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Peatlands in a eutrophic world – assessing the state of a poor fen-bog transition in southern Ontario, Canada, after long term nutrient input and altered hydrological conditions

Sina Berger (1,2), Gerhard Gebauer (3), Christian Blodau (2,3), Klaus-Holger Knorr (2,3)

(1) Karlsruhe Institute of Technology, Institute of Meterology and Climate Research, Germany (gefleckterschierling@gmx.de), (2) University of Muenster, Institute of Landscape Ecology, Germany, (3) University of Bayreuth, Laboratory of Isotope Biogeochemistry, Germany

Peatlands are of vital importance for global carbon (C) cycling as they sequester and store enormous amounts of C. Major threats to peatlands are excessive supply of nutrients from the atmosphere as well as from surface water and groundwater. Up to this date our knowledge of long-term consequences of such excessive nutrient supply is limited. We are unsure about how long peatlands can maintain their functioning under such circumstances.
We conducted a detailed study in a once ombrotrophic bog ecosystem (Wylde Lake peatland, Ontario, Canada), which is since the 19th century embedded in a eutrophic environment with intensive agriculture. Moreover, since AD 1954 the peatland borders a water reservoir which is strongly enriched with nutrients. Our objective was to elucidate to which extent the infiltration of nutrient from the peatland periphery can be buffered and whether the inner parts can maintain typical characteristics of a pristine bog.
To achieve this goal, along a transect of study sites, we Pb-210- and Cs-137-dated peat cores and determined elements of peat using x-ray fluorescence (XRF). To calculate N input, nitrogen enrichment factors in the vegetation and abundances of stable N isotopes in the peat were determined through isotope ratio mass spectrometry (IRMS). Furthermore, we re-investigated the vascular plant species composition 31 years after a previous investigation and lastly, we sporadically measured greenhouse gas fluxes with chamber techniques.
In the central part of the peatland we found great N input rates of 4.28±0.75 and 4.35±0.30 g N m-2 y-1, but even greater rates were found in the peatland fringe area (5.90±0.10 g N m-2 y-1). Also, all elements essential for plant growth were abundant in increased concentrations along all peat cores, especially near the bordering reservoir, presumably due to supply by the reservoir water. A more graminoid dominated vegetation in the wetter areas (near the reservoir) and a rapid increase of tree cover in drier areas (further away from the reservoir), both over a healthy Sphagnum carpet, as well as altered fluxes of CO_2, CH4 and N2O indicate a transformation of the once ombrotrophic bog into a poor fen. Very much to our surprise the peatland did not seem to decay after long-term excessive nutrient load, instead it tremendously accelerated peat accumulation which led to maximum growth rates of up to 500 g C m-2 y-1. Peatland functioning in terms of carbon storage appeared to be maintained. Our study, which combines a great variety of methods and which provides detailed insights into various processes along peat profiles and vegetation cover, therefore contradicts numerous previous studies in which it was stated that long-term excessive supply of nutrients to peatlands would cause dying of Sphagnum mosses and hence, a decay and increased peat loss of the affected site already after one decade.