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Variability of DOM concentration and quality in a peatland and forest headwater stream: seasonal and event characteristics

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Export of terrestrial dissolved organic matter (DOM) from soils to aquatic systems plays a fundamental role in surface water chemistry. In many catchments, main sources are peatlands and peaty riparian zones. However, not only total DOM concentration is of great interest for e.g. the carbon cycle or drinking water generation. Also the quality of DOM strongly affects function and fate of DOM in aquatic systems. Moreover, changes in DOM quality can help to elucidate sources of DOM and underlying controls of mobilization. Therefore, this study focused on changes of DOM concentration and quality in a peatland and forest headwater stream considering seasonal patterns and hydrological dynamics.

The study was conducted at the Odersprung bog, in a small headwater catchment characterized by an ombrotrophic peatland with adjacent, peaty forest soils in the Harz Mountains in northwestern Germany. During a one-year campaign, sampling of the headwater stream was conducted in biweekly intervals and in high resolution during selected high discharge events. DOM was characterized by spectrofluorometric indices, such as SUVA254nm, SR, HIX and FI, as well as by PARAFAC modelling of fluorescence spectra.

Results showed major changes in DOM concentration, as well as in DOM quality during the sampling period. DOM concentrations ranged between 5 to 45 mg C L-1 and were mainly controlled by season with low concentrations during snowmelt and spring and higher concentrations in late summer and fall. Highest concentrations occurred at a fall high discharge event. Compared to the peatland, the forested site with a peaty riparian zone exhibited higher DOM concentrations and a stronger variability induced by hydrologic conditions.

DOM quality changes as indicated by spectrofluorometric indices and modelled PARAFAC components were mainly induced by hydrology and showed no clear seasonal pattern. An increasing water level at the bog site caused hydrological connection of fresh DOM pools and a dilution of rather recalcitrant DOM from deeper peat layer. In contrast to the spring event, DOM export at the fall event was dominated by surface-near microbial and less aromatic DOM. At the forested site DOM was smaller and less aromatic in fall event than during spring event. DOM quality changed during the summer drought period toward a shallow groundwater signature with smaller and more microbial compounds at the forested site and toward deep-peat sourced DOM at the bog site. Overall, the study points out the importance to consider high discharge events, which can generate high DOC concentrations, but also export different DOM fractions from different sources, which differ in their chemical properties and biogeochemical behavior in aquatic systems. The peaty forest soils with shallow groundwater connection were mainly responsible for hydrologically induced short-term DOC concentration dynamics, while the bog generated rather constant concentration levels with less changes in DOM quality during high discharge events.