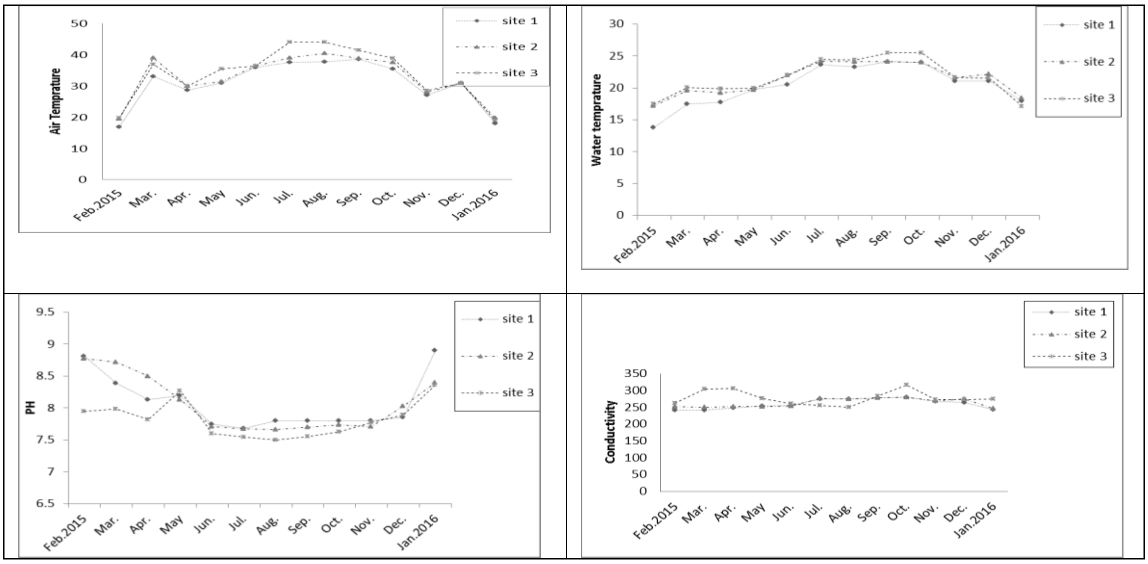

Fig. 2: Monthly variation of air temperature, water temperature, hydrogen ion concentration and conductivity at the three sites.

