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Delineation of bank filtrate and groundwater flux for drinking water production using multivariate statistics and a combined tracer approach

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In shallow or unconfined aquifers infiltration of contaminated river might be a major threat for ground water quality. Thus, the identification of hydrological pathways in coupled surface- and groundwater systems and specifically the delineation of areas influenced by bank filtrate are of paramount importance to ensure water quality.

Tracers have the potential to elucidate both, sources and flow patterns, and are widely applied in hydrological flow. Besides conventional tracers (Cl^-, SO_4^{2-}, stable water isotopes $\delta^{18}O$, δ^2H, etc.) only recently another class of tracers in hydrologic systems are emerging: trace contaminants as waste water markers. Compounds, such as artificial sweeteners, might enter the aquatic environment via discharge of waste water treatment plants and are ubiquitously found in sewage water receiving waters.

While the occurrence of waste water in aquatic systems can be confirmed by the detection of artificial sweeteners, it is still unknown whether those compounds are also suitable for the quantitative assessment of waste water and surface water in groundwater systems. The hereby presented field study aims at the identification of infiltration areas and the quantitative assessment of river bank filtrate using conventional tracers and artificial sweeteners as waste water markers.

The investigated aquifer system is located in an alpine head water catchment, it consists of quaternary gravel deposits (k_{fmax} 5 x 10^{-2} ms^{-1}, v_{max} 250 md^{-1}) and is used for drinking water production. It is hypothesized that a large proportion of the groundwater flux originates from bank filtrate of a nearby losing stream. During a sampling campaign in July 2012 water samples were collected from the entire aquatic system (2 springs, 3 surface and 40 groundwater samples). The in-situ parameters, major ions, stable water isotopes $\delta^{18}O/\delta^2H$ and artificial sweeteners (acesulfame ACE, sucralose SUC, saccharin SAC and cyclamate CYC) were measured. The water samples were classified according to their hydrochemical and isotopic composition with hierarchical clustering (Ward, 1963), identifying two predominant types of water in the aquifer: (1) groundwater influenced by bank filtrate and (2) groundwater originating from recharge. The mixing proportions of river water and spring water, representing bank filtrate and groundwater recharge, respectively, were determined by end member mixing analysis. The results show a contribution of more than 70% surface water in type (1) and less than 50% in type (2). The occurrence of ACE throughout the aquifer confirmed the influence of river water, however, it was not possible to obtain quantitative estimates due to the high variability of ACE concentrations in the river water.