

# *Heavy Metals Pollution in Street Dusts of Tehran and Their Ecological Risk Assessment*

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Received: June, 2011      Accepted: Oct., 2011

## **Introduction**

Street dusts are suspended particle matters in the air from different natural and anthropogenic sources that may fall down because of their size and density. The growth of population, industrial activities and vehicles, has recently increased urban systems pollution. Therefore, it has recently been focused on the assessment of street dust contamination as a major source of urban environment pollution, all over the world. Heavy metals in street dusts are among major environmental pollutants that may be originated either from anthropogenic sources such as high traffic loads, industrial activities, building erosions, corrosion of tires and car parts, mineral activities and fossil fuel burnings or from natural sources such as local soil. During recent years huge amounts of atmospheric dust have entered Tehran, crossing national western borders of Iran and settled on the surfaces of urban areas.

Assessing heavy metal contents of street dusts which can make serious human health risks seems to be important in this highly populated city. In this study, fifty street dust samples were collected from streets of southern and eastern parts of Tehran, the capital of Iran. The concentrations of nine metals (i.e., Cu, Cr, Pb, Ni, Cd, Zn, Fe, Mn and Li) were determined in samples.

Probable natural or anthropogenic sources of metals were identified using multivariate statistical analyses. Enrichment factors and Hakanson's ecological risk assessment method were also applied.

## **Materials and Methods**

Fifty locations were selected for sampling. The distribution of sampling points is as follows: ten samples from each Resalat, Baghery and Hengam streets, five samples from Esteghlal Street which are main streets in eastern parts of Tehran. Fourteen samples were collected from the South terminal of Tehran which is located in one of the high polluted areas in the south of Tehran and the last sample was collected from the campus of Iran University of Science and Technology. Dust samples were collected during summer under dry and stable weather conditions, using broom and suction from the edge of pathways in streets and terminal.

The samples were kept in special bags and were taken to laboratory. In the laboratory, the samples were air dried at room temperature until they were constantly weighted. Thereafter, they were passed through sieving sets of numbers 10, 35, 60 and 230 (63  $\mu\text{m}$ ).

The particles with sizes lower than 63  $\mu\text{m}$  can easily become suspended and emitted in the air. Therefore, their entrance into human's respiratory system and causing serious effects are more probable than larger ones. Dust particles with the size of less than 63  $\mu\text{m}$  were subjected to chemical analyses. Dust samples were acid digested (HCl, HNO<sub>3</sub>, HClO<sub>4</sub>). The metal contents of the samples were determined using Atomic Absorption Spectrometer (Buck Scientific model 210 VGP model).

By using of Hakanson's method and RI the ecological risks of each sampling location were calculated. Cluster and principal component analyses were used to identify probable sources of pollutants. In addition, possible effects of human activities on the concentrations of heavy metals were evaluated, using enrichment factor (EF).

The enrichment factor of a heavy metal is obtained according to the following formula:

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$$EF = \frac{\left[\frac{C_x}{C_{ref}}\right]_{\text{sample}}}{\left[\frac{C_x}{C_{ref}}\right]_{\text{background}}}$$

Where,  $\frac{C_x}{C_{ref}}$  is the ratio of concentrations of heavy metals to the concentration of reference metal in sample (e.g. Li in this study), and the background. Background is the concentrations of heavy metals in the earth's crust.

Determination of ecological risks of heavy metals is recommended by Hakanson (1980) as:

$$C_f = C_s / C_n$$

$$E_r = T_r \times C_f$$

$$RI = \sum_{i=1}^n E_r$$

Where  $C_s$  is the concentration of heavy metal in sample and  $C_n$  is the background value of the elements.  $E_r$  is ecological risk of each element and RI shows ecological risk of total elements. Hakanson (1980) defined  $T_r$  as "toxic-response factor" for a given substance and in sequence demonstrated this value for Cd, Cu, Pb, Cr, Zn as 30, 5, 5, 2, 1.

