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Impact of long term flooding on hydrogeochemistry and dissolved organic matter quality

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Peatlands store significant amounts of carbon but also contribute to global methane emissions. Large areas in the boreal and temperate zones are predicted to undergo changes in climate and concomitant changes in hydrology, according to climate change scenarios. Thus, it is crucial to understand the response of peatlands to altered climatic and hydrological boundary conditions. Here we investigated the response of a peatland to long term wetting, as especially in winter for large areas wetter conditions have been predicted. We hypothesized that long term wetting will change hydrological fluxes, probably nutrient inputs from the adjacent water body, and thereby result in changes in vegetation and concomitant changes in peat decomposability.

The Luther Marsh site in Ontario, Canada, that has been partly flooded since the 1950s due to the construction of a reservoir. Water management in the reservoir flooded a large part of the peatland and also causes seasonal flooding especially in winter and spring, but also draining in summer. This leads to shifting hydrological flow patterns and vegetation gradients. Therefore, this site may serve as a model system to understand the effect of long term wetting. Hydrology was monitored by means of piezometers and pressure transducers over one growing season over a transect of 7 sites from the reservoir to the inner, pristine part of the bog. At the same sites, we obtained pore water chemistry data and dissolved gases.

Surprisingly, partial flooding only partly affected the general hydrological regime of the peatland and the general flow direction of groundwater was still out of the peatland into the adjacent lake. On the other hand, wetting resulted in obvious changes in vegetation, increased nutrient availability, and thus increased decomposition activity in the wetted part. This was reflected more narrow CH_4 to CO_2 ratios in the pore water and higher concentrations and calculated turnover rates. Advective transport removed decomposition end products and introduced nutrient enriched reservoir water, as indicated by elevated pH and increased concentrations in Ca and Mg. Interestingly, DOC quality as assessed by fluorescence spectroscopy also gradually approached quality indices observed in the reservoir and the effect of wetting obviously reached far into the seemingly intact peatland.

This study demonstrated that partial flooding of a peatland significantly changes vegetation and the nutritional status, resulting in a shift towards more CH4 production and higher turnover rates.