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Factors affecting the distribution of some heavy metals in Lake Nasser water, Egypt.

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ABSTRACT

This study was carried out on Lake Nasser, Aswan province, Egypt, along of about 330 km, south of Aswan High Dam Reservoir (AHDR) extends to Argeen area near to Sudan border line. The objective of the study was to declare the distribution pattern and the levels of heavy metals and their effect on the Lake Nasser water quality which is the main source of fresh water in Egypt. Water samples were collected from subsurface and bottom water in 10 stations along the distance of the Lake Nasser inside of Egypt border during winter and summer 2005, with beginning of the flood period. The results showed that the main factors affecting the physico-chemical properties in the lake are temperature and flood water. The mean concentrations of Mn, Co, Ni, Cu, Cd and Pb in surface and bottom water increase in southern part than the northern area of the lake, as well as the increase occurs during summer than winter with low temperature and increase of dissolved oxygen. In addition, physico-chemical parameters have influenced on the distribution of heavy metals. There is strong positive correlation coefficient between Co with DO, total organic nitrogen, and NH_3 forming stable complexes which dissolve in water. Nickel solubles as $NiCO_3$ at high pH values. Cd has a negative correlation coefficient with SiO_3^-, TON, NH_3, COD. These correlations reveal that Cd makes many complexes compounds which precipitate from water to sediment. Pb has a positive correlation coefficient with TSS, temperature and Nitrate; this exhibits increase of lead content with these parameters. However, from the results obtained, the concentrations of these metals are lying in the permissible limits as compared with World Health Organization (WHO) figures except Cd and Pb during summer in southernmost site of Lake Nasser at Argeen.

Keywords: Lake Nasser, physico-chemical properties, heavy metals, permissible limits.

INTRODUCTION

The study include the effect of physico-chemical parameters on the distribution of heavy metals in Lake Nasser. Normal metal content in such environments varies from one place to another according to the geological nature of the catchments area. The Aswan High Dam Lake (AHDR), 500 km in length, extends from the dam itself in the north to the Cataract Da1, Sudan in the south.

The major portion of the lake lies in Egypt and is known as Lake Nasser (330 km) and Lake Nubian (170 km) on the Sudanese side. Lake Nasser extends between latitudes 22°00 –23° 58N and longitudes 31°19 – 33° 19 E. The main Nile's annual discharge is derived from Ethiopian High lands (86%), while only 14% is contributed by the Equatorial lakes (Mancy and Hafez, 1979). Metals enter rivers and lakes from a variety of sources, such as, rocks and soils directly exposed to surface waters; this is the largest natural source, dead and decomposing vegetation and animal matter, wet and dry fallout of atmospheric particulate matter, and from man's activities, including the discharge of various treated and untreated liquid wastes into the water body (Lasheen, 1987). Many studies have been carried out on the distribution of the different physical and chemical components in Lake Nasser water (Nessiem, 1972; Saad, 1980; Toufeek, 1993; Awadallah *et. al*., 1995). Recently, several studies have been investigated on the physical and chemical properties and trace metals in Lake Nasser water and sediment (Awadallah and Moalla, 1996; Elewa and Toufeek, 1997; Toufeek, 2005; Toufeek and Korium, 2005; Gindy and El-Dardir, 2008).