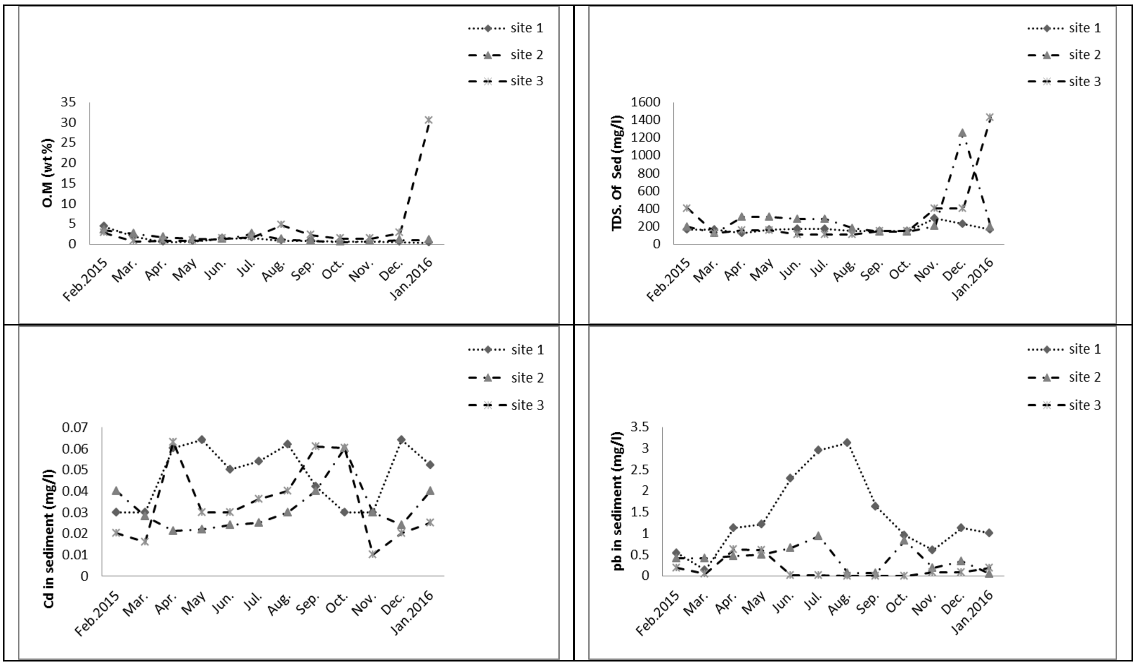

Fig. 3: Monthly variation of organic matters, TDS, cadmium and lead in sediment at the three sites

