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Isotopic characterization of groundwater sampling sites under bank filtration conditions in Quebec, Canada

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In Canada, many drinking water intakes rely on groundwater. Surface water can seep into the ground under forced gradient imposed by pumping wells, a process called induced bank filtration (IBF). Although IBF can promote natural attenuation, unintended infiltration may also increase vulnerability to surface-derived contaminants. This often-unintentional process may expose water intakes to risks that are not currently considered. Our aim is to identify the unintended IBF sites in Québec, estimate mixing proportions of surface water and groundwater and the mean transit times.

The characterization of IBF wells can be carried out using environmental tracers. In particular, the stable isotopes of the water molecule ($\delta^{18}O$ and $\delta^{2}H$) and electrical conductivity are useful tools for this purpose. A previous study [1] demonstrated the usefulness of these methods on 40 wells distributed across 3 watersheds in Québec. This methodology is currently being implemented across Québec on a selection of 173 municipal wells in various watersheds with contrasting hydrogeological contexts. Each site is sampled weekly to bi-weekly for a minimum of one hydrological year. The analysis also considers land use near the intakes, aquifer geology, and the delay between changes in river signals and those in the groundwater.

Preliminary results currently reflect only a limited number of samples and sites as the analysis for the 173 intakes is still ongoing. So far, results indicate that isotopic signals show significant variation at affected locations, confirming the presence of IBF. Because river water typically exhibits stronger seasonal and event-scale variability than groundwater. The data also reveal connections between human activities, such as land use, and the vulnerability of sites to contamination.

Better knowledge of sites affected by IBF helps identify risks not always considered in current protection plans. Vulnerability sources will be clearly reflected in the dominant factors controlling the mineralization of surface water and groundwater.

The scale, the diverse hydro(geo)morphological contexts and the extensive data collection covered in this study is unprecedented in Québec.

References

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