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Effects of submerged drains and ditch blocking on greenhouse gas emissions from intensively used grasslands on Histosols

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Since the Weichselian late-glacial, mires have emerged in the Northern German Lowland and became an integral part of today's landscape composition. During the last century, increasing cultivation efforts turned the majority of the sprawling bogs and fens into productive grassland or arable land. The ongoing drainage of these organic soils (Histosols) is still common practice, but promotes substantial land subsidence and turns them into a key source of greenhouse gases (GHG). The project 'SWAMPS' focuses on both maintaining the trafficability for conventional intensive grassland use and the reduction of GHG emissions by managing the groundwater level by submerged drains and blocked ditches. Here, we aim to evaluate the effect of water table management on the emissions of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) over two years.

We set up two field sites on both fen and bog peat in North-Western Germany. Submerged drains were installed at a distance of 4 to 5 m and with a target ditch level of 45 to 50 cm below mean soil surface. On the parcels with blocked ditches, the target ditch level is adjusted at 30 to 35 cm. The control parcels are drained by ditches and/or drainage pipes. The grassland is cut four to five times per year and fertilized accordingly. Diurnal CO_2 flux measurement campaigns are realised once every three to four weeks with transparent and opaque chambers and a portable gas analyser. CH_4 and N_2O samples are taken biweekly and additionally more frequently after fertilizer application.

Due to constraints in the water management, the full potential of managing water levels could only be realised from the second half of 2017 onwards. The first year (2017) was thus characterized by strong water table fluctuations. In the following year, different water management regimes were fully operational and clear differences in water levels could be achieved despite the extremely dry and hot summer of 2018. Especially at the bog site used as control, emissions of N_2O were very high (up to 20 kg N ha^{-1} a^{-1}) and thus clearly exceed standard emission factors for grassland on organic soils. CH_4 fluxes are negligible and correspond to the low water levels compared to natural peatlands. CO_2 emissions from the control sites were high, particularly at the bog peat site. At the fen peat site, CO_2 emissions in 2017 were reduced by 15 and 43 % at the treatments with submerged drains and blocked ditches, respectively. In strong contrast, CO_2 emission from the managed bog peat parcels were 48 % (submerged drains) and 29 % (blocked ditches) higher than from the control. This might have been caused by removing water limitation at the very dry control site. However, CO_2 emissions during the first year (2017) reflect a transition period between antecedent and experimental conditions and are not representative for a fully operational water management system. Results from 2018 will be presented as well, and measurements will be continued for another two years to clarify the effects of water management on GHG emissions.