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Preface: Remediation of Polluted Soils-Part 2

The collection of papers presented in this special issue is an outcome of the SSS8.3 Session "Remediation of Polluted Soils" of the International European Geosciences Union (EGU) Conference held in Vienna, April 2015.

Soils are essential components of the environment, the basis of terrestrial ecosystems and a crossroad for biogeochemical cycles at the lithosphere-hydrosphere-biosphere-atmosphere interface. Therefore soils are a limited, precious and fragile resource, the quality of which should be preserved. However, the increased concentration and distribution of heavy metals, metalloids, radionuclides and organic xenobionts in soils by anthropogenic mismanagement of industrial and mining activities, overuse of agrochemicals, sewage sludge and waste disposal cause contamination, environmental problems and health concerns. Therefore, soil pollution needs innovative technologies of remediation.

This special issue is dedicated to decontamination biological technologies and contains 19 papers written by authors from 16 countries: Australia, Bulgaria, Chile, China, Czech Republic, India, Italy, France, Greece, Malaysia, Pakistan, Poland, Russia, Spain, Turkey and UK. This collection of original studies focuses in two topics: mainly in Phytoremediation and a few about Bioremediation.

There are 15 papers dealing with the first topic, phytoremediation:

Buscaroli et al. assessed the capacity of *Dittrichia viscosa* (L.) Greuter, to absorb and accumulate in its tissues some potentially harmful elements in order to verify its possible use for phytoremediation in Montevecchio and Libiola (Italy) mining areas. The authors found that D. viscosa seems to be profitable for phytostabilization in sub acid and sub alkaline environments and, at a lesser extent, for phytoextraction purposes in the latter.

Zhang et al. explored the use of the hyperaccumulator *Pteris vittata* L. to remediate As contaminated soil in cold areas. The authors used four cover materials and found that a single layer of plastic film is the best choice to obtain the highest As removal amount of soil.

Lomaglio et al. investigated the effect of biochar amendments on the mobility and phytoavailability of As, Pb and Sb in a contaminated mine technosol. The authors found that biochar amendments can reduce Pb mobility and bioavailability, however Sb and As mobility were increased. These results suggest mainly a negative effect of biochar on As soil stabilization which probably is responsible of the dwarf *Phaseolus vulgaris* biomass decrease.

Lebrun et al. evaluated the effect of biochar amendments on As and Pb mobility and phytoavailability in contaminated mine technosols phytoremediated by *Salix*. Results showed that Salix alba was the best As and Pb phytostabilizer.

Soudek et al. examined the characteristics of different types of biochar and effects on the toxicity of heavy metals to germinating sorghum seeds. With biochar the toxicity of Cd, Cu and Pb was reduced. Bamboo-derived biochar was less efficient in reducing the toxicity of Cd and Cu compared with the other types of biochar. For Pb, the rice husk-derived biochar was the best efficient in reducing the toxicity.

Higueras et al. investigated some clues concerning metal uptake by *Quercus ilex* L. in abandoned Pb-Zn mining sites from central Spain. Results showed that the availability of potentially harmful elements (PHE) is conditioned by the soil properties (reactivity, salt contents and organic matter) and by PHE speciation in the soils. A simple way to assess toxicity of PHE in soils is proposed considering the correlations between contents in the leaves surpassing known toxicity levels and total or extractable contents in the soil.

Tripathi et al. investigated the effect of pure and modified chitosan beads on immobilization of Zn polluted soils and estimated the bioavailabilty of Zn in Indian mustard plants. The authors found that modified chitosan beads increased immobilization and decreased Zn plan uptake. Moreover Mo chitosan beads have shown greater effect on decreasing Zn bioavailability.

Endovitsky et al. researched the ions association in soil solution as the cause of Pb mobility and availability of the Belorerechensk chemical plant after application of phosphogypsum to chernozem. The authors discuss one of the possibilities of the ION-2 model to assess quantitatively the state of Pb in soil after application of phosphogypsum. They concluded that the Pb^{2+} added to the soil with phosphogypsum produced from low contaminated Kovdor apatite ore is of no hazard for soil and ecosystem.

Karczewska et al. studied the solubility of As and its uptake by ryegrass from mining polluted soils amended with organic matter in Sudeten (Poland). The authors established a pot experiment with ryegrass. The As uptake was reduced in organic matter-amended soils. Therefore ryegrass is suitable for soil phytostabilization purposes, but raises certain concern related to possible input of As into food chain. The effects of soil treatment with organic amendments on As phytoavailability to ryegrass turned out difficult to predict and should be experimentaly determined in each case of remediation.

