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Determination of Heavy Metals Concentration at Water Treatment Sites in Ahwaz and Mollasani Using Bioindicator

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Authors
Pourkhabbaz H. R.* *PhD*,
Hedayatzadeh F.[1] MSc
Cheraghi M.[1] *MSc*

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*Department of Environment, Faculty of Natural Resources, Behbahan Khatam Alanbia University of Technology, Iran
[1]Department of Environment, Faculty of Natural Resources, Tarbiat Modares University, Noor, Iran

Correspondence
Address: Department of Environment, Faculty of Natural Resources, Behbahan Khatam Alanbia University of Technology, Iran
Phone: +98 (61) 52799669
Fax: +98 (61) 52799669
pourkhabbaz@bkatu.ac.ir

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ABSTRACT

Aims Karun River, which is the largest river in Iran, represents a unique ecosystem. However, increased anthropogenic activities result in the formation of this river is seriously affected by a large range of pollutants especially the heavy metal pollutants which may be toxic to human and aquatic fauna. Therefore, there is a need for continuous monitoring of pollution levels in the river.

Materials & Methods In this study, water, sediment, and algae samples were collected from six different stations along the course of the river in September 2015 to investigate the quality of Karun's River in terms of heavy metals (Pb, Zn, Cr, and Cd) at the basin of drinking water treatment in Ahwaz and Mollasani cities. After drying and digestion of samples, heavy metal concentrations were determined using an atomic absorption spectrophotometry (Perkin Elmer-Analyst 300).

Findings The highest concentration of trace metals was found in sediment samples with Zn having the highest mean concentration values in all stations. The heavy metal concentrations in the downstream indicated an increase in the pollution load due to the flow of water from upstream to downstream of the river resulted in the movement and accumulation of all contaminants to the river in the downstream; hence, there was the highest concentration of metals in basin of the Kut Abdollah treatment (downstream) and the lowest in Mollasani (upstream).

Conclusion Comparison of the concentration of metals in the sediments with some universal standards including EPA3050 and the criterion of sediments quality standard from NOAA and Canadian Environment Agency showed that the concentration of chromium and cadmium in stations was higher than the allowable limit of EPA3050 standards and some environmental standards of Canada among all metals. Since algae samples have been able to accumulate a significant amount of heavy metals, therefore, these are suitable bio-indicators to determine the concentration of heavy metals in this aquatic ecosystems.

Keywords Algae; Heavy Metals; Karun River; Sediment; Water Treatment

CITATION LINKS

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Introduction

The rapid development of industries such as chemical industries along with the discharge of a variety of industrial and urban wastewaters into the environment over the past few decades has caused the contamination of surface and groundwater resources and the emergence of several environmental problems. Among the most important portable and consumed water resources in cities and villages, rivers play an important role in providing human and environmental health. However, unfortunately over the past few years, in response to various human activities, the quality of water of these important resources has changed, and the harmful effects of water contamination have gradually been unearthed.[1] Among the contaminants exist in wastewater industries, mines and urban and agricultural runoffs entered aquatic ecosystems; heavy metals are noteworthy.[2] Unlike organic contaminants, decomposition of this important group of contaminants in the environment requires a long time and due to their toxicity, persistence, and non-degradability in the environment. In addition, bioaccumulation potential in many aquatic species is one of the most important environmental hazards.[3] Since some of these metals have biomagnification properties after accumulation in the tissues of living organisms, they move toward higher levels of the food web, and finally, are transferred into the human body, which is on the top of the food web,[4] sometimes threaten the human health. Therefore, the determination of the levels of heavy metals in aquatic ecosystems can play an important role in the health of living organisms, especially human. The study of river water quality in terms of heavy metals due to their very low concentrations, and thus, the low measurement accuracy in water, is difficult, whereas the concentration of the metals is far higher in sediments. This has caused the bed sediments to be applied as a suitable tool in comparison with water for estimation of the status of contamination in rivers,[5] Furthermore, because of the fact that part of the metals that have bioavailability absorb in the body of living organisms, so measuring the amount of this part of the elements to understand the impact of these metals on the health of humans and other living organisms has substantial significance. Among the organisms of aquatic ecosystems, algae are widely used for measuring the levels of heavy metals in freshwater and seawater around the world. The importance of macrophytes, besides the wide distribution and easy sampling, is due to being placed at the beginning of aquatic food web.[6] Many studies in the field of checking river water quality in terms of heavy metals have been reported. For example, Babai *et al.*[7] examined the concentration of metals in Gamasyab River located in Hamedan province. The results showed that the concentration of heavy metals of copper and iron in the water of Gamasyab River had significant growth, possibly due to the entrance and leakage of agricultural and urban wastewaters. In addition, the results of studies conducted by Kamarehei *et al.*[8] evaluated the concentration of heavy metals in the water resources and river of Borujerd City in 2008–2009. Hu *et al.*[9], about the evaluation of the superficial and internal contamination of the sediments in the mouth of Kam River, and Hifung State in Vietnam indicated that different sources such as industrial development with agricultural activities in these regions, urban, and industrial wastewaters that enter into these rivers have caused significant contamination with heavy metals.