Goma (2001) studied the seasonal distribution of nutrients of lake Nasser, and concluded that concentrations of nutrient (PO_4^{3-}, NO_2^-, NO_3^- and total nitrogen) were increased from north to south, especially in the flood season. After construction of High Dam, an important change in the Nile water quality was observed. This change is resulted in increase of dissolved solids and decrease of the suspended solids in the Nile (Ramadan 1972 & 1978). Most heavy metals are present mainly as suspended colloids or fixed by organic and mineral substances. Many heavy metals do not exist in soluble forms in natural waters and therefore accumulated in bottom sediment or plankton. Korium (2001) concluded that, most heavy metals under investigation (Fe, Mn, Zn, Cu, and Pb) increased in water during hot periods at which anaerobic condition prevails due to the depletion of dissolved oxygen that cause remobilization of these metals from sediment into overlying water, with different types of nutrients (PO_4^{3-}, SiO_2^-, NO_3), while in the oxygenation period, heavy metals are adsorbed on the surface of the suspended solids and discharged to bottom sediment. The heavy metals in Lake Nasser increased with the increasing of the suspended and dissolved solids. During autumn and summer, when the H_2S is evolve and the heavy metals precipitate as sulphides, while during oxygenation period releases from the sediment as sulphate. The presence of carbonate anions is beneficial in the precipitation of heavy metals as carbonate. Generally, the high oxygen content, and pH values and lower temperature can lead to purification of water from toxic elements. Cadmium has been found to be toxic to fish, and other aquatic organisms (Rao and Saxena, 1981). The effects of Cd toxicity in man include many diseases. Lead is defined by the United State Environmental Protection Agency (USEPA) as potentially hazardous to most forms of life. It causes death of fish due to suffocation. Pb has no known beneficial biochemical attributes (Harrison and de Mora, 1996). The lake was suffered from chemical changes during the last years due to recent cultivated lands nearby the lake which wastewaters drainage increases progressively and affects greatly the lake biota. Even under natural conditions, lakes undergo eutrophication , an aging process that slowly fills in the lake with sediment and organic matter. The eutrophication process alters basic lake characteristics such as depth, biological productivity, oxygen levels and water clarity (USEPA, 1994). Copper is essential as micronutrient for fish and aquatic life. The permissible levels of copper in water are 1.0 ppm , while in fish tissues, they are 20 ppm according to WHO (1984). Most heavy metals in water are adsorbed on to clay and Mn^{4+} or Fe^{3+} hydrous oxides or occur as low soluble organic complexes. Toxicity of any heavy metal is influenced by many factors such as, metal species, pH value and organic matter content. The phyto and zooplankton are known to cause the removal of Cu, Mn, Pb, Zn and Cd from the water (Toufeek and Arifian, 2001). The WHO limits of drinking water are 1.0 and 50 μgl^{-1} for Hg and Pb respectively. The toxicity of these metals depends on their relative distribution between water and suspended solids. The aim of this study was to follow the change of physico-chemical characteristics in Lake Nasser water and to determine the concentration of some trace metals and its effect on the Lake Nasser environment.

MATERIALS AND METHODS

The study area:

Lake Nasser is the second artificial man – made lake, after Lake Volta (Ghana). It lies in subtropical arid region with hot summer climate. When the reservoir is nearly full at 180 m level it will has surface area of 6276 km2, with average depth of about 25 m. On the other hand, the mean width of the Lake Nasser at 180 m. level would be 17.95 km.

Sampling and procedure:

The present study was carried out during December (winter) and July (summer) 2005. Samples were collected from ten stations covering the whole Lake Nasser area: first Kalabsha station about 41 km to Argeen station about 331 km distance south of High Dam Reservoir (Fig. 1)

Two water samples from surface and bottom water in each station were collected during winter and summer by polyvinyl bottle (2L).On sampling site, water temperature was measured using thermometer (C^o), conductivity (μ mhos cm^{-1}) was measured by the electrical conductivity meter (YSI Model 33.S-C.T), water transparency by a secchi disc (50cm).The secchi depth measurements were carried out on the shaded side of the boat. Dissolved oxygen (mgl^{-1}) was measured by Winkler's method using azide modification of iodometric method, pH values by using (370 pH Meter–JENWAY), which was calibrated with two different buffer solutions (pHs 4 and 9). The chemical parameters were measured using methods adopted by Standard Methods described in APHA (1998). Carbonate and bicarbonate determined by direct titration with standard 0.02N H_2SO_4. Chloride was measured by Mohr's method. Organic matter (TOM) was determined by dichromate reflex method according to Dobbs and William (1963). The dissolved solids and total suspended matter were determined gravimetrically according APHA (1998). Ammonia was determined according to Nesslerization method at λ = 425 nm, Orthophosphate was determined spectrophotometrically by stannous chloride method, which utilized acidic molybdate solution at λ = 690 nm, Silicate was determined spectrophotometrically at λ = 410 nm according to molybdosilicate method. Nitrite content was determined spectrophotometrically at λ = 520 nm according to the modified Griess method.. Nitrate concentration was determined spectrophotometrically using sodium salicylate method at λ = 420 nm , sulphate was determined turbidmetrically using $BaCl_2$ at λ = 410 nm , total organic nitrogen was determined by Kjeldahl method, where organic nitrogen is converted to ammonium sulphate $(NH_4)_2SO_4$ and the ammonium distilled into boric acid solution and titrated with standard sulphoric acid using an appropriate indicator. Total Mn, Co, Ni, Cu, Cd and Pb in water were measured after digestion using Atomic Absorption spectrophotometer model (SOLAAR 32).

