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A proposed methodology to achieve true landscape reclamation of mine soils based on phytostabilization

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As a consequence of the long period of mining activity in Murcia Region, SE Spain, large volumes of wastes were generated during the mineral concentration and smelting processes. Wastes were dumped forming tailing ponds, leaving bare soils with unfavorable conditions for plant growth, such as residual heavy metals, high acidity and poor physical characteristics. Here we synthesise the methodology proposed for a large-scale reclamation project in two abandoned tailing ponds in Murcia Region. The first step for any reclamation plan is the characterization of the ponds to determine their environmental risks, reclamation possibilities and ecological stabilization.

Next step will be the application of amendments. The main goal is the application of marble waste and pig slurry to enhance the physical, chemical and microbiological properties of mine soils for the establishment of vegetation for long-term reclamation. Marble wastes are generated in the process of production of the commercial stone. These wastes are formed by particles of 5-10 μm diameter, which will be transported to the mining areas and applied to the pond surface at the calculated rate, by determining the carbonates content needed to neutralise all the acid according to percentage of sulphur present in the ponds. Afterwards, the pig slurry will be mechanically applied, and mixed up to a depth of 50 cm to minimise the losses by run-off. Pig slurries will be applied 3 times, every 6 months. The average pH of the wastes after the marble residues application will be 6.5-7.5, which decreases the mobility of heavy metals. With the application of the organic amendment (pig slurry), the organic matter content of soils will increase, favoring the formation of aggregates, increasing the water holding capacity, the level of nutrients and so the long-term establishment of vegetation.

Next step in the methodology is phytostabilization. The main goal of this step is the development of a vegetated landscape in harmony with the surrounding environment, with positive values in an aesthetic, productivity, or nature conservation context (a holistic landscape design must be developed from the beginning of the project). There will be a selection of native plant species adapted to semiarid conditions and salinity, and able to immobilize soil pollutants by absorption/adsorption by roots, or precipitation in the rhizosphere. Plantation will be carried out 2 months after the last application of pig slurry. This is justified by the fact that we need this time for the stabilization of the amendments so that an initial structured soil is created, with immobilization of heavy metals, and increases in organic matter, nutrients, water holding capacity and growth of microbial communities, in order to maximize the establishment and survival of plant species.

A monitoring of the evolution of soil properties and vegetation is essential to evaluate the achievement of the objectives, in order to support optimization processes to make the project most efficient in terms of soil, plant and landscape quality improvement. Every 6 months, a soil sampling will be carried out. Besides, the evolution of vegetation cover, richness and biodiversity will be quantified. Furthermore, different plants for each species will be randomly taken for laboratory analyses. Additionally, we will differentiate roots and shoots for analyses, just to identify if there is heavy metal uptake and where they accumulate in the plant to reduce risks for the food chain.

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