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Determination of Heavy Metals Concentration in the River Nile Sediments in Dongola and Merowe, Northern State, Sudan

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Abstract: *Environmental pollution is caused due to the discharge of substances or energy into air, water, or land that may impart acute (short-term) or chronic (long-term) detriment to the quality of life. This study aims to identify and determine the levels the HMs in the River Nile Sediments. The Sediments where analyzed in the Central Petroleum Laboratories (CPL), Khartoum, Sudan using Inductively Coupled Plasma– Optical Emission Spectrometer ICP-OES 725 E) instrument to determine Zn, Pb, Cu, Co, Ni, Cd, Mo, Cr, Fe, Li, and Hg levels in the above-mentioned matrices in the two previously mentioned localities and compare their concentrations with the national permissible levels (PLs), using the Complete Randomized Design (CRD) with three replications. Sediment samples collected from three different locations in the river Nile from Dongola and Merowe locality and revealed the presence of high levels of Zn (305.5, 177.15 and 126.5 ppm) and Cd (1.400, 1.75 and 1.45 ppm), in Dongola. The values for Merowe were Zn (298.5, 154.35 and 124.2 ppm) and Cd (1.3, 1.385 and 1.045 ppm).Its conclude that the contamination of Heavy metals in the northern state requires more efforts from the authorities.*

Keywords: Determination; Heavy Metals Concentration; Pollution; Contamination; River Nile Sediments; Sudan Northern State

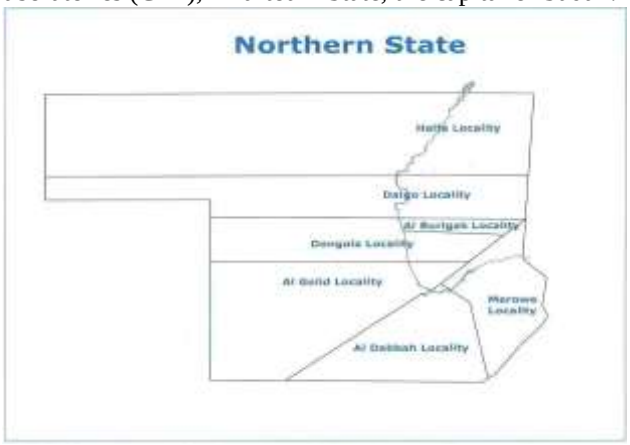
1. INTRODUCTION

Major indicators of pollution in aquatic environments are contaminated sediments that can be defined as soils, sand, organic matter (O.M.), or minerals accumulated at the bottom of a water body (USEPA 1998). Under certain conditions, contaminants found in sediments can released to waters and, thus, sediments can be important sources of the contaminants in waters (Allen 1995). The same author added that inorganic and organic materials have contaminated sediments of rivers, lakes and estuaries in a large number of locations. Among the inorganic materials, metals are frequent and important contaminants in aquatic sediments. They are involved in a number of reactions in the system, including sorption and precipitation, and they are greatly influenced by redox conditions in the sediments. Topcuoglu *et al.* (2002) added that HMs are transported as either dissolved species in water or an integral part of suspended solids. HMs may volatilize to the atmosphere or stored in riverbed sediments. Güven and Akyncy (2008) stated that HMs can remain in solution or suspension and precipitate on the bottom or taken up by organisms. The HM -content of sediments comes from natural sources (rock weathering, soil erosion, dissolution of water-soluble salts), as well as anthropogenic sources, such as municipal wastewater-treatment plants, manufacturing industries, and agricultural activities.

2. MATERIALS AND METHODS

Site of experiment

The study was carried out in Dongola and Merowe localities, Northern State (North Sudan; population 699,065).
The analysis was carried out in the Central Petroleum Laboratories (CPL), Khartoum State, the capital of Sudan.



Map of the River Nile State showing the River and the two studied localities (Dongola and Merowe)

3. METHODS

This study was meant to determine Zn, Pb, Cu, Co, Ni, Cd, Mo, Cr, Fe, Li, and Hg levels in River Nile Sediments and compared with the national permissible levels (PL) , using

the Complete Randomized Designed (CRD) with three replications.

4. SAMPLES COLLECTION

Sediment samples were collected three times (total of 27 samples), during October 2011 to September 2015 (4yr) from the two localities. These samples were collected from three locations at River Nile bank in each locality. Samples collected at 5cm depths after removing any plant debris and large stones in plastic bags and repeated three times, brought to the laboratory and stored at -20 ^{0}C until analysis. The samples were analyzed to determine the concentration of the above-mentioned metals by ICP-OES technique.

5. REAGENTS

The reagents required for this work were as follows: HNO3, H2O2 and deionized water.

6. INSTRUMENTS AND GLASSWARE

The materials used in this study were sterile water, measuring cylinders of different sizes, polyethylene sieve, container, agate mortar, microwave and Inductively Coupled Plasma – Optical Emission Spectrometer ICP-OES 725 E;, etc. were used.

7. SAMPLE PREPARATION

Collected sediment samples were transferred to a polyethylene container. The samples were dried at 110 ^{0}C for 24 hr and sieved by a polyethylene sieve to remove very large particles in order to obtain a homogenous sample. The samples were then ground in an agate mortar for 30 min. Dried samples were weighed (500 mg) and transferred to Teflon vessels. Acid mixtures (HNO3-H2O2) were added to samples. After the microwave digestion, all samples were diluted to 20 ml. The digested solutions were stored in acid-treated falcon tubes at 4 ^{0}C prior to analysis (Littlejohn *et al*., 1999).