RESULTS AND DISCUSSION

Frequencies of different physico-chemical parameters in Lake Nasser are recorded in (Table 1):

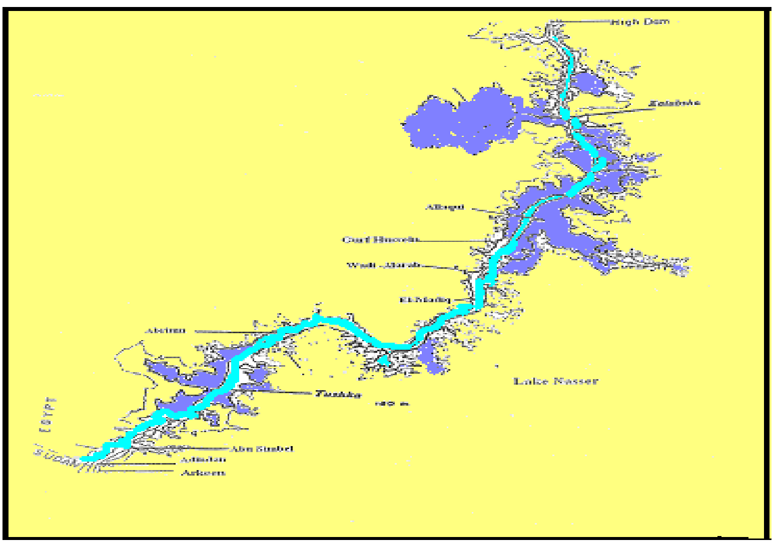

Table (1). Frequencies of physico-chemical characteristics of Lake Nasser water during winter and summer (2005)

Stations	Kalabsha		Allaqui		Gurf Hussien		Wadi Alarab		El-Madique	
Seasons / Param.	Winter	Summer	winter	summer	winter	summer	Winter	summer	winter	Summer
T^oc	22	25.3	21.7	24.3	22.8	26.4	22.5	27	23.5	23.9
E C	255	250	260	230	245	240	250	243	250	240
Turbidity (NTU)	2	4.7	1.75	2.58	2.45	5.1	2.35	5.35	2.2	3.42
TDS (mgl^{-1})	158	163	164		155	165.5	158	153.5	162	
TSS(mgl^{-1})	2.51	4.2	3.6	3.9	4.01	5.5	3.61	6.1	27	4.5
pH	7.88	8.2	8.12	7.72	8.3	7.9	8.25	8.15	8.3	8.15
DO (mgl^{-1})	7	3.9	6.8	3.2	6.6	3.6	6.8	3.8	7.5	3.4
(COD)	6.4	2.1	7.2	2.45	6.8	1.76	4.2	2.4	4.4	2.6
Carbonate mgl^{-1}	10	7	10	12	12	4	16	12	12	14
(HCO_3 mgl^{-1})	110	115	104	110	130	115	138	108	134	106
(NO_3 mgl^{-1}	320	920	480	210	300	1350	330	1150	240	210
Nitrite (gl^{-1}	25	13	60	5	10	100	8	15	30	10
NH_3	120	5	100	50	90	45	75	27	85	20
TON(mgl^{-1}	2.8	1.15	2.9	1.9	2.4	0.95	1.9	2.05	2.3	1.4
Chloride mgl^{-1}	6.3	5	6.5	4.5	7.7	4.75	5.3	6	6.7	
(SO_4 mgl^{-1}	13	11.2	11.5	11	12	11.3	11	10	11	15.5
(SiO_2 mgl^{-1})	10.8	9	11	8.5	10.5	10.5	11.2	10	10.8	7.5
(PO4 mgl^{-1}	55	110	60	85	55	100	40	75	60	85

