Interaction of surface water and groundwater in the Kyoto Basin

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Information on the interaction between surface water and groundwater is significant to understand regional hydrological system and to achieve appropriate groundwater-resource management. Geostatistical analysis of both hydrochemical and isotopic data from multiple environmental tracers was used to evaluate groundwater interaction with surface water in the Kyoto Basin, Japan. The study area covers the watersheds of the Kamo and Takano Rivers. Both rivers flow from the northern and northeastern mountains adjacent to the Kyoto Basin, meeting in the northeastern region of the basin, where they continue to flow southward. River water and groundwater samples were collected at 18 points along the Kamo River, 7 points along the Takano River, and from 28 wells within the watersheds. Concentrations of major dissolved components, hydrogen and oxygen isotope ratios (δD and $\delta^{18}O$), and Radon-222 (^{222}Rn) values of the samples were determined. Three-dimensional distributions of ion concentrations and isotope ratios of the groundwater within the aquifer were generated using the Ordinary Kriging interpolation method, taking into account the location, depth and screen sections of each well. The mixing ratio of groundwater to river water was calculated using the measured ^{222}Rn concentration of river water and the predicted ^{222}Rn concentration of groundwater, 5 m below the sampling point. It was assumed that all ^{222}Rn input upstream was diffused to air before reaching the sampling point.

A domain that has lower chloride ion concentration compared with the surrounding groundwater was identified below the river. At the confluence of the two rivers, the E–W cross section of this domain measures ca. 2100 m wide and 35 m deep; this extends to ca. 3400 m wide and 115 m deep, 2800 m further downstream. $\delta^{18}O$ was also lower within this domain. The domain is associated with a permeable sandy gravel layer; hence we conclude that the groundwater within this zone is an underflow. Notably, the ^{222}Rn concentration of river water was also highest around the confluence, with a groundwater mixing ratio of 35%. This suggests that surface water close to the confluence has a major groundwater component.