



Heavy metal mobility in humus layers impacted by copper industry in SW Poland

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The study was carried out on forest humus layers impacted by dusting from a copper smelter and copper ore tailings facility. The Legnica copper smelter is a part of the mining and metallurgy complex founded in 1951, which currently includes 4 mines, 3 ore enrichment plants and 3 smelters. The complex has been producing approximately 500000 tons of copper annually, one fourth of that is produced in the Legnica smelter. Copper smelting was connected in the past with a large emission of metal-containing dust, significantly reduced during the 1980s and 1990s in all the facilities comprised in the complex. Long-term copper smelting in the Legnica area has however resulted in an extensive soil contamination with number of trace elements. Copper ore tailings facility is located near Lubin in Lower Silesia Region of SW Poland is exploited since 1977. On the area of 1390 ha are assembled over 368 mln m³ of tailings from copper ore flotation. Because of their physical properties and technology of storage, tailings are the most important source of the local soil pollution. The main problem relevant to copper tailings facility exploitation is dust emission from dry beaches surrounding pond surface. Dust containing excessive amount of heavy metals such as Cu, Pb, Zn, Cd, and As becomes a potential source of soil contamination. Humus layers were selected under different tree stands – mixed pine-oak, pine and poplar stands and different levels of contamination with heavy metals. Litter samples were collected in year 2009, in four replicates, three times during the study period. In collected samples total concentration of copper, lead, cadmium, zinc and arsenic were analyzed on ICP MS after digestion in perchloric acid (1:10). Soluble forms of the elements were analyzed after extraction with distilled water and 0,11 M acetic acid (1:40) on ICP MS. Significant differences in total concentrations of studied elements were found between the sites. Humus layers in a vicinity of copper ore tailings facility were much less polluted with heavy metals, Cu – 666 mg/kg, Zn – 75 mg/kg, Pb – 200 mg/kg, Cd – 2,0 mg/kg and As – 19 mg/kg. At the distance of 0,3 km from the smelter total Cu concentration reached 12 700 mg/kg, Zn – 3 481 mg/kg, Cd – 111 mg/kg, Pb – 8 864 mg/kg and As - 774 mg/kg. Solubility and mobility of studied heavy metals and arsenic in all humus layers was low, reaching 24,4 mg/kg of Cu, 23,2 mg/kg of Zn, 9 mg/kg of Pb, 1 mg/kg of As at the site with the highest total heavy metal and arsenic content. The cause of that can be considered with a very high pH values deriving from alkalizing effect of smelter and facility dust. The highest solubility of studied elements was found in the youngest pine stand, where humus layer was not well developed. Solubility depended strongly on initial concentrations of the element and on the form of the metal in the humus. The use of 0,11 M acetic acid in extraction caused extreme increase of solubility of all studied metals. This can be an evidence that rapid acidification of humus layers in studied areas, especially in the surrounding of the copper smelter, can cause release of heavy metals into the deeper mineral horizons and ground waters, becoming also a potential risk human health.

