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Hydro-climatic control of stream dissolved organic carbon in headwater catchment

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Dissolved organic matter (DOM) is a key form of the organic matter linking together the water and the carbon cycles and interconnecting the biosphere (terrestrial and marine) and the soil.
At the landscape scale, land use and hydrology are the main factors controlling the amount of DOM transferred from soils to the stream. In an intensively cultivated catchment, a recent work using isotopic composition of DOM as a marker has identified two different sources of DOM. The uppermost soil horizons of the riparian wetland appear as a quasi-infinite source while the topsoil of the hillslope forms a limited one mobilized by water-table rise and exported to the stream across the upland-riparian wetland-stream continuum. In addition to the exportation of DOM via water fluxes, climatic factors like temperature and precipitation regulate the DOM production by influencing microbial activity and soil organic matter degradation.
The small headwater catchment (5 km^2) of Kervidy-Naizin located in Brittany is part of the Environment Research Observatory (ORE) AgrHys. Weather and the hydro-chemistry of the stream, and the groundwater levels are daily recorded since 1993, 2000 and 2001 respectively. Over 13 contrasted hydrological years, the annual flow weighted mean concentration of dissolved organic carbon (DOC) is 5.6 mg.L-1 (sd = 0.7) for annual precipitation varying from 488mm to 1327mm and annual mean temperatures of 11°C (sd = 0.6). Based on this considerable dataset and this annual variability, we tried to understand how the hydro-climatic conditions determinate the stream DOC concentrations along the year.
From the fluctuations of water table depth, each hydrologic year has been divided into three main period: i) progressive rewetting of the riparian wetland soils, ii) rising and holding high of the water table in the hillslope, iii) drawdown of the water-table, with less and less topsoil connected to the stream. Within each period base flow and storm flow data were first pooled then treated separately and the influence of preceding periods was tested. This hydrological division of time allowed us to identify climate effect on the topsoil DOM stores of the wetland and hillslope separately. Meteorological and hydro-pedological variables, like soil temperatures or duration of the water saturation in the organo-mineral horizons have been used to interpret the DOC concentrations and fluxes at the outlet within each period.
The three hydrological periods contribute respectively to less than 17%, more than 63%, and less than 26% of the annual DOM exportation with flow weighted mean concentration of DOC of 9.5, 6.1, and 3.8 mg.L-1. Considering several DOM sources with different properties of depletion under climatic control, the main output of the work is to provide a modified conceptual model of the DOC dynamics.