Geophysical Research Abstracts
Vol. 12, EGU2010-14753-1, 2010
EGU General Assembly 2010

Tracing nitrate in a restored river reach using 18O and 15N

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Riparian zones, including alluvial forests are important for biodiversity, flood mitigation and water retention. They can remove nitrate from adjacent upland areas and atmospheric deposition by natural processes such as plant uptake, denitrification and dilution. Riparian zones have become rare since rivers have been canalized to avoid flooding. However, their area might increase in the future with the changing policy for river management in Europe and in Switzerland. A good understanding of flow paths and nitrate sources in catchments is therefore important to assess the soil influence on groundwater quality and to select the most effective land management practices (forest, agriculture, river) to ensure a sustainable water supply of good quality. Numerous studies have investigated either the chemistry of percolation waters in the root zone or the groundwater quality. However, very few have assessed the biochemical transformation of the water composition along its flow path from the soil to the aquifer and the mixing in the aquifer with water from other sources within the catchment.

The proposed project aims at identifying the different sources of nitrate in soil- and groundwater (atmospheric deposition, nitrification, fertilizers and manure) and to better understand the N transformations along the flow paths from the soil to the aquifer by analyzing the oxygen and nitrogen isotopes in nitrate. The study is performed within a restored section of the river Thur (Canton Thurgau, Switzerland). It is part of the project cluster RECORD of the ETH domain, Switzerland, which was initiated to increase the mechanistic understanding of coupled hydrological and ecological processes in river corridors. Besides the sampling of river-, ground- and rainwater, soil solutions are collected in the unsaturated zone at three different depths (10, 50, 100 cm) and along two terrestrial transects following approximately the flow paths through different functional process zones (river - gravel bar with fresh fine sediments and densely colonised by canary reed grass – older overbank sediments planted with willows during recent restoration – mixed riparian hardwood forest growing on older overbank sediments – side channel). Samples were collected biweekly from May to October 2009, and will be completed by a seasonal sampling until April 2010 to assess the temporal variability of the major ion composition and the oxygen and nitrogen isotopic composition of nitrate. During floods, the observations were intensified to characterize the disturbance of the N cycle.

The highest nitrate concentrations have been measured in the forest soil at 1 m depth (mean value = 612 μmol/L) exceeding the average nitrate concentration in precipitation (37 μmol/L) by a factor 17 and in ground water samples (84 μmol/L) by a factor 7. Based on these first results we assume a nitrogen saturation of the forest soil mainly driven by the high input of organic matter during flooding (silty organic carbon-rich sedimentation). Furthermore, we assume that this high nutrient availability together with the homogenous soil profile are typical for a riparian zone and favor nitrification also at greater depth, releasing nitrate into groundwater. To support these hypotheses we will complete the hydrochemical dataset by the measurement of stable isotopes of oxygen and nitrogen in nitrate.