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Stabilizing organic carbon in post-mining soils through calcareous soil additions and microbial inoculation: Insights from an eight-year short rotation forestry field experiment

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The BMBF-funded collaborative project *MykoBEst* investigates the influence of the mycorrhizosphere on soil development and erosion reduction in post-mining landscapes, alongside lignocellulose production within short rotation forestry. Research is conducted on the test site “Gessenwiese” in the former uranium mining area of Ronneburg, Eastern Germany. The site is affected by acid mine drainage, low nutrient availability and moderate contamination with radionuclides and heavy metals.

Since 2016, land reclamation strategies combining calcareous substrate amendments (0%, 5%, or 20% Rendzina) and microbial inoculation with mycorrhiza and *Streptomyces* are developed alongside biomass production using birch, alder, and willow trees. The measures are aimed at securing the long-term restoration of post-mining landscapes while also meeting the new challenges posed by climate change.

A key focus is on enhancing carbon sequestration in the degraded soil and elucidating the role of dissolved and colloidal dissolved organic carbon for trace metal complexation and transport.

Mobile and colloidal natural organic matter fractions in pore- and groundwater were quantified and characterized using liquid chromatography – organic carbon/nitrogen detection (LC-OCD-OND). The stabilization of C_{org} within the soil solid phase was analyzed along with the aggregate stability as an indicator of soil quality improvement and erosion reduction. Metal/radionuclide concentrations in different size fractions were quantified using ICP-OES/-MS.

Colloidal organic phases, specifically fulvic acid-like compounds appear to play a major role in contaminant transport in this system, especially after heavy rain events. The concentration of mobile dissolved and colloidal organic phases in porewater was significantly higher in untreated plots, possibly indicating a greater stabilization of C_{org} and potential associated contaminants in treated plots. In fact, an enrichment of C_{org} compared to the initial substrate was observed, specifically in plots with 20% Rendzina combined with microbial additives. Aggregate stability was also significantly higher in plots with 20% Rendzina compared to those with 5% Rendzina and the control.

Microbially enhanced phytostabilization combined with calcareous substrate addition thus offers a promising, sustainable approach for improving soil quality and erosion resistance in post-mining areas.