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Transport of dissolved organic carbon from soil to surface water: Identifying the transport pathways

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Over the last decades, increasing concentrations of dissolved organic carbon (DOC) have been found in surface waters. It has also become clear that land use is an important driver for DOC export. However, causal factors controlling this temporal and spatial variation are not clear. Efforts to model DOC export on a catchment scale are rare.

In this research, we aim to determine the factors controlling variations in DOC concentration and quality in surface waters. Secondly, the importance of the different pathways (surface runoff, subsurface flow and groundwater flow) for the transport of dissolved organic matter from the soil to the surface water is investigated.

Six headwater catchments (100 - 400 ha) were selected in Belgium, representing three different types of land use, namely forest, grassland and arable land. At the outlet of each catchment, a flow-proportional sampler has been collecting samples of base flow and peak discharge since January 2010. In addition, samples of groundwater, subsurface water and precipitation water were collected on a regular base in three of the catchments. Samples were analyzed for DOC, specific UV absorbance (SUVA) and dissolved silica (DSi). Elemental analysis was carried out using ICP-OES. Since 2012, precipitation water and a selection of river water samples was also analyzed for O and H isotopes.

Overall, DOC concentrations were highest in forest catchments and lowest in grassland catchments.
For all land use types, measured DOC concentrations were highest during peak discharge. The rise in DOC concentrations was associated with a change in DOC quality. During periods of greater discharge, higher SUVA values were measured, indicating DOC with higher aromaticity (humic and fulvic fractions) reaches the outlet. ICP and DSi results also showed a significant difference in geochemical composition of the river water if peak events are compared to base flow samples. During an event, Ca, Mg, Na, S and DSi concentrations were lowered, while K concentrations rose. Isotope analysis showed more heavy O an H isotopes during peak events than during baseflow.

Results of the river water were combined with analysis of possible end-members in the catchments, using the groundwater, soil water and precipitation samples. An end-member-mixing-analysis (EMMA) gained more insight into the contributing pathways for the transport of organic matter from the soil to the surface water during base and peak flow. Furthermore, results from the different catchments were compared, and allowed to relate DOC transport to land use type. This is an important step towards a model describing DOC transport at the catchment scale.