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Effects of biodiversity, plant age, and mycorrhizal fungi on the plant-induced suction and shear strength of root-permeated soils

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Landslides pose a severe threat to the environment and humanity due to possible damage to residential areas, infrastructure or ecological goods and services in the aftermath. The consequences can be financial, with significant monetary losses or even worse, a catastrophe with many casualties. Considering that a failure can occur if the slope angle exceeds the internal friction angle of the soil that composes the slope, many slopes are only stable because vegetation, matric suction or dilatancy increase the shear strength, albeit under certain conditions that are not always guaranteed. Furthermore, these effects can be challenging to quantify individually, and when combined, interact in a complex way and at different scales, i.e. from soil particles to voids, or from roots to trees. This is an interdisciplinary problem that falls at the interface between several disciplines and must be solved.
An extensive laboratory test programme was conducted within this study on specimens prepared with different species, representing grasses, legumes, herbs and trees abundantly found in subalpine grasslands and pastures, and commonly used for eco-engineering measures. The effects of plant growth duration and mycorrhizal fungi on the water content, matric suction and shear strength of root-permeated soils under partially saturated conditions were also investigated. The results of the large-scale direct shear tests suggested that:
• both the above and below ground biomass play an important role in regulating the water content and matric suction of the root-permeated soil through different mechanisms
• root biomass, as well as the root:shoot ratio, was an indicator of both matric suction and shear strength under laboratory conditions
• longer plant growth duration, higher number of species, and the inoculation with mycorrhizal fungi increased the mean root biomass, and in turn, mean matric suction and shear strength of root-permeated soil