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Fine root longevity and biomass production in boreal peatlands

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Drainage for forestry alters the carbon (C) dynamics and stocks of peatlands. After drainage soil C stocks usually decrease, because of increased soil organic matter (SOM) decomposition, while the C stocks in vegetation (trees) increase, because of increased primary production. However, sometimes also the soil C stocks have been reported to have increased after drainage, despite of increased SOM decay. This observation can only be explained by the increased above- and belowground litter production. Above ground litterfall can be easily measured with litter collectors, and there is a rather good understanding of its dynamics and magnitude in forested peatlands. However, the rate of below ground litter input through the growth and death of fine roots, has remained uncertain, because of methodological challenges. One laborous but plausible method to estimate belowground litter input is the minirhitzotron-method, in which the lifetime, i.e., longevity (and its complement: turnover) of roots is measured with repeated photographing of roots through a transparent tube inserted into the ground. With the measurements of in situ root biomass, the root production rate can then be calculated as turnover rate × biomass.

We measured the longevity and biomass of fine roots (d<0.5 mm) in 11 undrained and forestry-drained peatland sites in the southern and central Finland. We followed the life of altogether 23303 roots in 102 minirhitzotrons for 4 years (19 sessions). The median longevity was estimated with the nonparametric Kaplan-Meier -method and a parametric regression model with Weibull error distribution. Root biomass samples (50 cm deep, one core beside every minirhitzotron tube) were collected once in late summer. The roots were separated from the peat sample, dried, and weighed to calculate fine root biomass (g m^{-2}). We analysed the effects of drainage, peatland site type, tree and understory plant species, root thickness, root depth, soil water table level and soil temperature on fine root lifetime/turnover and biomass production.

The median tree fine root longevity varied from 65 to 294 weeks among the 11 sites. Drainage had no effect on the FR lifetime. The longevity was distinctly, and significantly higher in the ombrotrophic, pine-dominated sites (Anova LS mean 276±17 weeks) than in the minerotrophic, spruce/alder -dominated sites (94±10 weeks). In the most nutrient poor site, no tree roots died during the four study years. Pine roots lived longer than spruce, birch, and alder roots, but there was a strong interaction with the site type. Sedge roots had the shortest lifetime. Thicker fine roots lived longer than thinner roots. The annual turnover values for all tree FR together varied between sites from 0.19/year to 0.83/year. Fine root production varied, on average, from 35 to 310 g m^{-2} a^{-1} among the sites. Drainage increased fine root production in the minerotrophic, spruce/alder

dominated sites but not in the ombrotrophic, pine dominated sites.