sMARt riverbank filtration monitoring: how environmental tracers and high-resolution data support resilient drinking water supply

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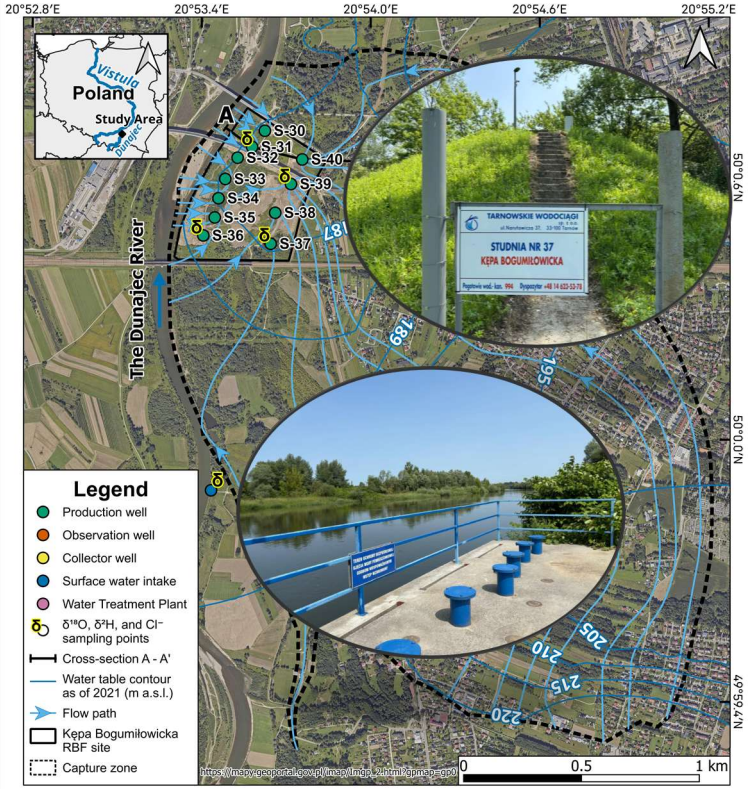
Introduction and study area

Riverbank filtration (RBF) is widely used MAR technique to secure drinking water supply, but its performance depends on dynamic river-groundwater interactions. Traditional low-resolution monitoring often fails to capture rapid hydrological changes and contamination risks.

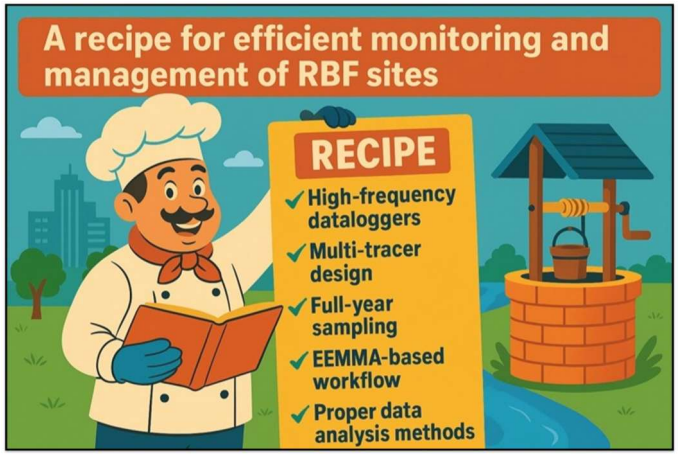
We propose a transferable and practical workflow for efficient monitoring and management of RBF systems.

- Location: Kępa Bogumiłowicka RBF site, near Tarnów (southern Poland), 11 production wells (siphon system)
- ~30% of regional drinking water supply
- Shallow alluvial aquifer, high hydraulic conductivity

Strong river-aquifer connectivity makes the system efficient but vulnerable.



Methods



Monitoring Components

12 monthly sampling campaigns (Oct 2022 to Oct 2023)

$\delta^{18}O$, $\delta^{2}H$, Cl^{-}, temperature, EC, water level

Six dataloggers (+ barologger) installed in the river, four wells, and piezometer

River water-groundwater mixing and RTs calculations

Instead of classical mixing models,

Ensemble End-Member Mixing Analysis (EEMMA) was used

RTs were evaluated by calculating cross-correlations between river and groundwater temperature time series

Paper

Poster

Sharing is encouraged

Key findings

Strong seasonality in isotopic signals from the Dunajec, tied to snowmelt vs. baseflow contribution.

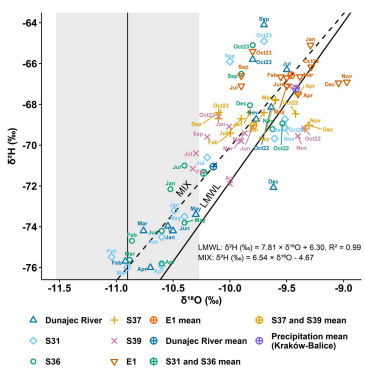
Groundwater isotopic signatures in the production wells varied differently depending on proximity to the riverbank:

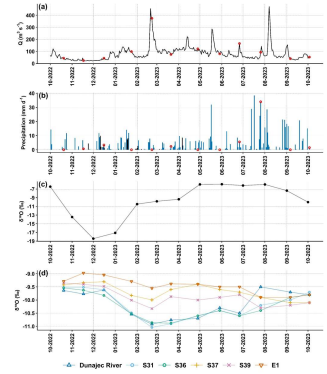
River-proximal wells (S31 and S36) closely resembled the river's isotopic fluctuations, especially during spring snowmelt.

>90% river water contribution

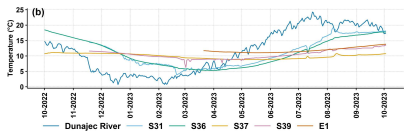
Wells further inland (S37 and S39) showed less variation throughout the year, more shifted towards native groundwater.

40-60% river water contribution



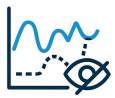


Estimated RTs equalled **18 and 22 days**, for S31 and S36



Short RTs → rapid system response, critical for contamination risk management

Without high-frequency monitoring, many processes remain **„invisible"**



Even local groundwater abstraction is controlled by distant catchment inputs

General conclusions

RBF recharge can often **depend on seasonality** and be **spatially heterogeneous**

Multi-tracer-informed monitoring, ideally with online data transfer,supports **faster, smarter, and safer** water management

The proposed workflow is **transferable and cost-effective**