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METAL ASSESMENT IN URBAN PARK SOILS IN SÃO PAULO 4. ALFREDO VOLPI (MORUMBI PARK)

Sonia P. Camargo [1], Ana Maria G. Figueiredo [1], Arthur C. Pavese [1], Felipe C. Gumiero [1], Jacinta Enzweiler [2]

[1] Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
spompeu@8415.com.br
anamaria@ipen.br

[2] Instituto de Geociências – UNICAMP
Cidade Universitária Zeferino Vaz, Distrito de Barão Geraldo, C.P. 6152
13083-970 Campinas, SP
jacinta@ige.unicamp.br

ABSTRACT

The presence of elevated metal concentrations in soils of the urban environment has been recognized as an important source of metal intake to humans, particularly to children, which are more susceptible to the adverse effects of soil ingestion than adults. There has been little research on urban soils in São Paulo, a very populated city with severe pollution problems, and there is little information about metal concentration levels in public parks of São Paulo. As part of a project which aims metal assessment in urban park soils from São Paulo, in the present paper the concentration of the elements As, Ba, Cr, Sb and Zn were determined in topsoil samples (0-5cm and 0-20cm) from Alfredo Volpi (Morumbi) park of São Paulo. Instrumental Neutron Activation Analysis (INAA) was used for metal analysis. Preliminary results showed higher concentrations of As, Ba and Sb compared with the values considered as reference for soils in São Paulo, according to Environmental Protection Agency of the State of São Paulo (CETESB). In some samples Ba showed concentration levels higher than the Prevention values reported by CETESB.

1. INTRODUCTION

Urban soils are the natural "recipients" of heavy metals from a variety of sources including industrial wastes, vehicle emissions and other activities. Human health in towns and cities is strongly dependent on the status of urban soils. The presence of potentially toxic metals in high concentrations in urban soils has been recognized as an important source of human metal intake particularly to children which are more susceptible to the adverse effects of soil ingestion than adults [1,2]. Studies on urban soil pollution started in the 60's [3,4,5] and recent studies on chemical composition of urban soils were made in cities such as Palermo [1], Uppsala [2], Madrid [6], Napoles [7], Hong Kong [8], Turim [9], e Galway [10].

São Paulo is a city with 19 millions of inhabitants distributed on 1,525 km² which shows severe pollutions problems. It has a huge industrial park and approximately one vehicle for each two inhabitants. There has been little research on urban soils in São Paulo and there is little information about metal concentration levels in public parks of São Paulo.

In the present study, the concentration of the elements: As, Ba, Cr, Sb and Zn were determined in surface soil samples (0 – 5 cm and 0 – 20 cm) from Alfredo Volpi (Morumbi) park of São Paulo. Alfredo Volpi was part of the old Morumbi tea farm. That park was created in 1971 to preserve the environment as far as it has a significant portion of Atlantic forest vegetation wich constitutes 80% of its 142.432 m^2. It is located at the Southern region of the city in a very residential and green area. This study is part of a project which aims to assess metal concentration in urban park soils of São Paulo.

2. INSTRUMENTAL NEUTRON ATIVATION ANALYSIS (INAA)

INAA is a powerful analytical technique to perform qualitative and quantitative multi elemental analysis. For many elements INAA provides detection limits of part per billion or better. Instrumental neutron activation analysis consists of irradiating a target (sample) with neutrons which interact with the nuclei of the elements present in the sample, originating nuclear reactions, mainly (n,γ) reactions. The radioactive nuclides formed decay by emission of one or more characteristic gamma rays. The energy of the radiation emitted is characteristic of the radioisotope produced and the intensity of the radiation at a given energy is directly proportional to the amount of the element which originated the radioisotope. The instrumentation used to measure the gamma rays consists of a semiconductor detector (hyperpure germanium detector – HPGe), associated eletronics and a multichanel analyser. The comparative neutron activation analysis was employed, which consists of irradiating the samples together with reference materials containing a known amount of the element of interest.

3. MATERIAL AND METHODS

12 topsoil samples (depth 0 – 20 cm) were collected along a line across the park. A distance of 30 cm was kept at each sampling point. A sample composed of sub-samples of (0-5cm) depth was collected in the same line at each 10 m. Figure1 shows the sampling points in Alfredo Volpi park

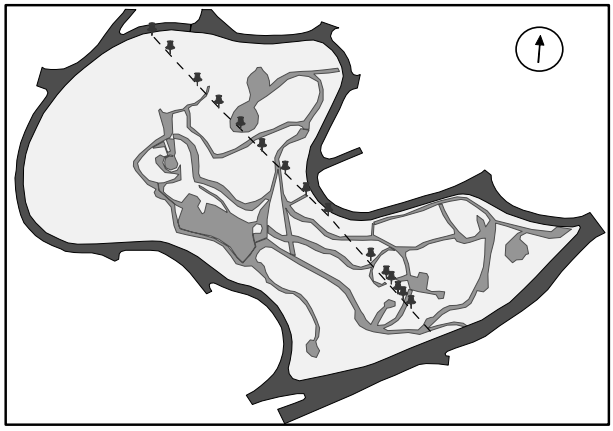

Fig. 1: Sampling points in Alfredo Volpi park

The samples were collected by using a polyethylene tube with 4 cm diameter and were stored in plastic bags. In the laboratory, the samples were dried at 40-50ºC and were sieved through plastic-only sieves into < 2mm fraction. Before and after sieving, the samples were homogenized and quartered and then grinded in an agate mortar.