8. RESULTS AND DISCUSSION

Metals are dangerous as they tend to bio-accumulate in the food-chain and, they can be harmful to humans, animals, plants and the environment. The HMs risk to human and animals health is provoked by their long-term persistence in the environment. Since the beginning of human kind, metals had been used for different activities and thus HMs have been emitted and deposited in the environment (Tokalioglu, *et al.*, 2003; Moja, 2007).

The present work deal with sediments in the two Localities from three different locations (far, near and inside the river) in the river Nile (Tables 1 and 2), which demonstrated the presence of high quantities of Zn (305.5, 177.15 and 126.5 ppm, respectively) and Cd (1.4, 1.75 and 1.45 ppm, following the same order) in Dongola. In Merowe, the HMs Zn (298.5, 154.35 and 124.2 ppm for far, near and inside the river, respectively) and Cd (1.3, 1.385 and 1.045 ppm, following the same order) in both Localities were higher than the USEPA (1997) PL .

Table (1). Concentration of Heavy metal (ppm) in the Sediments away, near and far from the river from Dongola Locality, Determined by ICP method.

HM	Away (Mean ± S.E.) (ppm)	C.V.%	Near (Mean ± S.E.) (ppm)	C.V.%	Inside (Mean ± S.E.) (ppm)	C.V.%	PL (ppm) USEPA (1997)
Zn	305.500 ± 1.500	1.44	177.150 ± 2.650	4.70	126.500 ± 0.100	8.97	123.00
Pb	16.080 ± 0.040	2.82	18.125 ± 0.005	2.58	17.545 ± 0.015	8.35	35.00
Cu	3.420 ± 0.010	2.44	2.470 ± 0.010	1.76	1.360 ± 0.010	9.71	35.70
CO	11.500 ± 0.100	8.15	16.350 ± 0.050	2.29	6.325 ± 0.015	3.09	NF
Ni	14.700 ± 0.100	1.04	18.350 ± 0.050	5.84	9.550 ± 0.150	6.36	NF
Cd	1.400 ± 0.100	9.9	1.750 ± 0.050	2.40	1.450 ± 0.050	2.04	0.60
Mo	9.115 ± 0.005	1.3	7.120 ± 0.010	5.08	5.220 ± 0.010	3.70	NF
Cr	19.400 ± 0.200	6.8	17.700 ± 0.200	6.20	12.115 ± 0.085	1.09	37.30
Fe	521.000 ± 1.000	3.6	468.000 ± 1.000	3.30	370.700 ± 0.300	8.70	NF

Li	7.200 ± 0.100	5.10	6.650 ± 0.150	3.10	3.775 ± 0.015	1.70	NF
Hg	0.003 ± 0.000	0	0.003 ± 0.000	0	0.0009 ± 0.000	0	0.17

HM = Heavy Metal PL = Permissible limit NF= Not Found

Table (2). Concentration of Heavy metal (ppm) in the sediments away, near and inside the river from Merowe Locality, determined by ICP method.

HM	Away (Mean ± SE) (ppm)	C.V. %	Near (Mean ± SE) (ppm)	C.V. %	Inside (Mean ± SE) (ppm)	C.V.%	PL (ppm) USEPA (1997)
Zn	298.500 ± 0.500	4.2	154.350 ± 0.250	4.3	124.200 ± 0.100	8.7	123.00
Pb	12.020 ± 0.010	8.5	13.550 ± 0.010	9.6	11.400 ± 0.010	1.1	35.00
Cu	2.360 ± 0.010	1.6	2.115 ± 0.015	10	0.975 ± 0.005	1.3	35.70
Co	9.220 ± 0.010	6.5	11.380 ± 0.010	8.1	4.735 ± 0.055	6.02	NF
Ni	11.155 ± 0.145	5.4	16.850 ± 0.040	2.9	6.245 ± 0.035	1.26	NF
Cd	1.300 ± 0.100	1.3	1.385 ± 0.085	1.1	1.045 ± 0.055	1.33	0.60
Mo	5.265 ± 0.005	7.5	4.480 ± 0.480	6.9	3.875 ± 0.045	6.04	NF
Cr	13.250 ± 0.150	6.3	12.830 ± 0.110	8.2	7.860 ± 0.010	5.6	37.30
Fe	488.000 ± 1.000	3.4	442.000 ± 1.000	3.1	317.500 ± 0.500	4.5	NF
Li	5.250 ± 0.050	7.3	3.590 ± 0.110	2.3	2.820 ± 0.010	2.14	NF
Hg	0.002 ± 0.000	0	0.001 ± 0.000	0	0.0007 ± 0.000	0	0.17

HM = Heavy Metal PL = Permissible limit NF= Not Found

The present study confirm the study done by Samir and Ibrahim (2008) who stated that in sediment samples Mn (in Lake Edku) and Cd (in Lake Manzala) recorded higher values than the sediment quality guidelines.

9. CONCLUSION:

The sediments from three different sampling sites (inside, banks and 1 km away) from both localities showed level highest than the USEPA limits, VIZ, Zn and Cd concentration in both localities are greater than the USEPA limits.

It is, therefore, recommended that the contamination of Heavy metals in the northern state requires more efforts from the authorities.

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