Karun River is one of the largest rivers in Iran that is placed near agricultural lands with large cities and several industries around itself, and the water of the river is used for irrigation of areas of planted, urban green space, and propagation, and growing aquacultural. 87.33%, 6.44%, and 6.23% of the Karun River's water are used for agriculture, aquaculture, and drinking, respectively.[10] However, unfortunately, due to the rapid development of urbanization, industries, and technology along with increased areas of cultivation, different contaminants in terms of physical, chemical, and biological contaminants are entered in this river annually. According to statistics, this river receives urban, agricultural, and industrial wastewaters as much as 26, 48, and 23%, respectively. Obviously, this over-contamination has hampered self-purification abilities of the river.[11]

Based on the above-mentioned points and the significance of Karun River in supplying drinking water in Ahwaz, study and evaluation of the quality of the water of this river in terms of heavy metals is of great importance. Accordingly, the overall aim of implementing this study is to evaluate the quality of water and sediments of Karun River in the basin of drinking water treatment plants of Ahwaz and Mollasani cities in terms of heavy metals (Pb, Zn, Cr, and Cd) using dominant algae of Karun River.

Materials & Methods

The studied region

Karun River is one of the most water full and longest river in Iran. The basin of this river extends from 48° 30' up to 51° 50' of the Eastern longitude and 30° 27' up to 33° 44' of the northern latitude. The area of the basin of this river until the river's estuary in the Persian Gulf is about 67000 km^2. Due to the extent of the river and the quality of the water of this river applied for different uses, a section of the river which is the basin of the drinking water treatment plants in Ahwaz and Mollasani, has been considered as the studied region.

Methodology

To carry out this study in Karun River, six stations of the basin of important drinking water treatment plants in the region of Ahwaz and Mollasani cities were taken into account with the following geographical coordinates [Table 1 and Figure 1]. The samples of water, sediment, and algae were taken from each station. Sampling was conducted in September 2015 from the intended stations. Taking samples of water, sediment, and algae from each station were replicated 3 times. The water samples were collected from 50 cm of the water surface using an acid-washed polyethylene container, and 1 ml nitric acid in each dish sampled was added to reach pH = 1.[12] The sediment samples were gathered 5 cm of the sediment surface using a plastic spoon. Sampling of algae is also harvested by hand and using quadrat with dimensions of 50 cm × 50 cm. After sampling, the accumulated samples were individually placed inside acid-washed sampling containers and then in the icebox transported to the laboratory and were kept frozen until further analysis.

For the digestion of the water samples, 20 ml of water samples were mixed with 5 ml of nitric acid (65%) and 2 ml hydrogen peroxide (30%).[13] The sediment samples were dried in an oven at 105°C for 24 h. The dried samples were powdered using an agate mortar and pestle to achieve a homogeneous mixture and then were passed through a 63-micron sieve. Thereafter, 1 g of the sediments was digested by adding a mixture of nitric acid (65%) and concentrated perchloric acid (60%) with a ratio of 4:1 through exposure to 40°C for 1 h and 140°C for 4 h.[14] To prepare the algae samples, the collected samples were washed in the laboratory by distilled water. Next, they were dried at 85°C for 24 h. Before acid digestion, a porcelain mortar was employed to grind and homogenize the dry tissue samples. Then, 1 g dried samples of algae were digested for one night at room temperature, afterward for 5 h at 140°C with 10 ml nitric acid (65%, Merck).[15] The digested samples were passed through Whatman filter paper 42 microns and were brought to a certain volume using twice-distilled water. Heavy metal (Pb, Zn, Cr, and Cd) concentrations were determined using atomic absorption spectrophotometry (Perkin Elmer-Analyst300). A recovery study was also performed for each metal to evaluate the accuracy and reliability of the results of the heavy metal concentrations obtained in the analysis more precisely. Linear calibration graphs were obtained using six consecutive Blanc concentration measurements for all of the studied metals. Table 2 presents the results of the calibration curve parameters constructed for the investigated trace elements in the samples.

