Integrated Isotope Techniques to Investigate Nitrate Dynamics along a Land-Use Gradient in a Mesoscale River Catchment

IZABELA BUJAK[1], CHRISTIN MÜLLER[2], RALF MERZ[3], KAY KNÖLLER[4]

[1]Theodor-Lieser Straße 4, 06112 Halle, Germany, izabela.bujak@ufz.de
[2]Theodor-Lieser Straße 4, 06112 Halle, Germany, christin.müller@ufz.de
[3]Theodor-Lieser Straße 4, 06112 Halle, Germany, ralf.merz@ufz.de
[4]Theodor-Lieser Straße 4, 06112 Halle, Germany, kay.knöller@ufz.de

The European Union Water Framework Directive calls for water quality management on a river basin scale. Furthermore, it emphasizes the need to prevent nitrate pollution of ground and surface waters as excess nitrogen from agricultural sources is one of the main causes of water pollution in Europe. However, catchment-scale management approaches in large catchments are often hindered due to the poor understanding of spatially and seasonally variable pathways of nitrate and its multiple possible sources. Therefore, we investigated nitrate dynamics in the Erlauf catchment representing a mesoscale river system (632 km²) characterized by an anthropogenic land-use gradient from pristine forests in headwaters to the agriculturally dominated areas in the lower course of the river. The seasonal monitoring of surface water and precipitation with high-spatial resolution (66 sampling locations) was carried out from 2012 to 2017. Our approach was based on the integration of the multi-isotope analysis ($\delta^{15}N_{NO3}$, $\delta^{18}O_{NO3}$, $\delta^{2}H_{H2O}$, and $\delta^{18}O_{H2O}$), geostatistical methods (Top-Kriging), Bayesian isotope mixing model (MixSIAR), and fluxes of nitrate and other solutes. This integrated approach served to quantify the contribution of nitrate sources in stream water and to address subsequent biogeochemical processes. The combination of isotope techniques with geostatistical and probabilistic methods proved its efficiency in tracing sources and fate of nitrate. Obtained results highlight the critical role of land-use management practices for regional nitrate dynamics.