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Role of root dynamics in soil organic carbon

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Forest ecosystems are important in carbon sequestration, and assessing the effect of landuse changes on carbon pools requires a good understanding of what drives soil organic carbon (SOC) levels. Numerous observations have indicated that SOC levels in the mineral soil do not decline significantly following forest harvesting, despite lower aboveground litterfall inputs. In addition, soil respiration losses seldom decline in clearcut sites. The processes underlying this stability of SOC following clearcutting are not well understood. Roots have been implied as the possible source of C, but there is only sparse and indirect evidence of the role of root dynamics in SOC.

In this study, we investigated how the dynamics of fine and coarse tree roots (fragmentation, decomposition) can stabilize SOC levels in the upper mineral soil of a spruce forest. Based on existing data from a high-elevation spruce forest at Achenkirch, Tirol and literature values, a model of fine and coarse root dynamics and their feedbacks to SOC levels was formulated that was consistent with current field observations. This modelling exercise was further augmented with experimental data on decomposition and fragmentation of fine and coarse tree roots obtained during a 5-month laboratory incubation experiment using soil and root samples from the same site.

This combination of field and laboratory observations and modelling provides new insight into the importance of roots and root turnover as a source of soil C, and also highlights some of the methodological challenges in accurately assessing SOC pools.