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Effects of timber harvesting techniques on soil biodiversity and greenhouse gas fluxes of temperate forest soils susceptible to compaction

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Temperate forests are a substantial sink for the greenhouse gases (GHG) methane (CH_4), carbon dioxide (CO_2) and soil emissions of nitrous oxide (N_2O) are low. However, most of these forests are managed with ground-based harvesting systems causing severe soil disturbance. Soil displacement and compaction has a long-term effect on the soil microbial community structure and alters soil respiration, CH_4 uptake, and nitrogen turnover. This significantly reduces the soil ecosystem services on extraction tracks and landings. Soil disturbance is particularly severe and persistent in compaction-prone silty and loamy soils, emphasizing the urgent need for specific techniques for these sites.

In an empirical Before-After Control-Impact study we compare the effects of harvester-forwarder use with/without tracks (HF/HFt) and cable-yarding with motor-manual-felling (CMM), on the soil chemistry, microbial community, and the soil-GHG balance. Our study is carried out within the project HoBo: Securing the Sustainability of Forest Soil Functions via Optimized Harvesting Technologies (https://dafne.at/projekte/hobo). The study sites are located in the Flysch zone and in the Molasse basin (North Alpine foreland basin). Soil GHG flux rates of CO_2, CH_4, and N_2O are measured with trace gas analyzers (Li-Cor 7810 and 7820), either manually at the recently thinned stands, or continuously with automatic chambers at plots that were thinned in 2016. For deeper understanding of the effects on soil chemistry and the changes in the microbial community, we determine nitrogen availability, microbial biomass carbon and nitrogen as well as the phospholipid

fatty acids (PLFA).

Preliminary results show a significant impact of all applied mechanized timber harvesting systems (HF/HFt/CMM) reducing CH_4 uptake rates and increasing N_2O emissions of both skid trails and cable yarding corridors, compared to the control plots outside the extraction tracks (thinned stand). Our findings underline that sustainable forest management practices should not only reduce soil compaction. It should also consider additional factors, particularly soil displacement induced by logging activities.