Each sample weighing about 100 mg was placed in a pre-cleaned inert plastic bag, inserted in an aluminum vessel and irradiated for 8 hours at a thermal neutron flux of 10^{13} n cm^{-2} s^{-1} at the IEA – R1 nuclear reactor of IPEN/CNEN–S.P. To obtain the concentration of the elements of interest the reference materials Soil7 (IAEA), GS-N and BE-N (GIT-IWG) were irradiated with the samples. The gamma ray spectrometry was performed by using a GX20190 hyperpure Ge detector (FWHM of 1.9 keV for the 1.332 keV peak of ^{60}Co) and associated electronics. Two series of countings were performed: the first one five days after irradiation and the second one 15 days after irradiation. The counting times varied from 1 to 2.5 hours. The gamma-ray spectra were processed by using the VISPECT gamma-ray software, which locates peak positions and calculates the energies and net areas.

4. RESULTS AND DISCUSSION

The concentrations of As, Ba, Cr, Sb and Zn in the topsoils soil of Alfredo Volpi park obtained in the this study were compared with the values considered as guiding values for soils in São Paulo, according to Environmental Protection Agency (CETESB) [11] and are shown in Table 1.

The results showed that except for Zn the concentration of all elements exceeded the Quality Reference Value (VRQ) reported by CETESB [11]. According to CETESB, the VRQ is the concentration of determined substance in the soil which defines a soil as clean. These values were determined based on the statistical interpretation of physical-chemical analysis of different kinds of soils from the State of São Paulo. The element Zn is considered a traffic-related element and the concentration range obtained may indicate that there is not a significant influence of vehicle exhausts in the Alfredo Volpi soil. Only Ba concentration exceeded the Prevention Value (PV) in the (0-20cm) samples. Metal concentration levels above the PV, according to CETESB, can cause prejudicial alterations in soil and subterranean water quality.

Table1: Metal contents in topsoils of Alfredo Volpi park (mg kg^{-1}).

Element	AV (0–5) cm	AVA (0–20) cm	Quality Reference Value [11]	Prevention Value [11]	Agricultural Intervention Value [11]
As	7 ± 1	3.0 – 13.0	3.5	15	35
Sb	1.4 ± 0,2	0.8 – 1.9	0.5	2.0	5.0
Ba	129 ± 3	100 - 231	75	150	300
Zn	41 ± 1	23 - 53	60	300	450
Cr	41 ± 3	29 - 63	40	75	150

5. CONCLUSIONS

The results obtained in this study showed that the concentrations of As, Sb, Cr in the soil of Alfredo Volpi park exceeded the VRQ reported by CETESB. The Zn concentration, a traffic-related element, was below the VRQ. In the case of Ba, concentration levels above the Prevention Value were obtained in the (0-20cm) samples. As far as the Alfredo Volpi park has a significant portion of preserved Atlantic forest vegetation, these results suggest natural concentrations of the analyzed elements in the soil

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REFERENCES

1. D.S. Manta., M Angelone., A.Bellanca, R. Neri, M. Sprovieri, "Heavy metals in urban soils: a case study from the city of Palermo (Sicily), Italy", *Sci Total Environ* **300**, pp.229-243 **(**2002).
2. K. Ljung, O. Selinus, E. Otabbong, " Metals in soils of children's urban environments in the small northern European city of Uppsala", *Sci Total Environ.,* **366**, pp. 749-759, 2006.
3. D. Purves, "Contamination of urban garden soils with copper and boron". *Nature*, **210,** pp.1077-1078 (1966).
4. C. Wilkins, "The distribution of lead in the soils and herbage of West Pembrokeshire" *Environ Pollut,* **15(1), pp.** 23-30 (1978).
5. B.E. Davies, "Plant-available lead and other metals in British garden soils", *Sci Total Environ* **19 (3)**, pp. 243 -262,(978).
6. E. De Miguel, M.J. De Grado, J.F. Llamas, A. Martín-Dorado, L.F. Mazadiego, "The overlooked contribution of compost application to the trace element load in the urban soil of Madrid (Spain)", *Sci Total Environ*, **215**, pp.113-122, (1998).
7. M. Imperato, P. Adamo, M. Arienzo, D. Stanzione, P. Violante, "Spatial distribution of heavy metals in urban soils of Naples city (Italy)", *Eviron Pollut*, **124**, pp. 247-256, (2003).
8. C.S. Lee, X. Li, W. Shi, S.C. Cheung, L. Thornton, "Metal contamination in urban, suburban, and country park soils of Hong Kong, "A study based on GIS and multivariate statistics", *Sci Total Environ*, **356(1-3)**, pp. 45-61 (2006)
9. M. Biasioli, , R. Barberis, F. Ajmone-Marsan, "The influence of a large city on some soil properties and metals content", *Sci. Total Environ*, **356**, pp. 154-164, (2006).
10. C. Zhang, "Using multivariate analyses and GIS to identify pollutants and their spatial patterns in urban soils in Galway, Ireland", *Environ Pollut*, **142(3)**,pp. 501-511.(2006).
11. CETESB, Decisão de Diretoria No. 195-2005-E, de 23 de novembro de 2005, Dispõe sobre a aprovação dos Valores Orientadores para Solos e Águas Subterrâneas no Estado de São Paulo – 2005, em substituição aos Valores Orientadores de 2001.