Assessment of nano zero-valent iron and biochar towards risk metal stabilisation in soil: a temporal study

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Risk metals such as Zn, Pb and Cd are non-degradable and therefore tend to accumulate in the environment presenting a threat of toxicity to living organisms. While water remediation from risk elements has been widely studied, research on soils is still limited but it is a critical environmental issue of our times.

Nano zero-valent iron (nZVI) and biochar (BC) are among the most popular sorbents used for remediation of various means. BC has been extensively used in soils not only as a sorbent but also as a fertiliser while nZVI has been mostly applied in water. The use of nZVI in soils has been scarce and is yet to be investigated whether this material is effective towards soil remediation and safe to be applied in field-scale.

Metal–contaminated soil originating from the Příbram District in Czech Republic, an area known for past mining and smelting activities, was used in our study. Several batches which included nZVI-amended soil, BC-amended soil and non-amended (control) soil were prepared. In every batch, the sorbents were applied i) as a mixture with the soil and ii) as a layer between soil and silica sand. Each batch, represented a different incubation period (i.e., 1 month, 6 months, etc.) by the end of which, samples were taken and subjected to a set of extractions and analyses.

Our principle aim was to test the metal availability in soils amended with nZVI or BC as a response to time, in order to further predict the long-term behaviour and remediation efficiency of these sorbents. Moreover, testing nZVI and BC by using 2 different experimental designs, provided us with important feedback related to real-scale applications.

According to our initial results, both sorbents were efficient in risk metal stabilisation in the studied soil. Significant immobilisation of Zn, Pb and Cd was monitored along with changes in the soil's physico-chemical parameters. The main stabilisation mechanisms were suggested to be sorption of risk metals on Fe and Mn oxides and hydroxides.