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ORIGINAL ARTICLE

Assessment of the mobile forms of zinc and copper content in soil samples from areas of different land use on example of the Krasnogvardeisky District of the St. Petersburg

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Abstract The present study investigated the actual content of Zn and Cu mobile fractions (buffer extractable) in soils of different land use scenarios within the Krasnogvardeisky District of the Saint Petersburg (Russia). The data were obtained via Atomic Adsorption Spectrophotometry, analyzing ammonium acetate buffer extracts (pH 4.8) of soil samples collected. The buffer-extracted metals are considered to be the most mobile fractions at given soil pH conditions. The results have shown low concentrations of mobile Zn and Cu in soils of recreational, agricultural and even industrial areas, fluctuating relative to the local area soil background values (Zn = 1.2; Cu = 2.70 mg kg^{-1}). Substantial levels of contamination were found in the loamy sand Technosol of residential land use amended with composted municipal solid wastes and savage sludge. Calculated geo-accumulation indices (I_{geo}), pollution indices (PI) and contamination factors (C_f) were of the higher values, indicating moderate to extremely high pollution levels with the mobile trace metals. Median topsoil metal concentrations three times exceeded the maximal permissible concentrations for soils (Zn = 23.00; Cu = 3.00 mg kg^{-1}), reaching the maximal values of 69.58 mg kg^{-1} for Zn and 10.17 mg kg^{-1} for Cu, respectively.

Keywords Heavy metals in urban soils · HMs mobility · Pollution assessment

Introduction

Heavy metals in soil are considered to be distributed among several phases which include water-soluble phase, exchangeable phase, organic associated phase, carbonate associated phase, bound and occluded in oxides and secondary clay minerals phase and residual within the primary mineral lattice phase (Brümmer 1986). Water-soluble and exchangeable fractions are considered readily mobile and bioavailable and hence the most hazardous form of HMs in soil is its mobile fraction (Ma and Rao 1997). Ingested soluble copper compounds (oxides, hydroxides, citrates) are readily absorbed through gastrointestinal tract while water-insoluble compounds (sulfides) are poorly absorbed (Venugopal and Luckey 1978). Gastrointestinal absorption of zinc is variable (20–80 %) and depends on the chemical compound as well as on zinc levels in the body and dietary concentrations of other nutrients (ATSDR 2005). Mobile HMs have high migration ability and persistence in the soil environment, i.e., duration of retention due to specific sorption of metals by soil absorbing complex (IECS) (Brümmer et al. 1983; Wilcke et al. 1998). In urban areas, maximal concentrations of mobile HMs are found at the topsoil (root zone), i.e., usually in the horizon Urbic—U_1, due to positive input–output budget of trace metals and retention in the soil (Kabata-Pendias 2010; Linde et al. 2001). Availability of HMs in soil environment is strongly affected by season dynamics, vegetation activity, and a range of different physical–chemical processes such as:

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