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Accumulation of Copper and Zinc in Sediments of Tigris River at Baghdad City

Muhammad N. Al-Azzawi[1], Muhanned R. Nashaat[2,*], Dhea′a S. Ahmed[3]

[1]Department of Biology, College of Science, University of Baghdad; [2] Agriculture Research Directorate, Ministry of Science & Technology, P.O. Box 765, Baghdad. Iraq;[3] Al-Mansoure General Company/ Ministry of Industry and Minerals, Baghdad, IRAQ

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Abstract: Heavy metals are great ecological significance pollutants due to their toxicity and accumulative behaviour. Therefore the present study aims to assess the concentrations of Copper and Zinc that collected from sediments of the Tigris River at Baghdad City. Four stations were chosen on the Tigris River along the Baghdad city, the samples were collected every 60 days from November 2010 to September 2011. The results showed that the general annual average of Copper and Zinc sediment were 39.8 µg/g and 80.5 µg/g respectively**.** The study concluded that the sediment of Tigers River was unpolluted by Zinc but slightly polluted by Copper, Also the sediment at station 4 showed higher values of Cu and Zn than the other stations. It may be due to the station sediment was loamy which dominated by fine sediments and high in organic matter which had a very high adsorption capacity.

Keywords*: Sediments, Heavy Metals, Copper and Zinc, Tigris River.*

Introduction

Sediments were selected as the possible media for metal uptake because of their high sensitivity compared to water as indicators of contamination in hydrologic systems (Solomons and Forstner, 1984). Hence it is considered to be the ultimate sink for a variety of toxicants because pollutants may persist in sediments long period after the original sources (Reynoldson, 1987). In fact sediments have the capacity to accumulate and integrate low concentrations of trace elements in water over time and, therefore, allow for metal determination even when levels in overlying waters are extremely low and undetectable (Soares *et al*., 1999).

Sediments are normally the final pathway of both natural and anthropogenic components produced or derived to the environment. Sediment quality is a good indicator of pollution in the water column, where it tends to concentrate the heavy metals and other organic pollutants (Mason, 2002). So the present study aimed to investigate two forms of heavy metals Copper and Zinc concentrations in sediment of the Tigris River and their related with some physical and chemical characters.

Materials and methods

Four stations were chosen to collect water samples (Figure 1) to study the status of the Tigris River from north to south of Baghdad city, the locations of these stations. Where: Station one (S1): located at the Al - Tajiyarea near Al-Muthanna Bridge, this area is an agricultural area consists of groves of orange and other citrus tree.. Station two (S2): located at Al- Kharkh area under 17th July Bridge. Station three (S3): Located at Al-Jadriyah area near Al -Jadriyah Bridge. Station four (S4): located at Al- Rasheed area which is near AL-Zafarania city southern Baghdad city, there are forms, groves and homes for farmers beside the river. The vertical distance between Station 1 and Station 2 was 10.5Km, while the distance between Station 2 and Station 3 was 8.6Km, and the distance between Station 3 and Station 4 was 7.5Km.Sampling was collected bimonthly from November 2010 to October2011. Heavy metals were extracted from sediment, according to APHA (1992) and measurement by using Atomic absorption spectrophotometer then final concentration measuring as the following equation:

$$E_{con} = \frac{A \times B}{D}$$

E_{con}: concentration of metal in sample (µg/g).

[*] *Corresponding: E-mail: muhanned_nashaat@yahoo.com; Tel: +9647801673542*

A: concentration of metal in calibration curve (mg/L).
B: final volume of sample (ml).
D: dry weight of sample (g).

