Comprehensive model-based prediction of micropollutants from diffuse sources in the Swiss river network

Ivo Strahm (1), Nicole Munz (1), Christian Braun (2), René Gälli (2), Christian Leu (3), and Christian Stamm (1)
(1) Eawag, Environmental Chemistry, Duebendorf, Switzerland (christian.stamm@eawag.ch, 0041-58-765 54 71), (2) BMG Engineering AG, Schlieren, Switzerland, (3) Federal Office for the Environment (FOEN), Ittigen-Bern, Switzerland

Water quality in the Swiss river network is affected by many micropollutants from a variety of diffuse sources. This study compares, for the first time, in a comprehensive manner the diffuse sources and the substance groups that contribute the most to water contamination in Swiss streams and highlights the major regions for water pollution. For this a simple but comprehensive model was developed to estimate emission from diffuse sources for the entire Swiss river network of 65 000 km.

Based on emission factors the model calculates catchment specific losses to streams for more than 15 diffuse sources (such as crop lands, grassland, vineyards, fruit orchards, roads, railways, facades, roofs, green space in urban areas, landfills, etc.) and more than 130 different substances from 5 different substance groups (pesticides, biocides, heavy metals, human drugs, animal drugs). For more than 180 000 stream sections estimates of mean annual pollutant loads and mean annual concentration levels were modeled. This data was validated with a set of monitoring data and evaluated based on annual average environmental quality standards (AA-EQS).

Model validation showed that the estimated mean annual concentration levels are within the range of measured data. Therefore simulations were considered as adequately robust for identifying the major sources of diffuse pollution. The analysis depicted that in Switzerland widespread pollution of streams can be expected. Along more than 18 000 km of the river network one or more simulated substances has a concentration exceeding the AA-EQS. In single stream sections it could be more than 50 different substances. Moreover, the simulations showed that in two-thirds of small streams (Strahler order 1 and 2) at least one AA-EQS is always exceeded. The highest number of substances exceeding the AA-EQS are in areas with large fractions of arable cropping, vineyards and fruit orchards. Urban areas are also of concern even without considering wastewater treatment plants. Only a small number of problematic substances are expected from grassland. Landfills and roadways are insignificant within the entire Swiss river network, but may locally lead to considerable water pollution. Considering all substance groups, pesticides and some heavy metals are the main polluters. Many pesticides are expected to exceed AA-EQS and in a substantial percentage of the river network.

Modeling a large number of substances from many sources and a huge quantity of stream sections is only possible with a simple model. Nevertheless conclusions are robust and may indicate where and for what kind of substance groups additional efforts for water quality improvements should be undertaken.