**Supplementary Materials for:**

# Contamination identification of trace metals in roadway dust of a typical mountainous county in the Three Gorges Reservoir region, China and its relationships with socio-economic factors

**Huiyun Pan [1,2], Xinwei Lu [1,*] and Kai Lei [3]**

[1] Department of Environmental Science, School of Geography and Tourism, Shaanxi Normal University, Xi'an 710119, China; panhy@hpu.edu.cn (H.P.); luxinwei@snnu.edu.cn, luxinwei88@aliyun.com (X.L.)
[2] Institute of Resources and Environment, Henan Polytechnic University, Jiaozuo 454000, China; panhy@hpu.edu.cn (H.P.)
[3] School of Biological and Environmental Engineering, Xi'an University, Xi'an 710065, China; handsomelei2005@126.com (K.L.)
* Correspondence: luxinwei@snnu.edu.cn, luxinwei88@aliyun.com; Tel.: +86-29-8531-0525 (X.L.)

Received: date; Accepted: date; Published: date

**Figure list**



**Table list**

*S1. Study area and sample collection*

By the end of 2018, Chongqing covered an area of 82,400 $km^2$, which had the resident population of 31.02 million and the motor vehicle amount of 3.5 million. Chongqing has a typical subtropical monsoon humid climate. The weather and geographical conditions in this area are poor for the pollutant diffusion. As a traditional industrial city, trace metal contamination is widely existed in soil and dust in Chongqing (Li et al., 2006; Li et al., 2015). Although the western development strategy in the last two decades stimulates the urban infrastructure constructions greatly, it might also increase the environmental risks in this area (Guo et al., 2016; He et al., 2017). The 38 counties and 589 townships in Chongqing are facing the similar challenges with urban areas of Chongqing.

Wushan county has an area of 2955 $km^2$ and an estimated population of 462 thousand. The key enterprises in Wushan include building materials chemical plant, cigarette factory, thermal power plant and cement plant. Two national highways (G42 and G103) go across the center of the county. Duping town is located in the southwest of Wushan and is about 123 kilometers away from the county town. Duping has a surface of about 132 $km^2$ and a population of 16 thousand. New urbanization construction has not only greatly promoted the local economic and social development, but also brought potential environmental risks.

The sampling sites were mainly distributed along the main streets in center areas of both locations with intensive population and traffic density. The samples were collected from concrete and asphalt road, where road dusts were easily accumulated due to less road cleaning. Sampling locations were positioned by using a hand-held globe positioning system (GPS) and indicated in the map as black dots (Fig. 1).

Road dust samples (approximately 200-300g at each site) were collected at the side of road by gently sweeping with a polyethylene brush. Each sample was put into a self-sealed polyethylene bag and was transported to the laboratory after labeled. All dust samples were air-dried at ambient temperature, and were passed through a 1.0 mm nylon sieve to remove impurities.

*S2. Analytical procedures and quality assurance*

After grinding and sieving, the 4.0 g milled dust sample and the 2.0 g boric acid were accurately weighed and put in a mold to make a 32 mm-diameter tablet with 30-ton pressure for trace metal determination.

The reference materials, i.e. GSS1 and GSD12, were obtained from the Institute of Geophysical and Geochemical Exploration, Chinese Academy of Geological Sciences.

