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Determination of heavy metal in water and sediment of Dez River, Dezful, Khuzestan province, Iran

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Abstract

Intensified industrialization and human activities have resulted in the release of various contaminants into the environment. Among them, heavy metals are often present as a result of mining, milling and agriculture industrial. In the present investigation, concentrations Cd, Pb and Zn in Dez River (Iran) bed sediments and water around the Agricultural land were measured from several sample locations. Significant variations in metal values were evaluated using One-Way analysis of variance (ANOVA) followed by Duncan post hoc test $p<0.05$. Concentration of studied metals in both water and sediment are measured by using atomic absorption spectrometer. In sediment high levels of Cd, Pb and Zn were measured in Hamid Abad Forest (0.18, 6.1 and 10.1 mg kg^{-1} dw). In water and sediment, levels of heavy metal for Cd, Pb and Zn in the present study were lower than International Standards for these metals as declare by the World Health Organization (WHO).

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Introduction

The Dez River is a tributary of the Karun River and is 400 km long. It is the site of the Dez Dam. Dez river one of the most important river in north Khuzestan province. Main industrial in this area is agriculture. It is well known that heavy metals are produced from a variety of natural and anthropogenic sources. People are becoming aware of the complexity of nature and the delicate balance that exists within the global ecosystem. Every action involved in modifying the environment has countless repercussions. Scientists seek to understand these complex interactions so that the present condition of the ambient environment can be assessed and measures taken to prevent or minimize future degradation. One important element of this dynamic system is the environment. Heavy metals are produced from a variety of natural and anthropogenic sources. In fluvial environments, however, metal pollution can result from direct atmospheric deposition, geologic weathering or through the discharge of agricultural, municipal, residential or industrial waste products (Dawson and Macklin, 1998). More than 50% of the world's population depends on groundwater for drinking (Fry 2005). For many rural and small communities, groundwater is the only source of drinking water (Hani 1990). Since groundwater moves through rocks and subsurface soil, it has a lot of opportunity to dissolve substances as it moves. Furthermore, they are widely distributed as an anthropogenic pollutant (Rangsivek and Jekel 2005). Heavy metals are encountered in various emission sources related to industrial, transportation and urban activities and agricultural practices (Brantley and Townsend 1999; Romic and Romic 2003), which have environmental adverse effects. Land disposal of municipal and industrial wastes and applications of fertilizers and pesticides for agriculture have contributed to a continuous accumulation of heavy metals in soils (Alloway and Jackson 1991). The resultant effect of continuous discharge of wastes in fluvial environments is a buildup of pollutants, including heavy metals, in sediments. Bioaccumulation of such metals in sediments has significant environmental implications for local communities, as well as for river water quality (e.g., Wright and Mason 1996; Ross and Kaye 1994). Dez River exposed entering agriculture sewage. Several studies have been conducted on heavy metals in fish Dez River. The aim of this study was to investigate the rate of accumulation heavy metals in water and sediments in the Dez River.

Materials and methods

Sampling and Sample preparation

The samples of sediments and water were collected from different location along Dez River, the northwest Khuzestan province, during March 2012. The sampling stations were chosen in Chalkandi (S1), Old bridge (S2) and hamid abad forest (S3) (Fig. 1). Using grab, sediment samples were collected from each site. Surface water samples were collected in polyethylene bottles (washed with nitric acid then deionized water), then were acidified with 10% HNO_3 and filtered through a 0.45 ml membrane filter. Twenty samples of water and sediment were transferred to the laboratory using icebox and kept frozen at -20 ^oC prior to analysis.

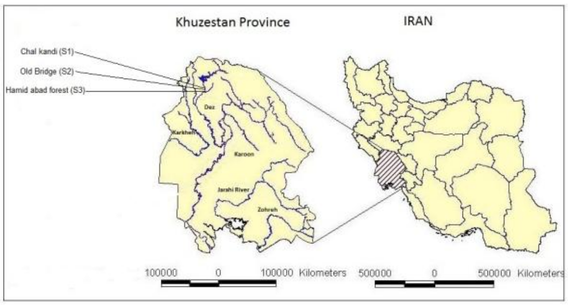

Fig. 1. The main components of the system in the Rivers Basin in Khuzestan province and map of the study area.

