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Metal Contamination of Urban Recreational and Residential Soils – Comparative Case Study of the Current Situation in Romania and India

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ABSTRACT

The present study aims at comparing the metal concentrations identified for Cd, Cu, Pb, Zn and Ni in two highly inhabited cities with similar characteristics situated in two countries that apply different policies when it comes to soil contamination. The metal concentration of urban soils in Bucharest, the capital of Romania, was investigated and compared with metal concentration formally identified in the industrial city of Ghaziabad, India in order to asses wheatear significant differences can be found.

KEYWORDS: metal contamination, soil, urban areas

Introduction

Metal contamination of soils in urban recreational and residential areas has been intensively studied over the past years due to its direct influence on public health (Mielke&Regan, 1998; Madrid, Diaz-Barrientos & Madrid, 2002). Conclusive research was first conducted in the United States (Mielke, Gonzales, Smith & Mielke, 1999) and in some western European countries (Hursthouse, Tognarelli, Tucker, Marsan, Martini, Madrid & Barrietons, 2004, Ljung, Selinus & Otabbong, 2006; De Miguel, Iribarren, Chacon, Ordonez & Charlesworth, 2007) followed closely by studies targeting other parts of the globe (Chen, Zheng, Lei, Huang, Wu, Chen, Fan, Wu & Tian, 2005; Tume, Bech, Sepulveda , Tume & Bech, 2007; Figueiredo, Tocchini & Santos 2011). Metal contamination is well known to be the result of anthropogenic activities. In order to limit metal contamination, thresholds or reference values are frequently used but the issue of metal contamination is treated differently based on the existing national approaches on the matter. Due to the fact that Romania and India have different environmental policies targeting soil the aim of the present study is to identify weather significant differences can be found when comparing metal concentration identified in soils of two rather similar cities.

Materials and methods

Study area

The current study focuses on assessing and comparing metal concentrations identified in soils of residential and recreational areas in two important industrial, social, cultural and financial municipalities. The first is Bucharest, the capital of Romania and the second is Ghaziabad, a large and well planned industrial city located closely to the capital of India, Delhi.

Bucharest is located in the Eastern Europe, on the banks of the Dambovita River and has an area of 228 square kilometres. The city's declared population according to the 2011 census was around 1,677,985 people (Census of Romania, 2011). The most significant sources of soil contamination are the intensive urban transportation and the main industrial activities are represented by energy industry, construction of machines and light industry (Lacatusu, Breaban, Lungu & Bretan, 2007).

Ghaziabad is located in the state of Uttar Pradesh and is one of the fastest growing cities in India due to its proximity to the country's capital, Delhi. The city's area reaches 210 square kilometres and the total population registered during the 2011 census is 1,636,068 people (Census of India, 2011). The major pollutants identified include textile, metal processing, lead reprocessing, chemical and pharmaceutical industry (Chabukdhara & Nema, 2013).

Both cities are similar in dimension number of inhabitants and evolutionary tendencies and therefore they can be equitably compared. Differences in the industrial activities conducted can be noticed. Moreover, the environmental policies and legislation applied in the two countries vary significantly. In Romania, soil contamination is regulated through the Government's Order no. 756 from 3rd November 1997. Reference values and thresholds are established for the most common soil pollutants, while in India, there is no regulatory criterion of metals concentrations in soils (Chabukdhara & Nema, 2013). Due to this particular reason metal concentrations in the present analysis were compared with reference values presented in the Romanian legislation.

Research methodology

The main objective of this scientific research is to identify and compare metal concentrations of recreational and residential soils in Bucharest (capital of Romania) with formally identified metal concentration in the same type of soils in the city of Ghaziabad (Chabukdhara & Nema, 2013).

In order to identify Cd, Cu, Pb, Zn and Ni concentrations for recreational and residential soils in Bucharest 21 topsoil samples (0-15 cm) were collected from 7 intensively visited locations. Soil samples wore dried using a drying stove at 110^0 and digested in aqua regia extract. Metal concentrations were determined using atomic absorption spectrometry and the arithmetical mean, standard deviation maximum and minimum were calculated using the resulted data. For the city of Ghaziabad the data was adopted from the recent research conducted by Chabukdhara & Nema published in 2013. The two sets of data were compared aiming to identify both similarities and most significant differences.

Results and discussions

Metal concentration for soil samples from recreational and residential areas in Bucharest ranges between 0.13 and 1.53 mg/kg for Cd, 11.5 and 43.1 mg/kg for Cu, 9.7 and 89.2 for Pb, 46 and 230 mg/kg for Zn and 10.5 and 29.1 for Ni. The Government's Order no. 756 from 3rd November 1997 stipulates the following thresholds (mg/kg) as normal: 1 for Cd, 20 for Cu, 20 for Pb, 100 for Zn and 20 for Ni. In 6 out of the 7 locations, the metal concentration identified exceeds the values considered as being normal in Romania for Cu, Pb, Zn and Ni. In 5 out of 7 locations lead concentration exceeds the alert threshold of 50 mg/kg.

