

## **A multitracer approach to estimate groundwater mixing ratios**

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In urban areas safe drinking water supply is often exposed to many sources of contamination. At our study site near the city of Basel in Switzerland, a steadily increasing water demand and decreasing water quality led to the implementation of managed aquifer recharge (MAR) in the mid-1950s. Groundwater is replenished by artificial recharge of surface water originating from the river Rhine. The groundwater system consists of two overlying aquifers, with potential hydraulic connections related to fractures and faults. The deeper aquifer contains contaminants, which possibly originate from nearby landfills and industrial areas. In order to reduce the contamination risk of the upper aquifer, it is crucial to know the mixing patterns of young infiltrated and old regional groundwater. With this knowledge the operation of the MAR site can be adjusted accordingly.

We studied the mixing between artificially infiltrated surface water and older groundwater resulting from the standard operation of the MAR site. We combined different natural tracers including dissolved <sup>222</sup>Rn, <sup>3</sup>H/<sup>3</sup>He, radiogenic <sup>4</sup>He, other atmospheric (noble) gases (e.g., Ar, O<sub>2</sub> and N<sub>2</sub>), temperature, electrical conductivity and major ions. All parameters were analysed at 15 observation and pumping wells distributed throughout the study area.

Our results show that most of the abstracted groundwater in the vicinity of the infiltration system exhibits young water only. Wells further away from these high recharge areas contain a mixture of young and old groundwater. Some wells near the fractured zones show higher <sup>3</sup>H/<sup>3</sup>He ratios and <sup>222</sup>Rn concentrations, which supports the hypothesis of a hydraulic connection between the two aquifers. Except for one pumping well, only groundwater at wells which are not used for drinking water production contain substantial concentrations of radiogenic <sup>4</sup>He indicating the admixture of a very old groundwater component.