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CrossWater – Modelling micropollutant loads from different sources in the Rhine basin

Andreas Moser (1), Hans-Peter Bader (1), Ruth Scheidegger (1), Mark Honti (2), and Christian Stamm (1)

(1) Eawag, Department Environmental Chemistry, Überlandstrasse 133, 8600 Dübendorf, Switzerland, (2) Budapest University of Technology and Economics Department of Hydraulic and Water Resources Engineering, Műegyetem rakpart 3, 1111 Budapest, Hungary

The pressure on rivers from micropollutants (MPs) originating from various sources is a growing environmental issue that requires political regulations. The challenges for the water management are numerous, particularly for international water basins. Spatial knowledge of MP sources and the water quality are prerequisites for an effective water quality policy. In this study within the Rhine basin, the spatial patterns of MP sources and concentrations from different use classes of chemicals are investigated with a mass flow analysis and compared to the territorial jurisdictions that shape the spatial arrangement of water management.

The source area of MPs depends on the specific use of a compound. Here, we focus on i) herbicides from agricultural land use, ii) biocides from material protection on buildings and iii) human pharmaceuticals from households. The total mass of MPs available for release to the stream network is estimated from statistics of sales and consumption data. Based on GIS data of agricultural land use, vector data of buildings, wastewater treatment plant (WWTP) locations, respectively, the available mass of MPs is spatially distributed to the subcatchments of the Rhine basin.

The modelling of concentrations in the rivers consists of two principal components. The first component – the substance transfer module – simulates the actual release of MPs to the stream network. This transfer is affected by many factors rendering spatial distributed modeling a serious challenge. Here we use a parsimonious approach that tries to represent the first order controls of the transfer processes. We use empirical loss rates relating concentration to river discharge for agricultural herbicides and to precipitation for biocides. For the pharmaceuticals the release is coupled to the human metabolism rates and elimination rates in WWTP. The prediction uncertainty was quantified by an error model that takes the seasonality of the herbicide input into account. The second component – the routing module – links contribution of the subcatchments and represents the in-stream transport and fate processes of the substances.

The substance transfer module was calibrated using field studies providing simultaneously data on application amounts of substances and on losses to the rivers. However the predictive uncertainty was often large because of some mismatches of high peaks. The model was subsequently validated with independent data from several comprehensive sampling campaigns in Switzerland. Despite acceptable performance in general, some compounds were poorly simulated for some catchments. Data inspection suggests that uncertainty about timing and application amounts are a major limitation. Finally, the calibrated model is used to simulate concentration time series for the Rhine and its main tributaries. The corresponding results will be presented.