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CO2, CH4 and N2O fluxes in Finnish forestry-drained peatlands

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In countries like Finland, where forestry-drained peatlands sum up to 4.6 million ha, knowledge on their greenhouse gas (GHG) emissions is eagerly needed for both annual GHG reporting and when considering ways to mitigate the climate change.

To get a good picture of variation in GHG fluxes in Finnish forestry-drained peatlands, this study aimed to cover the climatic and soil properties derived variation occurring in Finland. We measured both total (RTOT) and heterotrophic (RHET) soil respiration. Also the other possibly significant GHG:s, CH4 and N2O, were studied at the same study sites to make it possible to evaluate their significance in the GHG balance. We chose the 69 study sites so that the different site types of forestry-drained peatlands were equally represented in all parts of Finland.

At each site, we measured RTOT on 5 vegetated plots and RHET on five trenched plots (roots cut, litter layer and ground vegetation removed) every 2–3 weeks in May–October 2007–2008. Annual values were calculated using an Arrhenius type nonlinear regression between R and peat temperature. CH4 and N2O samples were collected at 4 vegetated plot 5–7 times during the study and annual fluxes were interpolated.

The dependency of annual CO2, CH4 and N2O fluxes on average May–October air temperature (Tas), tree stand stem volume (V), peat bulk density (BD), average May–October water table depth (WTa) and peat CN ratio (CN) was tested with linear and nonlinear regression models to find suitable variables for upscaling fluxes to country level.

Both RTOT and RHET depended on several factors. A linear model with Tas, V, BD and WTa as independents explained 64.2% of RTOT and 62.5% of RHET. Information on V, BD (only limitedly) and Tas for upscaling is found in National Forest inventory (NFI) data and weather statistics.

CH4 flux depended nonlinearly on WTa. WTa is not routinely measured in NFI, but can fairly well be substituted with V. N2O flux correlated nonlinearly with CN ratio. Information on CN for upscaling is available in a separate study conducted on NFI sites.