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Stable isotope methods for groundwater monitoring programmes at moderate climate lowland conditions

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The monitoring of the stable isotope – ^{2}H and ^{18}0 – values in groundwater can be a valuable addition to the monitoring programmes. The objective of most groundwater monitoring programmes is timely detection of any deterioration of quality or quantity of groundwater resources. As such the stable isotopes poses no directed threats, however they can be a useful indication of hidden process that eventually can have detrimental effect on the water resources. We have identified four possible applications of the stable isotope methods in groundwater monitoring in moderate climate, lowland conditions: (1) saltwater intrusions; (2) changes in recharge conditions; (3) surface water and groundwater interaction and (4) validation or calibration of hydrogeological models.

The saltwater intrusion in aquifers can be a tricky problem to understand as it is often encountered at seaside locations where salt can originate from seawater intrusion, upcoming of deep formation brines due to natural groundwater discharge or extensive abstraction or anthropogenic sources. The ratio between chloride ion concentration and ^{18}O abundance – two conservative compounds – is a robust indicator of the saltwater origin.

The isotope values of groundwater are set at infiltration and remain conservative unless geothermal condition is attained. Changes in the infiltration conditions such as in land use or land amelioration that shifts the balance between evaporation, infiltration and surface runoff control the groundwater isotope values, but so do the year-to-year variability of precipitation and evaporation and groundwater flow patterns. Therefor in most cases the fluctuation of isotopic values in groundwater will be difficult if impossible to link to any changes in recharge conditions at a regional scale but possible at local scale. On the other hand, intrusion of surface water into aquifers should be easily detected – the evaporation from free water surface produces the characteristic disproportional enrichment of ^{18}O compared to ^{2}H, that can be detected if background data are available.

The stable isotope values are noticeably depleted as the elevation above sea level increases. In steep terrains it can be used to constrain the elevation of groundwater recharge. However, in lowland conditions the land use and year-to-year variability have at least the same weight as elevation on the resultant isotope values in groundwater. In addition, the unknow heterogeneity of geological media produces groundwater flow patterns that are challenging to model on regional scale. Therefore, the stable isotope methods have little application in validation or calibration regional hydrogeological models. Hoverer, they can be useful for localised cases studies where very surface and subsurface data at fine resolution is available.

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