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Nitrate isotopes reveal the effectiveness of riparian denitrification for nitrate removal from riparian zones

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The riparian zone is a hydrologically and biogeochemically active zone, characterized by mixing of stream water with groundwater and transformation of nutrients such as nitrogen. The riparian zone thus plays a key role in natural attenuation of nitrate pollution. Among the attenuation processes in riparian zones, denitrification is the only one that leads to permanent removal of nitrogen from the riparian system via the release of dinitrogen gas into the atmosphere. In contrast, other biogeochemical processes such as nitrate uptake by plants merely result in a temporary nitrogen retention within riparian zones. While hydrochemical data and endmember modelling can help assess nitrate transformation in riparian aquifers, this does not allow quantifying the extent of nitrate removal via denitrification. In this talk, I will demonstrate how nitrate isotope data can be used in combination with chloride and nitrate concentration data to quantify spatial and temporal variations in the extent of denitrification and mixing between groundwater and surface water. I will illustrate how the application of this approach to a riparian groundwater study site in Central Germany revealed that denitrification is largely exceeded by other processes that merely lead to temporary nitrate removal from the riparian groundwater. In comparable settings, a major fraction of nitrogen inputs is thus likely retained in riparian zones and may eventually be discharged into rivers. Such information is crucial to determine the effectiveness of riparian zones for removing nitrate from aquatic ecosystems, which is highly relevant for many river ecosystems at risk of eutrophication because of high nitrogen inputs from agriculture.

Reference

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