Evaluation of nitrate in groundwater under long-term manure application

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ABSTRACT
High loading rates of manure can result in nitrate contamination of groundwater as excess nitrogen in agricultural soils can leach into groundwater along with infiltrating water. This study is part of a long-term field experiment that was initiated in 1973 at the Lethbridge Research Center. The goal of the long-term plot experiment was to determine the effects of repeated annual applications of beef feedlot manure on soil and groundwater quality by applying manure at different rates to non-irrigated and irrigated land. More recently, as part of the current study, a total of twenty-six monitoring wells were sampled during an 18-month period in order to determine the factors controlling the spatial and temporal distribution of groundwater nitrate concentrations. Results showed that groundwater nitrate concentrations significantly exceeded the drinking water standard of 10 mg-N/L in fourteen wells. Isotopic analysis of groundwater nitrate ($^{15}N\text{-}NO_3$) showed that denitrification was occurring in the majority of the wells (sampling locations) and was responsible for some of the nitrate attenuation across the study site. Generalized additive mixed models (GAMM's) were employed to further investigate contributing factors, such as depth to water table, groundwater temperature, precipitation, hydraulic conductivity, total organic carbon, $^{15}N\text{-}NO_3$, and cumulative nitrogen loading. GAMM analysis revealed groundwater nitrate distributions were most strongly related to the cumulative nitrogen loading from manure application. Analysis of temporal nitrate trends showed that nitrogen leaching to groundwater occurred following recharge events beneath plots where manure is still being applied as well as locations where manure application ceased in 2002. These findings support that manure should be applied conservatively to agricultural systems as manure application rates have a significant control on groundwater nitrate concentrations and current applications have the ability to affect groundwater quality for decades to come.