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Reducing agricultural peatland CO_2 emissions with hydrological conservation measures

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Peat soils are an important carbon stock in the global carbon cycle containing more than two third of the atmospheric carbon amount (600 GtC of 760 GtC) despite their relatively small landmass of 3% worldwide. Drainage of peatlands contributes significantly to the enhanced global warming, as it allows oxygen to intrude the soil, intensifying aerobic microbial decomposition associated with carbon dioxide emission. Water management strategies that result in a raise in (summer) groundwater tables can have the opposite effect. These measures, such as raising the surface water level and/or the application of submerged drain subsurface irrigation systems, are already being applied. However, the outcome of these strategies remains debated and is still largely to be tested. We aim to explore the potential effects of these water management strategies on reducing GHG emission in peatlands.

We simulated the effects of several water management strategies on potential aerobic peat decomposition in a managed Dutch grassland on sedge peat under various hydrological and climatological conditions. To estimate potential microbial activity in the unsaturated zone two main drivers, temperature and water filled pore space (WFPS) were used. We found that increasing ditch water levels yields a decrease in potential aerobic peat decomposition independent of summer drought, hydrological regime and peat hydrological conductivity. Furthermore, we found that submerged drainage-irrigation systems tend to establish a stable moist zone relatively close to the warm soil surface in which potential microbial activity can remain high over the complete summer period. Due to these stable conditions, we expect peat decomposition in this layer to be high, possibly counteracting the effects of decreased aeration depth due to higher water tables. Submerged drainage-irrigation systems generally decrease potential microbial activity in environments with downward flow, but increase the activity in environments with upward flow. Increased benefits of the submerged systems are found for dry years, with high surface water levels and/or decreasing hydrological conductivity of the intact peat.