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Long-term impact of biochar on the revegetation and mobility of Ni and Zn in an industrial contaminated site soil

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Biochar is a promising material in soil remediation for its multiple benefits in sustainable development, greening and carbon storage in addition to immobilising heavy metals and organic contaminants. However, its long-term performance in immobilising heavy metals has not been well investigated yet. In this research, a British hardwood biochar accompanied by a small amount of compost was employed in an industrial contaminated site in UK in 2011. A following three-year study was conducted to explore the impact of biochar on the revegetation of the trial pits, as well as the mobility of Ni and Zn in the soils. The revegetation on site failed, and the further laboratory incubation tests indicate that the failure was due to the insufficient addition of biochar and compost. The three-year carbonic acid leaching results of the treated soils reveal a reduction of Ni and Zn concentrations in the leachates along the time. The total metal tests and the Toxicity Characteristic Leaching Procedure (TCLP) on the third-year samples confirm that biochar can significantly reduce the mobility of Ni and Zn in the soils in the long term. Further, a quantitatively chemical method defined as "sequential extraction", which differentiates from the qualitative methods such as X-ray diffraction (XRD) and electron microscopies, was conducted to explore the interaction among heavy metals, biochar and soil. The results of the sequential extraction tests on the third-year samples indicate that Ni and Zn were mainly bound to Fe-Mn oxides and primary and secondary soil minerals, which had been enhanced by biochar addition. The findings in this research indicates that biochar rather than compost played the major role in immobilising Ni and Zn, and 0.5% (in w/w) addition of biochar was sufficient in practice. It also confirms the good performance of biochar in immobilising Ni and Zn in soils in the long term, and supports the potential large-scale application of biochar in soil remediation. Additionally, it sheds light on a novel way to explore the interaction between heavy metals and biochar treated soils.