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Analysis of denitrification process in the groundwater of floodplains using a modelling approach

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Nitrate contamination of freshwater systems is a global concern. In alluvial floodplains, highly vulnerable to nitrate pollution due to widespread agricultural activities, riparian areas have been proven to be efficient in nitrate removal through denitrification. However, denitrification presents complex spatio-temporal patterns and is controlled by many factors. Hence, modelling can provide useful knowledge about this biogeochemical process, by helping to identify key factors involved in denitrification process and its spatio-temporal variability.
In this study, a modelling approach combining i) a distributed hydrodynamic model, coupling surface and subsurface flow (MOHID Land), with ii) a simplified denitrification calculation module including dissolved organic carbon (DOC borned by the river) and particulate organic carbon (POC present in soil) have been applied to a monitored meander area of the Garonne river (6.6 km^2). The dataset include hydrological data and nitrates concentrations collected in a network of 25 piezometers during 12 monthly campaigns allowing the set up and the validation of the model application.
The average denitrification rate was estimated to 28 kg N/ha/yr representing 38% of the lateral nitrate input from the agricultural area. Denitrification was the highest in the low elevation riparian area in relation with inundated soils releasing topsoil organic carbon fueling denitrification. In addition high denitrification rates were simulated in downstream part of the meander in relation with the high nitrates flux coming from the agricultural area. Geomorphological settings and groundwater flows in the area play a major role in controlling denitrification in floodplain area. Flood events lead to high denitrification periods by increasing topsoil layer POC availability with higher water level in the aquifer. However, the role of DOC borne by the river seems restricted. The model can be applied to estimate nitrate removal capacity of riparian area and provide validation for larger scale modelling application.