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Modeling micropollutant fate at the catchment scale: from science to practice

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Micropollutants, such as pesticides, personal care products, veterinary and human pharmaceuticals, pose a possible threat to human and ecological health. Humans and ecosystems may be exposed to these chemicals via the water system. Catchment models can be used to optimise management in view of risk reduction of the chemicals. Along the trajectory of science to practice a number of catchment models are available that simulate the fate and transport of micropollutants. They range from physically-based fully-coupled soil, groundwater, and surface water models, over empirical management models, to purely statistical database-driven models. For assessing effects on ecosystems, models need to be able to predict the observed highly dynamic behaviour of pesticide concentrations in the surface water, since adverse effects will be determined by the number, intensity and frequency of ecological threshold exceedances. For assessing effects on humans, models need to predict the dilution between areas where the pesticide is released and the location of the drinking water intake, sometimes tens or hundreds of kilometres further downstream. We adapted management models to simulate dynamic pesticide behaviour and fate at the catchment scale. The models were also used to illustrate the effects of specific management options on risk reduction and to derive the dominant sources of pollutants in a catchment area. The results show that the concentrations of pesticides in river systems are attributed to (1) fast flow over and in soils or pavements, and to (2) point sources. Therefore, future models for improved estimation of chemical fate at the catchment scale need a combination of stochastic source characterisation, higher spatial resolution and reduced complexity of the mathematical description of fast flow processes. This will be illustrated by recent developments in model simplification coupled to increased spatial detail.