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Modeling large-scale biocide transfer to urban groundwater

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Biocides used as film protection in paints and renders wash off from facades and enter the urban water cycle. They can also reach urban groundwater, diffusely or at specific locations via urban stormwater infiltration systems (SIS). Up to now, there is limited knowledge to estimate biocide input to urban groundwater at larger scales. This study focuses on an urban area of 38ha and models biocide input to groundwater, including SIS. The aim is to determine preferential input locations, SIS retention capacities, transport and degradation of biocides in the saturated zone. The study area is located in southwestern Germany in the city of Freiburg. Due to a contamination site with chlorinated hydrocarbons (CHC), numerous urban groundwater monitoring wells exist. Hence existing monitoring data is substantial, including groundwater levels, biocide and CHC samples over a time period of at least seven years. The biocide terbutryn is chosen as a model biocide, as it is commonly used in paint and renders and was previously detected in the study area. The present study uses a model chain to reproduce biocide emission and transfer. First, terbutryn leaching is estimated using the model COMLEAM. Then, the urban water balance and groundwater recharge are calculated by the model Roger_WB_Urban. Coupling the estimated terbutryn emissions with groundwater recharge patterns provides an estimation of terbutryn inputs to groundwater over time. This pattern is finally used as input for a groundwater model (MODFLOW), which is calibrated with the help of the CHC plume development. First model results confirm groundwater monitoring data and indicate that retention capacities of the investigated SIS are limited, mainly because of shallow groundwater levels. This is reflected by simulated terbutryn concentrations in groundwater which are apparently higher downgradient of the SIS. However, also other input pathways exist. Overall, our model chain helps to understand biocide emission and transfer pathways in urban environments at larger scales and stresses the fact that measures to prevent groundwater contamination are most efficient at the source.