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Spontaneous plant colonization of brownfield soil and sludges and effects on substrate properties and pollutants mobility

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This work was done on brownfield soil and sludges from a dismantled steel plant, moderately polluted by heavy metals (mainly Pb and Zn), 1) to analyzed the effects of substrate properties and environmental conditions on spontaneous vegetation; 2) to assess changes in the chemical properties of soils and sludges, with particular reference to the mobility and bioavailability of pollutants, induced by spontaneous plants revegetation.
From 2006 to 2011, spontaneous plant colonization was monitored in the presence or absence of acidic peat both inside the degraded brownfield site and after transferal into a nearby Oak Park environment. During the five experimental years the vegetation growth was monitored using phytosociological method and data analyzed statistically. Both substrates, before and after plant growth, were analyzed for main chemical properties. Metals mobility and bioavailability was assessed using single (H_2O; DTPA) and sequential extractions (EU-BCR). At the end of the experiment, plant ability to uptake metal was evaluated on selected species.
Overall, 57 plant species grew healthily on the substrates. The combination of soil and sludges with peat resulted in an effective revegetation with a sensible increasing of plants biomass. Most of the species were found in the park (91%), showing plant colonization was mainly affected by the immediate environment rather than by substrate properties. Furthermore, after the five years, the substrate properties (pH, O.C.) were slightly affected by plant growth and, although metal pollutants in both substrates are characterized by low water solubility and DTPA availability, after plants growth an increase (even if not significant) of rhizospheric Cu, Fe, Mn and Zn solubility in H_2O was detected. Metals speciation indicated a low risk of Pb and Zn mobility being either largely trapped in the mineralogical structure of oxides and silicates and occluded in easily reducible manganese or iron oxides. Restricted metal uptake and tissue accumulation by selected plants were measured, with only Daucus carota showing a higher ability to translocate metals to shoots (shoot/root metal concentration quotient >1 with peat). Water always underestimated plant uptake, while DTPA and sequential extractions better predicted Pb and Zn uptake.
Phytostabilization with native plant species can be an efficient, environmentally appropriate and low cost technology for rehabilitation of industrial sites. The addition of organic matter may help the spontaneous re-vegetation and could facilitate the recovery of degraded environment. However, the changing induced by peat and plants might induced a solubilization of metal pollutants. A continuous monitoring of the potential changes of pollutants mobility-bioavailability by plants is crucial to prevent risks to the environment and human health.

Key words: Heavy metals, phytoremediation, Peat addition, bioavailability, sequential extractions