Sediment samples were thawed in room temperature before analysis and oven dried at 105^{o}C for 24 hour. Then the samples were powdered in an agate mortar and sieved through a 63-µm mesh (Safahieh *et al.,* 2011a). Approximately 1g of the sediment samples from each station was digested with 2 ml of HNO_3 and 6 ml of HCl (Merck, Darmstadt, Germany). The remaining digested solution was made up to certain volume with double distilled water (Safahieh *et al.,* 2011b; Abdolahpur Monikh *et al.,* 2011).

Apparatus and Reagents

To determine the metals in the samples, a GBC (Savant AA Sigma) flame atomic absorption spectrometer (AAS) was used. All chemical regents were analytical reagent grade (Merck). The glassware and plastic containers were acid washed with nitric acid 10% and rinsed with double distilled water before use. To avoid samples contamination and check the accuracy of the method, blank samples and CRM (Dorm-2, muscle of Dogfish, National Research Council of Canada) were analyzed. The recovery values for all metals were satisfactory and were fallen between90% to 113%.

Statistical analysis

All data were tested for normal distribution with Shapiro-wilk normality test. Significant differences between heavy metals concentration in the samples of various stations were determined using One-Way analysis of variance (ANOVA) followed by Duncan post hoc test. The level of significance was set at $\alpha = 0.05$.

Results

The bioaccumulation profile of 3 heavy metals (Cd, Pb and Zn) in the sediment and water of Dez River analyzed with GBC (Savant AA Sigma) flame atomic absorption spectrometer (AAS). The heavy metals profile was recorded in triplicate in each sample. According to the Table 1 and 2, the results of measurements of heavy metals cadmium and lead and zinc in sediment and water are shown. Cd, Pb, Zn were detected in all samples. Zn level was higher than the other metals ($p<0.05$). Distribution patterns of metal concentrations in the Sediment and water in Dez River in follows the sequence: Zn>Pb>Cd. The distribution patterns of Cd, Pb and Zn in Sediment and water in Dez River follow the order: Sediment> water. In this study the results showed that the highest concentrations of heavy metals were found in the Sediment ($p<0.05$), while the lowest concentrations were found in the water, except for S1 in Dez River.

Table 1. Heavy metal concentrations in the sediment samples (µg/g d. w) of the Dez River.

Stations	Cd	Pb	Zn
S1(Chal kandi)	0.14 ± 0.03^{a}	4.07 ± 0.22^{a}	7.72 ± 1.45^{a}
S2 (Old Bridge)	0.15 ± 0.03^{a}	4.85 ± 0.35^{b}	8.07 ± 0.55^{b}
S3 (Hamidabad forest)	0.18 ± 0.07^{b}	6.1 ± 0.42^{c}	10.1 ± 2.05^{c}
NOAA ERL	1.2^{c}	46.7^{d}	150^{d}

$^{a, b, c, d}$ $p<0.05$, significantly different in samples site with *NOAA* National Oceanic and Atmospheric Administration, America (Long and Morgan 1990); *ERL* effects range—low value.

Table 2. Heavy metal concentrations in the water samples (µg/l) of the Dez River.

Stations	Cd	Pb	Zn
S1(Chal kandi)	0.0012 ± 0.0002^{a}	0.023 ± 0.008^{a}	0.0044 ± 0.0007^{a}
S2 (Old Bridge)	0.0019 ± 0.0004^{a}	0.031 ± 0.008^{b}	0.0052 ± 0.0011^{ab}
S3 (Hamid abad forest)	0.0035 ± 0.0005^{b}	0.038 ± 0.011^{c}	0.0058 ± 0.0014^{b}
WHO	0.01^{c}	0.05^{d}	0.01^{c}

$^{a, b, c, d}$ $p<0.05$, significantly different in samples site with WHO (World Health Organization) standard Reference: WHO 1985, 1994, 2003

Discussion

Which indicates clearly inputs from anthropogenic sources such as industrial effluents, agricultural runoff, (return flows), domestic and municipal sewage. Assessing sediment pollution by using the total heavy metal concentrations values might not firmly guarantee the occurrence of deleterious ecological effects. In this study in all heavy metal, highest concentration observed in sediment and water of S3 (Hamid abad forest). This indicates that the downstream accumulation of heavy metals is higher. This could be due to increased input of wastewater to the downstream region. In addition, physicochemical factors that could control the amount of heavy metal in suspended phase and deposited phase are different among stations (Burger and Gochfeld, 2005; Turkmen *et al.,* 2005).

