Effects of grassland renewal and submerged drains on greenhouse gas exchange at an intensively managed bog peat soil

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Intact peatland ecosystems are efficient sinks of atmospheric carbon dioxide (CO₂). Disturbance, e.g. by drainage to transform peatlands into agricultural land, causes high emissions of the greenhouse gases (GHG) CO₂ and nitrous oxide (N₂O). Our Project “Gnarrenburger Moor” focuses on the evaluation of the effects of submerged drains on GHG emissions and dissolved solute losses from bog peat under intensive grassland management. Due to installation of the water management system, grassland renewal was necessary at one of our two experimental grassland sites, both being located in Northwest Germany and subjected to similar management in the past. Here, we report on the initial year of the project, which was dominated by the impact of grassland renewal as target groundwater levels were only reached after several months.

The reference site, representing common region-specific grassland management on peat, is deeply drained by tile drains, while submerged drains were installed at the project site to achieve constantly high water levels of 30 to 40 cm below ground. Both sites are equipped with eddy covariance towers for CO₂ measurements and 6 plots for manually measuring N₂O and methane (CH₄) with closed chambers. Water samples for the analysis of phosphorus and nitrogen species are collected from ditches, tile drains and suction plates at 15, 30 and 60 cm depths. Measurements started in March 2019, i.e. approximately one month before the grassland renewal. The mechanical renewal involved mulching of the old grass sward and grading the surface of the site. Due to very dry conditions, growth of grass species was poor and the site was mulched and re-seeded again in July 2019. Target groundwater levels were reached in September 2019.

During the initial year of our study, grassland renewal substantially dominated the response of the system. From April to November, net ecosystem exchange of the project site was approximately 400 g C m⁻² higher than that of the reference site. When including carbon input and output from organic fertilizer and harvest on the reference site, the project site is still by far (around 140 g C m⁻²) a larger source. When the bare soil and raising groundwater levels coincided between July and September, N₂O fluxes and dissolved nitrogen and phosphorus concentrations drastically increased at the project site. N₂O fluxes were partially 100 times higher than at the reference site.
The next years will show whether an operational water management system and a fully developed grass sward will turn the project site with submerged drains into a smaller source of GHGs than the reference site.