Application of environmental tracers to delineate recharge patterns and nitrate contamination in shallow groundwater around a river

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Hydrogeochemical data, stable isotopes, chlorofluorocarbon (CFCs) and 3H-3He in groundwater were applied to characterize residence time, recharge patterns and nitrate contamination of groundwater in a small agricultural area, Yangpyung, Korea. The study area is located around a river and the measured groundwater table ranges from 1.5 to 2.65 m during the year. Most residents in the study area practice agriculture and potato, strawberry, and cabbage are the typical vegetables grown. Vegetable fields are mostly located in the upgradient area of the study area while forest and residence areas are located in the downgradient area. A lot of chemical and organic fertilizers are applied in the upgradient area. The concentration of NO_3-N in groundwater showed 9.8-83.7 mg/L in the upgradient area and 0.1-22.6 mg/L in the downgradient area in 2014. It is necessary to monitor groundwater recharge patterns and transport processes of nitrate to protect surface water around the study area. The values of δ18O and δD showed that groundwater is recharged mainly from summer precipitation. The apparent groundwater ages using 3H-3He and CFCs ranged from 13 to 27 years in the upgradient area and from 25 to 35 years in the downgradient area. The NO_3-N in more recently recharged groundwater showed higher concentrations while the NO_3-N in older groundwater showed low concentrations. Some shallow wells in the downgradient area showed similar apparent groundwater age with that of the river water indicating groundwater-surface water interactions. A conceptual model of groundwater-surface water interactions using stable isotopes, apparent 3H-3He and CFCs age in groundwater will be useful to understand the hydrological processes and nitrate contamination of the study area.