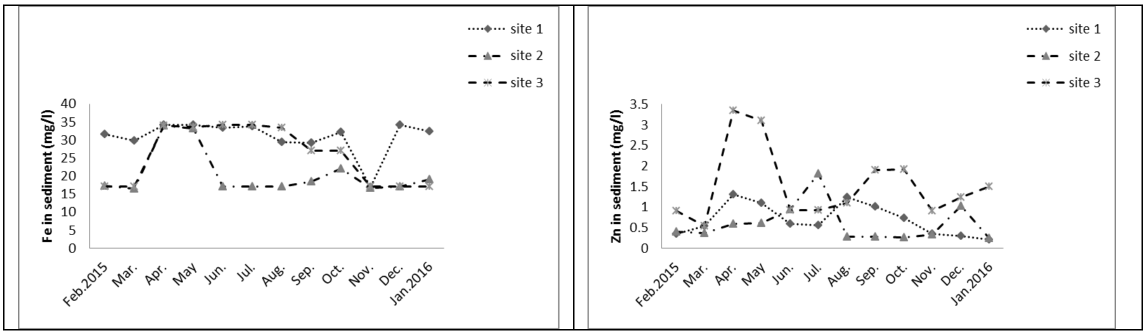

Fig. 4: Monthly variation of iron and zinc in sediment at the three sites

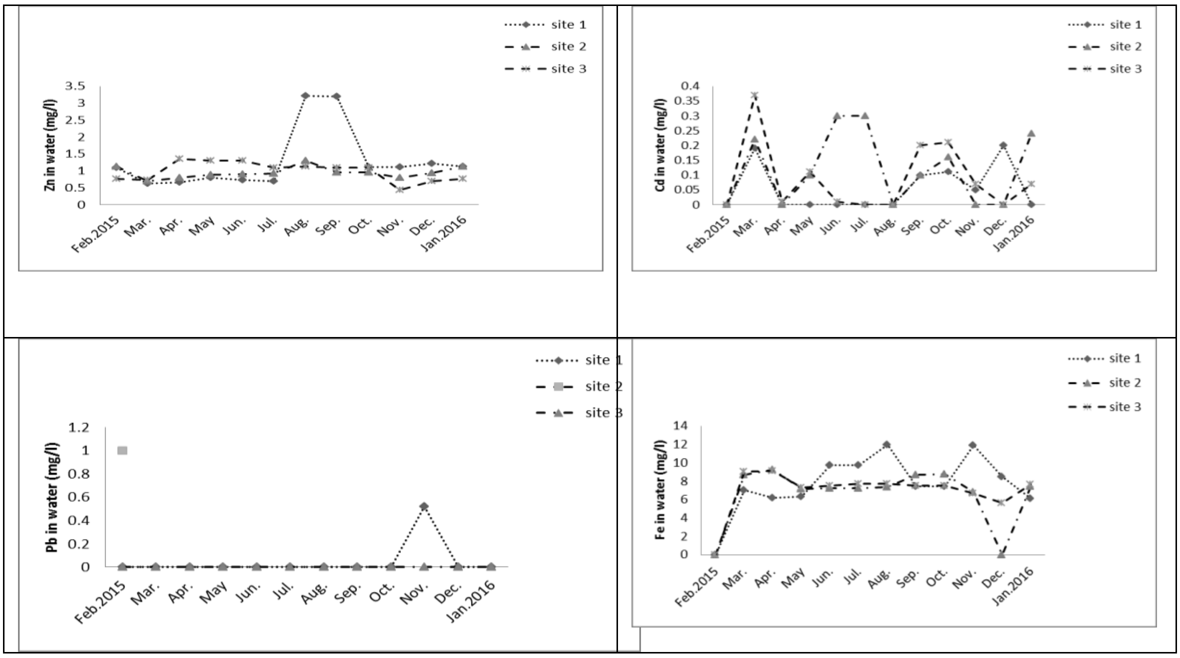

Fig. 5: Monthly variation of Zn, Cd, Pb and Fe in water at the three sites.

sediments than water, as the sediments act as reservoir for all contaminants and dead organic matter descending from the ecosystem above (Hamed, 1998 and Nguyena et al. 2005).

The increase of Pb and Cd concentrations more than the permissible limit may be related to the decaying of plankton and precipitation of organic matter associated with Pb and Cd to the sediment especially in site 3 Sakara moorage (Goher 1998). Cd may be explained by the fact that Cd in sediment is associated with the carbonate fraction and concentrates on the suspended matter (Laxon 1985), and will be mobilized from sediment to water (Goher 1998).The high concentrations of Fe found in the sediments may be mainly result from the natural deposits and industry. Organic matter in sediment tends to decrease the availability of metals to sediment dwelling organisms because of the formation of complexes between metals and organic matter (Black and Williams 2001; Camusso *et al*., 2002).

The decreasing phosphate content in all sites may be due to the increasing of mobilization of phosphorus from sediment to Nile water by increasing water temperature and water currents. Ca and Mg occur naturally in sediment and are the most common ions in freshwater and a major contributor to water hardness (USEPA, 1987). The decreases in Ca and Mg during cold seasons are mainly due to the release of CO2 from sediments because of oxidation of organic matter (Elewa *et al*., 1998).

Seasonal mean and standard deviation (SD)

The mean values of air temperature, water temperature, hydrogen ion concentration (pH), hydrogen ion concentration (Cond.) Dissolved oxygen (Do) and salinity at the three sites give no significant difference (Table12).The mean value of air temperature at the four seasons gave highly significant differences between each other, except in spring, autumn and summer (Table13).

The mean value of water temperature at the four seasons gave highly significant differences between each other, except in spring and winter. The mean value of hydrogen ion concentration (pH) at the four seasons gave no significant differences between winter & spring and autumn & summer but there were high significant differences between winter & summer, winter & autumn spring &summer, spring &autumn (Table 13).

The mean value of conductivity at the four seasons gave no significant difference between winter & spring, winter & summer and spring & summer but there were high significant differences between winter & autumn, spring & autumn and autumn &summer. The mean value of dissolved oxygen at the four seasons gave high significant differences between winter &spring, spring & summer and spring & autumn and significant difference between winter & autumn but gave no significant difference between winter & summer and autumn & summer (Table 13). The differences between means of salinity at the four seasons were not significant (Table 13).

Further statistical analysis (LSD) (Table 14 and 15) for sediment has revealed significant differences of these ecological factors between the investigated sites. This lead to the following conclusions:

Table (12): Seasonal mean and standard deviation (SD) of ecological factors at the three sites during the whole period of investigation.

Seasons	Temperature (ºC)		Hydrogen Ion	Dissolved oxygen (ppm)	Conductivity (µs/cm)	Salinity
	Air Mean± SD	Water Mean± SD	Mean± SD	Mean± SD	Mean± SD	Mean± SD
Winter	22.6±6.2	18.5±2.7	8.3±.4	2.1±1.5	258.7±13.5	0.12±0.04
Spring	32.9±3.5	19.3±.9	8.2±.2	3.7±.8	265.2±24.7	0.13±0.07
Summer	39.1±3.1	23.1±1.3	7.6±.09	1.2±.7	264.2±10.7	0.12±0.04
Autumn	34.9±5.5	23.5±1.6	7.7±.08	.9±.2	280.4±14.3	0.13±0.05