Cont. Table 1

Stations	Abrium		Tushka	Abu-Simble			Adindan		Argeen	
seasons / Parameters	Summer	Winter	summer	winter	summer	winter	summer	winter	summer	Winter
Temp. Toc	23.9	22.3	25	22.5	25.9	21.7	25.5	20.8	26.55	20.7
EC	240	260	240	35	245	230	245	220	248	210
Turbidity (NTU)	3.42	1.8	6.25	4.4	9.1	8.5	10.5	17.5	10.45	28.8
TDS (mgl^{-1})		161	158	151	158.5	148	157.5	141	153	138
TSS (mgl^{-1})	4.5	5.21	5.8	6.1	8.8	6.32	18.9	6.01	40.3	8.51
pH value	8.15	7.8	8.5	7.7	8.3	7.85	8.3	7.75	8.03	7.6
DO (mgl^{-1})	3.4	6.5	3.95	6.6	3.8	6.4	3.6	6.5	3.9	5.9
(COD) mgl^{-1}	2.6	5.2	1.72	5.2	3.6	7.8	3.8	7.8	5.4	7.2
(CO_3 mgl^{-1})	14	8	11	8	10	6	15	4	14	2
(HCO_3 mgl^{-1})	106	110	115	114	110	134	108	126	115	100
(NO_3 gl^{-1})	210	370	910	550	950	520	950	450	1400	480
NO_2(gl$^{-1)}$	10	30	3	8	1	12	5	11	5	8
NH_3(gl^{-1})	20	80	25	100	20	90	30	100	40	80
TON (mgl^{-1})	1.4	2.4	1.45	2.6	1.4	2.4	1.6	1.9	2.05	1.9
Cl (mgl^{-1})		4.7	3.8	5.8	4.4	4.6	5.55	3.4	6	4.3
SO_4 mgl^{-1})	15.5	11.7	8.6	10.5	9.7	9.7	8.7	7	6.85	6
SiO_2 mgl^{-1})	7.5	12.4	9.3	13.4	11.3	13.9	11.5	14.5	6.7	16.2
PO_4 mgl^{-1})	85	40	145	85	130	95	140	100	200	120

From the obtained data it is concluded that Lake Nasser water has a good quality according to National River Water Quality (NRWQ) (Singh *et al.*, 2008).

Correlation coefficient matrix between heavy metals and different physico-chemical parameters are estimated in (Table 2) to conclude the factors affecting that the distribution of these metals in Lake Nasser water.

Table (2): Correlation coefficient matrix for some physico-chemical parameters of water of Lake Nasser and concentrations of heavy metals

	HCO_3	Cl	CO_3	pH	E.C	NTU	DO	TTS	TDS	Temp	SO_4	Co	Mn	Ni	Cd	Pb
HCO_3																
Cl	0.138															
CO_3	0.131	0.459														
pH	0.225	0.137	0.621													
E.C	0.036	0.569	0.509	0.518												
NTU	-0.064	0.107	-0.246	-0.055	-0.103											
DO	0.46	0.259	-0.182	-0.231	0.075	-0.181										
TTS	-0.053	0.379	0.145	0.141	0.242	0.794	-0.304									
TDS	-0.008	0.391	0.392	0.563	0.866	-0.096	-0.224	0.147								
Temp	-0.19	0.135	0.351	0.486	0.31	0.184	-0.807	0.459	0.496							
SO_4	-0.002	0.293	0.317	0.135	0.403	-0.64	0.109	-0.599	0.541	-0.111						
Co	0.441	0.275	-0.182	-0.321	0.009	-0.082	0.969	-0.144	-0.324	-0.807	0.003					
Mn	-0.041	-0.137	0.205	-0.512	0.063	0.329	-0.392	0.433	0.139	0.409	-0.401	-0.381				
Ni	-0.064	-0.191	0.248	0.545	0.133	-0.007	-0.34	0.084	0.25	0.321	-0.107	-0.369	0.793			
Cd	-0.334	-0.119	0.147	0.144	0.039	-0.127	-0.769	0.094	0.236	0.746	0.122	-0.773	0.015	-0.078		
Pb	-0.196	0.218	0.127	0.246	0.117	0.78	-0.513	0.782	0.187	0.56	-0.411	-0.428	0.402	0.284	0.165	
Cu	-0.413	-0.108	-0.012	-0.059	-0.404	0.333	-0.407	0.397	-0.384	0.176	-0.659	-0.295	0.208	0.039	0.206	0.472
PO_4	-0.2444	-0.207	-0.037	0.135	-0.215	0.484	-0.618	0.702	-0.15	0.542	-0.683	-0.496	0.636	0.323	0.385	0.513
SiO_2	0.079	-0.408	-0.572	-0.494	-0.528	-0.202	0.584	-0.509	-0.655	-0.715	-0.173	0.589	-0.444	-0.257	-0.5	-0.463
TON	0.114	0.479	0.069	-0.29	0.207	-0.162	0.761	-0.067	-0.168	-0.591	0.119	0.802	-0.332	-0.349	-0.575	-0.429
NO_3	-0.16	0.108	-0.074	0.224	0.18	0.666	-0.554	0.791	0.276	0.742	-0.553	-0.486	0.467	0.208	0.398	0.762
NO_2	-0.084	0.078	-0.331	-0.142	0.236	-0.225	0.108	-0.207	0.459	0.019	0.308	0.041	-0.298	-0.066	0.116	-0.104
NH_3	0.303	0.317	-0.283	-0.458	-0.011	0.169	0.841	0.025	-0.249	-0.722	-0.06	0.885	-0.338	-0.387	-0.754	-0.242
COD	0.213	0.21	-0.331	-0.405	-0.158	0.279	0.701	0.198	-0.528	-0.697	-0.312	0.808	-0.287	-0.406	-0.619	-0.149