Luo et al. researched the phytoremediation efficiency for a mixed plantation of non-nitrogen-fixing *Eucalyptus globulus* with nitrogen-fixing Chickpeas in soil contaminated by Cd,Cu, Hg and Pb. The authors conclude that mixed cultivation is an efficient way to enhance phytoremediation, increase production, transpiration and metal accumulation of plants. The phytoremediation efficience of Cd and Cu was most significant in mixed-species plantations but there was almost no scavenging effect against Hg by low solubility.

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Mishra et al. assessed the phytoremediation potential of native grass species growing on red mud deposit. The authors noticied that *Saccharum bengalense* Retz. Is a dominant grass species on red mud deposits, even though its high alkalinity. The most of elements are stabilized in roots, except Fe, Zn and Cd. Therefore *S. bengalense* Retz. Could be used for phytostabilization as well as phytoextraction purposes.

Lam et al. evaluated the phytoremediation potential of three plant species to remediate Cu mine tailings with saline-alkali soils in Antofagasta (Northern Chile). The plants used in this study were: *Prosopis tamarugo*, *Schinus molle* and *Atriplex nummularia*, and were additioned amendments: $CaCO_3$, organic compost and inoculation with an arbuscular mycorrhizal fungus (AMF). Based on the results, the authors recommended the use of *P. tamarugo* and *A. nummularia* as tolerant plants and excluders of different metal species in tailings.

Gautam and Agrawal carried out an experimental study of phytoremediation of metals using vetiver (*Chrysopogon zizanoides* L. Roberty) grown under different levels of red mud in sludge amended soil. The authors found that vetiver to be a potential metal tolerant plant, efficient in transportation of Mn and Cu from roots to shoot and effective in phytostabilization of Fe, Zn, Mg, Ni, Pb, Cd and Cr in roots. The study suggests utilization of 10% red mud in sludge amended soil to sustain maximum plant grown coupled with enhanced phytoremediation potential of vetiver.

Sasmaz investigated the accumulation and transport of As, Ag and Pb from the soil into 11 terrestrial plants in mining areas. Results showed that *Glaucium* root, *Phlomis* root and shoot, *Verbascum* shoot for As, *Glaucium* root, *Silene* root and shoot, *Verbascum* shoot for Ag and *Phlomis* root and shoot for Pb could be accumulators.

Drozdova et al. studied the accumulating ability and Ni tolerance of Brassicaceae species of the North Caucasus in connection with the problem of phytoremediation. The authors used model experiments in sand culture the wildgrowing species of *Alyssum* and *Erysimum* and compiled a sequence of species tolerances to Ni: *A. murale* > *E. ibericum* > *A. campestre* > *A. allyssoides*. Species of *E. ibericum* can be used for phytostabilization of Ni contaminated areas and species *A. murale* and *A. campestre* for phytoextraction of Ni from soils.

There are four papers dealing with the second topic, bioremediation:

Nicolova et al. researched the remediation of an acidic soil heavily contaminated with radionuclides and Cu, Zn and Cd by means of bioleaching with acidophilic chemolithotrophic and heterotrophic bacteria in a green house. It was found that under optimal conditions the content of pollutants was decreased below the permissible levels within a period of 170 days. The soil cleaned in this way improved its production of biomass.

Khalid et al. conducted a comparison of clean-up technologies for remediation of heavy metal/loid contaminated soils. The authors concluded that cost involved, time required, long-term effectiveness, general acceptability, applicability to high and multimetal contaminated sites are the key factors of the applicability and selection and selection of remediation technologies. The cost of phytoremediation can be minimized by a better understanding of processes involved in remediation.

Kamran et al. studied the phytoextraction of Cr and the role of *Pseudomonas putida* (ATCC 39213) on *Eruca sativa* growth on polluted soil. The authors found the insight on plant growth promoting Rhizobacteria's such as *P. putida*, potential to henhance the plant growth by inhibiting the adverse effect of Cr in *E. sativa*. This study will contribute towards the environmental management of Cr- contaminated areas and enhancing plant growth under Cr stress conditions.

Emenike et al. proposed a sustainable remediation of heavy metal polluted soil based in a biotechnical interaction with selected bacteria species. The study has projected the blending of *Bacillus* sp., *Lysinibacillus* sp. and *Rodococcus* sp. for the optimal removal of selected metals in leachate-polluted soil of a landfill environment. Utilized bacterial strains optimized the reduction of extractable Al (72%), Cu (88%), Cd (41%), Mn (65%), and Pb (71%) ions from leachate-contaminated soil.

All these papers described above, cover important aspects of fundamental and applied research and provide advances in relation to existing knowledge on Phytoremediation and Bioremediation of Polluted Soils.

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