Heavy metal concentration in the sediment of the To Lich River and the Kim Nguu River in Hanoi city

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Introduction

Due to rapid expansion of cities waste products from municipalities and factories have been discharged and spilled into waterways. Much of these pollutants become adsorbed to the surface of fine-grained particles that settle and form polluted sediments at the bottom of the waterways. The polluted sediments pose a serious problem because of their potential for recontamination of the overlying water through release of pollutants from the sediments.

In Hanoi City there are two rivers, the To Lich River and the Kim Nguu River, the sediments of which function as "sinks" and reservoirs for pollutants discharged from the city. Water in these rivers is now being used for irrigation in suburban agricultural land. The To Lich River 17 km long with an area of 1,361 ha for sewage assimilation flows through the Thuong Dinh industrial zone where various factories are located. The waste stream discharges flowing into the river amount to 80 to 85 million m^3 which is two thirds of the total discharges in Hanoi City. The Kim Nguu River 11 km long with a sewage assimilation area of 596 ha receives 40 to 45 millions m^3 corresponding to one third of the total discharges. Various kinds of factories are also located along the river. In the present study, the chemical and physical properties, and heavy metal concentrations in the sediments were examined and correlations of heavy metal concentrations and organic matter content were discussed.

Materials and Methods

Materials: On December 3 to 6 of 2005, the samples were collected from the surface zone (20 cm) of the sediment in the sites submerged with water, and the core samples 90 cm in depth were taken at the sites where the sediment surface is exposed to the air.

Methods: The pH was measured in the suspension with a soil/solution ratio of 1/2.5. Organic carbon was determined by the Tyurin method, being converted to organic matter content by multiplying by 1.724. Particle size distribution was determined by the pipette method. The calcium acetate method was used for CEC determination. Heavy metals in the samples were digested in 1N HNO_3 solution at 96^0C for 1 hour, and dissolved metal concentrations were determined with atomic absorption spectroscopy.

Result and discussion

Physical and chemical properties

Table 1 shows the results of chemical and physical properties, and total heavy metal concentrations of the sediment samples. The pH and organic matter content varied 7.1 to 7.8 and 2.3 to 7.9 %, respectively. The highest organic matter content of the sample No 19 suggests the inflow of organic wastes from factories such as Huu Nghi Food, Hai Chau Candy, Dong Nam A Beer, open markets and residence. The CEC ranged 6.6 to 20.3 $cmol_c/kg$, and the sample No 19 showed the highest value which is caused by the high organic matter content. The sample No.11 is classified as sand and the samples No.13, 14, and 15 as silty loam. The samples other than these are all classified as sandy loam.

Total heavy metal concentration

Total heavy metal concentrations in the samples are shown in table 1. They varied considerably among the samples: 24.5 to 131.4 mg/kg for Cu, 23.2 to 80.2 mg/kg for Pb, 67 to 290 mg/kg for Zn, 0.31 to 65.6 mg/kg for Cd, 40 to 120 mg/kg for Cr and 11.3 to 63.5 mg/kg for Ni. Compared with the results on heavy metals studied in 1998 (Ho Thi Lam Tra, 2000), the metal concentration decreased slightly for Cu, Pb, Zn and Ni, but increased for Cr and Cd. The highest Cu (131.4 mg/kg) and Ni (63.5mg/kg) concentration for the sample No 19 would be a result of accumulation of the pollutants discharged from the factories such as Hanoi Leather, March 8 Textile, Minh Khai Lock, Mai Dong Mechanical Engineering and Win factory. The highest concentration of Zn (290 mg/kg) and Cr (120 mg/kg) for the sample No 18 would be responsible for the discharged sewage from Van Dien Engineering, Van Diem cemetery and Van Dien Chemical, and Van Dien phosphate factory. The high Pb concentration in the sample No 7 would be related the sewage rich in Pb discharged from Dai Kim plastic factory, Rang Dong Bulk factory. Extremely high Cd concentration over 60 mg/kg in the sample No.9 would be a result of accumulation of the pollutants from a painting factory.