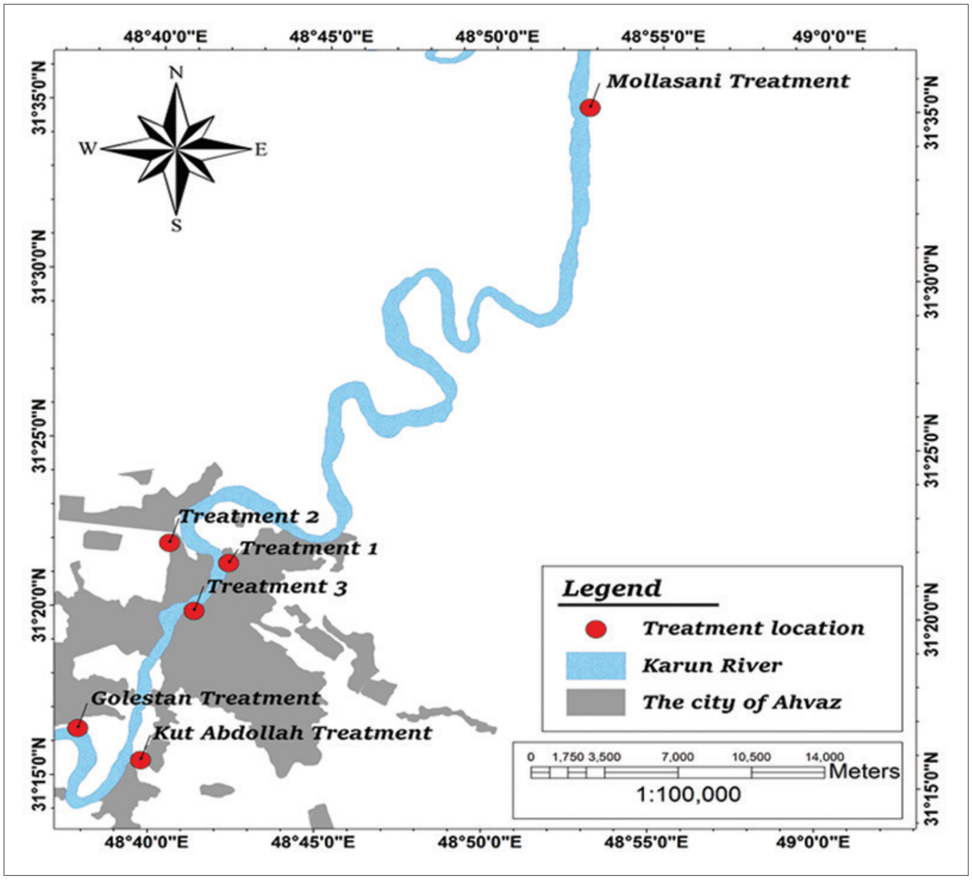

Figure 1: The position of the stations studied

Table 1: Geographical location of the sampling stations

Number	Station	Longitude (East)	Latitude (North)
1	Golestan treatment	48˚37'51"	31˚16'22"
2	Kut abdollah treatment	48˚39'45”	31˚15'28”
3	Treatment 3	48˚41'15"	31˚19'54”
4	Treatment 1	48˚42'16”	31˚21'20”
5	Treatment 2	48˚40'28"	31˚21'54”
6	Mollasani Treatment	48˚52'49"	31˚34'59”

Table 2: Linear regression equation, linear correlation coefficient (R) of calibration curves, wavelength of detection, LOB, LOD, and LOQ obtained for each element

LOQ (ppm)	LOD (ppm)	LOB (ppm)	Wavelength (nm)	R	Regression equation	Element
1.86	0.613	0.306	217	0.986	y = 0.011x + 0.0548	Pb
0.83	0.273	0.132	213.9	0.993	y = 0.1411x + 0.0286	Zn
2.92	0.957	0.481	357.9	0.957	y = 0.041x + 0.0426	Cr
0.29	0.095	0.097	228.8	0.995	y = 0.0273x + 0.0484	Cd

