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Agricultural practices within urban and industrial settings in Portugal: Levels of Cd, Cu, Pb and Zn in soils and crops

N. Cruz[1], C. Coelho[1], T. Teixeira[1], M. Dias[1], B.Henriques[1], A. C. Duarte[1], S.M. Rodrigues[1*], E.Pereira[1], Paul F.A.M. Römkens[2]

[1]CESAM & Departamento de Química, Universidade de Aveiro, 3810-193 Aveiro, Portugal ([*]corresponding author: smorais@ua.pt)
[2]Alterra – Wageningen University and Research Center, PO Box 47, Wageningen, 6700 AA, the Netherlands

Introduction

Soils are an essential component of the urban environment, contributing directly or indirectly to the general quality of life. (Ajmone-Marsan and Biasioli, 2010). The risk associated with concentrations of trace elements in urban soils is related with the potential for direct human exposure (through inhalation, ingestion and dermal contact) as well as with their potential to leach to groundwater and to enter the food chain through plant uptake (Ajmone-Marsan and Biasioli, 2010). The transfer of contaminants from soil to plants can be affected by soil properties and varies with the types of plants (Kabata-Pendias and Pendias, 2001).

Objective

At present, the information on the impacts of soil contamination on the quality of crops produced in urban settings in Portugal is scarce. The purpose of this study was therefore to assess levels of cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn) in soils and crops from a large urban agglomeration and to compare them with an area affected by intense industrial activity.

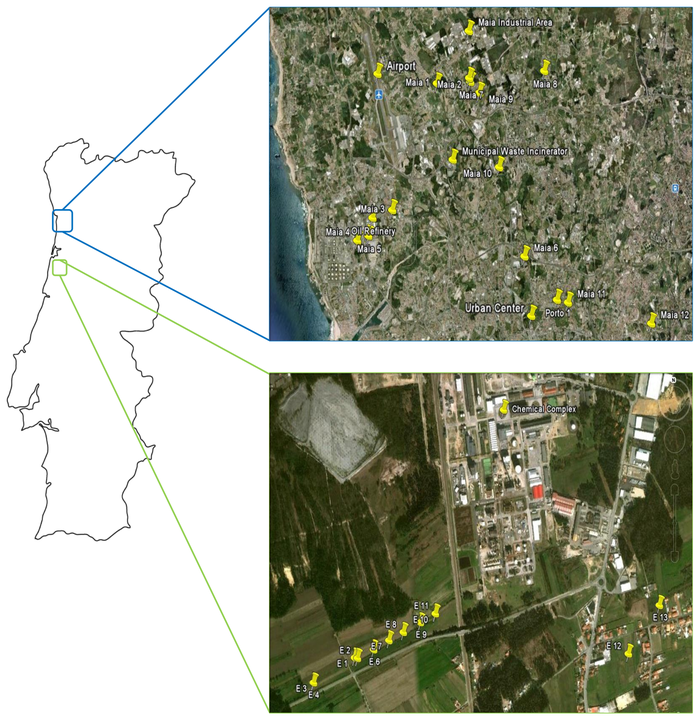
Experimental Procedure

A total of 45 soil and 45 plant samples were collected in the urban area. 39 soil and 33 samples were collected in the industrial sites. Types of plants sampled included mustard greens (*Brassica juncea)* (n=15) and ryegrass (*Lolium perenne*) (n=53) . All samples were collected in fields being used for agriculture / pasture.

	Sample Preparation	Procedure	Analysis
Soils	dried in the air until constant weight and sieved (<2 mm).	aqua regia digestion.	ICP-OES
Plants	dried in the oven at 45 ºC and ground.	pulverized at 450ºC and a 0.5 g split of each material were leached in hot (95 ºC) aqua regia for 60 min.	ICP-OES

Figure 1 – Types of plants sampled: Ryegrass (*Lolium perenne*) and mustard greens (*Brassica juncea*).

Location of sampling sites



Urban area

1,400,000 inhabitants

45 soil and 45 plant samples from pasture and agricultural fields near and within the city.

