APPLICATION OF SOIL MAGNETOMETRY FOR THE SOIL POLLUTION STUDY IN UPPER SELESIA (SOUTHERN POLAND) IN TWO DIFFERENT SCENARIOS

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Introduction

Application of soil magnetometry for study of spatial distribution of pollution in soil organic horizons in urban and industrial areas was proposed by many authors (Spiteri et al. 2005, Magiera et al. 2007, Jordanova et al. 2008; Kapička et al. 2008). The sources of magnetic signal are technogenic magnetic particles (TMPs) transported by the wind and deposited on the soil surface. TMPs are mostly ferrimagntic iron oxides with different potentially toxic elements (PTEs) adsorbed on their developed specific surface area. The magnetic and chemical properties of TMPs are dependent on the pollution sources, but their distribution in soil profile is different for forest and arable soils (Magiera et al. 2006). The aim of this study was to validate the application of soil magnetometry on two different areas (forest and agricultural) influenced by different pollution sources (industrial and urban deposition as well as dusting from the local Pb-Zn processing wastes).

Methods

Studies were carried out in two different scenarios: first performed on forest area affected by urban deposition from the city of Dąbrowa Górnicza (from the west) and from a large metallurgical complex "Huta Katowice" (from the east); the second one performed on arable land located in Piekary Śląskie, close to a large dump of slag remaining after Zn and Pb ore processing. On the both study areas the same measurement procedure was applied. As a first step, the surface magnetic susceptibility (κ) measurements using MS2D Bartington loop sensor were performed. Spatial distribution of κ values was presented as a map created using Surfer 8 software. On the basis of acquired maps the topsoil cores up to 30 cm depth were collected from magnetic "hot spots" and areas with medium and low κ values. The vertical distribution of κ in topsoil cores were measured using the MS2C Bartington sensor, and the layers with maximum values were selected for geochemical analysis. The content of 20 elements was determined with ICP-MS after digestion in HNO_3. Different set of elements was chosen for Pollution Load Index (PLI) calculation in different scenarios.

Results

Values of soil magnetic susceptibility (κ) in forest soils varied from 30 to 400 $\times 10^{-5}$ SI units. In soil profiles, the high increase of κ value was observed within uppermost 5 cm of organic horizon. Whereas, on arable land κ values were higher but more stable in the whole area within the range of 80 – 250 $\times 10^{-5}$ SI units, with a tendency to decrease with increasing distance from the waste heap. In soil profiles, the κ value was high, but stable within 25 cm of arable layer. In forest area influenced by urban and metallurgical sources, the high correlation coefficients between magnetic susceptibility and such elements as Fe, Ni and Cr (0.64, 0.76, 0.70 respectively) typical for iron metallurgy and Zn, Pb, Cd and Cu (0.68, 0.57, 0.66, 0.75 respectively) typical for urban sources were observed. In agricultural area influenced by non-ferrous waste dusting, very specific elements present in Zn-Pb ore wastes exhibit correlations with magnetic susceptibility values (Zn 0.83, Pb 0.96, Cd 0.80, Tl 0.83, As 0.82, Sn 0.85, Ba 0.94). The correlation between spatial distribution of magnetic susceptibility and PLI values were 0.86 for forest area and 0.94 for arable soil.

Conclusion

Different pollution sources emit different elements which are transported by TMPs. Therefore the kind of pollution source have to be considered in calculation of PLI index. In case of areas influenced by urban source and iron metallurgy, the content of Zn, Pb, Cd, Cu and Cr, Ni and Fe have to be the basis of PLI calculation. In area influenced by non-ferrous ore processing wastes, the content of Zn, Pb, Cd, Sn, Cu, Tl, Ba As and Se have to be taken into account in the PLI calculation.

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