LOB: Limits of blank, LOD: Limit of detection, LOQ: Limit of quantitation

The table illustrates the wavelength used for the AAS elemental analysis, limit of detection (LOD), limits of blank (LOB), and limits of quantitation (LOQ) of the trace elements analyzed. The LOD, which is defined as the minimum detectable amount of metal, was calculated using the equation: LOD = 3.3*s/m; where s is the signal of the blank and m is the slope of the calibration curve. The LOB, which is defined as the highest apparent analyte concentration expected to be found when replicates of a sample containing no analyte are tested, was calculated using the equation: LOB = 1.65*s. The limit of quantitation, defined as the lowest measurable concentration of the analyte (trace elements in this study), was evaluated using the formula: LOQ = 10*s/m.[16]

For data analysis, SPSS software and for plotting the diagrams, Excel software were used. After the investigation of the normality of the data using Shapiro–Wilk test and ensuring their normality, one-way analysis of variance (ANOVA) test was used to compare the concentration of metals among different stations. In the case where there was a significant difference between the concentrations of heavy metals in stations, Duncan *post hoc* was used to separate groups.

Findings and Discussion

The results of measurement of the mean concentration of heavy metals including Pb, Zn, Cr, and Cd in water, sediment, and algae in six stations of Karun River according to ppm were smmarized in Table 3.

The results of one-way ANOVA test to compare the mean concentration of heavy metals in different stations of the studied region.

According to the results of one-way ANOVA test, no significant difference was found in the amount of Pb in water, algae, and sediments of the sampling stations along the Karun River ($P > 0.05$). However, in terms of the amount of Zn, a significant difference was observed ($P < 0.05$). The highest concentration of Zn in water was at Station 2 and was at Station 4 in the sediment and algae, and the lowest concentration of Zn in water and algae was at Station 6 and was at Station 5 in the sediment. The results of one-way ANOVA test in terms of the concentration of Cr in water of the sampling stations in Karun River showed a significant difference ($P < 0.05$). The highest concentration of Cr in water was at Station 2, and the lowest concentration of Cr in water was at Station 6. However, there was no significant difference between the concentration of Cr in the algae and sediment between stations ($P > 0.05$). Furthermore, a significant difference was observed in the concentration of Cd in water of the sampling stations in the river ($P < 0.05$), as the highest concentration of Cd in water was at Station 2, while the lowest concentration of Cd in water was at station 6. However, no significant difference was seen in the concentration of Cd between the stations in the algae and sediments ($P > 0.05$).

Figure 2 (a-d) show the comparison of the mean concentration of Pb, Zn, Cr, and Cd in water, algae, and sediments among the stations (the different letters above the diagram is the indicator of significant difference among the stations (one-way ANOVA, ($P < 0.05$)).

To investigate the status of contamination of the region's sediments with heavy metals of Pb, Zn, Cr, and Cd, the mean concentration of metals in the sediments of the region was compared with the mean concentration of metals of sediments in some global standards [Table 4].

The results obtained from measurement of the mean concentration of heavy metal (Pb, Zn, Cr, and Cd) and comparing the concentration of these metals in different stations showed that the amount of lead was not significantly different in water, sediment, and algae samples. This can be derived from the sources of lead metal emissions along the river and in the vicinity of the stations under study; even it leads to the release of this metal in the river's water. However, unlike Pb, the concentration of Zn has a significant difference in the three studied sections (water, sediment, and algae) among the studied stations. This can be due to the sources producing this metal have been placed in a point form in the study area; because of this, the highest concentration of Zn has been observed in Station 2 where the water supply source for Kut Abdollah treatment is, while the lowest concentration

Table 3: The mean concentration of heavy metals (ppm) in water, sediments, and algae in summer