The mean percentage of organic matters and TDS gave no significant difference ($p>0.05$) between the three sites (Table 14). The mean concentration of cadmium gave no significant difference between Sakara moorage & Delta Isis while there was significant difference between Cataract hotel moorage & Delta Isis moorage and between Cataract hotel moorage & Sakara moorage. The mean concentration of lead gave significant difference between Cataract hotel moorage & Delta Isis moorage while there was high significant difference between Cataract hotel moorage& Sakara moorage and there was no significant difference between Delta Isis moorage& Sakara moorage (Table 15). The mean concentration of iron gave high significant difference between Cataract hotel moorage & Delta Isis moorage; there was significant difference between Cataract hotel moorage & Sakara moorage and between Delta Isis moorage & Sakara moorage (Table 15).

The mean concentration of zinc gave high significant difference ($p\leq0.01$) between Delta Isis moorage & Sakara moorage and gave significant difference between Cataract hotel moorage & Sakara moorage but Cataract hotel moorage and Delta Isis moorage gave no significant difference (Table 15).The mean concentration of magnesium and phosphate gave no significant difference between the three sites. The mean concentrations of calcium gave significant difference ($p\leq0.05$) between Cataract hotel moorage & Sakara moorage and give no significant difference between the other (Table 15). The mean concentration of carbonate gave significant difference between Cataract hotel moorage& Sakara moorage but gave no significant between the other sites.

Further statistical analysis LSD multiple comparisons between means of organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment of the three sites in the four seasons (Table 16 and 17) lead to the following conclusion:

Table (13): LSD multiple comparisons between ecological factors at different seasons during the period of investigation.

Seasons	Temperature (ºC)		Hydrogen ion (pH)	Conductivity (Cond) (µs/cm)	Dissolved oxygen(Do) (ppm)	Salinity
	Air	Water				
Winter &Spring	**	NS	NS	NS	**	NS
Winter &Summer	**	**	**	NS	NS	NS
Winter &Autumn	**	**	**	**	*	NS
Spring &Summer	**	**	**	NS	**	NS
Spring &Autumn	NS	**	**	**	**	NS
Autumn &Summer	NS	NS	NS	**	NS	NS

Table (14): Mean and standard deviation (SD) of organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment at the three sites during the period of investigation.

Sites	OM Mean± SD	TDS Mean± SD	Cd Mean± SD	Pb Mean± SD	Fe Mean± SD	Zn Mean± SD	Mg Mean± SD	Ca Mean± SD	PO4 Mean± SD	CO3 Mean± SD
Site (1)	1.20±1.08	174.92±43.42	0.05±0.01	1.39±0.94	30.91±4.79	0.72±0.38	8.52±4.30	18.67±9.47	6.31±12.34	8.15±6.92
Site (2)	1.49±0.91	302.75±307.78	0.03±0.01	0.41±0.29	20.44±6.31	0.59±0.46	10.53±8.34	34.80±30.79	6.17±6.52	12.25±4.33
Site(3)	4.21±8.32	308.92±373.64	0.03±0.02	0.15±0.22	25.73±8.01	1.52±0.89	13.90±11.18	39.50±33.97	2.86±3.54	12.75±5.74

Table (15): LSD multiple comparisons between organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment at different sites during the period of investigation.

Sites	OM	TDS	Cd	Pb	Fe	Zn	Mg	Ca	PO4	CO3
Site(1)&Site(2)	NS	NS	*	**	**	NS	NS	NS	NS	NS
Site(1)&Site(3)	NS	NS	*	**	*	**	NS	*	NS	*
Site(2)&Site(3)	NS	NS	NS	NS	*	**	NS	NS	NS	NS

The difference between mean organic matters concentration at the four seasons were not significant (Table 16). The difference between mean TDS concentration at the four seasons was high significant difference between winter & summer, there was significant difference between winter & autumn and winter & spring and gave no significant difference between the others (Table 17). The difference between mean Lead concentration at the four seasons was high significant between winter & summer, spring & summer, spring & autumn and autumn & summer and gave no significant difference between winter & spring and winter and autumn (Table 17).

