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# Using the N2/Ar-Method to check modelled diffuse $NO_3^-$ emissions from soils into the groundwater of Lower Saxony (Germany)

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Diffuse $NO_3^-$ emissions derived from agricultural N surpluses are the main cause of $NO_3^-$ pollution of aquifers and open water bodies. Denitrification is the key process for the attenuation of these anthropogenic $NO_3^-$ concentrations in soils and groundwater. Since the greenhouse gas N2O is an obligate intermediate of denitrification this process is also a major regulator of N2O emissions from soils and indirect N2O fluxes from aquifers and open water bodies which result from $NO_3^-$-leaching. Up to now the denitrification potential of soils and the potential $NO_3^-$ concentration in the groundwater recharge are modelled from agricultural N-surpluses, water balances (GROWA) and soil properties (DENUZ) (Wendland et al. 2009) (LBEG 2008).
In this study we compare modelled $NO_3^-$ emissions (pot-$NO_3^-$) (DENUZ) to the groundwater recharge with the calculated initial $NO_3^-$ concentrations in the groundwater at time of groundwater recharge ($NO_3^-$t0) (N2/Ar-method (Weymann et al. 2008)). $NO_3^-$t0 can be calculated from the measurement of dissolved gases N2, N2O, Ar and $NO_3^-$ concentrations in groundwater samples.
We analysed groundwater samples from 534 groundwater monitoring wells throughout Lower-Saxony (Germany). Median $NO_3^-$ and $NO_3^-$t0 concentrations were 0,4 and 29 mg $NO_3^-$ $l^{-1}$ respectively, showing that considerable proportions of the anthropogenic N-surplus is denitrified within the saturated zone.
First results showed a good agreement between measure and modelled $NO_3^-$ emissions for areas of coastal marshes in the North of Lower-Saxony (predominantly Fluvisols). Medians of measured and modelled $NO_3^-$ emissions are 12,5 mg $NO_3^-$t0 $l^{-1}$ and 0,3 mg pot-$NO_3^-$ $l^{-1}$ (mean values 20 mg $l^{-1}$ $NO_3^-$ pot and 9,3 mg $l^{-1}$ $NO_3^-$t0), respectively. Compared to the coastal marshes and in accordance with modelled pot-$NO_3^-$ concentrations our measurements show small-scale spatial heterogeneities of $NO_3^-$t0 concentrations in soil regions where the dominant parent material of soils are glacio fluviatile and moraine deposits (predominantly Podzols, Cambisols and Gleysols) in Lower-Saxony. In these regions the median of measured $NO_3^-$t0 concentrations was between 29 and 38 mg $NO_3^-$ $l^{-1}$ and on average 25 to 30 mg $NO_3^-$ $l^{-1}$ below the modelled $NO_3^-$ $l^{-1}$ concentrations. To further compare the modelled $NO_3^-$ emissions (pot-$NO_3^-$) with results of the N2/Ar-method ($NO_3^-$t0 values) we select groundwater monitoring wells with more homogenous soil properties, soil water residence times in their catchment areas.
We expect that further analysis will help to validate existing denitrification models. $NO_3^-$t0 values might then be used as a lower boundary condition if denitrification in soils is modelled.

References:
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