Cont. Table (2):

	Cu	PO_4	SiO_2	TON	NO_3	NO_2	NH_3
PO_4	0.615						
SiO_2	0.019	-0.329					
TON	-0.332	-0.472	0.297				
NO_3	0.295	0.706	-0.469	-0.425			
NO_2	-0.265	-0.301	0.06	-0.027	0.058		
NH_3	-0.312	-0.441	0.436	0.783	-0.305	0.143	
COD	0.032	-0.114	0.489	0.684	-0.19	-0.097	0.814

Heavy metals:

Most heavy metals in water are present mainly as suspended colloids or fixed by organic and mineral substances. Many heavy metals do not exist in soluble forms for very long time in natural waters and therefore they accumulated in bottom sediment or plankton.

Cupper (Cu^{2+}):

The concentrations of copper in water were higher in southern part of the lake (29.4 µgl -1) during winter at Argeen, but lower in other stations along the lake during this season. In summer, the lake showed increase of the concentrations of copper in southern part (10, 17, 20 and 9 μgl^{-1}) at Tushka, Abu-Simbel, Adindan and Argeen respectively. The minimum values were measured in northern part of the lake during winter and summer (Fig. 2), comparing , to that of lake Qarun water (2.93 mgl^{-1} , 1.25 mgl^{-1} during summer and winter respectively) (Mohammed and Hossam, 2007). This comparison reveals to low concentrations of copper in Lake Nasser water than lake Qarun. Copper in water has a weak positive correlation with TSS,, Cd and Pb (r= 0.387, 0.206and 0.472) respectively (Table 2). The copper in Lake Nasser water is associated with suspended matter and phosphate, subsequent Cu coagulates from water and accumulated in sediment. In other hand negative correlations with DO, TDS, HCO_3^- and SO_4^{2-} (r= - 0.407, 0.-0.384, -0.413 and -0.659 respectively), were estimated during the period of study. In overall, the decrease concentration of copper in Lake Nasser related to continuous of flood water every year and there are several types of aquatic organisms particularly algae and mollusks are known to accumulate copper and zinc. Increase of Cu during summer resulted from decomposition of organic matter (Elewa *et al*., 2001).

As well as ,decrease of Cu in the water during winter due to the adsorption of heavy metals on to surface of organic matter particles and their settlement downward (Goher, 2002).

Timperly and Allen (1974) mentioned that the accumulation of copper in sediment is mainly due to precipitation of reduced copper sulphide. This is reflected on the relatively low copper in water.

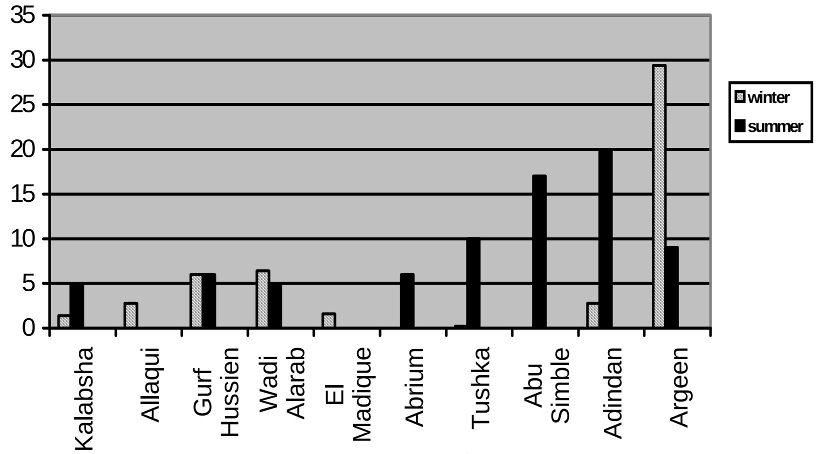

Fig. (2): Distribution of Cu in Lake Nasser water (μgl^{-1}) during winter and summer, 2005

Manganese (Mn^{2+}):