The difference between mean Iron concentration at the four seasons was high significant between winter & spring, the difference between mean at the four seasons was significant between winter & summer and spring & autumn and gave no significant difference between the others. The differences between mean Cadmium and Zinc concentrations at the four seasons were not significant. The difference between mean Magnesium concentration at the four seasons was significant between winter & spring) and winter & summer and gave no significant difference between the others (Table 17). The difference between mean Calcium concentrations at the four seasons was significant between winter & spring and spring & summer and gave no significant difference between the other. The difference between mean Phosphate concentrations at the four seasons was not significant between winter & spring, winter & autumn and autumn and summer, gave high significant difference between spring & summer and gave significant difference between the others. The difference between mean Carbonate concentrations at the four seasons was high significant between winter & spring and winter & summer and gave no significant difference between the other (Table 17).

The mean concentration of chlorophyll-a, Cadmium , Lead , Iron, Zinc, Magnesium , Calcium and Phosphate gave no significant difference between Cataract hotel moorage and Delta Isis moorage, between Cataract hotel moorage and Sakara moorage and between Delta Isis moorage and Sakara moorage (Table 19).

Further statistical analysis Mean and standard deviation (SD) table (18) and (LSD) (Table 19) for water has revealed significant differences of these ecological factors between the investigated sites. This lead to the following conclusions:

The mean concentration of TDS gave highly significant difference between Cataract hotel moorage& Sakara moorage and between Delta Isis moorage& Sakara moorage and gave no

Table (16): Mean and standard deviation (SD) of organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment at the three sites during the four seasons of investigation.

Seasons	OM Mean± SD	TDS.s Mean± SD	Cd.s Mean± SD	Pb.s Mean± SD	Fe.s Mean± SD	Zn.s Mean± SD	Mg.s Mean± SD	Ca.s Mean± SD	PO4 Mean± SD	CO3 Mean± SD
Winter	5.1±9.5	494.7±491.7	0.04±0.02	0.4±0.4	22.5±7.7	0.7±0.5	17.3±10.3	42.0±43.7	1.1±3.2	7.0±6.8
Spring	1.2±0.7	181.8±75.4	0.04±0.02	0.6±0.4	29.6±7.4	1.3±1.1	7.2±2.1	15.9±9.3	0.0±0.0	14.2±4.4
Summer	1.8±1.20	174.1±68.4	0.04±0.01	1.1±1.3	27.7±8.1	0.9±0.4	9.1±9.2	44.4±22.0	11.6±11.8	13.3±5.8
Autumn	1.0±0.5	198.2±92.1	0.04±0.02	0.48±0.57	22.9±6.0	0.9±0.7	10.4±7.4	21.6±14.1	7.8±6.6	9.7±4.2

Table (17): LSD multiple comparisons between organic matters, TDS, heavy metals, calcium, phosphate and carbonate in sediment at different seasons during the period of investigation.

Seasons	OM	TDS/s	Cd/s	Pb/s	Fe/s	Zn/s	Mg/s	Ca/s	PO4/s	CO3
Winter&Spring	NS	*	NS	NS	**	NS	*	*	NS	**
Winter& Summer	NS	**	NS	**	*	NS	*	NS	*	**
Winter & Autumn	NS	*	NS	NS	NS	NS	NS	NS	NS	NS
Spring & Summer	NS	NS	NS	**	NS	NS	NS	*	**	NS
Spring & Autumn	NS	NS	NS	**	*	NS	NS	NS	*	NS
Autumn & Summer	NS	NS	NS	**	NS	NS	NS	NS	NS	NS

significant difference between Cataract hotel moorage & Delta Isis moorage (Table 19).

