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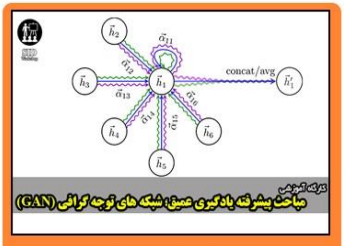

مباحث پیشرفته یادگیری عمیق؛
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ORIGINAL ARTICLE

Investigation of Heavy Metals Content in Sediments of Shirin Su Wetland, Western Iran

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KEYWORDS

Sediment;
Heavy metal;
Contamination factor;
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ABSTRACT: Shirin Su Wetland ecosystem, Hamedan Province, western Iran, has a great biodiversity and aesthetic. The distribution and accumulation of heavy metals: Cd, Cr, Cu, Fe, Pb and Zn in sediments were assessed from this wetland in February to May of 2013. The chemical speciation of elements was determined using mixed acid digestion. The results showed that the mean concentrations of metals (microgram per gram dry weight) in sediment samples were: 0.16 for Cd, 23.07 for Cr, 10.62 for Cu, 689.82 for Fe, 27.9 for Pb, 5.01 for Zn. Furthermore the mean concentrations of all metals except Fe in all sediment samples were lower than Threshold Effect Concentration and there are not adverse effects. According to I-geo values, in most stations the sediments quality was classified in unpolluted category. In addition, the sediment samples from station 2 and station 4 accumulated the minimum and maximum mean concentration of metals, respectively. Pearson correlation indicates that the anthropogenic sources of Zn, Fe and Cr are closely related in the sediment from Shirin Su Wetland.

INTRODUCTION

Earth materials may naturally or by human activities (industry, agriculture and etc.) contain heavy metals [1, 2]. In the aquatic ecosystems, sediment has a high potential to storage the pollutants. In the hydrological cycle, <0.1% of the elements are dissolved in the water and >99.9% are stored in sediments or soils [3, 4]. Therefore, geochemical studies of sediment cores are helpful and important role to pollution assessment, climatic conditions changes and rate of sedimentation [5].

The accumulation of heavy metals in environmental samples such as soils and sediments since these elements can transfer in aquatic media, uptake by plants and introduction into the food chain causes a potential of serious risk to human health [6, 7].

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Many studies have been conducted on heavy metal and trace elements contamination in water, soil and sediment [5-12]. Metal or trace element fractions in the water cause more damage to the aquatic ecosystem than the total metal concentrations in the water and in the sediment [6]. Therefore, to understand the dynamics of heavy metals and to evaluate the extent of pollution hazard in natural water bodies, the emphasis of different chemical fractions of metals in bottom sediments as an indicators for monitoring of contaminants have to be looked into besides the total quantity of metals in waters and sediments [6, 13 and 14].

Shirin Su Wetland is a fresh water lake located in 35° 30' to 35° 45' north and 28° 25' to 40° 48' east in the northwest of Hamedan Province, Iran (Figure 1). Area of Shirin Su Wetland is about 300 ha; its survival is mostly dependent upon the water quantity entrance through the natural springs and seasonal river near the mentioned lake. Shirin Su Wetland ecosystem has a great biodiversity and aesthetic value. Every year in winter, many aquatic and wading birds migrate to this lake such as *Gelochelidon nilotica, Anas platyrhnchos, Ciconia ciconia, Phalacrocorax carbo*. In addition, *Cyprinus carpio* are most commonly fish species founded in this wetland [15].

Because the metal pollution in aquatic ecosystems can be harmful to human health, it is necessary to assess the content of pollutants in sediment as an important indicator. Therefore, this study carried out to determine the levels of Cd, Cr, Cu, Fe, Pb and Zn in sediment from Shirin Su Wetland.

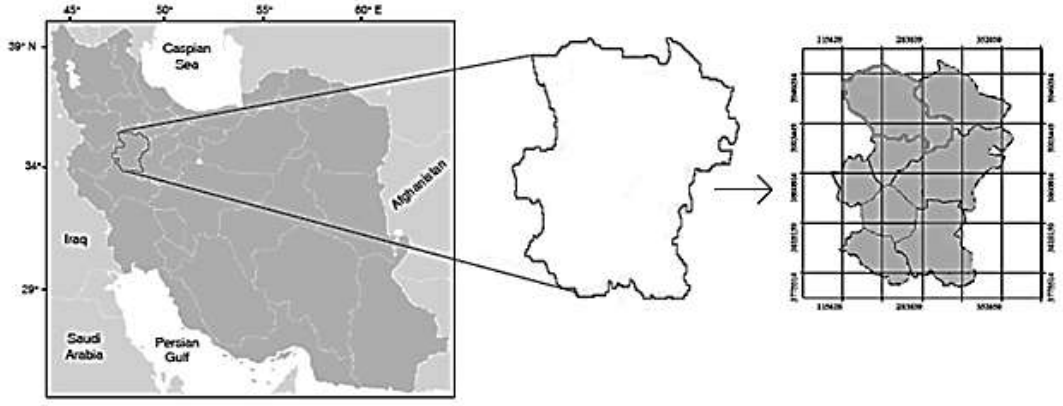

Figure 1: The location of Hamedan Province in western Iran and the study area.

MATERIALS AND METHODS

Sediment samples were collected from five stations along Shirin Su Wetland as shown in Figure 2 in February to May of 2013. The geographical coordinates (latitude and longitude) for each station were illustrated in Table 1. The samples were carried by polythene bag and transported to the laboratory and stored at temperature of 4 $^{\circ}$C, after which the sediment samples were air–dried for 2 weeks in the environmental pollution laboratory of Hamedan Branch, Islamic Azad University and sieved through a 1.7 μm mesh to remove the debris, then homogenization of samples for analysis of metals.

