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Mobility, bioavailability and speciation of potentially toxic metals in a sludges-polluted agricultural soil under remediation with poplar trees and native grasses

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For the assessment of health and environmental risks deriving from the pollution of agricultural soils, it is critical the identification and the chemical characterization of the contaminants and of the polluted soil, because these characteristics influence the mobility and bioavailability of the contaminants and therefore their transfer from soil to other environmental compartments and to the food chain. In addition, these information are crucial to assess the effectiveness of remediation and management actions.
Our study site is an agricultural area of 6 ha, currently under sequestration, located in the province of Naples (Campania Region), interested by past illegal dumping of industrial wastes, mainly tannery sludges. In the area, after an intense phase of soil characterization by geophysical and geochemical surveys, it is realizing an environmental remediation project with poplar trees and native grass species, also with the aim of analyzing the possible absorption and accumulation of contaminants in the vegetables.
The soil sampling was carried out by taking punctual samples of soil according to a grid of 20 x 20 m, at three depths (0-20; 30-60; 70-90 cm). Furthermore, materials attributable to the buried sludges were sampled from pedological profiles opened in the field. All the samples were analyzed for the content of potentially toxic metals and of heavy hydrocarbons (C>12). On selected samples were determined the main chemical and physical characteristics, mobile and bioavailable fractions of the major metal contaminants and their distribution in the soil geochemical fractions, with water (solid/liquid partition coefficient), 1 M $NH4NO_3$ and 0.05 M EDTA pH 7 extractions, and EU-BCR sequential fractionation. The data showed a significant, widespread and disorderly contamination by chromium, zinc and heavy hydrocarbons (up to values of: 4500 mg/kg for Cr, 1850 mg/kg for Zn 1250 mg/kg for hydrocarbons C>12). In certain sub-areas it has also been observed a punctual contamination by lead, copper, cadmium, and arsenic. Chromium was always found poorly mobile and bioavailable, unlike zinc, that was extracted in significant amounts in EDTA and $NH4NO_3$ and was found mainly distributed among the HOAc-extractable and reducible fraction of the soil. Chromium, instead, was found principally associated with the oxidizable and to a lesser extent the reducible fractions of the soil, presumably bound to organic matter and iron oxides, as also highlighted by SEM-EDS analysis.
Given the high chromium content of the soil and buried materials, on selected samples was also determined the content of Cr(VI) and assessed the oxidizing potential of the soil in respect to the Cr(III).

Keywords: chromium, zinc, metal speciation, bioavailability, polluted site.