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A new approach to quantify effects of plants and fungi on slope stability

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Within the last decade the frequency of heavy rainfalls was remarkably high, and so were the damaging events due to the resulting processes of erosion and landslides. In view of sustainable protection, the restoration of affected areas is of great importance.

As emergency and long-term measures, soil bioengineering methods are particularly appropriate, both ecologically and economically. However, compared to conventional technical systems, vegetation is not considered in calculations of slope stability and risk management. This is due to the lack of a convenient method to quantify vegetation effects on soil stability.

Our new approach aims to appropriately consider biological effects in conventional slope stability models. It is based on the angle of internal friction (Φ') as well as on multiple assets of mycorrhizal fungi, particularly in view of plant growth and soil aggregate stability.

Under the extreme conditions of degraded soil due to erosion and landslides, the symbiotic fungi increase plant performance and, in particular, root growth. Investigations on *Dryas octopetala* L. and *Alnus incana* (L.) Moench and several ectomycorrhizal fungi resulted in up to four-fold the root length compared to non-mycorrhizal plants.

Furthermore, the fungi are key players in the formation and stabilisation of soil micro- and macro-aggregates. Laboratory experiments revealed the potential of different fungi in view of the stability effect on soil aggregates both with and without plant partners. After three months of incubation, soils of different origin and grain size distribution developed up to three times higher aggregate stability, however, with

important differences among the species tested. Furthermore, based on undisturbed field samples a positive correlation was found between the stability of soil aggregates and the period after soil bioengineering measures were applied.

The validation of the results of the investigations on soil aggregate stability with data of the angle of internal friction (Φ') - derived from triaxial compression tests – results in a high accordance. Compared to untreated moraine soil the angle of internal friction of samples planted with *Alnus incana* was 3° to 7° higher, depending on rooting and, correspondingly, on mycorrhization. These results impressively demonstrate the contribution of plants and fungi and, therefore, of soil bioengineering measures to soil stability.