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Heavy metal pollution and spatial distribution in Surface Water and Sediment of Nanchang Section of Ganjiang River

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Abstract. In order to reveal the spatial distribution and pollution characteristics of heavy metals in surface water and sediment of Nanchang section of GanJiang River in JiangXi Province, potential ecological hazard index method and ground accumulation index method were used to evaluate the risk of heavy metals. The results show that: 1) The concentration of heavy metals in surface water of GanJiang River is much lower than the first standard limit of "Surface Water Environmental Quality Standard GB3838-2002". 2) The average RI value of sediment in Nanchang section of GanJiang River is 144.21, and the total ecological risk level is very high. The RI of two sections of Bayi Bridge are 169.89 and 192.38, respectively, which have become potential ecological high-risk areas. 3) According to the method of accumulative index, the pollution degree of heavy metals in GanJiang River is as follows: Cu > Cd > Pb > As > Cr > Zn. Among them, Cu and Cd are the main pollutants. Relevant departments should take urgent measures to strengthen the environmental management and pollution control of GanJiang River.

1. Introduction

With the acceleration of urbanization, all kinds of toxic and harmful substances enter into the environmental media, causing serious environmental pollution to rivers, lakes and other water bodies. Among them, the harm of heavy metals is particularly serious [1,2]. Heavy metals have the characteristics of "three causes" (teratogenesis, carcinogenesis and mutagenicity), so they have attracted the attention of scholars [3,4]. In recent years, with the over-exploitation and smelting of mineral resources in Jiangxi Province, many heavy metals have entered the Ganjiang River, which seriously threatens the water ecological environment of Ganjiang River. At present, the evaluation methods of heavy metals mainly include health risk assessment, potential ecological risk assessment, principal component analysis and so on. Many scholars have studied the assessment of heavy metal pollution in Ganjiang River and Poyang Lake, but there are few studies on the trend of heavy metal pollution in surface water and sediment of Ganjiang River [5]. Therefore, the pollution level of heavy metals in surface water and sediments of Nanchang section of Ganjiang River was studied in this paper.

2. Materials and methods

2.1. Sampling Point Layout and Sample Collection

The Ganjiang River is the main source of drinking water in Nanchang, The parts of industrial wastewater and domestic sewage are eventually flows to the Ganjiang river [6,7]. In the dry season of 2015, four sampling points were selected to collect surface water and sediment in Nanchang section of Ganjiang River. Sediment columnar collector was used to collect sediment in Nanchang section of Ganjiang River. Global positioning system was used to locate the sampling points. Water quality differences and hydrodynamic characteristics were taken into account in the setting of sampling points. A total of four sampling points was arranged: Bayi Bridge section S1 and S2., section S3and S4of Ganjiang Bridge. Surface water is collected 0.5 m below the surface of the water and filtered on site. The sediments are stored in acid and sealed bags. The sediments are brought back to the laboratory for pretreatment.

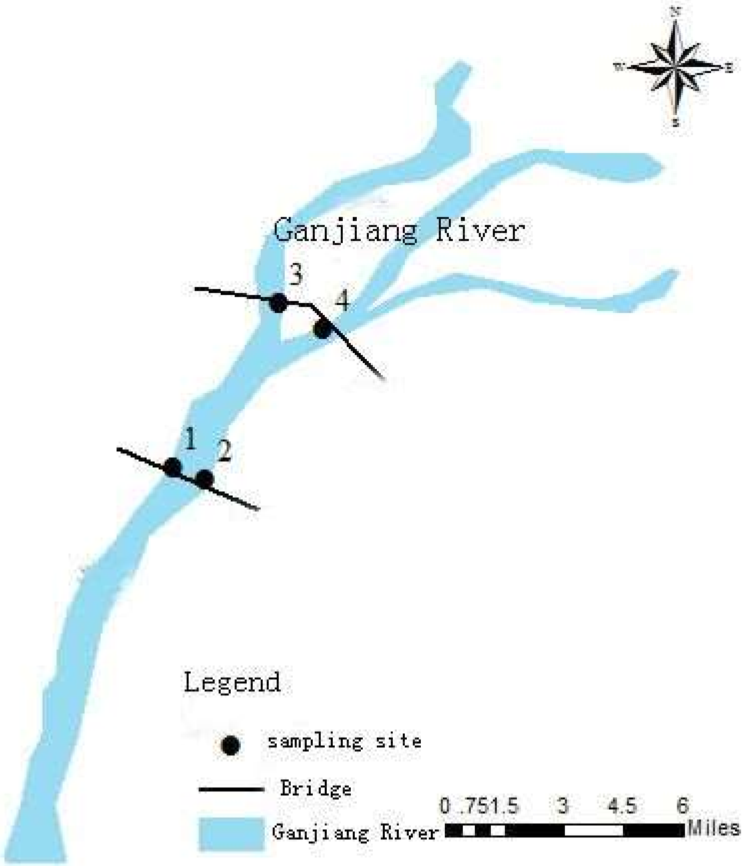

Figure 1. Sampling Points in Nanchang Section of Ganjiang River

2.2. Sample Processing and Analysis

The heavy metals in sediments were determined by Atomic absorption spectrophotometry and atomic fluorescence spectrometry after grinding, screening and digestion. At the same time, in order to ensure the accuracy of the experimental results, the national standard substances GSS-1 and GSS-3 were introduced into the experimental process. At the same time, three groups of parallel experiments were carried out for each sample [8]. The relative error was not more than 6%. The final results were analyzed and calculated with the mean value. Meanwhile, SPSS19.0 and Microsoft Office Excel 2010 were used for processing and analysis [9,10].