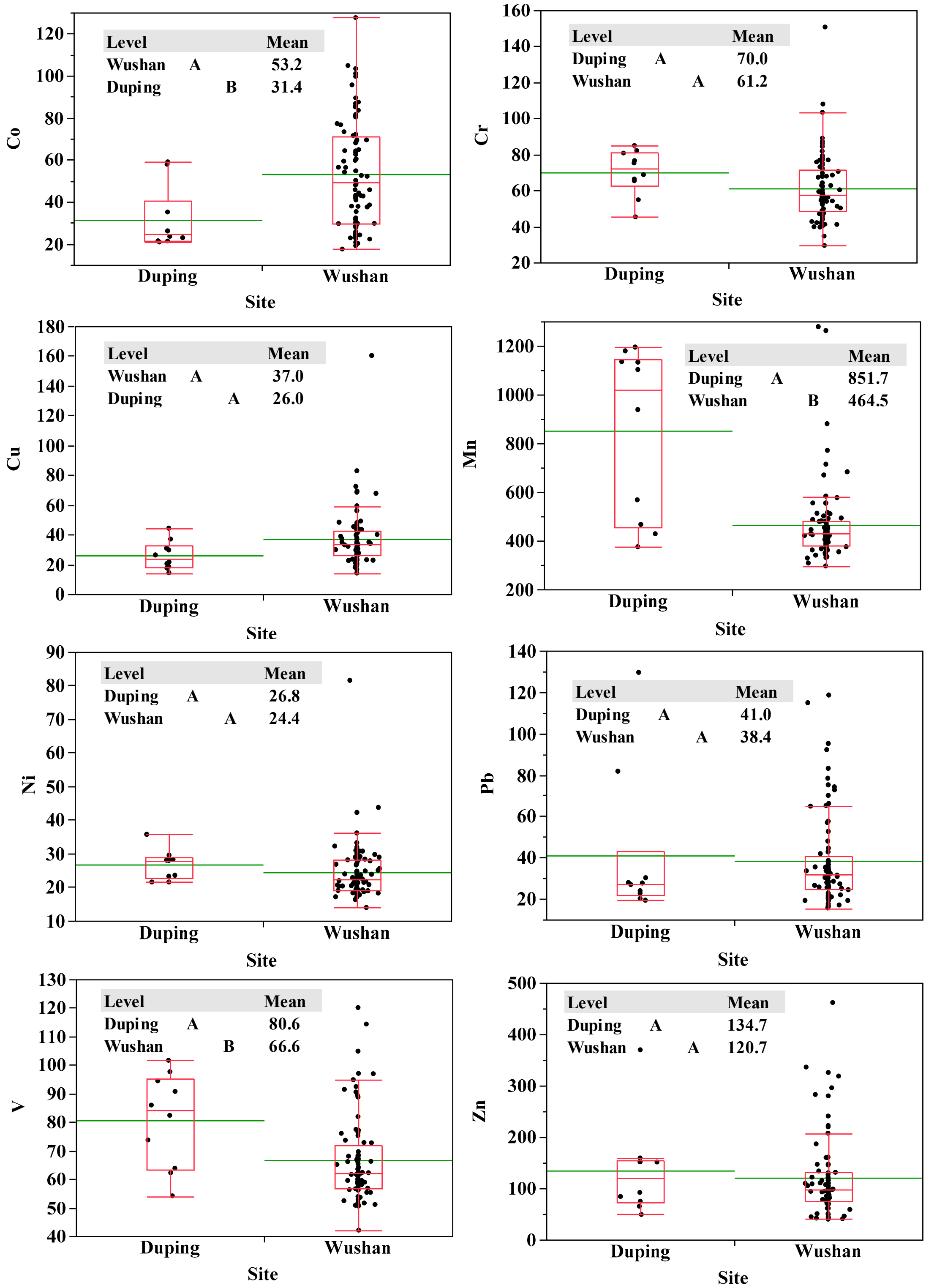


**Figure S1.** Comparison of trace metals concentrations between Wushan and Duping; the average value which does not share a letter (i.e. A or B) represents a significant difference ($\alpha$ = 0.05).

**Table S1.** Pollution categories on the bsis of $I_{geo}$ values (Förstner et al., 1990)

| $I_{geo}$ value | Class | Pollution degree |
|---|---|---|
| ≤ 0 | 0 | Non-pollution |
| 0-1 | 1 | Non-pollution to moderate pollution |
| 1-2 | 2 | Moderate pollution |
| 2-3 | 3 | Moderate to heavy pollution |
| 3-4 | 4 | Heavy pollution |
| 4-5 | 5 | Heavy to extreme pollution |
| > 5 | 6 | Extreme pollution |

