Application of the dual isotope approach to determine contamination sources and fate of nitrate in shallow groundwater near a river in South Korea

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Hydrogeochemical and dual isotopic approaches for nitrate and sulfate were applied to determine sources and transformation processes affecting groundwater contaminants in a small agricultural area, Yangpyung, Korea. The study area is located in the vicinity of a river. Most of the residents in the study area practice agriculture and potato, strawberry, and cabbage are the typical vegetables grown. The concentration of NO_3-N in groundwater varied between 0.6 and 74.8 mg/L in June, 2014 and between 0.1 and 83.7 mg/L in October, 2014. Thus, it is necessary to identify contaminant sources to protect water quality around the study area. The $\delta^{15}N\text{-}NO_3^-$ values in the study area ranged between +9.1 and +24.6‰ in June and +12.2 to +18.9‰ in October. The sulfate concentrations in groundwater samples obtained from the study area varied from 12.3 to 31.2 mg/L in June and 9.8 to 20.4 mg/L in October. $\delta^{34}S\text{-}SO_4^{2-}$ values ranged from +2.0 to +5.2‰ in June and +2.5 to +6.4‰ in October. Elevated concentrations of SO_4^{2-} with $\delta^{34}S\text{-}SO_4^{2-}$ values between 2.0 and 6.4‰ indicated that sulfate was derived from a mixture of atmospheric deposition and mineralization of soil organic matter. High values of $\delta^{15}N\text{-}NO_3^-$ with low values of $\delta^{18}O\text{-}NO_3^-$ in two sampling periods indicated that organic fertilizers are partially responsible for high concentrations of nitrate in groundwater in the study area. Some groundwater samples in northern parts of the study area showed elevated values of $\delta^{15}N\text{-}NO_3^-$ and $\delta^{18}O\text{-}NO_3^-$ suggesting that denitrification is removing nitrate from the groundwater. The results of this study indicate that it is necessary to control organic fertilizer usage to improve water quality in the study area.