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3. Results and discussion

3.1. The present situation of heavy metal pollution

Heavy metals in surface water and sediment of Ganjiang River in 2016 are shown in Table 1. It can be seen from table 1 that the concentration of heavy metals in surface water of Ganjiang River did not exceed the first-class standard limit of Surface Water Environmental Quality Standard GB 3838-2002. Cu, Pb, Cd, Cr and As were not detected, indicating that ρ (Cu), ρ (Pb), ρ (Cd), ρ (Zn), ρ (Cr) and ρ (As)in surface water of Ganjiang River were not the main pollution factors.

Heavy metals are easily enriched in sediment. Heavy metals can not truly reflect the content of heavy metals in Ganjiang River water only through the mass concentration of heavy metals in surface water. From Table 3, it can be seen that the content of heavy metals in sediment has obvious difference, and the difference between different sampling points is obvious. Among them, the contents of Cu, Pb and Cd are higher than the background values of Chinese soil, while the contents of four heavy metals (Cu, Pb, Cd and Zn) are basically higher than the background values of sediments in the corresponding Poyang Lake basin, indicating that the Nanchang section of Ganjiang River is already facing serious heavy metal pollution.

Table 1. Heavy Metals in Surface Water and Sediment of Ganjiang River in 2016.

Numblet		ρ/(mg·L^{-1})						w/(mg·kg^{-1})					
		Cu	Pb	Cd	Zn	Cr	As	Cu	Pb	Cd	Zn	Cr	As
Bayi Bridge	S1	ND	ND	ND	0.004	ND	ND	32.205	22.304	2.902	24.802	24.035	11.802
	S2	ND	ND	ND	0.004	ND	ND	36.625	33.275	3.139	26.138	28.135	16.702
Ganjiang Bridge	S3	ND	ND	ND	0.003	ND	ND	23.07	15.604	1.635	18.102	11.905	8.49
	S4	ND	ND	ND	0.004	ND	ND	26.135	18.125	1.688	19.325	16.735	9.689
	mean value	ND	ND	ND	0.004	ND	ND	29.509	22.327	2.341	22.092	20.203	11.671

3.2. Assessment of Heavy Metals Pollution in Sediment

3.2.1. Evaluation of Potential Ecological Hazard Index of Heavy Metals. The results of ecological risk assessment of heavy metals in sediments are shown in Table 2. The RI of each sampling point ranged from 103.47 to 192.38, with an average value of 144.21. Among them, the S1 and S2 sites were at high risk, while the S3 and S4 sites were at medium risk. The risk degree of each monitoring point is S2 > S1 > S4 > S3, and the potential ecological risk of S2 sampling point on the section of Bayi Bridge is the highest, and the main heavy metal pollutants are Cd and Cu.

Table 2. Results of ecological risk assessment of heavy metals

Numble	E_r^i						RI	level
	Cu	Pb	Cd	Zn	Cr	As		
S1	33.90	8.92	116.08	0.54	1.62	8.83	169.89	high
S2	38.55	13.31	125.56	0.57	1.90	12.49	192.38	high
S3	24.28	6.24	65.40	0.40	0.80	6.35	103.47	medium
S4	27.51	7.25	67.52	0.42	1.13	7.25	111.08	medium
mean value	31.06	8.93	93.64	0.48	1.36	8.73	144.21	high

3.2.2. Evaluation of Heavy Metal Accumulation Index Method. The evaluation results of the ground accumulation index of various heavy metals in surface sediments of lakes in the study area are shown in Table 3. From Table 3, it can be seen that all six heavy metals are in the state of pollution by the method of ground accumulation index. According to the degree of pollution, they are Cu > Cd > Pb > As > Cr > Zn. Among them, Cu and Cd are the main pollutants.

There are some differences in the evaluation results of heavy metals in sediments of Nanchang section of Ganjiang River by using land accumulation index method and potential ecological risk index method, which are mainly due to the different analysis angles of the two methods. Geo-accumulation index method is more focused on the impact of geological background, without considering the toxicity of heavy metal pollution to organisms. Potential ecological risk index method compensates for this shortcoming, preferring the ecological risk degree of heavy metal pollution. This study combines the two methods organically to evaluate the pollution characteristics of heavy metals in Ganjiang sediments more reasonably. At the same time, the evaluation results of geoaccumulation index method and potential ecological risk index method are comparatively similar. Among them, copper and cadmium are the main heavy metal pollutants, which are closely related to the industrial production around the lake. The unreasonable industrial structure and layout along the lake are the main causes of heavy metal pollution. The improvement of industrial enterprises in Nanchang section of Ganjiang River should be strengthened.

