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Spatial and temporal variabiliy in drinking water quality in a riverbank filtered drinking water supply system

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Riverbank-filtered systems are cost-effective and sustainable drinking water supply systems along major rivers. However, they are strongly dependent on the river stage. Climate change-induced extremely low or high river stages may cause water quantity and quality problems. In this study, a riverbank-filtered drinking water supply system along the Danube River in Hungary was investigated from a geochemical aspect at lower and higher river stages. We also aimed to understand the origin of elevated (>100 mBq L^{-1}) gross alpha activity measured in some wells.

10 producing, 2 monitoring wells, and the Danube were sampled at lower and higher river stages. Physico-chemical parameters were recorded on-site and the samples were analysed for major ions, trace components and hydrogen (δ^2H) and oxygen ($\delta^{18}O$) stable isotopic compositions as well. ^{234}U, ^{238}U and ^{226}Ra activity concentrations were determined by alpha spectrometry using selectively adsorbing Nucfilm discs. ^{222}Rn activity was measured by liquid scintillation counting.

Uranium activity was measured in the highest concentration (up to 222 mBq L^{-1}) among the examined radionuclides. ^{226}Ra and ^{222}Rn activities were barely above the detection limit. Based on these results, the previous non-compliant elevated gross alpha activity is caused by dissolved uranium in the groundwater. A spatial pattern was recognized in the geochemical characteristics of the produced water. Total dissolved solid, iron and manganese content and also uranium activity concentrations show increasing values from N to S, which corresponds well to the occurrence of organic matter-rich, clayey floodplain deposits underlying the aquifer and to their higher position to the S. Stable isotope ratios point to the increased influence of surface waters in

the N due to the position of an irrigation channel. Besides spatial variation, a temporal change was observed, too: higher uranium activity was measured at a lower river stage (up to 222 mBq L^{-1}) compared to concentrations at a higher river stage (up to 126 mBq L^{-1}). This phenomenon could be explained by the dynamic relationship between the groundwater and the river. The hydraulic gradient between the river and the wells decreases with decreasing river stage, which resulted in longer residence time of the water. The longer the residence time, the more the oxygen-rich water interacts with the clayey basement layers facilitating uranium remobilization.

This process will become increasingly dominant in extremely low river stages during long-lasting drought periods in the future and might lead to water quality problems. Our study highlights the vulnerability of riverbank-filtered drinking water supply systems, which can jeopardize their long-term use in the future.

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