Table 1. Descriptive statistics of metal concentrations in recreational and residential soil of Bucharest (mesured and calculated values) and Ghaziabad (statistical data adopted from the research conducted by Chabukdhara & Nema published in 2013)

		Cd (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Zn (mg/kg)	Ni (mg/kg)
Bucharest	Average	0.6	28	58	130	25
	Standard deviation	0.5	11	29	58	7
	Xmax	1.5	43	89	230	29
	Xmin	0.1	12	10	46	11
Ghaziabad	Average	0.2	53	111	65	27
	Standard deviation	0.1	31	60	19	10
	Xmax	0.3	98	162	87	38
	Xmin	0.1	24	27	38	13

Table 1 was elaborated to better structure metal concentrations and to illustrate relevant statistical values. From analysing table 1 it can be inferred that Cd and Zn concentrations measured in recreational and residential soils in Bucharest are relatively higher than Cd and Zn concentrations identified in the same type of soil in Ghaziabad. Cu and Pb concentrations in Ghaziabad exceed the ones for the same metals in

Bucharest. Ni concentrations in both cities are relatively similar.

Average concentrations for metals analysed in both cities were compared with the normal reference values considered in Romania's Government's Order no. 756 from 3rd November 1997, as shown in figure 1. Pb concentrations exceed normal values, especially in the city of Ghaziabad underlining the fact that industrial activities such as metal processing and lead reprocessing are consistent pollutants of the urban environment.

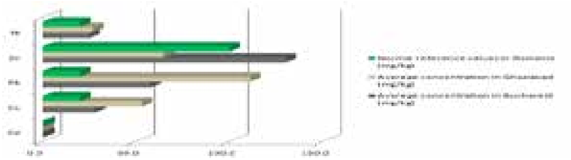

Figure 1. Normal reference values in used for regulating soli contamination on Romania compared to averge values in Bucharest (mesured and calculated) and Ghaziabad (data adopted from the research conducted by Chabukdhara & Nema published in 2013)

On one hand, taking into account the fact that maximum concentrations identified for Ni, Zn, Cu and Cd are situated under the alert threshold stipulated in Romania's Government's Order it can be concluded that no significant risks are posed to human health by soil contamination with the above mentioned metals. On the other hand, Pb concentrations in some recreational and residential soils in both cities exceed the alert thresholds and therefore it can be stated that lead contamination can pose risks to human health. In this situation further risk assessments needs to be conducted on case to case bases and if risks prove to

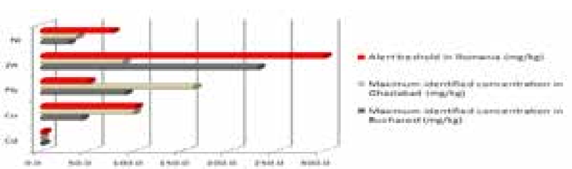

Figure 2. Alert tresholds for soil contamination in Romania compared to maximum values identified in Bucharest (mesured) and Ghaziabad (data adopted from the research conducted by Chabukdhara & Nema published in 2013)

Conclusions and personal considerations

In the present study Cd, Cu, Pb, Zn and Ni concentrations in soils of recreational and residential areas in two highly inhabited cities Bucharest and Ghaziabad, with similar characteristics situated in two different countries, Romania and India, were assessed and compared. The analysis shows that Cd and Zn concentrations measured in recreational and residential soils in Bucharest are relatively higher than Cd and Zn concentrations identified in the same type of soil in Ghaziabad while Cu and Pb concentrations in Ghaziabad exceed the ones for the same metals in Bucharest. Ni concentrations identified in both cities are relatively similar. The two sets of data were compared with the national thresholds established for Romania due to the fact that India lacks regulatory criteria of metals concentrations in soils. The results show that Pb concentrations exceed normal values and alert thresholds especially in the city of Ghaziabad underlining the fact that industrial activities such as metal processing and lead reprocessing can make a significant difference in terms of soil contamination.

Due to the fact that there are metals such as Cd and Zn that have higher concentrations in Bucharest than in the city of Ghaziabad can lead to the conclusion that the presence or absence of regulatory criteria for soil contamination does not necessarily make a significant difference in terms of metal contamination limitation. Nevertheless the presence of such reference values established throw national legislation represents a valuable starting point when assessing risks related to soil contamination.

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