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Aided phytostabilization reduces bioavailability of heavy metals in mine soils from SE Spain

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Sustainable management of mine soils contaminated with heavy metals is a real challenge, since currently applied remediation techniques are too expensive for these areas. Aided phytostabilization appears to be a cost efficient technique to reduce metal mobility in contaminated soils. In this context, this study aimed at evaluating the long-term efficiency of aided phytostabilization on two tailing ponds highly contaminated with heavy metals. The influence of revegetation aided by inorganic and organic amendments to reduce metal mobility was investigated. The study was conducted in the Cartagena-La Unión Mining District (SE Spain), where extensive mining activity has been carried out for more than 2500 years, till the nineties. Two representative tailing ponds generated by mining activities were selected: El Lirio and Brunita. Pig manure and marble wastes were applied in plots (2 m x 2 m), replicated 3 times. The soil sampling was carried out in May 2009 (5 years after application of amendments). At the same time, the shoots of the most dominant species were collected in each of the three replicated plots for analyses of metal concentration. These species were Piptatherum miliaceum, Zygophylum fabago, Dactilis glomerata and Brassica fruticulosa. Results showed that although the untreated plots remained without vegetation, natural plant species spontaneously colonised the amended plots with vegetation cover > 50%. Soil bioavailable metals decreased in the amended plots. Concretely, Cd, Cu and Pb decreased 50, 30 and 10 % respectively in El Lirio, comparing to initial levels, while Pb decreased 75% in Brunita, being the levels below the soil plant toxicity thresholds. Metal concentrations in shoots of plant species were similar except for Zygophylum fabago which had highest levels of Cd, Cu and Zn. However, metals concentrations in shoots were below plant tissue toxicity limits and domestic animal toxicity limits. No correlation between soil total, bioavailable and soluble heavy metals, and metals in any tested species was found. This indicates that plants in this study show a range of different mechanisms for protecting themselves against uptake of toxic elements and for restricting their transport within the plant. In addition, accumulation by plant roots or precipitation in the soil by root exudates immobilizes and reduces the availability of heavy metals. These results are promising since native vegetation of the mining area has adopted physiological mechanisms not to accumulate heavy metals. This supposes mitigation of transfer risks to the food chain if the plants are consumed by animals. Furthermore, plants growing in polluted sites also stabilize the soil and can serve as a groundcover thereby reducing erosion and direct contact of the contaminants with animals.

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