An isotopic study on shallow groundwater origins in a densely-populated area in Shinagawa, central Tokyo, Japan

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Stable isotopes (δ D and δ^{18}O) and hydrochemical tracers (electric conductivity, NH_4^+, NO_3^-, Cl^-) of water were applied to quantify 1) rainfall infiltration (natural recharge), 2) water supply leakage, and 3) sewage leakage in a shallow aquifer in a densely-populated area in Shinagawa, central Tokyo, Japan. Despite of a quite small area about 0.5 km (E-W) by 1 km (N-S), shallow groundwater took on a wide range of values: 28 ~70 mS/m electric conductivity, 0.0 ~9.1 mg/L NH_4^+, 0.1 ~ 36.2 mg/L NO_3^-, 4.8 ~46.6 mg/L Cl^-, and -8.7 ~-7.4‰ δ^{18}O. A ternary mixing model was used based on the Cl^-concentration and d^{18}O of three plausible origins of groundwater to estimate fractions of each component in shallow groundwater in the study area. As a result, a fraction of sewage leakage in groundwater proved large for one well as much as 70%, while for some wells rainfall infiltration contributed more than 80% of water to the formation of groundwater. These remarkable differences in contribution of urban leakage to the shallow aquifer may result from the different state of the water infrastructure in the vicinity of the respective wells.

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