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Modelling the impact of increased lateral connectivity on nutrient retention in Austrian Danube floodplains

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In the last centuries, rivers in Central Europe have severely suffered from hydro-morphological alterations and excessive nutrient inputs. Their adjacent floodplains have the ability to retain transported nutrients in case of inundation, but are subject to progressing decoupling from the main river stem. In the Austrian Danube Floodplain National Park, restoration measures have been carried out and are planned for the near future to increase lateral connectivity in accordance with navigation purposes.

We investigated nutrient retention capacity in seven differently connected side arms and the potential effects of further proposed reconnection measures using two complementary modeling approaches. With existing monitoring data on hydrology, nitrate and total phosphorus concentrations for three side arms, we derived a multivariate statistical model and compared these results to a larger scaled semi-empirical retention model (Venohr et al. 2011). We modelled nutrient retention at current state and after completion of side arm reconnections in a dry (2003) and wet (2002) hydrologic year.

Both models show comparable annual retention rates and agree in calculating higher nutrient retention in floodplains where reconnection allows more frequent inundations at low discharges. The semi-empirical approach results in highest retention rates at low hydraulic loads and shows more reasonable results at high floods. On the other hand, the statistical approach predicts increasing retention rates with higher nutrient loads entering the side arms and also takes into account nitrate reduction in the remaining water bodies at times of no surface water connection.

Our results suggest that water quality of the Danube River could be improved by increasing parameters related to lateral connectivity between river and floodplain. These include in particular the frequency and area of inundation, as well as nutrient input loads into the reactive zones of floodplains. Still, a frequently hydrologically connected national park stretch after restoration reduces nutrient loads of the Upper Danube by less than 0.1% due to its small areal extent in relation to transported river nutrient loads. In order to sustain an adequate water quality in future, both a reduction in nutrient emissions and a larger area of functional floodplains along the Danube River are required.

References:

Venohr, M., Hirt, U., Hofmann, J., Opitz, D., Gericke, A., Wetzig, A., ... & Mahnkopf, J. (2011). Modelling of nutrient emissions in river systems–MONERIS–methods and background. International Review of Hydrobiology, 96(5), 435-483.

Key words:

River floodplains, lateral connectivity, nutrient retention, river restoration, floodplain reconnection, water quality