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METAL ASSESSMENT IN URBAN PARK SOILS IN SÃO PAULO. 1. IBIRAPUERA PARK

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ABSTRACT

In the last years urban soils received increasing attention by scientists, leading to studies focused on their description and investigation all over the world, due to the increasing metal pollution derived from incinerators, industrial waste, atmospheric deposition of dust and aerosols, and other activities. Metal contamination in São Paulo public parks is an important environmental question and there is little information on this subject. 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, Pb, Sb and Zn were determined in surface soil samples (0-5cm) from Ibirapuera park of São Paulo. Ibirapuera park is one of the biggest and most visited parks of the city of São Paulo, receiving during the weekends more than 400,000 visitors. Instrumental Neutron Activation Analysis (INAA) and X-ray Fluorescence (FRX) were used for metal analysis. Preliminary results showed concentration levels of the analyzed elements higher than the values considered as reference values for soils in São Paulo, according to the Environmental Protection Agency of the State of São Paulo (CETESB). For As, Ba, Cr and Sb, in some samples the concentrations were even higher than the Prevention values reported by CETESB. The high concentrations of the elements As, Ba, Cr, Pb, Sb and Zn in the Ibirapuera park top soils suggest an anthropogenic source and indicate a potential damage to soil quality.

1. INTRODUCTION

The urban environment quality is of vital importance as the majority of people now live in cities. Human health in cities is strongly dependent on the status of urban soils [1]. Metals occur naturally in soil, but contents are generally increased in the urban environment due to anthropogenic activities.

Urban soils are known to have peculiar characteristics such as unpredictable layering, poor structure and high concentrations of trace elements [2]. It is difficult to characterize urban soils as far as these soils show major differences as compared to soils in natural and cultural

landscapes. Some have special characteristics as a result of the application and mixture of natural and artificial substrates (waste, bricks, concrete, etc.) [3].

In the last few years urban soils received increasing attention by scientists, leading to studies focused on their description and investigation all over the world, due to the increasing metal pollution derived from incinerators, industrial waste, atmospheric deposition of dust and aerosols, and other activities [1,2], [4-8].

Urban soils play an important role in maintaining the environmental quality as they can act as both source and sink for pollutants that can affect human health [7]. In areas where public gardens and parks are exposed to significant pollution levels, dust from the ground have toxic effects as a consequence of inhalation or ingestion by humans, particularly children which are more susceptible to the adverse effects of soil ingestion than adults due to their developing nervous system and high absorption rate [2,8].

Parks and playgrounds are where urban children spend most of their time outdoors and are also where children most frequently come in contact with soil. Children exposed to contaminated soils, dust and air particulates may ingest a significant amount of toxic elements through the hand-mouth pathway [7]. Contaminated urban soils have been identified by several authors as a significant source of Pb exposure in children [8].

In Austria some surveys have been performed dealing with the condition of soil in urban areas, in particular pollution levels. Whereas the load of heavy metals in arable soils showed only in individual cases increased concentrations of copper, lead, zinc, mercury and arsenic, half of the garden soils were polluted with heavy metals. The average concentration of lead, cadmium, mercury and zinc was more than two-fold above the average concentration of the same pollutants in the soils of the province of Upper Austria [3].

There has been little research on urban soils in São Paulo, the biggest city in Latin America. The metropolitan region of São Paulo is composed of 39 municipalities, with a population of 18 million people, with about 8000 km^2 and a strong industrial activity. The urban area is polluted by industrial emissions but, according to CETESB, the Environmental Protection Agency of the State of São Paulo [9], the governmental agency of air quality control, emissions from about 7.8 million motor vehicles daily are the main sources of air pollution.

São Paulo city has suffered a rapid and disordered growth in the last decades which lead to considerable loss in agricultural soils and urban greenspace. Therefore, São Paulo public parks play an important role as leisure areas for the population. There has been little research on metal concentration levels in public parks of São Paulo.

This study presents the results obtained for the concentration levels of 7 potentially toxic elements (As, Ba, Cr, Cu, Pb, Sb and Zn) in Ibirapuera park soils of São Paulo. Ibirapuera park, located in the Southern region of the city, is one of the biggest and most visited parks of the city of São Paulo, receiving during the weekends more than 400,000 visitors. In order to highlight the extent and severity of contamination, we take advantage of the availability of dataset provided by CETESB of reference values for soils of São Paulo [10].

2. MATERIALS AND SAMPLING STRATEGY

The soil samples were collected between October and December 2006. Top soil samples (0-5cm) were composed by sub-samples collected in the park in order to have representative samples of the whole park (Fig. 1). A polyethylene tube with 4 cm diameter was used to take the samples, which were stored in inert plastic bags. In the laboratory, the samples were dried at 40-50^{o}C and were sieved through plastic-only sieves into <2 mm fraction. Before and after sieving, the samples were homogenized and quartered. Samples were then grinded using an agate mortar in order to obtain a fine and homogeneous powder (< 75 mm).

