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Dissolved carbon and nitrogen quantity and quality at natural, drained and re-wetted bog sites in Lower Saxony (Germany)

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5 % of Germany's land area is covered with peatlands. Due to the large carbon and nitrogen stocks, changes in peatland hydrology for agricultural use have a huge impact on C and N cycling in the peatland and on the export to the atmosphere and adjacent ecosystems. Nonetheless, only a few studies focussed on the impact of drainage and re-wetting on C and N cycling in German raised bogs.

Four study sites in the "Ahlenmoor" near Cuxhaven (Northwestern Germany) were chosen. This bog has a deep, medium to weakly decomposed peat layer. The sites represent a gradient of the groundwater level combined with land use differences (intensive and extensive grassland, natural site, re-wetted peat-cutting area). The mean annual groundwater level decreases from the natural and re-wetted sites (near surface) to the extensive grassland (30 cm below surface) and, finally, the intensive grassland (56 cm).

The "Peeper" technique (dialysis sampler) was used to measure soil water chemistry in a high spatial resolution. At each site, three peepers (0-60 cm, 12 chambers each) collected soil water samples via diffusion. Monthly sampling was conducted from February 2012 till November 2012. The soil water solution was analysed for pH, EC, dissolved organic carbon (DOC), dissolved organic nitrogen (DON), NH4+, NO_3- and SUVA(280). Samples taken in November 2012 were additionally analysed for dissolved CO_2, CH4 and N2O.

Average DOC concentrations ranged from 211 to 41 mg/L and decreased in order intensive > extensive grassland > re-wetted = natural site. After 10 years of restoration, the re-wetted and the natural site show similar DOC concentrations. Average SUVA(280) values of 3.7 to 3.3 L/(mg m) were higher at the grassland sites than at the re-wetted and the natural site. This indicates a distinct increase in aromaticity of DOC in grassland sites as a result of more intense humification of the upper peat layer. In contrast to mineral soils, SUVA(280) remained constant with depth at our sites. Total nitrogen decreased in same order as DOC and was mainly composed of DON. NH4+ dominates the inorganic nitrogen fraction. The comparison of peat C/N to DOC/DON ratios indicates that the more degraded upper layer is the main source of carbon and nitrogen in the soil solution. Dissolved inorganic carbon (DIC) was mainly measured as dissolved CO_2-C (13.6 mg/L), followed by CH4-C (1.7 mg/L). While CH4-C was present over the whole profile at the re-wetted and the natural site, it was missing in the upper 40 cm of the grassland sites. Instead, dissolved N2O-N was found (19.8 μg/L). Especially in natural bogs with low DOC concentrations, DIC may be a relevant part of the carbon budget. Our results show that the groundwater level in combination with land use has a huge impact on C- and N-quality and quantity between sites and within the peat profile, and that re-wetting may result in a return to "natural" DOC concentration levels and properties.