Station	Metals	water	Sediment	Algae
Station 1	Pb	3.17 ± 0.68	29.93 ± 2.17	25.38 ± 1.71
	Zn	6.68 ± 1.46	66.78 ± 4.53	56.74 ± 5.37
	Cr	4.18 ± 0.84	47.75 ± 1.31	36.55 ± 2.01
	Cd	0.23 ± 0.05	3.54 ± 0.56	1.44 ± 0.56
	Pb	2.49 ± 0.69	24.82 ± 7.49	19.51 ± 10.09
Station 2	Zn	9.07 ± 2.70	87.45 ± 6.82	65.41 ± 9.35
	Cr	5.57 ± 1.22	62.83 ± 8.16	42.54 ± 7.43
	Cd	0.38 ± 0.02	3.32 ± 0.40	1.01 ± 0.20
	Pb	2.69 ± 0.87	28.24 ± 8.29	20.29 ± 10.62
Station 3	Zn	8.35 ± 1.91	68.80 ± 10.78	61.10 ± 12.58
	Cr	4.59 ± 1.03	53.93 ± 10.21	38.15 ± 7.88
	Cd	0.31 ± 0.03	4.38 ± 0.52	1.62 ± 0.47
	Pb	2.28 ± 0.47	25.13 ± 1.54	17.87 ± 6.31
Station 4	Zn	8.39 ± 0.96	89.29 ± 4.98	72.71 ± 4.87
	Cr	5.53 ± 1.46	51.98 ± 3.50	37.77 ± 3.73
	Cd	0.21 ± 0.06	3.73 ± 0.45	1.00 ± 0.32
	Pb	2.83 ± 0.25	23.96 ± 3.91	22.53 ± 5.07
Station 5	Zn	7.45 ± 1.95	59.96 ± 3.79	50.15 ± 1.60
	Cr	3.81 ± 0.96	48.62 ± 3.06	32.59 ± 1.89
	Cd	0.35 ± 0.07	3.67 ± 0.39	1.10 ± 0.23
	Pb	1.52 ± 0.46	24.57 ± 4.26	17.96 ± 3.54
Station 6	Zn	2.27 ± 0.79	61.88 ± 11.21	42.35 ± 5.48
	Cr	2.23 ± 0.87	53.75 ± 6.62	36.56 ± 4.37
	Cd	0.20 ± 0.02	3.45 ± 0.30	1.45 ± 0.29

Table 4: The comparison of the average concentration of metals in sediments of Karun River with some international standards

Location	Metals concentrations (ppm)				References
	Pb	Zn	Cr	Cd	
EPA[1] 3050	36	121	43	0.99	Helling, 1990
ISQG[2]	35	123	37.3	0.6	Persuad *et al.*, 1993
TEC[3]	35.8	-	43.4	0.99	NOAA, 2009
LEL[4]	31	120	26	0.6	NOAA, 2009
ERL[5]	35	120	80	5	Mac Donald *et al.*, 2000
PEC[6]	128	-	111	4.9	NOAA, 2009
PEL[7]	91.3	315	90	3.5	Persuad *et al.*, 1993
ERM[8]	110	270	145	9	Mac Donald *et al.*, 2000
SEL[9]	250	820	110	10	NOAA, 2009
Karun River	26.11	72.36	53.14	3.68	In this study

[1]Environmental protection agency, [2]Interim freshwater sediment quality guidelines, [3]Threshold effect concentration, [4]Lowest effect level, [5]The effect range low, [6]Probable effect concentration, [7]Probable effect levels, [8]The effect range median, [9]Severe effect level

of this metal has been seen at station 6 where the water supply source for Mollasani treatment is. The amount of Zn compared with other metals values was higher at all stations. The entry of sewage caused by the activities of agriculture, industry and domestic sewage into these ecosystems can be in effect among the reasons for high levels of this element in water resources.[17-21] Since these wastewaters entering the Karun River are abundant, therefore, high amount of this metal can be justified compared to the other studied metals. There was a significant difference between the concentration of two metals Cr and Cd in water samples of stations. However, there was not any significant difference in the concentration of this metals in sediment and algae samples. The highest concentration of Cr and Cd in the water sector was at Station 2 where the water supply source for Kut Abdollah treatment is, while the lowest concentration of these two metals in the water sector was found at Station 6 where the water supply source for Mollasani treatment is. As can be seen, the amount of metals in the water samples of the stations is significantly different, whereas they are not different in algae and sediments samples (except for Zn). This can be due to the elements in water are unstable and under the influence of water's physiochemical parameters in various stations and their level is variable. However, the elements present in sediments are less affected by these parameters because they are located in the bed river. Therefore, their levels are not significantly different at various stations. On the other hand, because algae are in direct contact with bed sediments of river; hence, they are affected by the concentration of metals in the sediments of stations, that if the concentration of metals in sediments differs between stations, it will be different in algae as well, and vice versa.