**Table S2.** Trace metals contents in road dust of this study area and other cities (mg/kg)

| City | Co | Cr | Cu | Mn | Ni | Pb | V | Zn | Reference |
|---|---|---|---|---|---|---|---|---|---|
| Beijing | - | 84.7 | 69.9 | - | 25.2 | 105 | - | 222 | Wei et al., 2015 |
| Shanghai | - | 159 | 197 | - | 84.0 | 195 | - | 734 | Shi et al., 2008 |
| Xi'an | 30.9 | 145 | 54.7 | 511 | 30.8 | 125 | 69.6 | 269 | Pan et al., 2017 |
| Lanzhou | - | 62.1 | 73.0 | 592 | - | 62.7 | - | 297 | Wang et al., 2012 |
| Wuhan | 12.4 | 75.3 | 62.1 | 603 | 27.7 | 103 | 65.6 | 224 | Yang et al., 2010 |
| Chongqing (urban area) | - | 83.9 | 78.2 | - | 34.7 | 73.6 | - | 144.7 | Li et al., 2015 |
| Massachusetts (American) | - | 95 | 105 | 456 | - | 73 | - | 240 | Apeagyei et al., 2011 |
| Thessaloniki (Greece) | 9.55 | 187.3 | 526.2 | 529.1 | 95.71 | 191 | 53.7 | 671 | Bourliva et al., 2016 |
| Tehran (Iran) | - | 33.5 | 225.3 | 1214.5 | 34.8 | 257.4 | - | 873.2 | Saeedi et al., 2012 |
| Wushan | 53.2 | 61.2 | 37.0 | 465 | 24.4 | 38.4 | 66.6 | 121 | This study |
| Duping | 31.4 | 70.0 | 26.0 | 852 | 26.8 | 41.0 | 80.6 | 135 | This study |

**Table S3.** Spearman's correlation coefficients among trace metals, Al and Fe in road dust from Wushan; the bold value in the table shows a significantly positive correlation between two variables.

| | Co | Cr | Cu | Mn | Ni | Pb | V | Zn | Al | Fe |
|---|---|---|---|---|---|---|---|---|---|---|
| Co | 1.000 | | | | | | | | | |
| Cr | -0.042 | 1.000 | | | | | | | | |
| Cu | 0.018 | **0.590**** | 1.000 | | | | | | | |
| Mn | -0.051 | **0.681**** | **0.291**** | 1.000 | | | | | | |
| Ni | **-0.260*** | **0.813**** | **0.526**** | **0.668**** | 1.000 | | | | | |
| Pb | 0.022 | **0.573**** | **0.546**** | **0.329**** | **0.441**** | 1.000 | | | | |
| V | -0.184 | **0.563**** | 0.164 | **0.712**** | **0.672**** | 0.219 | 1.000 | | | |
| Zn | 0.076 | **0.652**** | **0.707**** | **0.372**** | **0.578**** | **0.686**** | **0.225*** | 1.000 | | |
| Al | -0.084 | **0.400**** | -0.010 | **0.648**** | **0.496**** | 0.113 | **0.841**** | 0.111 | 1.000 | |
| Fe | -0.060 | **0.778**** | **0.442**** | **0.877**** | **0.784**** | **0.382**** | **0.722**** | **0.447**** | **0.648**** | 1.000 |

* Significant level at the 0.05 (two-tailed); ** Significant level at the 0.01 (two-tailed)

**Table S4.** Spearman's correlation coefficients among trace metals, Al and Fe in road dust from Duping; the bold value in the table shows a significantly positive correlation between two variables.

| | Co | Cr | Cu | Mn | Ni | Pb | V | Zn | Al | Fe |
|---|---|---|---|---|---|---|---|---|---|---|
| Co | 1.000 | | | | | | | | | |
| Cr | 0.055 | 1.000 | | | | | | | | |
| Cu | 0.515 | 0.309 | 1.000 | | | | | | | |
| Mn | -0.442 | 0.527 | -0.030 | 1.000 | | | | | | |
| Ni | -0.334 | 0.511 | 0.116 | **0.809**** | 1.000 | | | | | |
| Pb | 0.333 | 0.600 | **0.818**** | 0.067 | 0.304 | 1.000 | | | | |
| V | -0.212 | **0.721*** | -0.042 | **0.806**** | **0.729*** | 0.103 | 1.000 | | | |
| Zn | -0.382 | -0.394 | -0.042 | -0.030 | -0.061 | 0.067 | -0.370 | 1.000 | | |
| Al | -0.115 | **0.685*** | -0.103 | **0.648*** | **0.723*** | 0.091 | **0.927**** | -0.418 | 1.000 | |
| Fe | 0.030 | **0.758*** | 0.067 | **0.685*** | 0.620 | 0.236 | **0.939**** | -0.358 | **0.891**** | 1.000 |

* Significant level at the 0.05 (two-tailed); ** Significant level at the 0.01 (two-tailed)

