Determination of Groundwater-River Water-Rainwater Interaction in Bangkok Thailand Through Stable Isotopes and Hydrochemistry

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Water with stable isotopic compositions ($\delta^{18}O$ and $\delta^{2}H$) has been utilized as environmental tracers to understand the complex hydrogeological processes such as paleoclimate, groundwater-surface water interactions, groundwater recharge, and precipitation sources. The current work focuses on a detailed seasonally variable interaction analysis and flux quantification between the river, monsoon precipitation, and groundwater in the Chao Phraya River basin. Water samples were collected in Bangkok between 2013 and 2015 and in 2019. The majority of the samples come from shallow groundwater, precipitation, and the Chao Phraya River. Water $\delta^{18}O$ and $\delta^{2}H$ values were measured and reported relative to the Vienna Standard Mean Ocean Water (VSMOW) using a cavity ring-down spectroscopic isotopic water analyzer (L2130-i, Picarro Inc., Sunnyvale, CA, USA). For $\delta^{18}O$ and $\delta^{2}H$, the analytical precision (1σ) was 0.16 and 0.45, respectively. Furthermore, in 2019, samples were tested for hydrochemical facies using an ion chromatography analyzer (Systronics, 883 Basic IC plus). On a temporal scale, contributing parameters to total river discharge are evaluated using three-component hydrograph separation and the End-Member Mixing Analysis (EMMA).

The results show that the surface water isotope was the highest compared to others. Its primary characteristic can be due to evaporative enrichment in river water. The rainfall isotope, on the other hand, has a broader range. This finding reflects the altitude impact in the basin. Furthermore, the Local Meteoric Water Line (LMWL) depicts the connections of $\delta^{18}O$ and $\delta^{2}H$ in precipitation. Precipitation was the predominant source of groundwater aquifer and river runoff along this LMWL, showing that precipitation is the primary source of groundwater aquifer and river runoff. According to the EMMA, groundwater discharge in the river is maximum during the dry season (26 percent of total discharge) and drops to 2 percent during the wet monsoon. During the monsoon, precipitation directly causes river runoff, supported by the isotopic amplitude damping technique for both river water and precipitation. The average water residence duration is roughly 30 days, which means that the molecules of monsoon precipitation have been in the river for a month.

Furthermore, depending on river morphometry, hydrological interaction shows quantitative variability. The current study also provides insight into aquifer vulnerability. The Piper diagram was used to analyze the chemical analysis results of 266 groundwater samples. Groundwater was determined to be of three types: Na-K-CO_3-HCO_3, Na-K-Cl-SO_4, and Ca-Mg-CO_3-HCO_3. Na-K-Cl-SO_4 concentrations were high in shallow groundwater near the coast. An analysis of the groundwater types revealed a mixing process between upstream freshwater and saline water visible in the shallow groundwater. In addition, there was a clear indication of the contribution of rock weathering. The principal process operating in the groundwater environment was mineral dissolution. These findings contribute to a better understanding of the hydrogeological processes along the rainfall-river-aquifer border, as well as how they are linked to geochemical processes and policies for conjunctive water allocation.

Keywords: Hydrochemistry; Stable isotopes; Salinization; Unsaturated zone