Table 3. Evaluation results of heavy metal geoaccumulation index

Numble	Cu	Pb	Cd	Zn	Cr	As	I_{geo}	level
S1	2.18	0.25	1.37	-1.47	-0.89	-0.76	0.67	1
S2	2.36	0.83	1.48	-1.39	-0.66	-0.26	2.35	3
S3	1.70	-0.26	0.54	-1.92	-1.90	-1.24	-3.09	0
S4	1.88	-0.05	0.59	-1.83	-1.41	-1.05	-1.88	0
mean value	2.03	0.19	0.99	-1.65	-1.22	-0.83	-0.49	0

4. Conclusion

(1) The content of heavy metals in surface waters of Ganjiang River did not exceed the standard limit of "GB3838-2002 Surface Water Environmental Quality Standard". Cu, Pb, Cd, Cr and As were not detected, indicating that the surface waters of Ganjiang River were not polluted by heavy metals. The contents of Cu, Pb and Cd in the sediments of Ganjiang River exceed the first-class standard of soil environmental quality and the background values of Chinese soil. The contents of Cu, Pb, Cd and Zn in the sediments of the Poyang Lake Basin basically exceed the background values of the sediments of the corresponding Poyang Lake Basin, indicating that the Nanchang section of Ganjiang River has been facing serious heavy metal pollution.

(2) The results of potential ecological risk index show that Cd and Cu are above medium risk, which are the main contributing factors of pollution, and other heavy metals are at low ecological risk level. The S1 and S2 sections are at high risk level, and the ecological hazards of S2 sampling sites are extremely high risk. The ecological risk of Bayi Bridge is more serious than that of Ganjiang Bridge. According to the evaluation results of accumulative index, six kinds of heavy metals are polluted in different degrees, of which copper, cadmium and lead are the main pollutants. The pollution degree of four sections is S2 > S1 > S4 > S3, which is basically consistent with the results of potential ecological risk index. The results show that the results are accurate and reliable.

By comparing the contents of heavy metals at sampling points, it was found that the contents of various metals were Cu > Cd > Pb > As > Cr > Zn. The average RI of the whole Nanchang section of Ganjiang River is 144.21, and the total ecological risk level is very high. The RI of the two sections of BaYi Bridge are 169.89 and 192.38, respectively, which have become potential ecological high-risk areas. At the same time, Cd and Cu are the main risk pollutants in Nanchang section of Ganjiang River. Therefore, the treatment of heavy metal pollution in Nanchang section of Ganjiang River should focus on Cu and Cd. Relevant departments should take urgent measures to strengthen environmental management and pollution control of Ganjiang River.

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References

[1] Pan L, Wang Y, Ma J, et al. A review of heavy metal pollution levels and health risk assessment of urban soils in Chinese cities[J]. Environmental Science and Pollution Research, 2018, 25(2): 1055-1069.
[2] Sun Z, Xie X, Wang P, et al. Heavy metal pollution caused by small-scale metal ore mining activities: A case study from a polymetallic mine in South China[J]. Science of the Total Environment, 2018, 639: 217-227.
[3] Islam M S, Hossain M B, Matin A, et al. Assessment of heavy metal pollution, distribution and source apportionment in the sediment from Feni River estuary, Bangladesh[J]. Chemosphere, 2018, 202: 25-32.
[4] He J, Yang Y, Christakos G, et al. Assessment of soil heavy metal pollution using stochastic site indicators[J]. Geoderma, 2019, 337: 359-367.
[5] Zhang P, Qin C, Hong X, et al. Risk assessment and source analysis of soil heavy metal pollution from lower reaches of Yellow River irrigation in China[J]. Science of The Total Environment, 2018, 633: 1136-1147.
[6] Huang Y, Chen Q, Deng M, et al. Heavy metal pollution and health risk assessment of agricultural soils in a typical peri-urban area in southeast China[J]. Journal of environmental management, 2018, 207: 159-168.
[7] Omwene P I, Öncel M S, Çelen M, et al. Heavy metal pollution and spatial distribution in surface sediments of Mustafakemalpaşa stream located in the world's largest borate basin (Turkey)[J]. Chemosphere, 2018, 208: 782-792.
[8] Wu W, Wu P, Yang F, et al. Assessment of heavy metal pollution and human health risks in urban soils around an electronics manufacturing facility[J]. Science of the Total Environment, 2018, 630: 53-61.
[9] Cundy C I W. Heavy metal and hydrocarbon pollution in recent sediments from southampton water, southern England: a geochemical and isotopic study [J]. Environmental Science& Technology, 1995, 5(29): 1288-1296
[10] Li Y, Zhou S, Zhu Q, et al. One-century sedimentary record of heavy metal pollution in western Taihu Lake, China[J]. Environmental pollution, 2018, 240: 709-716.