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The topographic wetness index as a predictor for hot spots of DOC export from catchments

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Dissolved organic carbon (DOC) concentrations in the discharge of many catchments in Europe and North America are rising. This increase is of concern for the drinking water supply from reservoirs since high DOC concentrations cause additional costs in water treatment and potentially the formation of harmful disinfection by-products. A prerequisite for understanding this increase is the knowledge on the spatial distribution of dominant soil DOC sources within catchments and on mobilization as well as transfer processes to the surface water. A number of studies identified wetland soils as the dominant source with fast mobilization and short transit times to the receiving surface water. However, most studies have either focussed on smaller, hillslope and single catchment or on larger scale multi-catchment assessments. Moreover, information on the distribution of soil types in catchments is not always readily available. This study brings together both types of assessment in a data-driven top-down approach: (i) a detailed survey on DOC concentration and loads over the course of one year within two paired data-rich catchments discharging into a large drinking water reservoir in central Germany and (ii) a database of hydrochemistry and physio-geographic characteristics of 113 catchments draining into 58 reservoirs across Germany over the course of 16 years. The objective is to define hot spots of DOC export within the catchments for both types of assessments (i, ii) and to test the suitability of the topographic wetness index (TWI) as a proxy for well-connected wetland soils at various spatial scales. In the sub-catchments of assessment (i) the spatial variability of concentrations and loads was much smaller than expected. None of the studied sub-catchments was a predominant producer of the total DOC loads exported from the catchments. We found the mean concentrations and loads to be positively correlated with the share of groundwater-dominated soils in the sub-catchments. These soils are distributed in riparian wetlands along all streams within the catchments. As a readily available proxy for wetland soils percentiles of the probability distribution of the TWI in the sub-catchments were found to be good predictors for mean DOC concentrations in catchment outlet as well as for loads. In the larger dataset across Germany (ii) we also found a surprisingly good correlation between the TWI within the catchments and mean DOC concentrations. Thus we can show that, despite the wide range of topographies, land use types, geological setups and climatic conditions within this dataset the dominant source zones of DOC export is well captured by the TWI as a proxy for the share of wetland soils and DOC source zones within the catchments.