Assessing denitrification in groundwater (Betrachtungen zur Abschätzung von Denitrifikation im Grundwasser)

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Abstract

Extended industrialisation and agricultural production led to increased availability of nitrogen in terrestrial and aquatic ecosystems during the past decades. Since nitrate is subject of enhanced leaching from soils by percolation towards the groundwater due to its high mobility, denitrification in groundwater is an important process, which counteracts to nitrogen transport by groundwater to surface water bodies. Denitrification in groundwater was subject of several scientific studies indicating the importance of denitrification reducing nitrogen levels in groundwater and therewith of diffuse nitrogen emissions to surface waters.

Up to now *in-situ* assessments of denitrification in groundwater are highly uncertain determining changes in isotopic composition of nitrogen or of the produced nitrous oxide, when complete denitrification is suppressed. Additionally, the consideration of denitrification processes in groundwater in several quantification tools for nitrogen emission estimations differs considerably in regard to model complexity, the approaches that account for nitrogen losses via denitrification and variability in denitrification potential for local environments.

In two selected Austrian case study regions denitrification in groundwater could be observed based on nitrogen surplus assessments in relation to groundwater and surface water quality observations. Differences between the selected case study regions in respect to nitrogen fluxes and denitrification activity in subsurface zone could be related to hydrological circumstances, which were characterised by water balance calculations using the conceptual SWAT 2000 model. Using the empirical emission model MONERIS the total nitrogen emissions were calculated for both case study areas and the major emission pathways for nitrogen could be identified.

A new approach was developed for the calculation of diffuse nitrogen emissions to surface waters with consideration of denitrification processes in groundwater based on calculated groundwater residence times. This approach enabled the identification of catchment areas, which are responsible for most of diffuse nitrogen emissions to the surface water and which are therefore highly sensitive in terms of controlling diffuse nitrogen emissions to the receiving coastal waters of the Black Sea. These areas could be clearly distinguished from areas, which are important for local groundwater protection and revealed the contrarious effects of measures related to specific protection goals with focus on either the reduction of nitrogen levels in groundwater or the reduction of nitrogen emissions to surface waters.