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Soil aggregation and slope stability related to soil density, root length, and mycorrhiza

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Eco-engineering measures combine the use of living plants and inert mechanical constructions to protect slopes against erosion and shallow mass movement. Whereas in geotechnical engineering several performance standards and guidelines for structural safety and serviceability of construction exist, there is a lack of comparable tools in the field of ecological restoration. Various indicators have been proposed, including the fractal dimension of soil particle size distribution, microbiological parameters, and soil aggregate stability. We present results of an soil aggregate stability investigation and compare them with literature data of the angle of internal friction ' which is conventionally used in slope stability analysis and soil failure calculation.
Aggregate stability tests were performed with samples of differently treated moraine, including soil at low ($\sim$15.5 kN/m^3) and high ($\sim$19.0 kN/m^3) dry unit weight, soil planted with Alnus incana (White Alder) as well as the combination of soil planted with alder and inoculated with the mycorrhizal fungus Melanogaster variegatus s.l. After a 20 weeks growth period in a greenhouse, a total of 100 samples was tested and evaluated. Positive correlations were found between the soil aggregate stability and the three variables dry unit weight, root length per soil volume, and degree of mycorrhization. Based on robust statistics it turned out that dry unit weight and mycorrhization degree were strongest correlated with soil aggregate stability. Compared to the non-inoculated control plants, mycorrhized White Alder produced significantly more roots and higher soil aggregate stability. Furthermore, the combined biological effect of plant roots and mycorrhizal mycelia on aggregate stability on soil with low density ($\sim$15.5 kN/m^3) was comparable to the compaction effect of the pure soil from 15.5 to $\sim$19.0 kN/m^3.
Literature data on the effect of vegetation on the angle of internal friction ' of the same moraine showed similar correlations, i.e. that ' of low density soil material ($\sim$15.5 kN/m^3) increased by the same amount whether by planting with White Alder or by compaction to $\sim$19.0 kN/m^3.
Based on this coincidence the method to quantify soil aggregate produced satisfying results which indicate that soil aggregate stability is a potential proxy for ' and the joint impact of mycorrhizal fungi and plant roots increase the resistance against superficial soil failure. It is concluded that soil aggregate stability mirrors biological effects on soil stability reasonably well and may be used as an indicator to quantify the effectiveness of ecological restoration and stabilisation measures.