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ORIGINAL ARTICLE

ASSESSING THE CONTAMINATION OF HEAVY METALS IN THE WATER AND SEDIMENTS OF BED OF TEMBI RIVER BEFORE AND AFTER ENTERING WASTEWATER

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ABSTRACT: Nowadays, diseases caused by water pollution are found to be one of the main causes of mortality, especially in developing countries. In this context, heavy toxic metal pollution are most outstanding among aqueous environment pollutions. Heavy metals not only pollute drinking water of human and animals, but also they exacerbate soil contamination so that arable lands affected by them, may lose their fertility over time. Heavy metals can contaminate the groundwater while leaching to the deep. To evaluate heavy elements entrance into the soil, due to their accumulative behavior in soil, uptake by plants and groundwater, contamination is very importance. The present research aims to investigate concentration of heavy metal such as copper, zinc, lead, iron, chromium, cadmium, nickel and cobalt in the discharge of sewage of Masjed Soleiman city into the Tembi River. During the survey in 2012-2013, sampling on water and sediment from upstream and downstream of the point of discharge of sewage into the river was conducted. The samples were transferred to the laboratory, and were subjected to atomic absorption spectrophotometry to determine concentration. The results indicated intensely water and sediment pollution by heavy metals and its exacerbation due to sewage.
KEYWORDS: Contamination, Heavy Metals, Water, Tembi River, Waste Water.

INTRODUCTION

Emission of heavy metals into environment which is due to increasing trend of industrialization and population growth is one of the main issues that most countries in the world are encountered. Heavy metals are not biodegradable and have chronic impacts on tissues of living organism. Heavy metals are generated through different industrial processes and entered into the environment through effluents. The most hazardous heavy metals to human, are lead, mercury, cadmium, arsenic, copper, zinc, chromium and nickel (Shukla *et al.*, 2005). Heavy metals are dispersed widely throughout the environment and human is exposed to them via anthropogenic activities and natural events through various paths, wastewater irrigation, solid waste disposal, fuel combustion and industrial processes are some of the most important sources of environmental pollution with heavy metals (Singh *et al.*, 2004; Chen *et al.*, 2005).

Heavy metals not only pollute drinking water of human and animals, but also they exacerbate soil contamination so that arable lands affected by them, may lose their fertility over time. Heavy metals can contaminate the groundwater while leaching to the deep. Due to their accumulative nature, uptake by plants and polluting groundwater they entail for more investigation. Heavy metals release following wastewater decomposition, and pile up in soil surface because of slow movement or limited absorption by vegetation (Smith, 1994). These pose plant to be toxic (Kardos and Hook, 1976; Muchuweti *et al.*, 2006) and waste soil micro-organism (Levy and Kearncy, 1999; Harold, 1984). Accumulation of heavy metals in plants depends on the type of plant and its utilization (Rattan *et al.*, 2005). Sediments are an integral part of water ecosystems and water reservoirs. Sediments provide a bed for organisms and their interactions within the water, in this way they play a significant role in aqueous ecosystems (Burden *et al.*, 2002). They mainly serve as a source of contaminant and in case when they accumulate on soil surface, water and crop quality are affected. Pollutants are not necessarily removed by sedimentation, but may be treated through chemical and biological agents in deposition process. The contamination of heavy metal in the sediments, have a large impact on the survival of the benthic organisms in direct contact with the sediment, and concentration of heavy metals in the aquatic environment (Malins, 1984). Sediments provide a suitable habitat for most of aquatic organism and are the main sink for most of the water-

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dissolved chemicals. Chemicals in the aquatic environment resulting from human activities and wastewater contain toxic organic and inorganic chemicals, finally accumulating in sediments. In aquatic mediums heavy metals mainly move as particulate matters and as a result, high concentrations of heavy metals is found in deposits in many industrial ports and coastal areas around the world (Feng *et al.*, 2004; Wang *et al.*, 2007; Chen *et al.*, 2001). Heavy metals in sediments may enter into water, hence sediments can be considered as a major sources of pollution in the water (Allen, 1995; Guven and Akinci, 2008). Most deposits are polluted in rivers, lakes and oceans by pollutants. Such pollutants are discharged into the aquatic environment from industrial zones, urban wastewater, runoff of urban and agricultural areas, and occasionally the remains of contamination left in water (Begum *et al.*, 2009). The concentration of heavy metals in sediments depends on natural resources (rocks weathering and erosion, and decomposition of water-dissolved salts) as well as resources such as wastes made by human while connecting nature like municipal, industrial and agricultural operations (Guven and Akinci, 2008).
The present study aims to investigate the concentration of heavy metals such as copper, zinc, lead, iron, chromium, cadmium, nickel and cobalt in the discharge of sewage of Masjed Soleiman city into the Tembi River.

MATERIALS AND METHODS

2.1. The study area
Tembi River is one of the flowing rivers passing through Masjed Soleiman city located within east longitude 48° 55′ - 49° 53′ E and north latitude 31° 42′ - 32° 37′ N at eastern border of Khuzestan province. Crossing through south-western part of Masjed Soleiman city this river receives sewage from villages without any refinement. It crosses from border of town and the area known as Tembi, a public recreation center, and a place which people swim there. Figure 1 illustrates Tembi River position in relation to Masjed Soleiman.

