Transient times as a tool to resolve “hot moments“ of nitrogen transformations at a mixed land use catchment

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Resolving the nitrogen sources in river discharge and the “hot moments” of nitrogen transformations to mobile nitrogen species at river catchment is crucial in attempts to reduce nitrogen export. This study introduces an approach to utilize transient time information and stable isotopes of water and nitrogen compounds to interpret where and when nitrate that enters the river discharge has been formed. We investigate nitrogen dynamics at a lowland catchment of Sauerbach creek (10 km²) in central Germany. Sauerbach creek is feeding Selke river and is a part of TERENO Observatory at the foreland of Harz mountains. The catchment is predominantly covered by low relief agricultural areas and steeply sloped forested headwaters.

To evaluate the catchment dynamics, we monitor daily precipitation input for $^{18}$O-H$_2$O, $^2$H-H$_2$O, $^{15}$N-NO$_3$ and $^{18}$O-NO$_3$ and collect biweekly water samples from the creek at four sampling sites. Furthermore we monitor the creek and groundwater for discharge, ground water level, temperature and electrical conductivity in high temporal resolution. In addition bimonthly soil samples and seasonal groundwater samples are collected. The isotopic constitution of water and nitrogen species and the chemical properties of soil water, groundwater and surface water are thus defined.

As water isotopic signature is an intrinsic property of water itself, it is an ideal tracer for water movement in the catchment system. In this study the water isotopes are used to define time variant transient times of water at the creek outlet. The transient times are modeled by coupling particle tracking of stable water isotopes with a conceptual hydrological rainfall-runoff model (HBV-model). The travel time information is further used to analyze nitrogen transport and to spot the relevant times of nitrate formation within the catchment.

The results are suggesting that nitrate is not considerably controlled by in stream processes and that the nitrate dynamics in the creek is mainly driven by relatively young water.