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Increasing Eco-Engineering Success with the Contribution of Plants and Mycorrhizal Fungi

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Sustainable restoration and reclamation concepts require a sound understanding of the factors that protect the fragile skin of earth. WSL proposes soil aggregate stability as a key parameter to meet this challenge.

Soil aggregate stability is a pivot of terrestrial ecosystem processes, taking over crucial functions in nutrient cycling, water balance, aeration as well as erodibility and slope stability. Plants and micro-organisms, in particular mycorrhizal fungi essentially contribute to the formation of stable soil aggregates. Consequently, soil aggregate stability provides a unique chance to concertedly address an essential unsolved problem in eco-engineering, i.e. quantification of biological effects on slope stability in view of planning, implementation, and evaluation of eco-engineering measures as well as appropriate consideration of biological effects in conventional calculations of slope stability and risk management.

Within this scope, relevant aspects of mycorrhizal fungi, plants and soil aggregate stability were investigated in an ancient landslide area at Dallenwil (Central Switzerland), a long-term study area of WSL. Undisturbed soil samples were taken from three plots within the same catchment sharing the same geology and exposition: a gully with joint technical and biological measures exemplarily processed roughly 25 years ago ("Schwandrübi"), an untreated gully ("Hexenrübi") still bare of vegetation with ongoing processes of erosion and landslides, and an unaffected natural climax forest ("Hornwald"). Soil aggregate stability was measured by a wet sieving procedure with cylindrical soil samples and quantified as the fraction of water stable aggregates.

Soil aggregate stability significantly increased from "Hexenrübi" (41%) to "Schwandrübi" (78%) to "Hornwald" (90%). Furthermore, multiple linear regression indicates

a significant influence of root intensity and ectomycorrhization. A robust statistical model based on previously conducted laboratory experiments relating soil aggregate stability to the angle of internal friction (Φ') was tested with the field based data of the presented study. The predicted increase of slope stability of up to 5° due to mycorrhizal fungi and better rooting did not significantly differ from the true field data.

The key role of mycorrhizal fungi in the process of soil aggregation was further emphasised by the increase in both abundance of arbuscular mycorrhizal fungi and the degree of ectomycorrhization along the gradient of progressive soil and plant development from “Hexenrübi” to “Schwandrübi” to “Hornwald”.

Due to ongoing mass movements, the spore abundance of arbuscular mycorrhizal fungi is drastically reduced in “Hexenrübi”. This lack of mycorrhizal fungi seriously impedes initiation and development of a functional plant cover. Consequently, the combined use of plants and mycorrhizal inoculation technologies bears the potential for a substantial increase in the effectiveness and sustainability of revegetation practices. Particularly under the harsh environmental conditions of soils affected by landslides and erosion, the application of mycorrhizal fungi offers an excellent tool to initiate, accelerate, and promote autogenic ecosystem recovery by creating beneficial synergies between abiotic and biotic processes.