The results of this study suggested that the upstream stations along the river have the lowest concentration of metals in comparison with downstream stations. For example, the water supply source for Mollasani treatment which is located in the upstream of the river has the lowest metal contamination load comparing to downstream stations. In the upstream of the river, cultivated areas are more concentrated, and after using river's water for irrigation, by entering the animal and chemical (phosphate) fertilizers, pesticides, herbicides, insecticides, organic, and mineral nutrients, it leads to contamination. Therefore, the increasing consumption of pesticides and herbicides and chemical fertilizers in addition to soil contamination transfer these materials by water irrigation or rainfall resulting in the contamination of adjacent surface water. Furthermore, insecticides and some of the toxins, metals such as Cd and Zn are used in making phosphate chemical fertilizers, consequently some amount of these metals always enter into the river through agricultural wastewaters.[22] The phosphate and nitrate fertilizers used in agricultural lands contain trace elements of Ar, Cd, Cr, Cu, and Zn.[23]

Within the internal range of the city, generally urban and industrial wastewaters are entered into Karun River; therefore, some stations such as the water supply source of treatment 1 and 3 located within this region receive urban and industrial wastewaters. Urban wastewaters commonly contain large amounts of hydrocarbons, fats, salts, detergents, soaps, alkaline, and organic compounds in addition to considerable levels of heavy metals.[24]

Discharge of industrial wastewaters into receiving waters is also one of the most prominent examples of industrial contaminations. The active industries in this region are food, chemical, metal, iron melting, and steel industries.[23] The high multiplicity and variety of different industries around Karun River and entering wastewater of these industries together with urban wastewater cause the city limits to have a high concentration of the metals.

In the third section, a composition of urban, industrial and agricultural wastewaters can be observed in the downstream of the river. Based on the obtained results, it can be inferred that the downstream regions of the river have a higher contamination load than other regions. It is because agricultural wastewaters together with urban and industrial wastewaters are flown simultaneously in the upstream of the river and the city limits, causing abundant contamination in these regions. For example, the water supply source for Kut Abdollah treatment, located in the downstream of the studied region and after the discharge place of hospital wastewaters and the place of agricultural and animal husbandry activities, had the highest contamination load.

The results of this study suggesting high levels of contaminations in downstream stations along the river compared with upstream rivers are congruent with other research achievements in this area. For example, the results of the study performed by Madadinia *et al.*,[25] in the qualitative study of Karun River water within the range of Ahwaz city using water quality index showed that the water quality index declined gradually from the first to the last stations and Kut Abdollah station (in the downstream) with annual index of 62.5 had the worst status, while Kian Abad Station (upstream) with annual index of 65.25 had the best status. Furthermore, the results of studies conducted by Ahmadi *et al.*,[26] investigated and estimated the contamination load of organic compounds and nutrients resulting from urban wastewaters introduced into Karun River within Ahwaz range and Haghighifard *et al.*,[27] in the analysis of bacterial agents and physiochemical parameters in the basin of treatment plants in Ahwaz indicated that amount of contamination entered into Karun River from the river's upstream to downstream within the city range has an ascending trend. The reason of high concentration of contaminants in the downstream of the river can be due to the entrance of wastewater from other sources such as the wastewater produced by industries, agriculture, and hospitals into the river in addition to urban wastewater.

Because of the fact that the present contaminants in water eventually enter sediments; therefore, the sediments of rivers can be a suitable place for storage of the contaminants resulting from the discharge of urban, industrial, and agricultural wastewaters. In response to aggregation of metal contaminant elements in these sediments, water contamination hazard is developed, because, under certain physical and chemical conditions, the contaminated compounds buried in these sediments are released and enter the solution phase. Karun's sediments have a great ability in absorbing the contaminants resulting from sewage entering into the river by reason of their clay nature and possessing high electrical charge as well as high cation exchange capacity. As a result of the increasing trend of sedimentation, increased units of cultivation and industry, increased population and naturally magnified the number of industrial, urban, and agricultural wastewaters and thus further contamination of these sediments. It also increases Karun's contamination potential and raises the hazards of toxins caused by the excess concentration of contaminant elements.[28]