From the results obtained (Fig. 3) concentrations of manganese along Lake Nasser increase during summer especially in southern areas of the lake where is the maximum values were observed at Abrium, Adindan and Argeen (231, 101, 120 □gl^{-1} respectively), low values were noticed at Allaqui, Gurf Hussein and Wadi- Alarab (28, 23, 22 □gl^{-1} respectively) in the same season, while the lowest values were measured during winter. This decrease of Mn concentration during winter due to oxidation of Mn^{+2} to Mn^{+4} in presence microorganisms, that discharge from water to bottom sediment and to the adsorption of Mn on the surface of suspended solids coming with flood water particularly in southern parts, also assimilation by phytoplankton, or due to the adsorption of Mn on the surface of nutrients and co-agulated from water to sediment (Miyai *et al*., 1985), this can be explained by the positive correlation between Mn and , PO_4 ,NO_3 (0.636, 0.467) respectively). Higher manganese concentrations in southern areas of the lake water during summer are affected by higher temperature (r= 0.512), and flood water which contain considerable amount of heavy metals in water, (Doilido and Demora, 1996). The positive correlation coefficient between Mn and temperature can be explained by the thermal stratification in lake water subsequent to oxygen depletion resulting in the mobilization of Mn from sediment to overlying water , or decomposition and decay of phytoplankton and other aquatic plants which working as metal accumulators (Harrison and Mora, 1996).

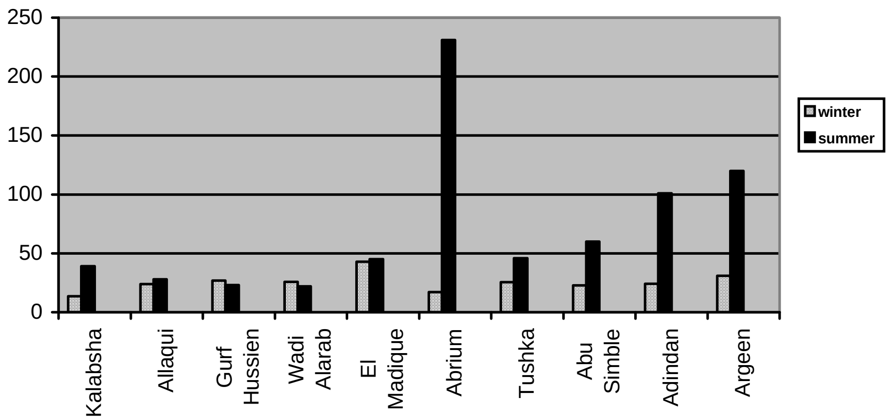

Fig. (3): Distribution of Mn in Lake Nasser water (µgl^{-1}) during winter and summer, 2005

Cobalt (Co^{2+}):

The distribution and concentration of dissolved Co were higher in winter (the range between 32 to 41 µgl^{-1}) than in summer (fluctuated between 3 to17 µgl^{-1}). Available data shows increase trend from the north of the lake to south, where the maximum values were observed at Tushka and Abu- Simbel 41 µgl -1 in south part, while the minimum concentrations to be localized in the northern part of the lake Fig.(4). From the static mathematics, Table (2) exhibits significant correlation between Co and DO (r=0.969), revealed increasing of dissolved Co in presence of high amounts of DO during winter. In addition, cobalt makes chelating with total organic nitrogen (r=0.802), Co with NH_3 (r=0.885) with total organic matter (r=0.808), and with silica (r=0.589) forming stable complexes which dissolved in water, consequently increase concentrations of Co during winter. In other side, Co has a negative correlation with temperature (r=-0.807), this explains decrease amount of Co with high temperature during summer.

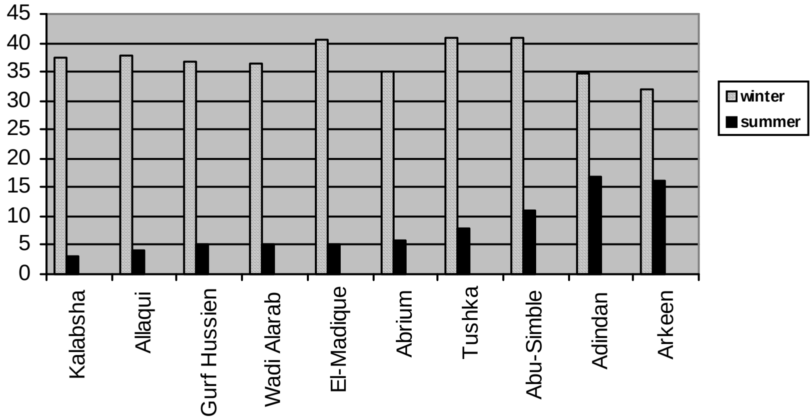

Fig. (4): Distribution of Co in Lake Nasser water (μgl^{-1}) during winter and summer, 2005.

