



Investigating in-stream nitrogen removal at variable flow conditions using new optical sensors

Michael Rode (1), Kay Knoeller (2), and Uwe Kiwel (1)

(1) Helmholtz Centre for Environmental Research - UFZ, Department of Aquatic Ecosystem Analysis and Management, Magdeburg, Germany (michael.rode@ufz.de, ++49 (0)391 810 9699), (2) Helmholtz Centre for Environmental Research UFZ, Department Catchment Hydrology, Halle, Germany Halle, Germany

Most experimental studies on in-stream nitrogen removal concentrate on low flow conditions. Considerable knowledge gaps exist on nitrogen removal during high flow stages, especially for mid- sized streams. The objective of the study is quantify nitrogen removal during low and high flow conditions in the 4th order Bode river, which is part of the TERENO Hydrological Observatory of UFZ, Germany. To measure nitrogen removal at variable flow conditions we used new optical and conventional water quality multi-parameter sensors for continues measurements (10-15 min frequency) on electric conductivity, temperature, pH-value, nitrate-N, soluble oxygen, turbidity, chlorophyll a and SAC 254 (specific absorption coefficient) at two river stations. Additional automatic samplers were installed to conduct four low flow campaigns and to measure four high flow events at a 30km river reach from 2010 to 2012. Several nitrogen and phosphorus compounds as well as $\delta^{18}\text{O}$ and $\delta^{15}\text{N}$ isotopes at nitrate have been analyzed using a two hour sampling interval. The study river reach is an ideal system to investigate the impact of flow conditions on nitrogen removal by mass balances and natural abundance of nitrogen isotopes because upstream inflow is equal with downstream outflow with less the 3% deviation on a yearly basis. Continues sensor measurements show that nitrate removal is occurring throughout the year depending on primary production, temperature and nitrate concentrations. During low flow conditions in the vegetation period a clear diurnal variation of nitrate concentrations is observable. Nitrate-N concentrations, which range between 2 and 8 mgN l⁻¹, can vary by 10% between day and night time during periods with high algae concentration. The nitrogen balance calculations for the four low flow sampling campaigns suggest a loss of nitrogen between 10 and 20 % in the 30km reach. Losses were highest in August 2011 and lowest in October 2010. Surprisingly also during high flow events considerable nitrogen removal was found. During a summer event without active floodplains nitrogen removal ranged between 12 and 24% of nitrogen load. For a similar winter event with low temperature nitrate removal was low. In contrast a large winter event with active floodplains showed nitrate losses between 10 and 15%. The results indicate that nitrogen removal is not restricted to low flow conditions and that high flow losses are controlled by complex interactions between seasonal effects and hydraulic flow conditions of a given discharge event.