Understanding Groundwater Salinization in Coastal Aquifers of North China

Seawater intrusion (SWI) due to groundwater over-exploitation has led to the salinization of fresh groundwater in coastal areas, threatening numerous water supply sources worldwide. With the agricultural, industrial and urbanized development in the coastal regions, it is imperative to understand the major hydrological and chemical processes responsible for improving groundwater quality in the coastal aquifers.

A research team led by HAN Dongmei and SONG Xianfang from the Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences has scored an important progress on identifying the anthropogenic and natural inputs for modifying groundwater hydrochemistry in the coastal aquifers of north China.

Their study focused on the coastal aquifers in the Dalian area, northeastern China. The researchers investigated the physical flow and concomitant hydrogeochemical processes by systematically analyzing hydraulic, geochemical and isotopic data. The partially positive correlation between δ18O values and total dissolved solids (TDS) concentrations of groundwater, the high NO3 concentrations and sulfate isotope mass balance suggested that the present-day elevated salinities in groundwater are more likely to have risen from agricultural activities via irrigation return flow.

Seawater mixing with fresh groundwater is another important source in the carbonate aquifer where formerly intruded seawater may still reside in immobile zones. The results pointed to an alarming level of impact from local intensive agriculture on the groundwater system, which is a widespread problem throughout China.

The good inverse relationship between groundwater mean residence time (MRT) (92–467 years, determined with 3H and CFCs) and the NO3 concentrations in the shallow quaternary aquifers indicated that elevated nitrate concentrations are attributable to more recent recharge for shallow groundwater.

Cross section showing the conceptual hydrogeological and hydrogeochemical model derived from hydrological, geochemical and isotope data. Arrows in aquifers indicate groundwater flow direction. (Image by HAN Dongmei)

The groundwater MRTs in the carbonate aquifers are 8–411 years and has no significant relationship with the NO3 concentrations. This indicates that nitrate in the complex carbonate aquifer without denitrification effects could transport for tens of years and accumulate in the groundwater irrigation cycle.