Industrial area

7,800 inhabitants

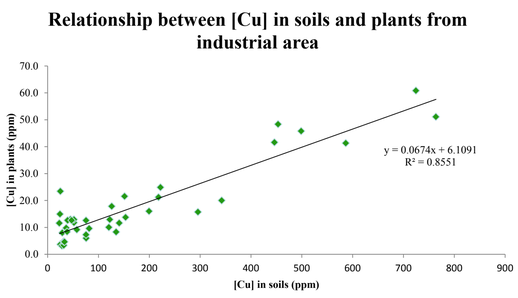
39 soil and 33 plant samples from agricultural fields surrounding the Estarreja Chemical Complex.

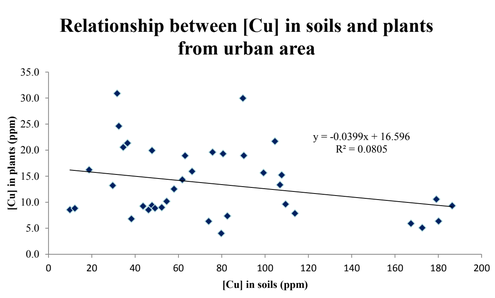
Figure 2 – Sampling sites.

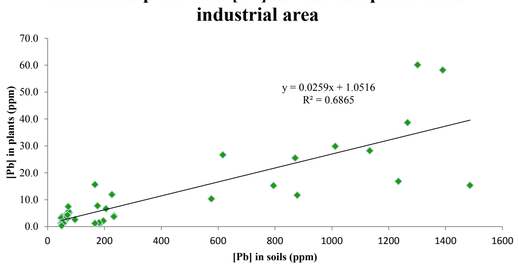
Results

Table 1 – pH values from industrial and urban area soils.

pH values						
	0-10 cm			10-20 cm		
	Max	Min	Median	Max	Min	Median
Industrial Area	5.7	4.4	4.8	5.8	4.5	4.9
Urban Area	7.2	4.2	5.4	7.3	4.4	5.4







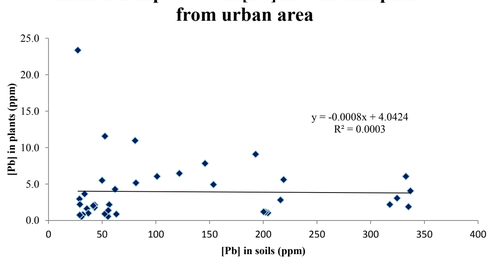


Figure 3– Scatter plot ilustrating relationship between concentration Cu and Pb in soils and plants from industrial and urban area.

