Changes of N-loads and N-isotope values in a small river under differential anthropogenic impacts

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Large nutrient inputs due to anthropogenic impacts increased dramatically during the last decades. Beside the increased nitrogen load itself, eutrophication can alter biological N-retention, which can dynamically change N-loads in aquatic ecosystems.

In this study, we investigated nitrate inputs in a small river (Holtemme, Saxony-Anhalt) along a gradient of anthropogenic influence, from a natural protected area to a waste water treatment plant (WWTP) and agricultural impacts downstream. We aimed to determine alterations in the nitrate loads and isotope signatures in the water column as well as the influence of these loads on biological filtering due to seasonal turnover processes in the river sediment.

Water samples were taken seasonally at six stations inside the gradient for measuring nutrient concentrations and $\delta^{15}N$ and $\delta^{18}O$ of nitrate. To differentiate rates of nitrate production and removal, additional sediment cores for sediment incubations were taken in the pristine part and at the end of the gradient in the N-polluted area.

Pristine nitrate isotope values showed a clear influence of natural sources like biological nitrogen fixation, or atmospheric deposition. Along the gradient, nitrate concentrations and $\delta^{15}N$ then increased in all seasons, decreasing again slightly after the WWTP towards the agricultural area.

In general, nitrogen turnover rates were higher in the polluted area than in the pristine area. In the polluted part of the river, turnover rates were higher in summer than in autumn, but nitrate removal clearly exceeded nitrate production. In the pristine area, a shift occurred from summer to autumn from net nitrate production to net removal.

Our measurements quantify the nitrate increase due to anthropogenic activities in a small river that receives little N from other sources. We also traced N-isotope changes of urban, waste water and agriculture. This high nitrogen load results in a shift from nitrate production to nitrate removal in river sediments, but the removal capacity is apparently overwhelmed by surplus N-inputs.