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Impact of long-term flooding on the hydrology and carbon biogeochemistry of a northern bog in Ontario, Canada

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Climate change and impoundment construction may lead to rising water tables in many northern peatlands. In this study the hydrological and biogeochemical effects of flooding were analyzed at a peatland in southern Ontario, Canada, that was partly flooded 60 years ago. By a comparison of sites of increasing distance to the lake, the effects of inundation on the peatland biogeochemistry were identified. The approximate range of lake water intrusion into the peatland was determined using 18O in water. Furthermore the local hydrology was analyzed by quantifying distributions of hydraulic conductivity and small-scale groundwater flow patterns. By measuring nitrate, phosphate, ammonium, sulfate and DIC, CH4 and DOC in the lake and groundwater the chemical and biogeochemical influence of the inundation was determined. Gas fluxes of CO_2 and CH4 at the site were quantified using a static chamber approach. The findings indicate that the infiltration of water from the lake at these sites occurred in time periods of higher lake levels. During summer these locations were only fed by precipitation and the previously infiltrated surface water was diluted or replaced. Nutrient concentrations in the lake water were generally lower compared to the peat pore water. The main solute entering the peatland with the intrusion was sulfate, which also influenced methane concentration patterns. Vertical flow seemed to be an important hydraulic process and control on solute transport at the study site, which has not been described to this extent previously. Additionally, indications for a discharge of groundwater into the peat during a flow reversal were found, though the assumed low permeability of underlying layers should not allow for this process. While the impact of reservoir creation on hydrologic processes appeared to be limited, the changes in water table, soil moisture and vegetation patterns had large impacts on trance gas fluxes to the atmosphere, especially on methane, whose emissions were several times higher than at reference sites. These changes also went along with increased methane concentrations belowground.