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A case study on the correlation of micro-contaminants and potassium in the river Leine (Germany)

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Numerous organic micro-contaminants have been detected in surface waters. Significant sources are effluents from wastewater treatment plants (WWTP), direct discharge of raw sewage and agricultural runoff. Their specific and numerous sources make micro-contaminants good indicators for groundwater-surface water (GW-SW) interaction. Therefore, the understanding of processes influencing GW-SW interaction and quantification of mass fluxes is highly important for the assessment of groundwater quality.

River monitoring with focus on the correlation of 41 micro-contaminants with potassium (K+) and its temporal and spatial variation was carried out at the river Leine (Germany). Since urine is a significant source of K+, a correlation of concentrations of wastewater related micro-contaminants and K+ is to be expected. This correlation was found for compounds, which meet the following criteria:

1. effluent from wastewater treatment plant (WWTP) is the dominating source,
2. variability of mass flux in the WWTP is negligible, and
3. the compound is persistent in WWTP and environment.

The excellent correlation of carbamazepine and K+-concentration resulted in a universal linear equation across the seasons, whereas almost all other correlating compounds (1H-benzotriazole, citalopram, diclofenac, metoprolol, sotalol, sulfamethoxazole and tolyltriazole) demonstrated higher slopes in winter. This was attributed to lower degradation and attenuation in WWTP and environment at low temperatures and increased consumption. A sampling campaign to identify compounds demonstrating stable ratios of micro-contaminant with K+ along the whole flow path of river Leine ($\sim$ 280 km) was further conducted. Among other compounds, carbamazepine, sulfamethoxazole and tolyltriazole demonstrated the best correlations with $R2 > 0.89$. K+ equivalents of the individual micro-contaminants depended on land use and population structure of the investigated river section.

The approach introduced in this case study could be thought to be a useful addition to studies proving indicator quality on the basis of wastewater burden. A correlation with K+ indicates, that the concentration of the respective micro-contaminant only depends on river discharge. Following this thought, the prediction of micro-contaminant concentrations at certain locations could be substantially simplified. Furthermore, regarding bank filtration and the interaction of surface water and groundwater in general, it may be possible to derive input functions of the correlating micro-contaminants.