### Results and Discussion

Results showed higher concentrations of Cd, Mn, Zn and Fe in the street dusts of Tehran in comparison with other cities around the world. However, Pb and Cu contents in Tehran street dust samples were higher than those studied in Mutah and Ottawa, while they were lower than that of Amman (Table 1).

**Table 1: Mean concentration of heavy metals in street dusts of Tehran (n=50) and other selected cities (mg kg<sup>-1</sup>)**

Heavy Metals City	Ø(µm)	Cu	Cd	Pb	Ni	Cr	Mn	Zn	Fe	Li
Tehran (this study)	<63	222	10	254.4	34.5	33.3	1212.2	863.6	47763.7	9.3
Amman	<200	249.6	1.1	976	16.2	18.3	144.6	410	5370.6	1.72
Birmingham	<63	466.9	1.6	48	41.1			534		
Kuala Lumpur	<63	35.5	2.9	2466			153	344	1790	
London	<500	155	3.5	1030				680	26000	
Mutah	<63	69	1.3	143	1.7		136	132	5362	
Madrid	<100	188		1927	44	61	362	476	19300	
Ottawa	100-250	188	0.6	68	19	59	534	184	25660	9
Kavala	<63	172.4	0.2	386.9	67.9	232.4		354.8		
Heavy metal concentration in the earth's crust	----	50	0.2	14	80	100	950	75	41000	20

As it can be seen from Table 1, all metals studied except Cr are much higher than for reference values such as the earth's crust. The results indicate that there may be serious health and environmental impacts related to the uptake of Cd in Tehran and further investigations are needed.

For determining the EF values, Li was used as a reference metal. Using Li as the reference metal, ranges of EF values for the fifty studied samples were as follows: Fe (0.9-8.1), Zn (14.1-65.7), Ni (0.38-3.2), Cr (0.4-1.9), Pb (8.2-189.3), Cd (62.3-310.4), Cu (2.3-51.2).

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Heavy metals with EF values more than 10 are mainly from anthropogenic resources; hence, human activities are major resources of Cu, Zn, Pb and Cd in Tehran's street dusts. EF was very high for Cd. Thus, it is the metal with highest risk in the study area. Fe and Ni have moderate enrichment factors, too.

Cluster and PCA analyses results showed three main categories. Cu, Fe, Pb, Cr, Zn and Ni have common resources. These pollutants are almost certainly from human activities. The main resources of Pb in street dusts are fuel additives. Cr, Cu, Zn and Fe are from alloy erosions that are used in vehicle covers or other metallic surfaces and materials. Ni is from grease and fossil fuel combustion. The second category contains Cd. In this study there were many buildings in the streets. Therefore, building materials and tire and battery erosions could be the main resources of this element. Mn and Li are in the third bunch. As it was cited, these elements are mainly from natural sources. RI was used to determine the ecological risks of dusts in sampling stations. Results showed very high ecological risks for all sampling sites. RI values show that Cd has more serious effects on the environment than other metals. All of the fifty points demonstrated high ecological risks.

The results of this study could be used to calculate the background values of heavy metals in the street dusts of Tehran for further researches.

### **Conclusions**

In this study the concentrations of nine different heavy metals in some street dust samples of Tehran were determined. Metal Concentrations in Tehran street dust were higher than those in mean earth crust and some selected cities. Correlation coefficients, CA and PCA analyses results suggest that Cu, Pb, and Zn have common anthropogenic origins.

EF and ecological risk values of Cd, Pb, Cu and Zn are extremely high in Tehran's dust samples. Traffic and other related activities, abrasion of tires and asphalt pavement, in addition to old buildings and workshops, were identified as the main local sources of contamination. In view of the high enrichment of metals (particularly Cd and Pb), high ecological risks, toxicity and negative health effects of the dust indicate that further detailed studies of the health and environmental risks of street dusts in Tehran are necessary.

### **Key words**

Street Dust, Heavy metal, Ecological Risk, Enrichment Factor, Tehran.