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Fate of organic micropollutants in two sequential reaches – a sampling approach including temporal and spatial resolution

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Anthropogenic organic micropollutants enter river systems mainly via wastewater treatment plants (WWTP). Characterization of turnover processes and fate of these compounds including temporal and spatial resolution at the same time remains challenging. Still, published results rely frequently on grab samples that do not account adequately for advection, dispersion and transformation along the studied reach. This study aims to compare degradation rates calculated from a Lagrangian Sampling concept in two different sequential reaches with calculations from arbitrary grab samples.

Field investigations took place at two sequential reaches at the Ammer River close to Tübingen in the southwest of Germany that differ in (hydro-) morphology, slope and amount of groundwater inflow. Time-series measurements of organic chemical compounds (target screening), accompanied by electrical conductivity (EC), and conservative ions were conducted over a period of 24 hours. A lumped parameter model approach accounting for advection and dispersion was applied to the time-series measurements to calculate degradation rate constants affecting water parcels entering and leaving the same reach. In an alternative approach, degradation rate constants were calculated from arbitrary grab samples of the time series, representative for samples not properly considering travel time of water in the river. The influence of dilution caused by tributary and groundwater inflow was included for the overall attenuation rate in both approaches.

The Lagrangian sampling approach integrates temporal dynamics such as the changed solar radiation or input of the WWTP into the river throughout the whole day and thus leads to representative degradation rates and characterization of turnover processes. In contrast, results from arbitrary grab samples may be misleading and indicating unrealistic processes and rates.

The different results of the tested approaches show the relevance of identifying and including temporal and spatial aspects of river systems for characterization of the fate of organic micropollutants. They highlight the need to consider hydrological processes in the river for future field-based attenuation investigations.