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Application of multiple isotopes to assess nitrate contamination and seawater intrusion in a heavily cultivated coastal area

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Hydrogeochemical and multiple isotope data for groundwater samples were applied to determine contaminant sources and transformation processes of nitrate in a coastal aquifer underlying a heavily cultivated watershed in Hwaseong, South Korea. The local aquifers are vulnerable to contamination due to high anthropogenic N inputs and the location close to the ocean. Thus, it is necessary to monitor groundwater quality in the study area. The concentrations of NO_3-N in groundwater ranged from 0.1 to 45.6 mg/L in August 2015 and from 0.2 to 39.6 mg/L in March 2016. The δ15N-NO_3- values in groundwater ranged between +1.8 and +15.6‰ in August 2015 and +1.2 to +15.9‰ in March 2016. High concentrations of NO_3-N and high δ15N-NO_3- values in two sampling periods indicated that organic fertilizers are partially responsible for nitrate contamination of groundwater in the study area. Some groundwater samples in the northern parts of the study area showed low concentrations of NO_3-N with elevated values of δ15N-NO_3- and δ18O-NO_3- suggesting that denitrification is removing nitrate from the groundwater. High concentrations of Cl- (388-1,107 mg/L) and high values of electrical conductivity (1,027-2,715 μS/cm) were observed in the study area suggesting seawater intrusion. Strontium isotope ratios (87Sr/86Sr) and oxygen isotope ratios of groundwater (δ18O) were applied to elucidate the extent of groundwater mixing with seawater. The results of this study indicate that multi-isotope approaches can be effectively applied to distinguish natural and anthropogenic contaminant sources in groundwater systems.