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TABLE 1. Chemical and physical properties of sediment samples

No	Depth (cm)	pH $_{H2O}$	OM (%)	CEC ($cmol_c$/ kg)	Particle size distribution (%)			Total heavy metal concentration (mg/kg)					
					Clay (<2 µm)	Silt (2-20 µm)	Sand (20-1000µm)	Cu	Pb	Zn	Cd	Cr	Ni
1	0-30	7.5	4.1	10.5	4.3	24.3	71.4	39.4	39	154	0.31	97	12.9
2	30-60	7.7	4.2	11.0	4.0	24.0	72.0	54.4	45	189	0.67	98	35.2
3	60-90	7.8	4.4	12.4	4.3	24.3	71.4	37.5	44	146	0.82	114	17.4
7	20	7.5	4.1	10.8	3.3	25.0	71.7	127	80	214	23.2	83	42.5
9	20	7.4	5.6	12.8	4.0	35.3	60.7	78.4	47	205	60.5	91	33.5
11	20	7.8	3.8	6.6	3.3	7.3	89.4	57.1	37	177	0.83	105	11.3
13	0-30	7.2	2.3	9.5	7.3	53.3	39.4	24.5	23	67	0.76	40	19.8
14	30-60	7.1	5.3	9.6	8.5	54.2	37.6	26.8	30	69	0.88	46	10.9
15	30-90	7.2	3.8	9.2	10.3	59.0	40.2	27.0	28	65	0.89	44	11.8
16	20	7.4	3.5	10.4	5.6	25.3	69.1	56.2	44	143	7.09	84	21.7
18	20	7.1	4.9	12.8	4.3	19.7	76.0	66.0	47	290	13.5	120	51.3

Note: Sample No 1, 2, 3, 7, 9, 11, 13, 14 and 15 were taken from the ToLich River
Sample No 16, 18 and 19 were taken from the Kim Nguu River
OM: Organic matter content

Correlation of Organic matter and total heavy metal concentration

Figures 1 shows that there are significant possitive correlations between the metal concentrations and the organic matter content. This can be explained in terms of the adsorption of Cu, Pb and Ni by organic matter. Sebastien et al. (2000) asserted that the most improtant factors affecting dissolved heavy metal as well as total heavy metal concentrations is organic matter content. The mechanisms proposed for the immobilisation and consequent reduction in the phytoavailability of metals by organic matter include: enhanced metal adsorption through increased surface charge, increased formation of organic and inorganic metal complexes, precipitation of metals, and reduction of metals from higher valency mobile form to lower valency immobile form (Boalan and Duraisamy, 2003). There is evidence to suggest that the major functional group of the humic acid with which the metal cations interact is the carboxyl group.

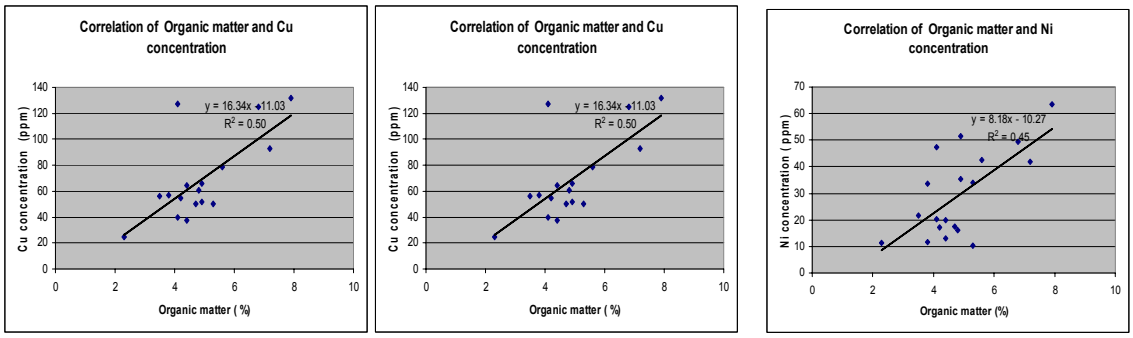

Fig. 1 Correlation of organic matter content (OM) and heavy metal concentrations
(All the correlations are significant at 1 % level)

Conclusion

The heavy metal concentration of sediment samples varied to a great extent by the difference of the site and metal type. High level metal concentrations in some samples are the result of accumulation of sewage with different sources. There are positive correlations between organic matter content and concentrations of Cu, Pb and Ni.

References

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