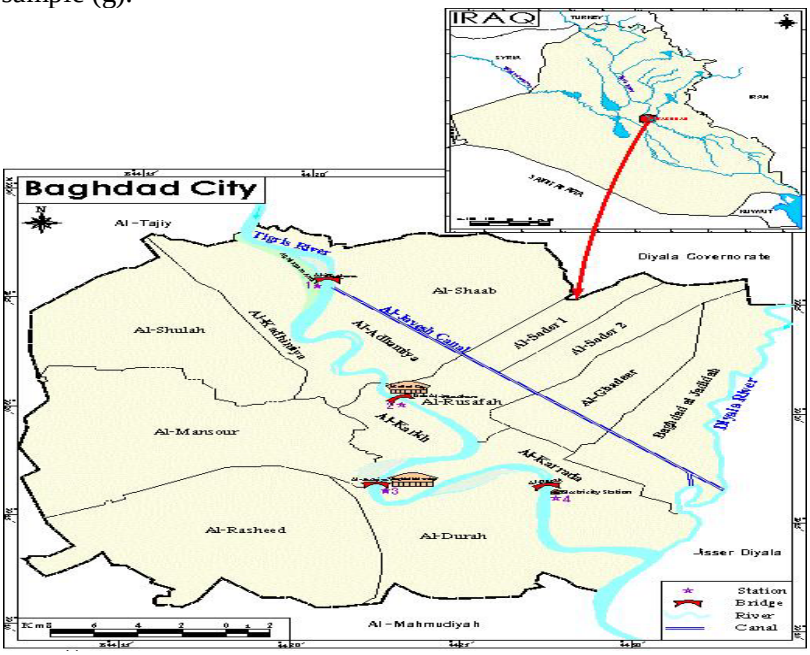

Figure 1. Map of Iraq and Baghdad shown the station on the Tigris River. (Source: Ministry of Water Resource.2007. *Map scale 1/100000*).

Results and Discussion

The present study showed that the concentration of Zn in the sediment at study stations varied seasonally, the lowest value of Zn in sediment was 47 µg/g in winter at station 3, while the highest value was 137.5 µg/g in summer at station 4. Whereas the lowest concentration of Cu was 19.96 µg/g in spring at station 1, but the highest concentration was 63.3 µg/g in winter at station 4 (Figure 2; 3).
Statistical analysis of Cu values of sediment showed that significant differences among stations, and the lowest significant difference was at station 1 ($p \leq 0.05$). Whereas the highest significant differences of Zn values at station 4 ($p \leq 0.05$) (Table 1).
Bottom sediment is the substrates which adsorbed and accumulated the metals in the natural conditions, and reflected the bottom status as well as the area nearby (Groot *et al*., 1986). They were sensitive indicator of temporal changes in metal discharges (Thomson *et al*., 1987). A large portion of heavy metals that are introduced in different aquatic environments are precipitated as sparingly soluble metal component which are immobilized in particulate and finally accumulated in the sediments, so sediments act as an archive for many pollutants (Al-Khafaji, 1996).

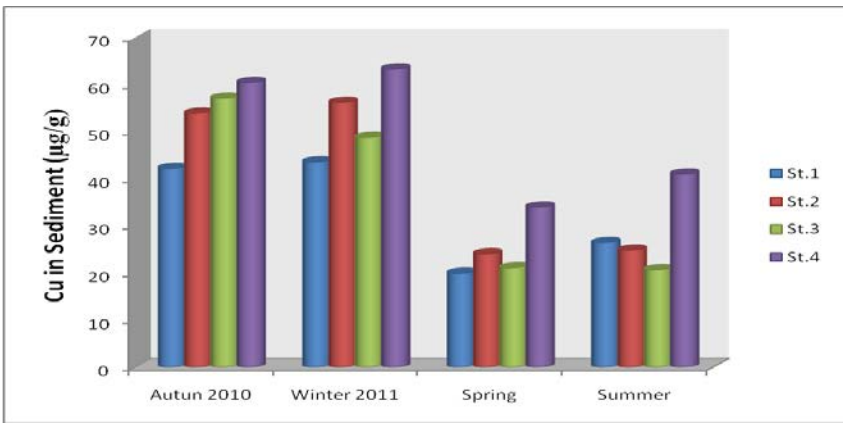

Figure 2. Seasonal variation of Copper in sediment at Tigris River during 2010 to 2011.

