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Partitioning of organic carbon in European Russian tundra and taiga ecosystems

M.R. Oosterwoud (1), E.J.M. Temminghoff (2), and S.E.A.T.M. van der Zee (1)

(1) Soil Physics, Ecohydrology and Groundwater Management Group, Wageningen University, Wageningen, Netherlands (marieke.oosterwoud@wur.nl), (2) Soil Quality, Wageningen University, Wageningen, Netherlands

Sorption of dissolved organic carbon (DOC) on mineral phases is an important process for carbon preservation and element cycling in soils. Sorption of DOC to active minerals results in its fractionation because hydrophobic compounds (humic and fulvic acids) will be preferentially sorbed. Binding of cations (Ca^{2+}, Mg^{2+}, Al^{3+}, Fe^{3+}) by the DOC reduces the negative charge and thus its water solubility. At low pH and high cation concentrations, cations may cause coagulation of DOC. The sorption and/or coagulation are important factors in relation to DOC transport.

Little is known about DOC partitioning between the soil solid and solution phases of arctic ecosystems. As a consequence of future warming arctic ecosystem will shift from surface water dominated to groundwater dominated systems. In general, permafrost affected soils with shallow active layers, having lateral flow towards the stream with only short contact time to mineral layers, lead to higher hydrophobic (humic and fulvic acid) DOC concentrations in streams compared to permafrost free soils where a larger share of hydrophilic DOC is expected to be discharged into streams. Changes in the delivery of DOC, nutrients and major ions to arctic rivers may have important consequences for primary production and carbon cycling. The partitioning of DOC is a fundamental process needed for modelling current and future stream water quality and solute transport. Therefore, the objective of this study is to determine the sorption and consequent fractionation of DOC in arctic ecosystems.

During fieldwork carried out in the summer of 2007 and 2008 in the Russian Komi Republic, we collected soil, soil solution and surface water samples in both a forested taiga and a permafrost affected tundra catchment. The liquid samples were analysed for total organic carbon and inorganic cations. A rapid batch procedure was used for determining the humic-, fulvic- and hydrophilic acid fractions. Using the chemical speciation model Orchestra we modelled the adsorption of humic, and fulvic acids (hydrophobic compounds) to cations according to the NICA-Donnan model. This model describes the specific binding of cations to the humic reactive sites (NICA) as well as the nonspecific (electrostatic) binding of cations due to the negative charge of the humic substances (Donnan).

Our first results show that DOC concentrations in surface water in taiga are higher than in tundra. By comparing total (TOC) and dissolved (DOC) organic carbon concentrations in surface water we can conclude that particulate organic carbon (POC=TOC-DOC) is hardly present. Large differences between 2007 and 2008 surface water DOC concentrations in tundra reveal the large annual fluctuations in surface water DOC fluxes that may occur. For the inorganic concentrations the differences between 2007 and 2008 are much smaller than for DOC. In the permafrost affected tundra ecosystem, DOC concentrations in surface water decreased with increasing cation concentrations. The composition of the DOC in both taiga and tundra surface water consists dominantly of fulvic acids with a minor contribution of hydrophilic acids. Only in a large thermokarst lake in the tundra and in upstream, fen peat draining, locations in taiga humic acids are found.

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