Table 3. Heavy metal concentration in water (μg/l) from other guidelines.

Standards	Cd	Zn	Pb	References
MPL for aquatic life	5	-	25	Gardiner and Mance, 1984
ANZECC	2	-	5	ANZECC, 1992
Southwestern Turkey	0.27	1.75	0.26	Demirak *et al*, 2006
Water quality criteria (CMC)	4.3	120	65	US EPA (1999).
Water quality criteria (CCC)	2.2	120	2.5	US EPA (1999).

The distribution patterns of heavy metal in sediment and water of Dez River consistency of concentration of heavy metal in liver and muscle of *Capoeta trutta* in Dez River (Mojoudi *et al.,* 2013). The sequential chemical partitioning technique (Chester and Hughes 1967) provides information on possible chemical form of heavy metal in sediments (Xiangdong *et al.*, 2000) for 3 heavy metals in this study (Table 1).

Table 4. Heavy metal concentration in sediment (μg/g d. w) from other guidelines.

SStandards	Cd	Zn	Pb	References
ROPME	1.2-2	-	15-30	ROPME (1999)
ISQG	0.7	124	30.2	Mooraki *et al.*, 2009
PEL(Canadian SQG)	4.2	271	112	Mooraki *et al.*, 2009
ERM (NOAA)	9.6	410	218	Mooraki *et al.*, 2009

ISQG= interim marine sediment quality guideline. PEL= probable effects levels. ERL= effects range low.

The metal pollution status of Dez River sediment and water is given in Table 1 and 2. The tables is generated by comparing measured concentrations of elements with water and sediment quality standards currently effective in WHO for water (WHO 1985, 1994, 2003) and other guideline in Table 3 (Gardiner and Mance, 1984; ANZECC, 1992; US EPA 1999; Demirak *et al.,* 2006) and for sediment NOAA ERL (Mooraki *et al.*, 2009) and other guidelines in Table 4 (ROPME, 1999). The heavy metal levels of water and sediment in Dez River were lower compared to the metal levels in Gediz River (Uzunoğlu, 1999) and Atatürk Dam Lake (Karadede and Ünlü, 2000) and Avsar Lake (Öztürk *et al.,* 2009) in turkey and Gorgan gulf (Rajaei *et al.,* 2012) in Iran. The heavy metal levels of water and sediment in Dez River were consistent with southwest Caspian Sea (Hassanpour *et al.,* 2011).

The effects of heavy metals in the environment depend, to a large extent, on whether they occur in forms that can be taken up by plant or animals. Lead maybe strongly adsorbed on to sediment particles and therefore largely unavailable (Elith and Garwood, 2001), while cadmium ions can be directly absorbed by water and it is known to be most mobile among the other metals (Kabata- Pendias and Pendias, 2001). A wide range of value for heavy metal concentration was observed for the sediment. Assuming that bioavailability is related to solubility, metal bio-availability decrease in order of: Exchangeable > sulfide ions > organic > residual (Ma and Rao 1997; Xiangdong *et al.*, 2000). The residual forms are not expected to be released under normal conditions in nature (Dean 2002) and could be considered as an inert phase (Xiangdong *et al.,* 2000). Forstner (1985) reported that cadmium fraction was more mobile than most of other heavy metals (Kong and Liu, 1995).

Conclusion

Which indicates clearly inputs from anthropogenic sources such as industrial effluents, agricultural runoff, (return flows), domestic and municipal sewage. The heavy metal averages of river bed sediments are above and more concentrated than the combined averages contributed by lithogenic sources. Prevent the entry of agricultural waste to the river are important for the health of the aquatic environment. Periodically Measurement to prevent the entry of wastewater is especially important.

Refrences

Abdolahpur Monikh F, Hosseini M, Peery S, Maryamabadi A, Ghanemi K, Abdi Bastami A, Karami O. 2011. Heavy Metals Levels in Sediment and Ray Fish (*Dasyatis bennettii*) from Musa Estuary and Selech Estuary, Persian Gulf. American-Eurasian Journal of Toxicological Sciences **4,** 224-227.