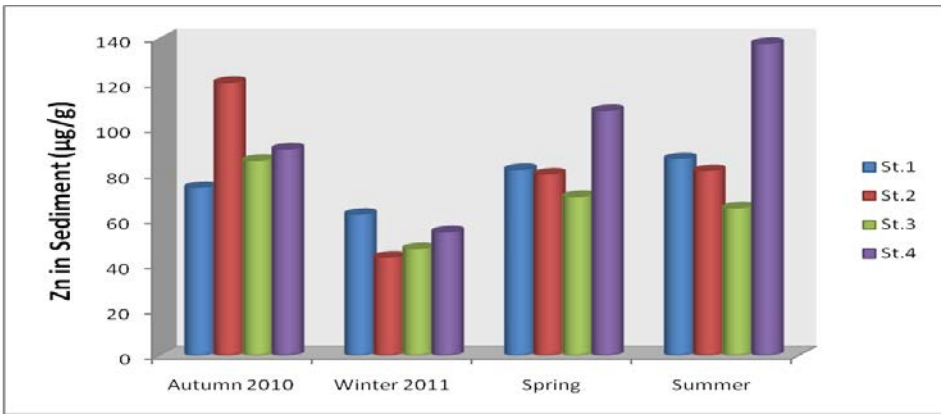

Figure 3. Seasonal variation of Zinc in sediment at Tigris River During 2010 to 2011.

Table1. Copper and Zinc concentrations in sediment of Tigris River in Baghdad City during 2010 to 2011.

Stations	**1**	**2**	**3**	**4**
Cu in Sediment µg/g	32.32±5.63 12.2-51.25 c	39.52 ± 7.29 22.5-64.1 b	37.67±7.72 17.15 - 61.45 b	48.83±6.12 29.2-67.7 a
Zn in Sediment µg/g	76.86± 7.65 48.50-99.50 c	87.62±12.50 43.50-129.50 b	70.66±7.61 47.00-98.55 c	98.29±14.22 54.50-137.50 a

Or it may be in this aspect sediment samples were not separated into individual particle-size fractions, but analysed as a whole (Garbarino *et al.* 1995). Study results finding were higher than previous studies such as: Kassim *et al.* (1997) they studied heavy metals in the upper region of the Euphrates River, they showed that the Cu values were ranged from 11 µg/g to 26 µg/g and Zn values were ranged from 12 µg/g to 70 µg/g, while Rasheed *et al.* (2001) studied the distributed of heavy metals in the Tigris River, they mentioned that the Zn values were ranged from 24.8 µg/g to 85 µg/g, whereas Sabri *et al.* (2001) showed that the concentration of Zn were ranged from 43.5 µg/g to 57.5 µg/g in the Tigris River at Samarra Impoundment. Also Al-Lami *et al.* (2002) was recorded that the concentrations of Cu values in sediment were varied from 17.4 µg/g to 28.9 µg/g and Zn were ranged from 8.3 µg/g to 47.1 µg/g, when they studied heavy metals of upper and mid region of the Tigris River.

According to sediment criteria proposed by EPA Region, Tigris River in Baghdad city considered as not polluted by Zn and slightly polluted by Cu (Table 2). But Zn and Cu concentrations in the Tigris River sediment within Iraqi and world standards (Table 3).

Table 2. Sediment criteria proposed by EPA Region

Heavy metal	**Not Polluted**	**Slightly Polluted**	**Severely Polluted**	**Tigris River Sediment**
Zn	< 90	90 – 200	> 200	80.56
Cu	< 25	25 – 50	> 50	39.85

All conc. in µg/g dry weight (Engler, 1980).

Table 3. Comparison between concentrations of Copper and Zinc in Tigris River sediment with world and Iraqi standards

This study (Mean of Metal in Sediment µg/g)		Canadian Council of Ministers of the Environment (1999, updated in 2001) µg/g.	U.S. Environmental Protection Agency (1996, EPA 905/R-96/008) µg/g.	Iraqi regulation for public water (Abbawi,1990) µg/g
Cu	39.85	197	100	100
Zn	80.56	315	450	500

Sediments are usually regarded as the ultimate sink of heavy metals discharged into the environment; therefore the analysis of heavy metals in sediments offers a more convenient and more accurate means of detecting and assessing the degree of pollution (FAO, 1992).