Nickel (Ni^{2+}):

The concentrations of Ni exhibit higher values in summer than in winter and in southern parts of the lake than in northern parts. In summer, the maximum concentrations were observed at Abrium and Abu-Simbel (44,24μgl^{-1}) respectively, while in winter, the higher values varied from 10.8 to 15 μgl^{-1} at Gurf Hussein and Abrium sites respectively (Fig. 5) . In other side, low values in summer fluctuated between 4 and 11 μgl^{-1}, while in winter, low values ranged between zero to 8.4 μgl^{-1}.

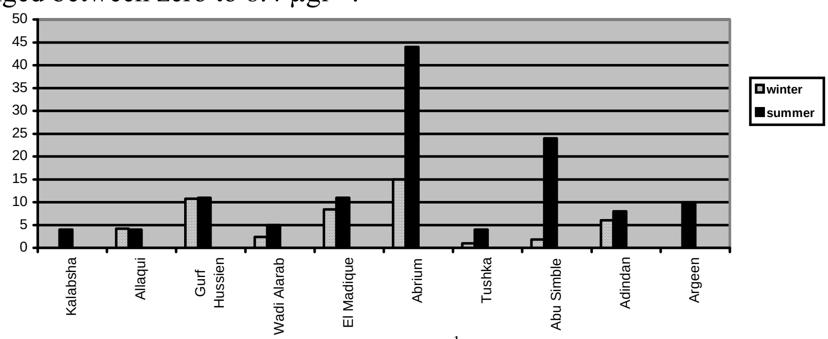

Fig. (5): Distribution of Ni in Lake Nasser water (μgl^{-1}) during winter and summer, 2005

From the data obtained, it is noticed that low levels of heavy metals in the northern parts of Lake Nasser could be attributed to the sedimentation process of most of the suspended matter occurs from the south to north along the lake . However, Nickel is a fairly mobile metal in natural water, particularly soluble as Ni^{2+} and $NiCO_3$ at high pH values where a positive correlation between concentrations of Ni and pH (r= 0.545).

The removal of Ni by scavenging action of hydrous MnO_2, correlation coefficient between Ni and Mn (r= 0.793) was demonstrated by KrausKopf (1985) who observed that clay minerals, apatite and organic matter are ineffective scavengers

Cadmium (Cd^{2+}):

The distribution of dissolved Cd is graphically presented in (Fig. 6), showed high values at most stations of Lake Nasser during summer. The maximum values were 28, 26, 25 □gl^{-1}, and the minimum values were3,4 □gl^{-1}. In winter less minimum values were detected along all areas investigated in Lake Nasser and the range fluctuated between ND, 0.6, 0.8 and 2 □gl^{-1}. On the overall, the concentrations of Cd were random values between south and north parts of the lake. The lowest concentrations were detected in winter that can be explained from the negative correlation coefficient between Cd and DO (r= - 0.769), this may be show, the decrease of Cd concentration in cold season. As well as, negative correlation coefficient with SiO_2, TON, NH_3, COD (r= - 0.500, - 0.575- 0.754 and – 0.619 respectively). These correlations reveal that Cd makes many complexes compounds which precipitate from water to sediment, in addition to that of phytoplankton and zooplankton and other organisms in surface water, led to decrease of cadmium content in the surface water (Harrison and Mora, 1996). In addition, lowest Cd concentration due to its precipitation as carbonate changed to sulphide or hydroxide as the following equations (Diaz *et al*., 1998) :

$$CdCO_3 + S \rightleftharpoons CdS + CO_3^{--} \downarrow$$

$$CdCO_3\,(s) + H_2O + O_2 \rightleftharpoons Cd\,(OH)_2 + CO_2 + H_2$$

In other hand, the highest concentrations of cadmium were measured during summer with the highest water temperature and lowest pH value (Toufeek, 2005). This is indicated by the positive correlation between Cd with temperature (r= 0.746).

