URBAN GREEN AS INDICATOR OF METAL POLLUTION

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Introduction

Among air pollutants, particulate matter (PM) poses the greatest risk to human health. Throughout Europe, a network of air monitoring stations provides continuously gravimetric-based concentrations of atmospheric PM. However, its chemical composition is often neglected. Moreover, the spatial resolution of these conventional air monitoring stations is too low to properly monitor the high spatial variability in atmospheric PM exposure within urban environments. Urban vegetation can play herein an important role as it provides a natural surface for deposition and immobilization of small airborne particles. The use of e.g. plant leaves as passive collectors of urban PM submitted to magnetic analyses, provides a robust and cost-effective PM monitoring, as an alternative and complement to the conventional air monitoring systems. Several studies confirmed the saturation isothermal remanent magnetization (SIRM) of leaves to be a suitable magnetic bio-indicator to investigate metal-containing PM pollution at high spatial resolution as correlations were found between leaf SIRM and e.g. cumulative atmospheric PM concentrations (Hofman et al., 2014) or PM mass (Mitchel and Maher, 2009; Muxworthy et al., 2003). Because this methodology is rapid and inexpensive, it can be used to identify and delineate high-polluted areas in urban environments (Moreno et al., 2003). However, particle analysis such as in terms of composition and size should not be overlooked, as these factors closely influence the PM effects on human health, and may be decisive for source attribution purposes. In this study, SIRM-magnetic analysis and scanning electron microscopy (SEM-EDX) were used to investigate PM deposition on plant leaves collected from different land use classes.

Methods

Common ivy (*Hedera sp.)* leaves were collected between 1.30 – 1.70 m in height from five different land use classes (forest (F), rural (R), roadside (RD), industrial (I), and train (T)). The leaf surface was examined using a Quanta 250 scanning electron microscope (FEI, USA) operated at high-vacuum conditions, accelerating voltage of 20.00 kV, magnification of 500×, and spot size of 3.6. Particles were detected based on their backscattered electron signal, and analyzed individually using an energy dispersive X-ray spectrometer (EDX) coupled to the SEM microscope. From this SEM-EDX analysis, data were obtained in terms of particle composition, size and shape for ca. 40,000 leaf-deposited particles. The leaves were then

submitted to a SIRM-based magnetic analysis using a Molspin pulse magnetizer (pulsed field of 1T) and a Molspin Minispin magnetometer (Molspin Ltd., UK). The surface area of the leaves was measured using a leaf area meter LI-3100C (Licor Biosciences).

Results

The area-normalized leaf SIRM results obtained from the collected ivy leaves ranged from 19.9 µA to 444.0 µA, in the following order F < R < RD < I < T. The leaf particulate Fe content ranged from 9 to 11% for the forest, rural and industrial sites, but for roadside and train leaves almost 25% of the total volume of leaf-deposited particles was composed of Fe. Although the relation between the two variables (leaf SIRM and Fe content from SEM-EDX) was not linear across the different land use classes (Figure 1), it represented a good starting point to investigate the complementarity of these two different methodologies.

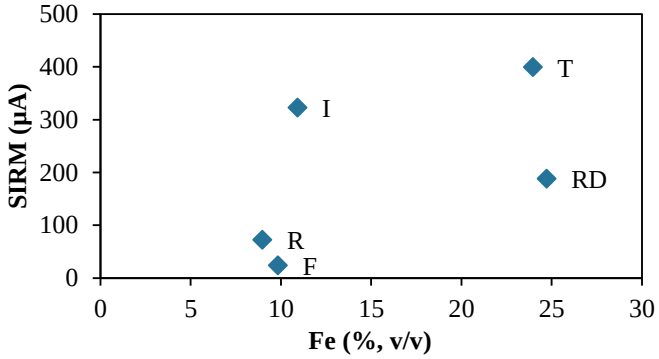

Figure 1. Plot of the mean leaf SIRM results against the estimated mean Fe content for the different land use classes (F – forest; R – rural; RD – roadside; I – industrial; T – train).

Conclusion

Leaf SIRM of ivy can be used as indicator of urban PM and metal pollution, and is able to distinguish between land uses with different urban habitat quality. The combined use of magnetic analysis and scanning electron microscopy offers potential for a better assessment of leaf-deposited PM.

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