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Combined effect of drainage, rewetting and warming on primary mire greenhouse gas fluxes and vegetation

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Northern peatlands function as significant carbon storages. This key ecosystem service may be threatened by anthropogenic activities and climate change. We lack a consensus on the strength and future of the carbon storage of different types of peatlands, or peatlands under different land uses. We studied impacts of forestry drainage and restoration, combined with warming treatment on greenhouse gas flux dynamics in young primary mires with thin peat layers. We measured CO_2, CH4 and N2O fluxes with chamber method over two growing seasons and connected fluxes with environmental variables. In addition, we estimated plant species cover and measured the leaf area development form the sites.

Five years after restoration vegetation had started to change towards undrained reference sites. Especially, the cover of sedges had increased and there were no differences in leaf area between undrained and restored sites. Leaf area was lower in drained sites compared to undrained sites. Warming increased leaf area, but had little effect on vegetation composition.

We found a clear impact of land use on CO_2 exchange. Forestry drainage increased respiration rates and decreased net ecosystem CO_2 exchange (NEE), while at restoration sites the flux rates were similar to undrained sites. CH4 and N2O emissions were exceptionally low at all sites during our study years due to natural drought, which highlights the importance of water table in controlling these emissions. Moderate warming, caused by open top chambers increased leaf area rather equally through the land use classes. This had a positive impact on CO_2 balance and global warming potential (GWP) of these graminoid or shrub dominated habitats, where mosses play a minor role. Altogether, the gas flux dynamics were primarily controlled by water table, leaf area and temperature.

The aim of the ecological restoration is to return the ecosystem structure and functions of the desired reference, usually a pristine ecosystem. Our results indicate that five years after restoration the initial steps towards the successional pathway of peatland development have been taken. While the GWP of restored sites was not negative, it was similar to undrained sites and showed clear improvement compared to drained sites. Therefore, restoration that changed the two fundamental properties, water table and vegetation structure, was a good means to bring back the key ecosystem functions and services of these peatlands.