Geophysical Research Abstracts
Vol. 20, EGU2018-9938-1, 2018
EGU General Assembly 2018
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Decontamination of heavy metal contaminated soils by plants takes millennia up to millions of years

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The transfer of toxic elements from soils to crop plants have been determined for a variety of plants growing on heavy metal contaminated soils with various pHs and grain size distributions. Plants with high biomass yields such as maize, triticale, wheat etc. mostly contain only low heavy metal contents; accumulator plants such as amaranth show high concentrations but have often low yields. The highly plant-available and mobile element Cd needs hundreds to thousands of years to be extracted by plants, that of the immobile Pb millions of years, even if accumulator plants are used. The metal concentrations in soils and plants during phytoremediation follows an exponential decrease function.
From the systematic investigations on the element uptake of crops from contaminated soils the following availability sequence can be derived: Pb, U, Hg, Co, and Cr(III) are nearly immobile and non-transferable into plants; As, Sb, Mn, Ni, and Cu show an intermediate transfer; Se, Mo, Zn, Tl, and Cd are mobile and highly transferable. Even for the last group, centuries to thousands of years are necessary to clean contaminated soils. Most polluted sites contain multi-element contaminations. Even if the available Cd may be extracted other elements will persist at high levels.
One important question after phytoextraction is, what to do with the plant material enriched in heavy metals? It cannot be used as food or fodder. If burnt it will lead to emissions.
We propose a concept of cultivating high yield energy crops in contaminated areas (Sauer & Ruppert 2013). For security reasons, non- to low-accumulating crops such as maize, wheat, triticale or grass should be cultivated. The crops can be transformed in an anaerobic fermenter into biogas which can be used for energy production. The biogas residue is distributed over the field, where the crops were harvested. In this way, every element extracted by the plants is returned to the soil. The application of additional fertilizer is not necessary (except N). The organic rich residue will additionally improve the soil quality. There is now competition for valuable farmland for food production.

Sauer, B. & Ruppert, H. (2013): Bioenergy Production as an Option for Polluted Soils – A Non-phytoremediation Approach. In Ruppert, H. et al. (ed.): Sustainable Bioenergy Production - An Integrated Approach. pp. 425-444. Springer Dordrecht etc