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Quantification of whole stream and compartmental nutrient processing in streams under multiple human pressures

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Since the beginning of the anthropocene, humans have substantially increased inputs of nutrients into stream ecosystems and subsequently changed nutrient limitations and processing. Human activities also modified fine sedimentation patterns, stream morphology, and light conditions, which furthermore influence the functioning of stream ecosystems. This multitude of pressures may control nutrient processing in streams by altering the biological activity of the major stream ecosystem compartments (pelagic, benthic, and hyporheic zone). Still, quantification remains largely unknown for both, the contribution of each compartment to whole stream nutrient uptake and how the mentioned pressures affect those contributions. Beyond, linking reach scale findings to functioning at catchment scale needs to be investigated more intensively.

We chose six first and second order streams of the mesoscale Holtemme catchment located in the Harz Mountains and the nearby lowland region (Central Germany). The catchments of three of the streams are dominated by arable farming and forests, respectively. We repeatedly measure in-stream net nutrient uptake (based on nutrient spiralling approach, i.e. longitudinal variation in nutrient concentration along reaches) and ecosystem metabolism (based on continuous oxygen data). Equally, we investigate hydrologic turnover (mass balance approach for gaining/losing of water from/to the groundwater) by applying conservative tracer additions at several stations along the reaches. We perform this assessment in a one-year monitoring to capture different hydrologic regimes. Additionally, we address a range of other hydrological, morphological, and biogeochemical characteristics as well as measurements regarding fine sediment and light.

We aim at finding a statistical linkage between the characteristics of the tracer breakthrough curves and hyporheic exchange fluxes. Combining the concept of nutrient spiralling with hydrologic turnover will help to unravel compartmental contributions to whole-stream uptake. We argue that benthic and, especially, hyporheic uptake will be crucial for the total balance and most sensitive to stress such as fine sediment inputs. We anticipate that the concept of hydrologic turnover can be utilized to link the results to the catchment scale owing to its systemic applicability.