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Monitoring, modelling and management of persistent, mobile and toxic chemicals in the Danube River Basin

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Chemicals are part of our life. Several hundred thousand are used in multiple applications in the European Union (EU) and may ultimately reach water systems. Chemicals are used as pharmaceuticals, personal care products, pesticides/biocides or so-called industrial chemicals. Losses to the environment may occur throughout all stages of the life-cycle of products. Specifically, mobile, persistent and toxic chemicals (PMTs) are considered as major concern for human and environmental health. Exceedances of current environmental quality standards (EQS) are recorded all over Europe. A significant increase in the number of chemicals that need to be considered and a major tightening of EQS is currently under discussion in the EU.

Emission, fate and transport models can help to map the temporal and spatial variability of environmental exposure and support risk assessment for water bodies where monitoring is lacking. They can be used to identify sources and pathways responsible for current exposures and to assess the impact of potential future developments of PMT-exposures in surface water and groundwater. Such scenario assessment may include changes in PMT use, effects of pollution control measures, accidental spills and climate change impacts. TU Wien led and still leads various research projects for the enhancement of monitoring, modelling and management of PMTs in the Danube Basin: (i) Danube Hazard m^3c (EU Interreg Danube Transnational Program) (ii) the “Danube case study” in the frame of the project PROMISCES (EU Horizon 2020) and (iii) Tethys (EU Interreg Danube Region).

This contribution provides a short overview on basic considerations, concepts and methods of these activities and exemplifies them on the case of water pollution with per- and polyfluoroalkyl substances (PFAS) in the upper Danube Basin. Investigations show that an upstream located chemical park and diffuse inputs from urban areas are the main sources of perfluorinated carboxylic acids (PFCA) for surface waters. For perfluorinated sulfonic acids (PFSA), diffuse urban inputs predominate. A large part of the overall emissions is due to legacy pollution, which will persist even if strict source control for PFAS is implemented. Wastewater treatment effluents contribute a share of up to 25% of emissions for both PFAS groups.

Most of the surface waters in the upper Danube River Basin, including the Danube itself, show a low risk of exceeding the threshold of the EU drinking water directive of 100 ng/l for the sum of 20 PFAS. This is of relevance in case that surface waters are used as drinking water source via bank filtration. There is nevertheless a high risk of exceeding the European Commission’s proposed

quality standard for surface and groundwater of 4.4 ng l-1 PFOA toxicity equivalents as a sum of 24 PFAS in the Danube and in most of its tributaries. Simulated scenarios show that these risks may be reduced by massive efforts to implement water pollution control measures (including groundwater remediation in hot spot areas). However, the risk might even increase if low effort is made to control water pollution and at the same time the Danube's flow decreases due to climate change.