The results of this section of the research implied that the mean concentration of Pb and Zn elements measured in the sediments of the sample stations was lower than some global standards including EPA3050 standard and the standard criteria of the quality of sediments from NOAA organization and the Canadian Environment Organization that is not considered contaminated in any of the stations. However, the results obtained from comparison of the concentration of Cr and Cd in the sediments of different stations with the allowable levels of the concentration of heavy metals according to these standards revealed that the mean concentration of Cr and Cd in stations is more than the allowable limits of EPA3050 standards and some environmental standards of Canada. The presence of heavy metals causes the occurrence of environmental problems and complications for the inhabitants of that place and the ecosystem more than the defined standards in the environment. Cr is a toxic element and its toxicity depends on its chemical forms so that the hexavalent Cr is more toxic than the trivalent Cr. Biological and no biological factors because of increased hexavalent Cr can cause elevated toxicity of this element in water. In addition to geological properties, one of the reasons of the high concentration of Cr in aqueous ecosystems is agricultural activities.[21] Moreover, the wastewater of advanced industries such as aviation, electroplating, dye making, textile, printing, photography, and leather making industries as well as disposal of chromium-containing wastes causes the entrance of Cr into water resources.[21] Cd and its compound are also very toxic. Naturally, every year around 25000 tons of Cd are introduced into the environment. About half of this Cd enters into rivers through weathering of rocks. Forest firing and volcanoes, human activities such as the leachate of industrial wastes, and production of artificial phosphate fertilizers are the important sources that emit Cd.[29] This metal exists as an impurity in products such as phosphate fertilizers, detergents, crude oil refinery products, and byproduct in the refinement of Zn and sometimes Pb.[30] Cd is a very toxic metal which has not been unknown as essential for the human body for no biological function.[31] This element is obtained as byproduct of Zn treatment, and most of its characteristics are similar to those of Zn. Possessing chemical properties similar to Zn (which is an essential micronutrient for plants and animals), Cd can replace Zn and cause disorders in biological processes.[32]

The results of this study showed that various parts (water, sediment, and algae) accumulate different amounts of elements in themselves and the order of accumulation of all elements in these sections was observed: Water <algae> sedimentation. Hence, the accumulation of these metals in the sediments is higher than the algae, and it is more than the river water in the dominant algae (Chaetomorpha sp.). Lower concentrations of metals in river water can be due to the fact that elements in seawater and rivers are highly reactive; therefore, the elements are quickly removed from the water surface through adsorption reactions and accumulate in sediments and organisms. So that more than 90% of the heavy metals entering into the aquatic ecosystems are bound to suspended particles or accumulated in sediments.[33] Besides, it was observed that concentration of the metals studied in samples of algae was less than sediment since the elements are in different parts of sediments; hence, all the metals forms in the sediments are not bioavailability for algae and just a part of the sediment elements is absorbed by algae.[34] Due to the fact that these species of algae have been able to accumulate a significant amount of heavy metals in themselves; therefore, these algae are appropriate bio-indicators to determine the concentration of heavy metals in this aquatic ecosystems.

In addition, since there was a significant positive correlation between the concentrations of metals (Pb, Zn, Cr, and Cd) in sediments and algae tissue; these algae (Chaetomorpha sp.) are regarded as the suitable bio-indicator for these pollutants especially in the Karun River sediments.[35]

Conclusion

In this study, the concentration of the intended heavy metals in water, sediments, and dominant algae in Karun River was investigated across six key stations which are the sites that provide the entered water into the treatment of Ahwaz and Mollasani. The results of this research indicated that the stations situated in the upstream of the river (Mollasani) had a lower metal contamination load than downstream stations (Kut Abdollah) due to the transfer of contaminants in response to water flow from the upstream to downstream of the river. In general, the results obtained from comparing the mean concentration of metals in this river with some global standards showed that the concentration of Pb and Zn metals measured in the sediments of the sampling stations is lower than the allowable limit of standards and is not considered as contamination in none of the stations. However, the mean concentration of Cr and Cd was found more than the allowable limit of some of these standards. Accordingly, it can be stated that the conditions governing the region including enter urban, rural, industrial, and agricultural wastewaters can cause excessive accumulation of heavy elements, especially Cr and Cd in sediments in the long term. To control this trend and inhibit the elevation of the river's contamination load with other toxic elements, special measures should be taken into consideration concerning the management of the contaminating sources entering into this important ecosystem, where the control of the quality of river's water through the management of input wastewaters can be effective. Since this species of algae have been able to accumulate a significant amount of heavy metals in themselves and also there was a significant positive correlation between the concentrations of metals in the sediments and algae tissue; therefore, alga (Chaetomorpha sp.) is a suitable bio-indicator to determine the concentration of heavy metals in this aquatic ecosystems, especially in the Karun River sediments.

