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Mass fluxes and integrated modelling of urban micropollutants

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The urban aquatic environment is increasingly polluted by low concentrated but high eco-toxic compounds as pharmaceuticals, fragrances and endocrine disruptors. These so-called xenobiotics are emitted into the surface and subsurface waters by outlets of waste water treatment plants and/or by seeping processes of waste water. This contamination could have a long-time impact on the urban ecosystem and on human health.

Within an interdisciplinary project on risk assessment of water pollution, we work on the identification of water and substance fluxes in urban areas. The objective is an integrated modelling tool for the description of transport of substances in the urban environment. Transport processes of interest are related to surface water, groundwater and the groundwater – surface water interaction zone.

In a first attempt we used a flow model concept with in- and output and surface water transport represented by the city of Halle, Germany, and the river Saale. The river Saale acts as surface water system collecting lateral inputs along the city traverse. Using indicators for xenobiotic impacts on water resources such as Bisphenol A and t-Nonylphenol, Carbamacepine, Galaxolide and Tonalide, and the isotopes ^{34}S-sulphate and ^{15}N-nitrate investigations of the pathways and the behaviour of the substances in the environment have been carried out. In the city of Halle/Saale, concentrations of the indicators at a magnitude of ng/L to μg/L were found in rivers and in groundwater. A balance of water and substance fluxes in the rivers was built up for the city as a

whole. The calculation of the loads shows increasing values of the investigated indicators over the distance of the city passage. Carbamacepine and t-Nonylphenol increase significantly at some tens of percents and Galaxolide and Tonalide at some hundreds. Solely Bisphenol A stagnates along the passage through the city.

The understanding of the interaction between groundwater and surface water is important to quantify the exchange of substances between the two hydrological compartments. In order to investigate this, a transient hydrodynamic river reach model of the Saale River and a groundwater flow model of the area connected to the reach were built up and coupled. Using this model, the inter-compartmental transport of the indicator Carbamacepine that exfiltrated from the Saale River into the groundwater was simulated. The parametrization of the substance transport was performed using isotopic methods. The attenuation efficiency of the indicator Carbamacepine was estimated by that to 0.3. Using this, the model was calibrated and the simulation of the mass fluxes of the fluid and the substance through the interaction zone was performed over a time period of one year.