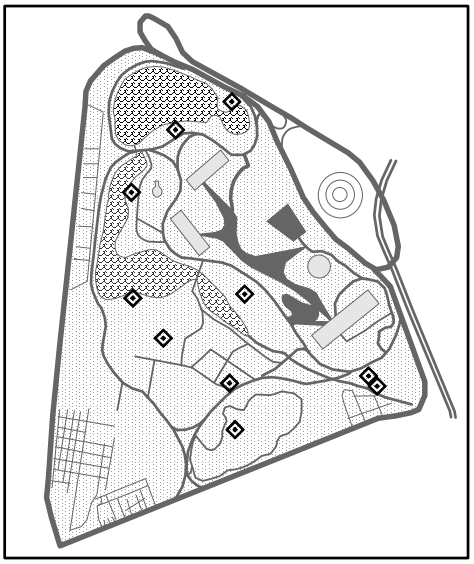

Figure 1. Ibirapuera park and the sampling points

2.1. Analytical Methods

Instrumental Neutron Activation Analysis (INAA) and X-ray Fluorescence (FRX) were used for metal analysis.

Instrumental neutron activation analysis (INAA) was employed to analyse As, Ba, Cr, Sb and Zn. One hundred to one hundred and fifty mg of each sample and of the geological reference materials basalt BE-N (ANRT) and granite GS-N (ANRT) were accurately weighed in polyethylene bags. Samples and reference materials were 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. The measurements of the induced gamma-ray activity were carried out in gamma-ray spectrometer with a GX20190 hyperpure Ge detector (Canberra). The accuracy and precision of the results were verified by the analysis of the reference materials Soil-7 (IAEA). The results showed good accuracy (relative errors to certified values < 5% for most of elements) and good precision (relative standard deviations < 15%).

X-ray florescence (XRF) was employed to determine Pb, and Cu. Pellets (40 mm diameter) consisting of a mixture of 9 g of the sample and 1.5 g of powdered wax (Hoechst) were prepared and measured in a sequential XRF spectrometer (PW2404, Philips), equipped with a rhodium tube. The accuracy and precision of the results were verified by the analysis of the reference materials GSS-2 and GSS-4, presenting relative errors and precision better than 10%.

3. RESULTS AND DISCUSSION

The concentration ranges of As, Ba, Cu, Cr, Pb, Sb and Zn in the investigated urban soils are presented in Table 1, as well as the guiding values for São Paulo soils, according to the Environmental Protection Agency of the State of São Paulo [10] and concentrations found in other cities parks [2,3].

The results obtained showed concentration levels of the analyzed elements higher than the values considered as reference values for soils in São Paulo [10] (Table 1). It has to be pointed out that the analytical techniques employed for metal determination by CETESB was based on the partial acid extraction of the soil samples followed by Atomic Absorption Spectrometry ,which may give different results from INNA and XRF, which provide total metal analysis.

Table 1. Metal concentrations in Ibirapuera Park Topsoil

Element	Ibirapuera Park 0-5cm	Quality Reference Value [10]	Prevention Value [10]	Intervention Value [10]	Public greens and parks in Viena, Austria [3]	Green areas and Parks in Palermo, Italy [2]
As	11.5-21.5	3.5	15	35	---	
Sb	1.4-2.5	0.5	2,0	5.0	---	3.0
Ba	85-251	75	150	300	---	
Zn	73-225	60	300	450	84.2-269.6	138
Co	2.3-3.1	13	25	35	---	5.2
Se	1.1-2.5-	0.25	5	---	---	
Cr	61-102	40	75	150	16.4-40.3	34
Cu	24-54	35	60	200	22.6-81.1	63
Pb	31-83	17	72	180	37.2-143.7	202
V	104-168	275	--	--	---	54
Ni	17.5-27	13	30	70	22.2-34.5	17.8

For Co and V, concentration levels below the Quality Reference Value reported by CETESB were obtained.

For Cu, Ni, Se, Pb and Zn, concentration results were between the Quality Reference Value and the Prevention Value. For As, Ba, Cr, and Sb, the soil samples presented concentration levels near or above the Prevention Values reported by CETESB (2005). Metal concentration levels above the Prevention value, according to CETESB, can cause prejudicial alterations in soil and subterranean water quality.

It can be seen that the results obtained are of the same order of magnitude of the metal concentrations reported for green areas and parks in Viena and Palermo, presenting much lower Pb concentration.

The results obtained suggest an anthropogenic source and indicate a potential damage to soil quality.

4. CONCLUSIONS

The results obtained showed that elements such as As, Ba, Cr, Sb, Se e Zn in Ipirapuera park topsoils are present in concentration levels much higher than the Quality Reference Value for soils of São Paulo State, reaching in some cases the Prevention Value. These results may show a potential risk to soil and groundwater quality and to the park users.

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