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Constraining river baseflow age structure in a partially ice-covered river using ^{3}H and ^{85}Kr and a controlled injection of He and SF_6.

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Groundwater-derived baseflow is the main contributor to most river systems [1], controlling surface waters availability and quality responses to long-term changes at the surface (*e.g.* urbanisation, climate change, contamination). Yet, constraining its age structure remains challenging due to the progressive loss of gaseous tracers through air-water exchanges. The seasonal river ice cover in cold regions is expected to reduce air-water gas exchange, lowering gas transfer velocity and increasing the reliability of gaseous tracer applications [2]. We applied a multi-tracer approach (noble gases, SF_6, ^{3}H, ^{85}Kr) to quantify both gas transfer velocity and river baseflow age structure in a medium-sized catchment in Québec, Canada (Rivière Nelson; 70 km²). A dual inert-gas injection was conducted in the partially ice-covered Rivière Nelson, enabling a controlled and continuous release of He and SF_6. Results demonstrate reduced gas transfer velocities compared to values typically found in open waters. Baseflow age structure was then constrained using ^{3}H and ^{85}Kr, as CFCs and SF_6 proved unsuitable due to aquifer contamination. Both radioactive tracers yielded consistent results and reveal a mean transit time of 10 years with both exponential and dispersion models. Finally, we introduce a new vulnerability assessment tool that combines both the long-term average of the river baseflow fraction and its mean residence time [3]. Integrating these two metrics shows strong potential for identifying vulnerable catchments and improving water resource management in a wide range of hydroclimatic settings worldwide.

References:

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3. Picard, A., et al., *River baseflow age information inferred from environmental tracers (3H–85Kr): a new tool for the description of surface water resources vulnerability.* Journal of Hydrology, 2026. **666**.

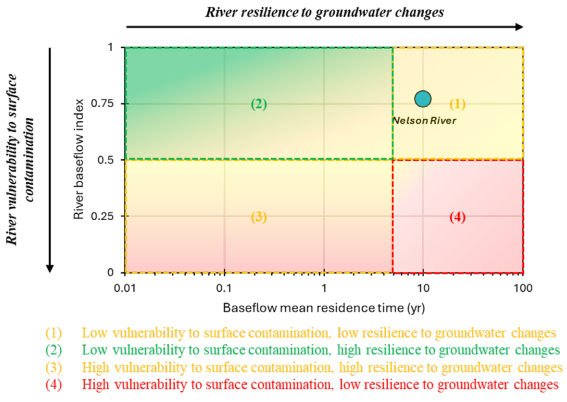

Fig. Tool for assessing the resilience and vulnerability of rivers as functions of baseflow mean residence time (BRMT) and river baseflow index respectively (BFI). The grey dot represents the long-term BFI value (0.77) with the MRTT (10 years) found for the Rivière Nelson.