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Spatio-temporal patterns of mass fluxes of micropollutants in Swiss rivers of catchments with different land use

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It is known from many studies that a large number of micropollutants like pesticides, household products or pharmaceuticals can be found in water bodies. However, there is a general lack of systematic monitoring data that allow for distinguishing between possible sources, detecting temporal trends, or evaluating effects of possible mitigation measures. Including micropollutants in existing monitoring programs is not a trivial task for several reasons (e.g., sorption to sampling equipment, hydrolysis, detection limits etc.). Here, we present systematic concentration and load data for 12 substances (7 pesticides and/or biocides, 3 pharmaceuticals, and 2 anti-corrosives) obtained from a one-year sampling campaign within the "National Long-term Surveillance of Swiss Rivers" (NADUF) programme. Six (partially) nested sampling stations were selected to monitor these compounds in weekly or bi-weekly, flow-proportional samples over one year. Due to the high sensitivity of the LC-MSMS method all compounds could be quantified in almost all samples. Only at the reference site without any effluent from waste water treatment plants and hardly any arable farming, the concentrations were always below the limits of detection of a few ng/L. At all other sites, concentrations generally ranged between 10 and 200 ng/L. Only, the anticorrosive agent benzotriazole often exceeded 1000 ng/L.

According to the use of the compounds, different temporal load patterns can be expected. In general, the data confirmed these patterns with almost constant loads of pharmaceuticals at most sites, increased herbicides loads during the periods of agricultural use and positive correlations with discharge year round for biocides used in material protection. However, at some sites the expectations were not met for all compounds. The pain-killer diclofenac for example showed strongly declining loads during the summer months at sites influenced by lake water. This compound is not stable in the epilimnion of lakes, where it has a residence time of several weeks, while it flows through the river system within a few days. This example illustrates how compound properties, season and spatial location may interact and control the occurrence of micropollutants in a stream.

The spatial nesting of study catchments made it possible to check the data for plausibility and consistency: we present data on cumulative mass balances downstream and test whether the load development along the river network corresponds to the spatial distribution of possible compound sources (e.g., acreage of arable fields, number of inhabitants etc.).

Overall, the data show that monitoring of micropollutants may be achieved even without changing an existing monitoring programme. However, given the generally low concentrations in the composite samples of the NADUF programme compounds with lower use and/or lower stability may fall below the limit of reliable quantification or even detection. A proper interpretation of the data relies on additional (spatio-temporal) information like land use data or precipitation patterns.