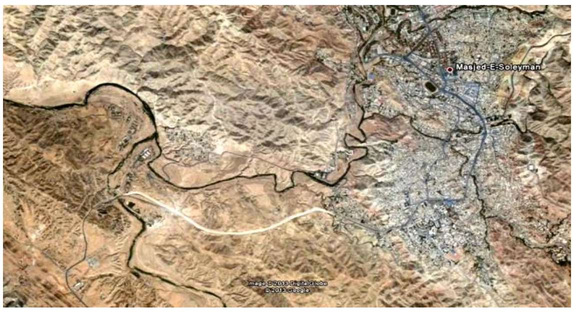

Figure 1: Map of the study area, Masjed Soleyman

Its water is not used for drinking purpose but because it joins to Karun River in the north of Shushtar city it has a great impact on water quality of the rivers in that region.

2.2. Sampling
After determining the location of sewage discharge of Masjed Soleiman into Tembi River, water and sediment samples were taken for a year and two samples per month (water samples were taken from subsurface of water and sediment ones from a depth of 30-20 cm of bed) in the downstream and upstream of sewage discharge point.

2.3. Analysis of samples
Having been digested and condensed, sediment and water samples were analyzed by atomic absorption spectrophotometry. Water samples were acidified by nitric acid till pH=2 afterwards were transported to the laboratory with other samples. In the laboratory, first sediment samples were dried at a temperatures of 105° C and 1 g of each sample were heated in a beaker and weighed carefully. Then added to 5 ml of dense nitric acid and were heated on sand bath (80° C) until giving off white vapor and dried. Heating and acid adding phase was repeated two other times and then distilled water was added to residuals. Content of the beaker was filtered by Whatman paper 0.45 micron and the filtrated solution was increased to 50 ml in volume using distilled water. As for water samples, 2 liters of sample were placed on the sandy oven in a temperature of 80° C until the volume reached 50 mL, then prepared samples were analyzed to determine the amount of metals of interest by atomic absorption spectrophotometry (Dastjerdi *et al.*, 2013).

RESULTS AND DISCUSSION

Results from the water tests showed that in the upstream of the river and before entering the sewer the Pb density (mg/lit) accounted for the highest concentration 1.66 h in April. In addition the lowest concentration of 0.04(mg/lit), was attributed to manganese which recorded in September (Table 1).

Table 1: upstream and before entering wastewater

Metal	Ave. concentration	Max. concentration	Min. concentration
Cd	0.17	0.27	0.07
Cr	0.19	0.24	0.14
Cu	0.46	0.63	0.26
Fe	0.59	1.04	0.17
Mn	0.47	0.82	0.04
Ni	0.5	0.84	0.18
Pb	1.04	1.66	0.5
Zn	0.19	0.31	0.11

The experiments conducted in downstream of Tembi River indicated the highest density of 1.95(mg/lit) for Pb in April and the lowest amount of 0.1(mg/lit) for Cd in September (Table 2).

Table 2: upstream and after entering wastewater

Metal	Ave. concentration	Max. concentration	Min. concentration
Cd	0.28	0.4	0.1
Cr	0.38	0.59	0.25
Cu	0.6	0.72	0.4
Fe	1.05	1.88	0.29
Mn	1.1	1.5	0.61
Ni	0.66	0.8	0.39
Pb	1.31	1.95	0.66
Zn	0.35	0.5	0.2

The results obtained from the digestion of the samples of sediment and consequently determining concentrations showed in upstream before entering wastewater, manganese with a concentration of 715 (mg/lit) in August and the lowest amount of 8 (mg/lit) was related to Mn and Cd in September respectively (Table 3).

Table 3: downstream and before entering wastewater

Metal	Ave. concentration	Max. concentration	Min. concentration
Cd	14.8	25	8
Cr	41.7	58	27
Cu	52.9	70	37
Fe	175.4	241	18
Mn	364.9	715	304
Ni	91.2	130	52
Pb	188.3	254	141
Zn	36.8	60	24

According to the tests on river downstream, the highest and lowest heavy metals concentrations were related to Mn (820 mg/lit) in August and Cd and Cr (11mg/lit) had the lowest amounts in March and February respectively (Table 4).

Table 4: upstream and after entering wastewater

Metal	Ave. concentration	Max. concentration	Min. concentration
Cd	22.5	40	11
Cr	54.7	75	11
Cu	65.6	100	40
Fe	249.7	320	210
Mn	409.8	820	278
Ni	120.3	150	80
Pb	227	275	178
Zn	45.1	83	21

3.1. Assessment of heavy metal pollution in river Tembi

Among river pollution measures, the comparison of the concentrations in water and sediment to standard values is important. Based on the average values presented in Tables 1 to 4, these values were compared to global standards.

The mean of concentrations of heavy metals in water of river Tembi to Drinking Water Quality Standards (Anonymous, 2003 and Anonymous, 2005) and water suitable for the aquatic indicated that mean concentration obtained for Cu is in the acceptable range for drinking water, and mean concentrations obtained for copper, manganese and lead are in the allowed limits for water in irrigation and just average concentration of zinc was found to be in allowed range of all three standards. According to the results, as a whole, water of Tembi River is not suitable for drinking and aquaculture purposes in terms of heavy metal pollution standards.

Average concentration of heavy metals in downstream sediments of the Tembi River has been increased in more than 88% of cases. The highest concentration of manganese and lowest concentration of cadmium were recorded in downstream and upstream respectively. Kothari found that sediment physicochemical nature affects metals deposition while investigating the origin of the heavy concentration of contaminants in the Tembi River (Dastjerdi *et al.*, 2013).

The comparison of mean of the heavy metals concentration in sediments with proposed standards for the allowed concentration in freshwater shows that except Pb the average concentration of Cd, Cr, Cu, Ni and Pb were more than the suggested amounts by the standards, while when comparing to the marine sediments standards of heavy metals, only the average concentration of cadmium exceeds the allowed limits.

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