By comparing the accumulation of heavy metals in water and sediments, it can be concluded that the heavy metals, highly accumulate in sediments than water, since the sediments act as reservoir for all contaminants and dead organic matter descending from the ecosystem above. Similar findings were reported by other researchers (Hamed, 1998; Nguyena *et al*. 2005).

In this study station 4 showed higher values of Cu and Zn than the other stations. It may be due to this station is loamy which dominated by fine sediments and with high organic matter (Table 4), while the other stations had more sand fraction with low organic matter. This variation in the stations sediment was reflected the metals distribution. This complies with Franc *et al*. (2005) who mentioned that sediments contain more sand and lower values of organic matter exhibit low metals enrichment. Also the concentrations of heavy metals in sediment increase as the amount of organic material increase (Tsai *et al*., 2003), they also mentioned that the pollutant concentrations in sediments increased with decreasing the particle size in sediments.

Table 4. Sediment Texture of Tigris River bed near the banks during 2010 to 2011

Stations / Sediment type	1	2	3	4
Sand (60 mm – 2 mm) %	57.8	74.6	9.5	30.8
Silt (3.9 mm- 60 mm) %	24.2	16.4	19.7	46.2
Clay (< 3.9 mm) %	18	8	9.5	23
	Sandy Loamy	**Sandy**	**Sandy Loamy**	**Loamy**

Sediments with large amount of organic matter has high colloidal content and has a very high adsorption capacity, it can strongly adsorb phosphate, different anions and cations (Hickling, 1962). Abdel-Baky *et al.* (1998) found a correlation between the concentration of heavy metals in sediment and the abundance of organic matter. The present study found a positive correlation between Cu concentration in sediment and organic matter (r=0. 461). While no correlation between Zn and organic matter (Table 5).

Table 5. The Correlation between copper and zinc in sediment with water parameters.

	Air Tem.	Water Temp.	pH	E.C.	TDS	Sal.	DO	BOD	TH	Ca	Mg	NO_3	PO_4	TOM
Sed.Cu	-0.137	0.449	-0.59	0.612	0.622	0.622	0.08	-0.1	-0.3	-0.24	0.39	-0.115	-0.17	0.36
Sed.Zn	0.351	0.329	-0.16	-0.343	-0.328	-0.328	-0.35	0.43	-0.1	-0.31	-0.05	-0.06	-0.47	0.014

Organic matter is rich in legends which form complexes with free metal ions and hydroxides, these reactions are chelation, complex binding, ion exchange, surface adsorption, coagulation, or peptidization reactions (Petersen *et al.*, 1987). The toxicity of metals in aqueous solutions is altered by water pH, hydroxides, carbonates, chlorides and others (Janes and Playle, 1995). The present study was found negative correlation between Cu in sediment and water pH (r= -0.598). While no correlation between Zn and pH. The correlation between Cu in sediment and Total Hardness found a weak inverse correlation (r= -0.369). And no significant correlation was found between Zn and T.H. (r=-0.172; Table 5).

Conclusions

1. Sediment unpolluted by Zinc but slightly polluted by Copper according to (EPA Region, 1980), but it's considered within Iraqi and world standards.
2. Sediment at station 4 showed higher values of Cu and Zn than the other stations. It may be due to the station sediment was Loamy which dominated by fine sediments and high in organic matter which had a very high adsorption capacity.

References

Abdel-Baky TE, Hagras AE, Hasssan S H, Zyadah MA, (1998) Environmental impact assessment of pollution in Lake Manzala. In: Distribution of some heavy metals in water and sediment. *J. Egypt Ger. Soc. Zool.*, **26**, 25-38.

Al-Khafaji BY, (1996) *Trace metals in water, sediments and fishes from Shatt Arab estuary, NW Arabian Gulf, PhD. Thesis*, University of Basrah, Basrah.