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تعیین غلظت فلزات سنگین در ایستگاه‌های تأمین آب تصفیه‌خانه‌های شهرستان‌های اهواز و ملاثانی با استفاده از شاخص زیستی

حمیدرضا پورخباز* PhD
گروه محیط زیست، دانشکده منابع طبیعی، دانشگاه صنعتی خاتم الانبیا (ص) بهبهان، بهبهان، ایران

فریبا هدایت‌زاده MSc
گروه محیط زیست، دانشکده منابع طبیعی، دانشگاه صنعتی خاتم الانبیا (ص) بهبهان، بهبهان، ایران

میترا چراغی MSc
گروه محیط زیست، دانشکده منابع طبیعی، دانشگاه تربیت مدرس، ایران

چکیده

اهداف: رودخانه کارون به عنوان بزرگترین رود ایران، یک اکوسیستم منحصر به فرد است. با این حال، افزایش فعالیت‌های انسانی منجر به این می‌شود که این رودخانه به طور جدی تحت تاثیر طیف وسیعی از آلاینده‌ها، به ویژه آلاینده‌های فلزات سنگین باشد که ممکن است برای انسان و موجودات آبزی سمّی باشد. بنابراین نظارت مداوم بر سطح آلودگی در رودخانه ضروری است.

مواد و روش‌ها: در این تحقیق به منظور بررسی کیفیت آب رودخانه کارون از نظر آلودگی فلزات سنگین (سرب، روی، کروم و کادمیوم) در نقاط تأمین آب تصفیه‌خانه‌های آب شرب شهرستان اهواز و ملاثانی، نمونه‌های آب، رسوب و جلبک از ۶ ایستگاه مختلف در طول رودخانه در شهریور ۱۳۹۴ برداشت شد. پس از خشک‌شدن و هضم نمونه‌ها، غلظت فلزات سنگین با استفاده از دستگاه جذب اتمی تعیین شد.

یافته‌ها: بالاترین غلظت فلزات مورد مطالعه در نمونه‌های رسوب یافت شد. فلز روی نیز بیشترین مقدار غلظت را در تمام ایستگاه‌ها داشت. غلظت فلزات سنگین در پایین‌دست رودخانه نشان‌دهنده افزایش بار آلودگی به دلیل جریان آب از بالادست به پایین‌دست رودخانه است که منجر به حرکت و تجمع همه آلاینده‌ها در پایین‌دست رودخانه می‌شود؛ از این رو، بالاترین غلظت فلزات در محل آبگیر تصفیه خانه کوت عبدالله (پایین‌دست) و کمترین در محل آبگیر تصفیه خانه ملاثانی (بالادست) وجود داشت.

نتیجه‌گیری: مقایسه غلظت فلزات در رسوبات با برخی استانداردهای جهانی از جمله EPA3050 و معیار استاندارد کیفی رسوب از NOAA و سازمان محیط زیست کانادا نشان داد که در میان تمام فلزات غلظت کروم و کادمیوم در ایستگاه‌ها بالاتر از حد مجاز استاندارد EPA3050 و برخی استانداردهای زیست محیطی کانادا بود. همچنین از آنجا که نمونه‌های جلبک قادر به تجمع مقدار قابل توجهی از فلزات سنگین در خود بوده‌اند، بنابراین شاخص زیستی مناسبی برای تعیین غلظت فلزات سنگین در این اکوسیستم آبی هستند.

کلیدواژه‌ها
جلبک؛
فلزات سنگین؛
رودخانه کارون؛
رسوب؛
تصفیه‌خانه آب

*نویسنده مسئول
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آدرس پستی: گروه محیط زیست، دانشکده منابع طبیعی، دانشگاه صنعتی خاتم الانبیا (ص) بهبهان، بهبهان، ایران
pourkhabbaz@bkatu.ac.ir