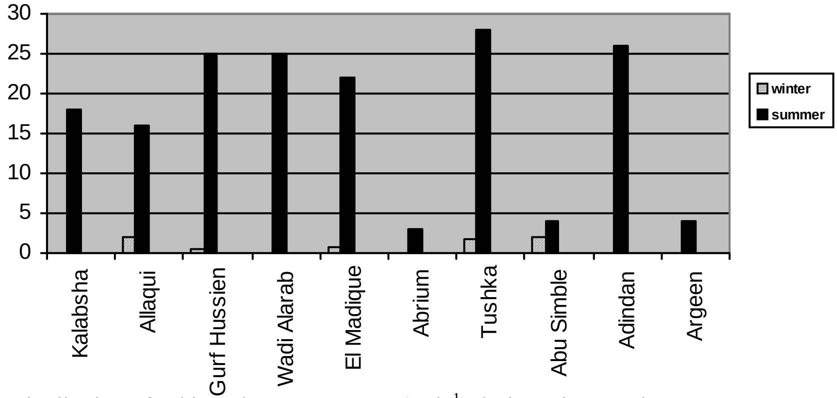

Fig. (6): Distribution of Cd in Lake Nasser water (μgl $^{-1}$) during winter and summer, 2005

Lead (Pb $^{2+}$):

The distribution of Pb showed a clear pattern during winter and summer. The higher values were recorded during summer as compared to lower during winter along the lake, (Fig. 7). The maximum concentrations varied from 5 to 77 gl $^{-1}$ during summer. The lowest concentrations occurred in winter 2005 and fluctuated between zero to 25.6 gl^{-1}. According to these results, the high value (77 gl $^{-1}$) during summer was measured at Argeen station in southern part of Lake Nasser. Also, the maximum level (25.6 gl^{-1}) was observed during winter at Argeen station, which lies in the border with Sudan and this is related to flood water coming with high turbidity, suspended solid, by action of high temperature and water current during this period. This could be indicated by positive correlation coefficient between Pb with NTU (r= 0.780) with TSS (r= 0.782) and with Temp (r= 0.560), also Pb dissolved in water as nitrate (r= 0.762) as in Table 2 . On the other side, the lower Pb content was recorded in different sites of Lake Nasser during winter, where there is a negative correlation coefficient between Pb and DO (r= - 0.513). The lower concentrations of Pb were observed in northern areas of Lake Nasser are related to the precipitation of Pb as sulphides or carbonates or other minerals and they can be also adsorbed on the surface of the Fe or Mn oxides , hydroxides or precipitated with organic complexes (Drever, 1988 ; Buffle, 1990).

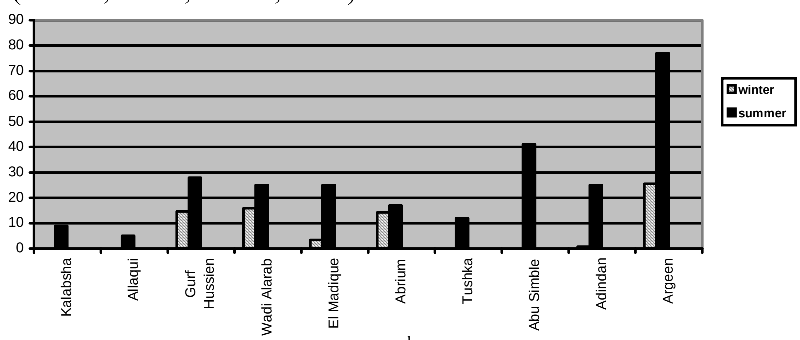

Fig. (7): Distribution of Pb in Lake Nasser water (μgl $^{-1}$) during winter and summer, 2005

CONCLUSIONS AND RECOMMENDATIONS

Since Lake Nasser is the main source of fresh water in Egypt, so it is important to monitoring and continue studies on the physico-chemical characteristics of water and to assess its effect on the distribution dynamics of the trace metals. The important results of this study can be summarized as follows: metal contents were in the ranges Cu, 9 - 29.4; Mn, 22 - 231, Cd, nd.- 28, Co, 3 - 41, Ni, nd. - 44,and Pb, nd. - 77, $\mu g l^{-1}$. These concentrations are very low values comparing to those reported in other lakes in Egypt. Although, at suitable concentrations some heavy metals are essential for enzymic activity, they also form an important group of enzyme inhibitators when natural concentrations are exceeded. The significant drop in metal concentrations in Lake Nasser water might result from dilution or from precipitation and adsorption reactions which would tend to reduce the metals levels. So, trace metals should be kept to a minimum in all aquatic systems. In recent years, we are warning from pollution that could be occured resulting from discharge of drainage water of thousands of agricultural lands, which are reclaimed to side the lake and gradually increase of population in west side of Lake Nasser. It is recommended to control discharge of drainage and sewage water into the lake or at least minimize the usage of fertilizers in agricultural lands and treatment of drainage water is essential to improve water quality and biodiversity of the lake.

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