Al-Lami AA, Al-Jaberi H H, (2002) Heavy metals in water, suspended particles and sediment of the upper-mid region of Tigris River, Iraq. *Proceedings of Inter. Symposium on Env. Pol. Control and Waste Management* 7-10 Jan. 2002, Tunis, 97-102.

APHA (American Public Health Association), (1992) *Standard Methods for the Examination of water and Wastewater*, 18th Ed. Washington, D.C.

FAO, (1992) Committee for Inland Fisheries of Africa. Report of the third session of the Working Party on Pollution and Fisheries. Accra, Ghana, 25-29 November 1991. *FAO Fisheries Report*, 471, Rome, FAO.

Franc S , Vinagre C, Cacador I, Henrique CN, (2005) Heavy metal concentrations in sediment, benthic invertebrates and fish in three salt marsh areas subjected to different pollution loads in the Tagus Estuary (Portugal). *Baseline/Mar. Poll. Bull.*, **50**, 993–1018.

Garbarino JR, Hayes, HC, Roth DA, Antweiler RC, (1995) Heavy metals in the Mississippi River Geological Survey Circular. Virginia.

Groot AJ, Zchuppe KH, Salomons W, (1986) Standardization of methods of analysis for heavy metals in sediments. *Hydrobiol.*, **92**, 689-695.

Hamed MA, (1998) Distribution of trace metals in the River Nile ecosystem, Damietta branch between Mansoura city and Damietta Province. *J. Egypt. Ger. Soc. Zoo.*, **27**, 399-415.

Hickling CF, (1962) Fish Culture. *Faber and Faber*. London. 295p.

Janes N, Playle RC, (1995) Modelling Silver Binding to gill of rainbow trout (*Oncorhynchus mykiss*). *Environ. Toxicol. Chem.*, **14**, 1847-1858.

Kassim Th I, Al-Saadi HA, Al-Lami AA, Al-Jaberi HH, (1997) Heavy metal in water, suspended particles, sediments and aquatic plants of the upper region of the Euphrates River, Iraq. *J. of Envir. Science and Health. Part A*, **32**, 2497-2506.

Mason CF, (1998) Biology of freshwater pollution. 3nd Addison *Wesley Longman Limited*, London, England.

Nguyen H, Leermakers M, Osan J, Tfrfk S, Baeyens W, (2005) Heavy metals in Lake Balaton: water column, suspended matter, sediment and biota. *Sci. Total Environ.*, **340,** 213-230.

Petersen RC, Hargeby A and Kullberg A, (1987) Biological Importance of Humic Material in Acidified Waters. *National Swedish Environment Protection Board*, Solna. Sweden: 149pp.

Rasheed Kh A, Sabri AW, Al-Lami AA, Kassim ThI, Shawkat SF, (2001) Distribution of some heavy metals in water suspended solids, sediments, fishes and aquatic plants of river Tigris. *Sci. J. Atomic Energy Commission*, **3**, 196-207.

Reynoldson TB, (1987) Interactions between sediment contaminants and benthic organisms. *Hydrobiologia*, **149**, 53- 66.

Sabri AW Al-Jubori S, Al-Lami AA, (2001). Movment of Some Heavy metals (radioactive and stable nuclides) in the food chain of Tigris River Impoundment Samarra. *Wat. Res*., **27**, 1099-1103.

Soares HMVM; Boaventura RAR, Machado AASC, Esteves de Silva JCG, (1999). Sediments as monitors of heavy metal contamination in the Ave River basin(Portugal): multivariate analysis of data. *Environ. Pollut*, **105**, 311-323.

Solomons W, Förstner U, (1984). Metals in the hydrocycle. Springer, Berlin.

Thomson EA, Luoma SN, Johansson CE, Cain DJ, (1987) Coparisonof sediment and organisms in identifying sources of biologically available trace metal contamination. *Wat. Res*., **18**, 755-765.

Tsai LJ, Ho ST, Yu KC, (2003) Correlation of extractable heavy metals with organic matters in contaminated rivers sediments. *Water Sci. & Tech.*, **47**, 101-107.