Mixed acid digestion (Conc. $HClO_4$ and HNO_3 at a 2:1 ratio (v/v)) as described by Lacatusu and Chale was used for extraction of metals from sediment samples [16, 17]. Then 20 mL of 0.5 M HNO_3 added and the solution was filtered through Whatman No 42 filter paper. Finally, for analyzed of metals levels using inductively coupled plasma optical spectrometry (ICP-OES) (710-ES, Varian).

Table 1. Location of studied stations

station	Latitude	Longitude
1	267756˝ N	3932209˝ E
2	268126˝ N	3931814˝ E
3	267269˝ N	3931354˝ E
4	268297˝ N	3931410˝ E
5	267992˝ N	3930928˝ E

Figure 2. Map of sampling stations in Shirin Su Wetland

RESULTS AND DISCUSSION

The descriptive statistics for sediment samples are shown in Table 2. Cd, Cr, Cu, Fe, Pb and Zn concentrations in sediment samples ranged from 0.062-0.13, 3.44-38.05, 0.62 -27.92, 475.20-704.24, 3.11-80.82 and 0.26-6.58 μg/g, respectively. The ranking of the mean concentration of metals in study area is as follows: Fe> Cr> Pb> Cu> Zn> Cd. Numerical Sediment Quality Guidelines (SQGs) include a TES and a Probable Effect Concentration used for asses metal concentrations in sediment samples (Table 2) [18]. The mean concentrations of Cd, Cr, Cu, Pb and Zn in all samples are lower than the Threshold Effect Concentration, and means these metals are not adverse effects. While, the mean concentration of Fe was exceed to compare with TEC in all samples and indicated that studied area was in potential risk

Table 2. Mean concentrations of metal in sediment samples (μg/g DW)

Station	Cd	Cr	Cu	Fe	Pb	Zn
1	0.12	25.55	8.10	684.33	7.90	4.41
2	0.08	22.14	8.58	672.05	6.85	4.33
3	0.06	19.21	27.92	698.87	37.89	6.58
4	0.09	22.33	4.89	689.65	80.82	4.40
5	0.13	26.16	3.64	704.24	6.05	5.37
Mean	0.16	23.07	10.62	689.82	27.9	5.01

Assessment According to U.S.EPA

The results of assessment of chemical contamination in the sediments by comparison with the SQGs proposed by U.S.EPA [19, 20] are shown in Table 3. The result shows that Cd, Cr, Cu, Fe, Pb and Zn mean concentrations are classified in not polluted category.

Table 3. U.S.EPA sediment quality guidelines

Metal	Not Polluted	Moderately Polluted	Heavily Polluted	Present Study
Cd	.....	…..	>6	0.06-0.13
Cr	<25	25-75	>75	19.21-26.16
Cu	<25	25-50	>50	3.64-27.92
Fe	<17000	17000-25000	>25000	672.05-704.24
Pb	<40	40-60	>60	6.05-80.82
Zn	<90	90-200	>200	4.33-6.58

Assessment According to Geo-accumulation Index (I.geo)

I-geo is a common criterion for assessment the heavy and toxic metal pollution in sediments and classified in seven grades (0-6) ranging from unpolluted to extremely polluted (Table 4). I-geo can be calculated by the equation 1 [21].

$$\text{I-geo} = \log 2 (Cn / 1.5\ Bn) \quad \text{Eq. 1}$$

where, Cn and Bn are the concentration of element and world surface rock average, respectively [18]. The factor 1.5 is incorporated in the relationship to account for possible variation in background data due to lithogenic effect.

Table 4: Muller's classification for I-geo

I-geo Value	Class	Sediment Quality
≤0	0	Unpolluted
0-1	1	Unpolluted to moderately polluted
1-2	2	Moderately polluted
2-3	3	Moderately to strongly polluted
3-4	4	Strongly polluted
4-5	5	Strongly to extremely polluted
>6	6	Extremely polluted

According to the results of I-geo values (Table 5) in most stations the sediments quality were classified in unpolluted category

Table 5: I-geo for metal in sediment samples of Shirin Su Wetland

Station	Cd	Cr	Cu	Fe	Pb	Zn
1	-1.91	-2.40	-3.06	-6.68	-1.92	-5.01
2	-2.49	-2.61	-2.98	-6.70	-2.13	-5.04
3	-2.91	-2.81	-1.27	-6.65	0.34	-4.43
4	-2.32	-2.60	-3.79	-6.65	1.43	-5.01
5	-1.79	-2.37	-4.21	-6.64	-2.31	-4.73

CONCLUSIONS

The content of metals in sediments can be a secondary source of water pollution, once environmental situation is changed [22, 23]. Therefore, an evaluation of metal contamination in sediments is an essential tool to assess the risk of an aquatic ecosystem [24]. Except for Fe the mean concentrations of Cd, Cr, Cu, Pb and Zn in sediment samples are lower than the TECs, and there are not adverse effects from these metals. Besides, according to the I-geo values in most stations the sediments quality was classified in unpolluted category. Therefore, it can be argued that the anthropogenic activities such as agriculture in the short term had no effect on the accumulation of heavy metals in the Shirin Su Wetland sediments.

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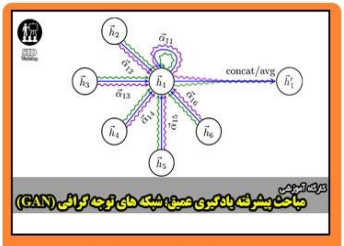

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