Alloway BJ, Jackson AP. 1991. The behavior of heavy metals in sewage amended soils. Sci Total Environ **100,** 151–176.
http://dx.doi.org/10.1016/0048-9697(91)90377-Q

ANZECC. 1992. Australian Water Quality Guidelines for Fresh and Marine Waters, Australian and New Zealand Environment and Conservation Council (ANZECC).

Brantley AS, Townsend TG. 1999. Leaching of pollutants from reclaimed asphalt pavement. Environ Eng Sci **16,** 105–116.
http://dx.doi.org/10.1089/ees.1999.16.105

Burger J, Gochfeld M. 2005. Heavy metals in commercial fish in New Jersey. Environmental Research **99**, 403–412.
http://dx.doi.org/10.1016/j.envres.2005.02.001

Chester R, Hughes RM. 1967. A chemical technique for the separation of ferromanganese minerals, carbonate minerals and adsorbed heavy elements from pelagic Sediment. Chemical Geology, **2,** 249–262.
http://dx.doi.org/10.1016/0009-2541(67)90025-3

Czarnezki JM. 1985. Accumulation of lead in fish from Missouri streams impacted by lead mining. Bull Environ Contam Toxicol **34,** 736–745.
http://dx.doi.org/10.1007/BF01609801

Dawson EJ, Macklin MG. 1998. Speciation of trace metals in floodplain and flood sediments: a reconnaissance survey of the Aire valley, West Yorkshire, Great Britain. Environmental Geochemistry and Health **20,** 67–76.
http://dx.doi.org/10.1023/A:1006541724394

Dean JR. 2002. Methods for environmental heavy analysis. New York: Wiley.

Demirak A, Yilmaz F, Tuna L, Ozdemir N. 2006. Heavy metals in water, sediment and tissues of *Leuciscus cephalus* from a stream in southwestern Turkey. Chemos **63,** 1451–1458.
http://dx.doi.org/10.1016/j.chemosphere.2005.09.03

Elith M, Garwood S. 2001. Investigation into the levels of heavy metals within Manly Dam Catchment. In Freshwater ecology report Sydney. Department of Environmental Sciences, University of Technology.

Forstner U. 1985. Chemical forms and reactivities of metals in sediment. In Leschber R, Davids RD, Hermite L (Eds.), Chemical methods for assessing bio-available metals in sludges and soils (pp. 1–30). London: Elsevier.

Fry A. 2005. Water facts and trends, World Business Council for Sustainable Development: 16.

Gardiner J, Mance G. 1984. United Kingdom water quality standard arising from European Community directive. Water Research Center No. 204.

Hani H. 1990. The analysis of inorganic and organic pollutants in soil with special to their bioavailability. Int J Environ Anal Chem **39,** 197–308.
http://dx.doi.org/10.1080/03067319008027697

Hassanpour M, Pourkhabaz AR, Ghorbani R. 2012. Measurement of heavy metal in water, sediment Changar wild bird in around southeast Caspian Sea. Journal of Mazandaran University of Medical Sciences **21(1),** 184-194. (In Persian).

Kabata-Pendias A, Pendias H. 2001. Heavy elements in soils and plants (3rd ed.). Boca Raton: CRC.

Karadede H, Ünlü E. 2000. Concentrations of some heavy metals in water, sediment and fish species from the Atatürk Dam Lake(Euphrates), Turkey. Chemosphere **41(9),** 1371–1376.

Kong IH, Liu SH, 1995. Determination of heavy metals distribution in the anoxic sediment slurries by chemical sequential fraction. Ecotoxicology and Environmental Safety **32,** 34–38. http://dx.doi.org/10.1006/eesa.1995.1082

Long ER, Morgan LG, 1990. The potential for biological effects of sediment sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandumn, NOS OMA 52, Seattle.

