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On the impact of timber harvesting on soil water retention and surface runoff

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Structural properties of undisturbed soils are critical for water retention and the reduction of peak flows after heavy rainfall events. Forest soils commonly show high infiltration rates that can be attributed to a high organic content and the formation of larger pores through biological activity. Though soil disturbances, especially soil compaction, due to timber logging can be considered a rare event, the impacts may be long lasting. The productive, often fine textured soils of the Alpine Flysch belt are particularly susceptible to compaction, posing a challenge for timber harvesting.

In a controlled experiment in the Flysch zone (Vienna Woods, Austria), we assessed the effects of different timber harvesting technologies – specifically harvester-forwarder (with or without bogie tracks) and chain saw-cable yarder – on soil functions. For the quantification of the surface runoff, we applied rainfall simulation experiments on seven plots of 50 m² each. All rainfall simulation experiments were conducted for one hour with a targeted intensity of 100 mm/h before and after harvesting. Within each irrigation plot, we sampled undisturbed soil cores at up to five depth levels (5, 15, 25, 40, 65 cm) for further analyses in the laboratory. We measured saturated hydraulic conductivity (KSAT device; METER Group, Munich, Germany), as well as soil water retention in the wet and medium soil moisture range using the HYPROP device (METER Group, Munich, Germany). In the dry soil moisture range (pF>4.2) we measured water retention with the dew point method using the WP4C device (METER Group, Pullman, USA). Additionally, soil texture and soil organic carbon were determined from the same soil samples.

Preliminary results suggest a strong impact of the harvester-forwarder system (w/wo bogie tracks) on all hydrologically effective soil properties, while the cable yarder system seems to have lower,

yet still noticeable impacts. For the $\log_{10}$ of the saturated hydraulic conductivity ($\log_{10}$KS) the harvester-forwarder treatments cause significantly lower values, with reductions of up to >99% compared to values prior to harvesting. The decline of $\log_{10}$KS in cable yarding systems is only marginally significant (up to -49%). First order analyses of runoff coefficients show a strong effect of the harvester-forwarder system with observed values of up to 0.66. Undisturbed sites had no surface runoff and cable yarding only generated minimal surface runoff.