SOILS

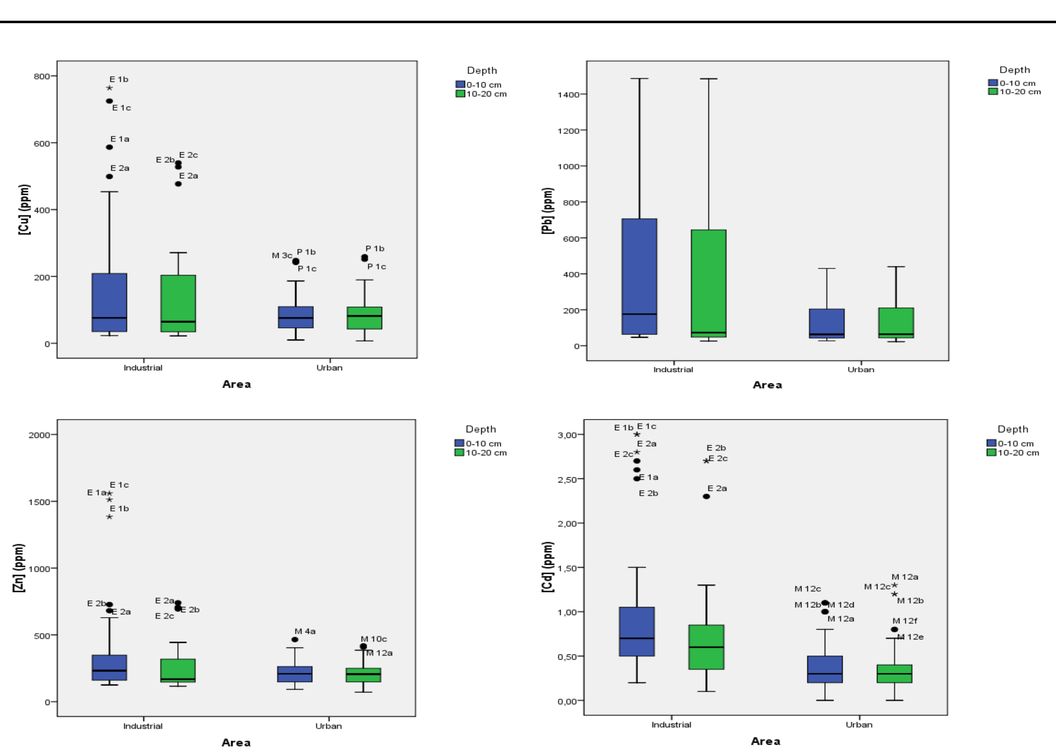


Figure 4 – Boxplot of metal concentrations (ppm) for Cu, Cd, Pb and Zn in soils from industrial and urban area.

PLANTS

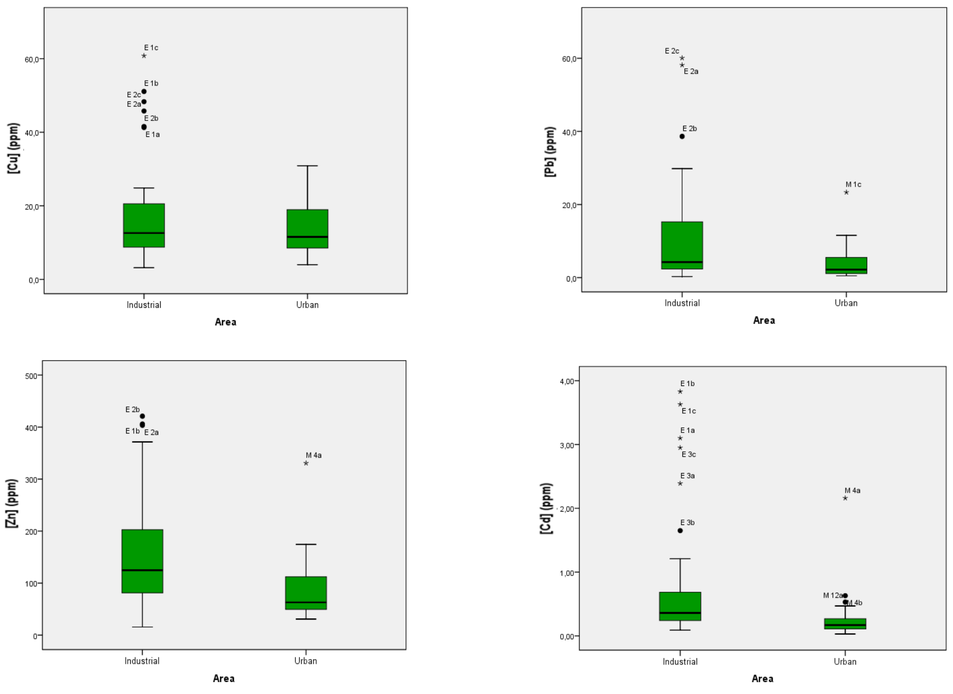


Figure 5 – Boxplot of metal concentrations (ppm) for Cu, Cd, Pb and Zn in plants from industrial and urban area.

Conclusions

- Although the median concentration of Cu, Pb and Zn in soils from the industrial area was not considerably different from that in urban soils, there was a higher variability of Cu and Pb in industrial soils.
- For Cd, urban soil concentrations were relatively lower than those from the industrial area.
- Outlier metal concentrations in soils from the industrial area were associated with the proximity of a former effluent stream.
- Outlier metal concentration in soils from the urban area were associated with intense traffic areas and potential leachates from surrounding industries.
- There was also higher variability in crop metal contents in the industrial area compared to the urban sites which were associated with the soil contamination from a former effluent stream.
- The analysis of the relationships between soil and crop levels of Cu and Pb in soils from the two areas showed a better agreement in the case of the industrial sites. One explanation is the wider contamination ranges observed in the industrial area. It may also indicate that, other factors (such as soil properties) rather than just the soil total concentration affect crop metal contents in the urban area. This requires further investigation.

References

Ajmone-Marsan, F., Biasioli, M., Trace elements in soil of urban areas, **2010**, Water Air Soil Pollution, 213, 121-143.

Kabata-Pendias, A., Pendias, H., Trace elements in soils and plants, **2001**, Third Edition, CRC Press Inc., London.