

ESR20-013 - Health risk of emerging concern: PFAS in the urban water cycle

Abstract

The increasing release of chemicals into the urban water cycle poses an emerging threat to public health and jeopardises the good status of water bodies. In this context, poly- and perfluoroalkyl substances (PFAS) are a particularly critical group due to their extreme persistence and stability, and the growing body of evidence demonstrating their adverse health effects at very low concentrations. Thanks to a targeted monitoring campaign in a large Central European city, we estimated average emissions of about 0.1-5 µg per person per day, depending on the different compounds. For some PFAS, we were able to attribute the whole of the observed loads to specific sources, the dominant ones being washing and impregnation of apparel, and the release of PFAS from other daily products. However, we also found that a considerable proportion of PFAS in sewer systems stems from groundwater infiltration and runoff from paved urban areas. PFAS emitted into sewer systems are also largely emitted into surface waters, as conventional wastewater treatment plants are not designed to remove these compounds. Once in surface waters, PFAS can then be further transported into drinking water resources obtained through riverbank filtration. Although riverbank filtration is an effective barrier against several organic compounds, it was found to be ineffective in removing PFAS during subsurface passage. We observed this by monitoring a real riverbank filtration site along the Danube and were also able to demonstrate it with experiments. These experiments also provided new insights into which characteristics of the chemicals and of the soil-groundwater system mostly influence the transport behaviour. The groundwater quality at our study site meets current drinking water requirements. However, as in many other parts of Europe, it would exceed the newly proposed threshold for groundwater. Furthermore, using a novel modelling tool that considers the current scarcity of data and knowledge regarding PFAS, we simulated in terms of probabilities how and to what extent the potential human exposure via drinking water obtained through riverbank filtration in the Upper Danube would change in different management and climate change scenarios. The results suggest that implementing drinking water technologies would be most effective when combined with the remediation of legacy polluted sites in the catchment area, as well as with the use restriction of PFAS in non-essential applications. This would require significant societal effort and investment. Furthermore, the simulations suggest that hydrological alterations due to climate change could cause an increase in PFAS concentrations in groundwater and worsen human exposure via drinking water. Regarding the risk of PFAS, the project investigated the toxicity of selected legacy and new compounds on zebrafish embryos and human placental cells. Already described effects could be confirmed and new discoveries were made. A particular highlight was the demonstration of a molecular mechanism behind the toxicity of a specific PFAS compound (PFDA), which is highly relevant as a basis for risk assessment.

Scientific disciplines:

Water quality (50%) | Toxicology (25%) | Risk research (25%)

Keywords:

PFAS, organic micropollutants, water quality, hydrology, groundwater, drinking water, wastewater, human health, environmental health, material flow analysis, fate and risk model

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Further links to the persons involved and to the project can be found under
<https://www.wwtf.at/jpeto2.brunner.at/funding/programmes/esr/ESR20-013/>