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Effects of rewetting on greenhouse gas emissions in different microtopes in a cut-over drained bog in Schleswig-Holstein, Germany

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In peatlands, all biogeochemical processes and the amount of exported carbon and nitrogen compounds are strongly influenced by changes in the water table. Peatland drainage leads to increased peat oxidization and changes peatlands from carbon sinks to net carbon sources. Especially, the emissions of the important greenhouse gases (GHG) carbon dioxide, methane and nitrous oxide are increased due to drainage. The currently ongoing restoration in the bog Himmelmoor (N 53˚44'20", E 9˚51'00", Quickborn) with an extent of about 6 km^2 one of the largest raised bogs in Schleswig-Holstein, offers the possibility to characterize and to document the development of the fluxes at different sites before, during and after rewetting, using a method of small-scale closed chambers. Six subsites with differing water level and land use were identified: an area that was rewetted 30 years ago with *Sphagnum* vegetation, an area rewetted in 2009, an area with on-going peat extraction, deep peat cutting ditches refilled with peat with and without *Eriophorum angustifolium* vegetation and a comparatively dry peat dam.

We determined that in the course of years 2014-2015 the measured N_2O and CO_2 fluxes varied between -0,1 and 1,9 mg m^{-2} h^{-1} and between -0,12 and 1,09 g m^{-2} h^{-1}, respectively, and the highest nitrous oxide as well as carbon dioxide fluxes are typical for the dry peat dam study site. The measured CH_4 fluxes were between -1,8 and 22,7 mg m^{-2} h^{-1}, where the highest rates were found on the area rewetted 30 years ago and on the peat cutting ditches with *Eriophorum angustifolium*.

Accounting for the different global warming potentials (GWP) of the measured greenhouse gases, the annual GHG balance was calculated. Emissions from all study sites ranged between 5,2 and 36 t CO_2-eq ha^{-1} $year^{-1}$ and were dominated by high emissions of CO_2 (2,5 up to 25,5 t CO_2-eq ha^{-1} $year^{-1}$). Highest emission rates were found at the dry peat dam site and at the area rewetted 30 years ago. The peat dams and piles are also strong N_2O sources. The rewetted, vegetated microtopes are strong CH_4 sources, whereas all other areas show insignificant CH_4 fluxes. The annual GHG emissions in the area rewetted 30 years ago are at least triply as high as the rates of the extraction on-going area, thus demonstrating the long period needed for the establishment of a carbon balance that is similar to the pre-drainage situation.