DENTRIFICATION IN SHALLOW GROUNDWATERS – AN ECOSYSTEM SERVICE OR A POLLUTION SWAP?

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Denitrification in groundwaters has been identified as a key attenuation process, where leached NO_3^- can be reduced to dinitrogen (N_2 — a harmless gas), offering an ecosystem service in terms of water quality protection. However, a partial denitrification can release nitrous oxide (N_2O — a greenhouse gas), resulting into a pollution swap protecting water quality but adding to global warming potential. There is very limited information available about occurrence, characteristics and dynamics of subsurface denitrification in shallow groundwaters across New Zealand agricultural catchments.

We studied 6 pastoral farms located in various hydrogeological settings in the Manawatu and Rangitikei Rivers catchments, in the lower North Island of New Zealand. We collected a set of monthly groundwater observations over a period of 7 months from March to September, 2018. The collected groundwater samples were analysed for the groundwater redox parameters, including dissolved oxygen (DO), oxidation-reduction potential, pH, NO_3^-, iron, manganese and sulphate. We also conducted a set of push-and-pull tests to gain insights into dynamics of subsurface denitrification occurring in the groundwater samples at the study sites. We measured changes in NO_3^-, dissolved N_2O, dissolved N_2, and excess N_2 during the push-and-pull tests.

Our results suggested a spatially variable groundwater redox conditions and subsurface denitrification occurring across the study sites. The dominant terminal product of subsurface denitrification (whether it was N_2O or N_2) also spatially varied according to the redox status of the groundwater. We observed an increase in excess N_2 concentrations under the anoxic groundwater conditions during the push and pull test. While under oxic groundwater conditions, dissolved N_2O appeared to be the dominant product.

Our observations highlight the influence of different hydrogeological settings on spatial variability of partial or complete (benign) denitrification in shallow groundwaters. A better understanding and quantification of spatial and temporal variability of subsurface denitrification process will help inform, design and formulation of targeted and effective management measures for sustainable agricultural production while protecting soil, water and air quality.

Editor's Note: An extended manuscript has not been submitted for this presentation.