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Modelling hydrological processes and dissolved organic carbon dynamics in a rehabilitated Sphagnum-dominated peatland

Léonard Bernard-Jannin (1,2,3), Stéphane Binet (1,2,4), Sébastien Gogo (1,2,3), Fabien Leroy (1,2,3), Laurent Perdereau (1,2,3), Fatima Laggoun-Défarge (1,2,3)

(1) Université d'Orléans, ISTO, UMR 7327, 45071, Orléans, France, (2) CNRS, ISTO, UMR 7327, 45071 Orléans, France, (3) BRGM, ISTO, UMR 7327, BP 36009, 45060 Orléans, France, (4) ECOLAB, Université de Toulouse, CNRS, UPS, INPT – UMR 5245, Toulouse, France

Sphagnum-dominated peatlands represent a global major stock of carbon (C). Dissolved organic carbon (DOC) exports through runoff and leaching could reduce their potential C sink function and impact downstream water quality. DOC production in peatlands is strongly controlled by the hydrology, especially water table depth (WTD). Therefore, disturbances such as drainage can lead to increase DOC exports by lowering the WTD. Hydrological restoration (e.g. rewetting) can be undertaken to restore peatland functioning with an impact on DOC exports. The objective of this study is to assess the impact of drainage and rewetting on hydrological processes and their interactions with DOC dynamics in a Sphagnum dominated peatland.

A hydrological model has been applied to a drained peatland (La Guette, France) which experienced a rewetting action on February 2014 and where WTD has been recorded in four piezometers at a 15 min time step since 2009. In addition, DOC concentrations in the peatland have been measured 6 times a year since 2014. The hydrological model is a WTD dependent reservoir model composed by two reservoirs representing the micro and macro porosity of the peatland (Binet et al., 2013). A DOC production module in both reservoirs was implemented based on temperature and WTD. The model was calibrated against WTD and DOC concentrations for each piezometer.

The results show that the WTD in the study area is strongly affected by local meteorological conditions that could hide the effect of the rewetting action. The preliminary results evidenced that an additional source of water, identified as groundwater supply originating from the surrounding sandy layer aquifer, is necessary to maintain the water balance, especially during wet years (NS>0.8). Finally, the DOC module was able to describe DOC concentrations measured in the peatland and could be used to assess the impact of rewetting on DOC dynamics at different locations and to identify the factors of control of DOC exports at the peatland scale before and after the restoration. This simple conceptual model requires few data to operate. Its application on different sites with contrasted settings (hydrological and climatic conditions) could provide insight on the dominant hydrological processes and their impact on DOC dynamics in peatlands.

Binet S., Gogo S., Laggoun-Défarge F., A water-table dependent reservoir model to investigate the effect of drought and vascular plant invasion on peatland hydrology, Journal of Hydrology, Volume 499, 30 August 2013, Pages 132-139, ISSN 0022-1694, http://dx.doi.org/10.1016/j.jhydrol.2013.06.035.