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Artificial sweeteners as waste water markers in a shallow unconfined aquifer

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One key factor in groundwater quality management is the knowledge of flow paths and recharge. In coupled ground- and surface water systems the understanding of infiltration processes is therefore of paramount importance. Recent studies show that artificial sweeteners - which are used as sugar substitutes in food and beverages - are suitable tracers for domestic wastewater in the aquatic environment. As most rivers receive sewage discharges, artificial sweeteners might be used for tracking surface waters in groundwater. In this study artificial sweeteners are used in combination with conventional tracers (inert anions Cl^-, SO_4^{2-}, stable water isotopes $\delta^{18}O$, δ^2H) to identify river water infiltration and the influence of waste water on a shallow unconfined aquifer used for drinking water production.

The investigation area is situated in a mesoscale alpine head water catchment. The alluvial aquifer consists of quaternary gravel deposits and is characterized by high hydraulic permeability (k_{fmax} 5 x 10^{-2} ms^{-1}), high flow velocities (v_{max} 250 md^{-1}) and a considerable productivity (2,5 $m^3s\text{-}^1$). A losing stream follows the aquifer in close proximity and is susceptible to infiltrate substantial volumes of water into the alluvial sediments.

Water sampling campaigns in March and July 2012 confirmed the occurrence of artificial sweeteners (Acesulfam ACE, Sucralose SUC, Saccharin SAC and Cyclamat CYC) at the investigated site. The local sewage treatment plant was identified as point source of artificial sweeteners in the river water, with ACE concentrations up to 0,6 μgL^{-1}. ACE concentrations in groundwater where approximately of one order of magnitude lower: ACE was present in 33 out of 40 sampled groundwater wells with concentrations up to 0,07 μgL^{-1}, thus indicating considerable influence of sewage water loaded surface water throughout the aquifer. Elevated concentrations of ACE and SAC in single observation wells denote other sources of locally limited contamination.

Also, the temporal variability of sweeteners in surface water and the drinking water production well is compared with other tracers. ACE, Cl^- and SO_4^{2-} exhibit similar patterns in the river water. However, this behaviour cannot be observed in the production well, where ACE concentrations are varying compared to Cl^- and SO_4^{2-}.This suggests that the production well does receive groundwater being infiltrated prior to the sewage water treatment plant. Time series analysis of ^{18}O, δ^2H will give more insight in travel times and the location of infiltration zones.