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# Soil $CH_4$ and $N_2O$ fluxes from drained and undrained peatland forests in the Baltic region.

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Peatland ecosystem degradation and changes made in hydrology by artificial drainage may affect the biogeochemistry of peatlands and, together with projected global warming, may lead to significant changes in greenhouse gas (GHG) fluxes. Drainage of peatlands increases organic matter's aerobic decomposition, changes native vegetation, and may decrease the storage of C. The vegetative characteristics of forest ecosystem types may change a net GHG sink peatland to a source in drained organic soils.

However, soil $CH_4$ and $N_2O$ fluxes in peatlands are spatially and temporally (interannual, seasonal) variable, and detailed data from drained nutrient-rich organic soils in the hemiboreal zone is lacking. We conducted a study spanned over two years comprising drained (n=18) and undrained (n=7) peatland forests with dominant tree species of Scots pine (Pinus sylvestris), Norway spruce (Picea abies), birch (Betula sp.), and black alder (Alnus glutinosa) spread across Estonia, Latvia, and Lithuania. Instantaneous fluxes of $CH_4$ and $N_2O$ were measured monthly for the whole year using the manual static chamber method. Environmental parameters in soil, such as soil water level (WTL), moisture, and temperatures at depths (0-40 cm), were monitored continuously, and detailed soil chemical analyses were conducted. To constrain the factors regulating temporal fluxes of various environmental conditions and differentiate annual emissions between land use in the Baltic region.

The results show that all drained forest soils were annual $CH_4$ sinks (−37.0 ± 4.5 µg C $m^{-2}$ $h^{-1}$), while undrained forests were emitters on average 388.5 ± 142. Mean annual $CH_4$ uptake is significantly higher in deep-drained soils −45.5 ± 3.6 µg C $m^{-2}$ $h^{-1}$ (WTL > −50cm) than in poorly drained soils ($p<0.05$), regardless of dominant tree species. The in situ and annual $CH_4$ fluxes statistically correlated with soil water level and temperature. Most of the drained sites emitted $N_2O$ (49.4 ± 17.8 µg N $m^{-2}$ $h^{-1}$); drained wet forest sites were higher emitters (84.7 ± 32.4) than drier sites (23.67 ± 15.6) in comparison to tree species. The instantaneous $N_2O$ fluxes were directly controlled by soil surface temperature and oxygen concentration of soil water, whereas variability

in annual $N_2O$ emissions was associated with soil water content. Moreover, soil nutrient status regulated by specific ground vegetation functional groups has significantly impacted the emissions of nutrient-rich organic soils.

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