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# Why integrated river basin management is likely to fail without adequate representation of nutrient transport and transformation at the river – aquifer interface

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The analysis, assessment and prediction of hydrological processes and ecological conditions in an integrated river basin management require catchment scale model simulations of the water balance as well as of transport and transformation of nutrients and pollutants. Applications of coupled groundwater – surface water models for lowland catchments highlighted the specific sensitivity of the groundwater-surface water interface for simulation of floodplain hydrology and nutrient transport. Because of the lack of precise data, the direct interface between groundwater and surface water is in many model applications implemented as a leakage boundary which is often subject to excessive calibration. Nutrient transformation in the hyporheic zone, the area of groundwater and surface water mixing is usually completely ignored in catchment scale models.

This paper presents the results of experimental and model-based investigations of nutrient transport and transformation in lowland catchments which are questioning the accuracy of current river basin modelling approaches and highlight their limitations and uncertainties. Results from several field sites show that physical streambed conditions and in particular the hyporheic transmissivity significantly control the patterns of groundwater-surface water exchange fluxes and residence times. This has further implications for the transport and transformation of redox-reactive nutrient compounds and reaction times in variable oxidising or reducing environments. Our results indicate that during summer baseflow periods the intensity of hyporheic nutrient transformation is controlled by the spatial and temporal coincidence of (i) connectivity patterns between groundwater and surface water and the resulting exchange rates and residence times and (ii) patterns of redox-reactivity and reaction efficiencies.

We found nitrate concentration changes in up-welling groundwater of more than 300% in the uppermost 100 cm hyporheic streambed sediments. The implications of hyporheic nutrient transformation for river loads appear to follow seasonal dynamics and were most important during summer baseflow conditions.

The presented results prove that at the investigated field sites ignoring of hyporheic nutrient transport and transformation would have lead to significant over- or under estimation of nutrient delivery and loads in the baseflow. Therefore we hypothesise that model applications in integrated river basin management which don't implement estimations of hyporheic nutrient transformation may be inaccurate and can contain significant uncertainties.