

## Ecological risk assessment and source identification of heavy metals in surface sediments of West Lake, East China

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West Lake is the only lake in China that is listed as a World Heritage site; accordingly, it is particularly important to protect the environment of the lake. The objectives of this study were (1) to determine spatial and temporal distributions of heavy metals in surface sediments of West Lake, (2) to assess the pollution degree and potential ecological risks of these heavy metals by comparison with sediment quality guidelines (SQGs) and the methods of geoaccumulation index (Igeo) and potential ecological risk index (PERI), and (3) to identify the natural and/or anthropogenic sources of these heavy metals using combined multivariate statistical techniques.

The spatial and temporal distribution, ecological risks, and sources of heavy metals including As, Cd, Co, Cr, Cu, Pb, Zn, Mn and Ni were analyzed in surface sediments from West Lake. The average concentrations of Cd, and Pb were 4.9 and 6.4 times their background values, respectively. The average concentrations of As, Co and Zn was higher than the background values. Cu, Pb and Zn exhibited similar spatial distributions in concentrations higher at the east and part of west of West Lake. Based on the results of the SQGs, Igeo, and PERI, Cd, and Pb were identified as the major heavy metal pollutants in surface sediments. The metals in the surface sediment may pose moderate ecological risk. The east and part of west of West Lake were identified as the priority regions of environmental monitoring and management. Multivariate statistical analyses showed Cu, Pb, and Zn mainly originated from traffic activities and domestic wastewater. Cd, Mn and As mainly originated both from natural erosion and anthropogenic activities. Co, Cr and Ni might have a natural source. Therefore, the measures and strategies should be implemented to reduce the traffic flow in Hangzhou City. Also, measures and strategies are required to decrease ecological risks from Cd pollution.

	Mn <sub>1</sub>	Cd <sub>1</sub>	Co <sub>1</sub>	Cr <sub>1</sub>	Cu <sub>1</sub>	Pb <sub>1</sub>	Zn <sub>1</sub>	As <sub>1</sub>	Ni <sub>1</sub>
Ave <sub>1</sub>	684.85	0.84	15.73	66.87	30.62	121.74	141.70	11.25	31.56
Min <sub>1</sub>	238.45	0.45	9.09	24.41	11.79	36.48	77.75	4.40	15.77
Max <sub>1</sub>	1299.50	1.28	21.90	128.95	61.35	248.10	302.75	18.66	64.70
Std. Dev <sub>1</sub>	261.54	0.17	2.71	21.29	11.39	53.40	45.36	3.48	7.99
SB <sub>1</sub>	770.00	0.17	14.00	72.00	33.00	19.00	95.00	7.70	52.00
TEL <sub>1</sub>	-	0.60	-	37.3	35.7	35.0	123.1	5.9	18.0
PRL <sub>1</sub>	-	3.53	-	90.0	196.6	91.3	314.8	17.0	36.0
<TEL(%) <sub>1</sub>		5		5	63	0	40	8	2
≥TEL<PRL(%) <sub>1</sub>		95		73	37	30	60	89	78
≥PRL(%) <sub>1</sub>		0		22	0	70	0	3	20

**Table1** Summary statistics of heavy metal concentrations in the sediments of West Lake and guideline values (mg/kg).