Ma LQ, Rao GN, 1997. Chemical fractionation of cadmium, copper, nickel, and zinc in contaminated soils. Journal of Environmental Quality **26,** 259–264. http://dx.doi.org/10.2134/jeq1997.00472425002600010036x

Mojoudi N, Mojoudi F, Kafilzadeh F, 2013. Investigae of accumulation the heavy metal Cd, Pb and Zn in liver and muscle tissues *Capoeta trutta* fish from Dez River, southwest Iran. International journal of Biosciences **3(8),** 325-331. http://dx.doi.org/10.12692/ijb/3.8.325-331

Mooraki N, Esmaeli Sari A, Soltani M, Valinassab T. 2009. Spatial distribution and assemblage structure of macrobenthos in a tidal creek in relation to industrial activities. Intern J of Environ Scie and Technol. **6,** 651-662

Öztürk M, Özözen G, Minareci O, Minareci E. 2009. Determination of heavy metal in fish, water and sediment of Avsar Lake in Turkey. Iran. J. Environ. Health. Sci. Eng. **6(2),** 73-80.

Rajaei G, Hassanpour M, Mehdinezhad MH. 2012. Investigation of concentration heavy metal Zn, Pb, Cr and Cd in water and sediment of Gorgan Gulf and Gorganroud estuaries. Journal of Health Systems Research **8(5),** 748-756. (In Persian).

Rangsivek R, Jekel MR. 2005. Removal of dissolved metals by Zero-Valent Iron (ZVI). Water Res. **39,** 4153–4163. http://dx.doi.org/10.1016/j.watres.2005.07.040

Romic M, Romic D. 2003. Heavy metal distribution in agricultural topsoil in urban area. Environ Geol **43(7),** 795–805. http://dx.doi.org/10.1007/s00254-002-0694-9

ROPME. 1999. Regional Report of the State of the Marine Environment. The Regional Organization for the Protection of the Marine Environment (ROPME), Kuwait, 173 p.

Ross SM, Kaye KJ. 1994. The meaning of metal toxicity in soil-plant systems. In S. M. Ross (Ed.), Toxic metals in soil-plant systems (pp. 27–61). Ontario: Wiley.

Safahieh A, Abdolahpur Monikh F, Savari A, Doraghi A. 2011b. Heavy metals contamination in Mullet fish, *Liza abu* from petrochemical waste receiving creeks, Musa estuary (Persian Gulf). Journal of Environmental Protection **2,** 1218-1226. http://dx.doi.org/10.4236/jep.2011.29140

Safahiekh A, Abdolahpur Monikh F, Savari A. 2011a. Heavy metals contamination in sediment and Sole fish (*Euryglossa orientalis*) from Musa estuary (Persian Gulf). World Journal Fish and Marine Science **3(4),** 290-297.

Turkmen A, Turkmen M, Tepe YL, Akyurt I. 2005. Heavy metals in three commercially valuable fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey. Food Chemistry **91,** 167–172.
http://dx.doi.org/10.1016/j.foodchem.2004.08.008

US EPA. 1999. National Recommended Water Quality Criteria Correction Office of Water, EPA 822-Z-99-001, 25 p.

Uzunoğlu O. 1999. Gediz nehrinden alınan su ve sediment örneklerinde bazı ağır metal konsantrasyonlarının belirlenmesi. Yüksek lisans tezi. Celal Bayar Üniversitesi Fen Bilimleri Enstitüsü, Manisa, Türkiye. (In Turkish).

WHO. 1985. Review of potentially harmful substances—cadmium, lead and tin. WHO, Geneva. (Reports and Studies No. 22. MO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution).

WHO. 2003. Malathion in drinking water. Background document for preparation of WHO guidelines for drinking water quality, Geneva, World Health Organistaion (WHO/SDE/WSH/03.04/103).

World Health Organization. 1994. Quality directive of potable water, 2nd edn. WHO, p 197.

Wright P, Mason CF. 1996. Spatial and seasonal variation in heavy metals in the sediments and biota of two adjacent estuaries, the Orwell and the Stour, in eastern England. Science of the Total Environment **226,** 139–156.
http://dx.doi.org/10.1016/S0048-9697(98)00383-0

Xiangdong L, Zhenguo S, Onyx WHW, Yok-sheung L. 2000. Chemical partitioning of heavy metal contaminants in sediments of the Pearl River Estuary. Chemical Speciation and Bioavailability **12,** 17–25.