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A sampling scheme to assess persistence and transport characteristics of xenobiotics within an urban river section

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Xenobiotic contaminants such as pharmaceuticals or personal care products typically are continuously introduced into the receiving water bodies via wastewater treatment plant (WWTP) outfalls and, episodically, via combined sewer overflows in the case of precipitation events. Little is known about how these chemicals behave in the environment and how they affect ecosystems and human health. Examples of traditional persistent organic pollutants reveal, that they may still be present in the environment even decades after they have been released.
In this study a sampling strategy was developed which gives valuable insights into the environmental behaviour of xenobiotic chemicals. The method is based on the Lagrangian sampling scheme by which a parcel of water is sampled repeatedly as it moves downstream while chemical, physical, and hydrologic processes altering the characteristics of the water mass can be investigated. The Steinlach is a tributary of the River Neckar in Southwest Germany with a catchment area of 140 km^2. It receives the effluents of a WWTP with 99,000 inhabitant equivalents 4 km upstream of its mouth. The varying flow rate of effluents induces temporal patterns of electrical conductivity in the river water which enable to track parcels of water along the subsequent urban river section. These parcels of water were sampled a) close to the outlet of the WWTP and b) 4 km downstream at the confluence with the Neckar. Sampling was repeated at a 15 min interval over a complete diurnal cycle and 2 h composite samples were prepared.
A model-based analysis demonstrated, on the one hand, that substances behaved reactively to a varying extend along the studied river section. On the other hand, it revealed that the observed degradation rates are likely dependent on the time of day. Some chemicals were degraded mainly during daytime (e.g. the disinfectant Triclosan or the phosphorous flame retardant TDCP), others as well during nighttime (e.g. the musk fragrance HHCB and the pharmaceutical oxcarbacepine). Some behaved conservatively (some phosphorous flame retardants and the pharmaceutical carbamazepine). A differing susceptibility to photo degradation appears a likely explanation. A deeper investigation of the involved processes will be subject of future studies.