**Table S5.** Rotated component matrix of principal components analysis of trace metals in road dust from Wushan

| Target metals | PC 1 | PC 2 | PC 3 | PC 4 | Communality |
|---|---|---|---|---|---|
| Co | -0.118 | 0.044 | -0.051 | **0.976** | 0.971 |
| Cr | **0.629** | 0.515 | 0.305 | 0.108 | 0.766 |
| Cu | -0.081 | **0.686** | 0.517 | -0.029 | 0.746 |
| Mn | **0.865** | 0.134 | 0.047 | -0.064 | 0.773 |
| Ni | 0.415 | 0.092 | **0.805** | -0.119 | 0.843 |
| Pb | 0.144 | **0.915** | -0.091 | -0.021 | 0.867 |
| V | **0.869** | -0.057 | 0.226 | -0.133 | 0.827 |
| Zn | 0.133 | **0.674** | 0.507 | 0.275 | 0.805 |
| Eigenvalue | 2.131 | 2.060 | 1.329 | 1.077 | |
| Contribution rate of variances (%) | 26.64 | 25.74 | 16.61 | 13.47 | |
| Cumulative contribution rate of variances (%) | 26.64 | 52.38 | 68.99 | 82.46 | |

## References


Apeagyei, E., Bank, M.S., Spengler, J.D., 2011. Distribution of heavy metals in road dust along an urban-rural gradient in Massachusetts. Atmos. Environ. 45, 2310–2323.

Bourliva, A., Papadopoulou, L., Aidona, E., 2016. Study of road dust magnetic phases as the main carrier of potentially harmful trace elements. Sci. Total Environ. 553, 380–391.

Förstner, U., Ahlf, W., Calmano, W., Kersten, M., 1990. Sediment criteria development-contributions from environmental geochemistry to water quality management in: Heling Dietrich.

Guo, J., He, T., Xie, C., Li, S., 2016. Analysis of heavy metals contamination characteristics of roadside soil from urban functional core area in Chongqing. J. Chongqing Norm. Univ. (Natural Science Edition) 33, 64–70. (in Chinese)

He, M., Li Q., Wang D., Zhao J., Yang T., 2017. Bioaccumulation and correlation of heavy metals in human hairs from urban and rural areas of Chongqing. Environ. Sci. 38, 1697–1703. (in Chinese)

Li, Y., Li, Z., Xiong, H., Chen, Y., Dai, Y., 2015. Risk assessment of roadside heavy metal pollution to human health in Chongqing. J. Southwest Univ. (Natural Science Edition) 37, 18–23. (in Chinese)

Li, Z., Chen, Y., Yang, X., Wei, S., 2006. Heavy metals contamination of street dusts in core zone of Chongqing municipality. J. Soil Water Conserv. 20, 114–116. (in Chinese)

Pan, H., Lu, X., Lei, K., 2017. A comprehensive analysis of heavy metals in urban road dust of Xi'an, China: Contamination, source apportionment and spatial distribution. Sci. Total Environ. 609, 1361–1369.

Saeedi, M., Li, L.Y., Salmanzadeh, M., 2012. Heavy metals and polycyclic aromatic hydrocarbons: pollution and ecological risk assessment in street dust of Tehran. J. Hazard. Mater. 227, 9–17.

Shi, G., Chen, Z., Xu, S., Zhang, J., Wang, L., Bi, C., Teng, J., 2008. Potentially toxic metal contamination of urban soils and roadside dust in Shanghai, China. Environ. Pollut. 156, 251–260.

Wang, G., Oldfield, F., Xia, D.S., Chen, F.H., Liu, X.M., Zhang, W.G., 2012. Magnetic properties and correlation with heavy metals in urban street dust: A case study from the city of Lanzhou, China. Atmos. Environ. 46, 289–298.

Wei, X., Gao, B., Wang, P., Zhou, H., Lu, J., 2015. Pollution characteristics and health risk assessment of heavy metals in street dusts from different functional areas in Beijing, China. Ecotox. Environ. Safe. 112, 186–192.

Yang, T., Liu, Q., Li, H., Zeng, Q., Chan, L., 2010. Anthropogenic magnetic particles and heavy metals in the road dust: Magnetic identification and its implications. Atmos. Environ. 44, 1175–1185.