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Character, quality and bioavailability of Dissolved Organic Carbon (DOC) in a boreal stream network (Invited)

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ABSTRACT

The conceptual understanding of the role of terrestrially derived dissolved organic carbon (DOC) in freshwaters has been changing rapidly. While it was once considered mainly a pool of recalcitrant compounds, DOC is now better known for its interactivity and ability to affect both the biogeochemistry and ecology of streams, rivers and lakes. Here we summarize the recent work from the multi-investigatory project conducted in the Krycklan Catchment Study in Sweden with an emphasis on the spatial and temporal variability of the character and bioavailability of DOC. In total, 15 streams and their adjacent soils have been investigated. The streams cover a forest-wetland gradient, spanning from 0% to 69% wetland coverage (hence with a 100% to 31% forest cover). Lower values of the ratio between absorbance measured at 254 nm and 365 nm (A_{254}/A_{365}), in both soil plots and streams, indicated that wetland-derived DOC has a higher average molecular weight than forest DOC. Higher SUVA₂₅₄ (DOC specific ultraviolet absorption at 254 nm) in wetland runoff indicated more aromatic DOC from wetlands than forests. In accordance, low molecular weight non-aromatic compounds such as free organic acids (OA), amino acids (AA) and carbohydrates (CH) had higher quantities in the forested streams. We have shown that a variety of the OA, AA and CH compounds can be significantly assimilated by bacteria, meeting 15-100% of the bacterial carbon demand and explaining most of the observed variance in bacterial growth efficiency. We can now also show that in small homogenous catchments, the hydrological functioning provides a first order control on the temporal variability of stream water DOC and its quality. As a consequence, streams with heterogeneous catchments undergo a temporal switch in the DOC source. In a typical boreal catchment of 10-20% wetlands, DOC originates predominantly from wetland sources during low flow conditions whereas the major source of DOC originates from forested areas of the catchment during high flow resulting in dramatic shifts in the character and bioavailability of DOC during different flow conditions. By connecting knowledge about the sources and quality of DOC with detailed hydrological process understanding, an improved representation of stream water DOC regulation can be provided. This work also illustrates that the sensitivity of stream water DOC in the boreal landscape ultimately depends on how individual landscape elements are affected, the proportion of these landscape elements and how these changes are propagated downstream.