Statistical analysis Mean and standard deviation (SD) and LSD multiple comparisons between means of chlorophyll-a, TDS, heavy metals, calcium and phosphate in water of the five sites in the four seasons lead to the following conclusion:

The mean difference of chlorophyll-a gives highly significant difference between winter & summer and between spring & summer and significant difference between winter &autumn and gave no significant difference between the others (Table 20). The mean difference of TDS gave highly significant difference between spring & summer and spring & autumn and gave significant difference between winter & spring, winter & summer and winter & autumn and gave no significant difference between autumn & summer. The differences between mean Cadmium, Lead, Zinc and Ca concentrations at the four seasons were not significant. The mean difference of Iron gave highly significant difference between winter & spring, summer and winter & autumn and gave no significant difference between the others (table 20).

The mean difference of Iron gave significant difference between winter & summer and winter & autumn and gave no significant difference between the other (Table 21)...

The differences between mean Calcium and Phosphate concentrations at the four seasons were not significant except winter &summer give significant difference (Table 21)...

Table (19): LSD multiple comparisons between chlorophyll-a, TDS, heavy metals, calcium and phosphate in water at different sites during the period of investigation.

Sites	Chl-a	TDS	Cd	Pb	Fe	Zn	Mg	Ca	PO4
Site(1)&Site(2)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Site(1)&Site(3)	NS	**	NS	NS	NS	NS	NS	NS	NS
Site(2)&Site(3)	NS	**	NS	NS	NS	NS	NS	NS	NS

Table (20): Mean and standard deviation (SD) of chlorophyll-a, TDS, heavy metals, calcium and phosphate in water at the three sites during the four seasons of investigation.

Seasons	Chl-a Mean± SD	TDS Mean± SD	Cd Mean± SD	Pb Mean± SD	Fe Mean± SD	Zn Mean± SD	Mg Mean± SD	Ca Mean± SD	PO4 Mean± SD
Winter	.64±1.03	48.89±5.44	.05±0.09	.00±0.00	.92±3.3.81	0.98±0.19	7.01±5.71	3.11±3.89	2.10±3.01
Spring	.56±2.82	52.33±9.12	.11±0.13	.00±0.00	.78±1.23	.87±0.27	4.77±8.55	6.89±5.21	.40±0.71
Summer	.68±5.86	45.89±6.64	.07±0.13	.00±0.00	.45±1.65	.25±0.77	.54±4.29	5.78±5.70	.05±0.15
Autumn	.24±5.02	45.67±2.35	.11±0.07	.06±0.17	.08±1.60	.19±0.78	0.13±2.61	5.78±4.41	.57±3.14

Table (21): LSD multiple comparisons between chlorophyll-a, TDS, heavy metals, calcium and phosphate in water at different seasons during the period of investigation.

Seasons	Chl-a	TDS	Cd	Pb	Fe	Zn	Mg	Ca	PO4
winter&spring	NS	*	NS	NS	**	NS	NS	NS	NS
Winter& Summer	**	*	NS	NS	**	NS	*	NS	*
Winter & Autumn	*	*	NS	NS	**	NS	*	NS	NS
Spring & Summer	**	**	NS	NS	NS	NS	NS	NS	NS
Spring & Autumn	NS	**	NS	NS	NS	NS	NS	NS	NS
Autumn & Summer	NS	NS	NS	NS	NS	NS	NS	NS	NS

CONCLUSION

From the previous study it can be concluded that there are increasing of Cd, Pb, Fe, Zn, and phosphate and decreasing of dissolved Oxygen in water and sediments in the chosen three sites than the permissible limit of Law 48(1981). The phosphate content in sediments is lower than in water in all sites due to the increasing of mobilization of phosphorus from sediment to Nile water by increasing water temperature and water currents. Ca and Mg occur naturally in sediment and are the most common ions in freshwater and a major contributor to water hardness (USEPA, 1987). The decreases in Ca and Mg during cold seasons are mainly due to the release of CO2 from sediments because of oxidation of organic matter (Elewa *et al*., 1998).

Ca and Mg occur naturally in sediment and are the most common ions in freshwater and a major contributor to water hardness. The decreases in Ca and Mg during cold seasons are mainly due to the release of CO2 from sediments because of oxidation of organic matter. Statistical analyses show that the chosen three sites often show no significance differences between ecological factors during the period of investigation. Hence, there is a pollution of Nile water and sediments in the three chosen sites

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