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Nitrogen attenuation along delivery pathways in agricultural catchments

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Hillslope hydrologic systems and in particular near-stream saturated zones are active sites of nitrogen (N) biogeochemical dynamics. The efficiency of N removal and the ratio of reaction products (nitrous oxide and dinitrogen) in groundwater is highly variable and depends upon aquifer hydrology, mineralogy, dissolved oxygen, energy sources and redox chemistry. There are large uncertainties in the closing of N budgets in agricultural catchments. Spatial and temporal variability in groundwater physico-chemistry, catchment hydrology and land-use gives rise to hotspots and hot moments of N attenuation. In addition the production, consumption and movement of denitrification products remains poorly understood. The focus of this study is to develop a holistic understanding of N dynamics in groundwater as it moves from the top of the hillslope to the stream. This includes saturated groundwater flow, exchange at the groundwater-surface water interface and hyporheic zone flow. This project is being undertaken in two ca. 10km2 Irish catchments, characterised by permeable soils. One catchment is dominated by arable land overlying slate bedrock and the other by grassland overlying sandstone. Multi-level monitoring wells have been installed at the upslope, midslope and bottom of each hillslope. The piezometers are screened to intercept the subsoil, weathered bedrock and competent bedrock zones. Groundwater samples for nitrate (NO_3-N) nitrite (NO_2-N), ammonium (NH4-N) and total nitrogen are collected on a monthly basis while dissolved gas concentrations are collected seasonally. Groundwater NO_3-N profiles from monitoring data to date in both catchments differ markedly. Although the two catchments had similar 3 year mean concentrations of 6.89 mg/L (arable) and 6.24 mg/L (grassland), the grassland catchment had higher spatial and temporal variation. The arable catchment showed relatively homogenous NO_3-N concentrations in all layers and zones (range: 1.2 - 12.13 mg/L, SD = 1.60 mg/L). Whereas in the grassland catchment NO_3-N concentrations ranged from 0.001 - 23.9 mg/L (SD = 4.40 mg/L) with elevated concentrations in the midslope and upslope zones and groundwater at the hillslope bottom which were consistently close to the limits of detection, indicating a potential denitrifying zone. Using a combination of groundwater flow modelling (Visual Modflow-Flex), high density spatial and temporal sampling and push pull tracer techniques; it is aimed to contribute to the wider understanding of N dynamics in terms of the individual environmental parameters affecting N attenuation, spatial and temporal variability in denitrification rates and gaseous emissions along the hillslope flow path.