European Commission

Science for Environment Policy

Europe's rivers 'highly contaminated' with long-chain perfluoroalkyl acids

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Long-chain perfluoroalkyl acids (PFAAs) are persistent chemicals with proven toxic effects. This study estimated the emissions and concentrations of two such chemicals, perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), in 11 of Europe's most populated river catchments. Estimated emissions were lowest in the Thames and highest in the Rhine, while the EU environmental quality standard for PFOS was exceeded in all rivers. This study provides a picture of PFAAs contamination in rivers across Europe, and makes recommendations for achieving reductions.

Every year around 400 million tonnes of chemicals are produced and about a thousand new substances are developed[1]. While these provide numerous benefits to humans, there are mounting concerns about the effect of the thousands of synthetic substances on the environment.

This study focused on PFOS and PFOA — perfluoroalkyl acids used (or present as impurities) in industry and consumer items, such as textiles, food packaging and firefighting foams. These toxic, persistent and bioaccumulative substances have been linked to human health effects such as hormone disruption and cancer.

These chemicals can pose a long-lasting risk, not least because the substances can last for many years (in the many products in use that contain them, in waste streams and in the environment, including in wildlife). Additionally, while the production and use of some is limited in the EU[2], these non-degradable chemicals are still produced in other parts of the world and, because they can undergo long-range transport, they pose a risk globally.

Although high concentrations have been found in some European rivers, in many other rivers, concentrations are unknown, making it difficult for regulators to ascertain risk or the effectiveness of interventions. Recognising this problem, this study aimed to predict concentrations of PFOS and PFOA in major European rivers.

A simulation was undertaken for 11 major European river catchments (all with more than 10 million inhabitants): the Danube, Don, Dnieper, Elbe, Oder, Po, Rhine, Rhone, Seine, Thames and Vistula. The researchers, who received funding from the EU[3], used the STREAM-EU model — a spatially and temporally resolved model that can predict the environmental fate and transport of organic contaminants in river basins — to estimate the concentrations in the rivers. Emissions to the catchments were estimated using data for population, wealth and wastewater treatment.

The highest values of PFOS emissions were found in the Rhine (1.6 tonnes/year), while the lowest were in the Thames (0.4 tonnes/year). Emissions estimates for PFOA ranged between 0.2 tonnes/year (also for the Thames) and 1.7 tonnes/year for the Dnieper catchment, which flows through Russia, Belarus and Ukraine.

The authors point out that a catchment with lower emissions may not necessarily have a better environmental status. Although the Thames had the lowest emissions estimates, it also had the highest emissions *per unit area*. The researchers say that higher emissions are associated with a larger population, greater economic power (signifying higher consumption per capita) and lower-quality urban effluent treatment.

Continued on next page.

Source: Lindim, C., van Gils, J. & Cousins, I. (2016). Europe-wide estuarine export and surface water concentrations of PFOS and PFOA. *Water Research*, 103: 124–132. DOI: 10.1016/j.watres.2016.07.024.

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1. http://www.solutions-project.eu/

2. The manufacture and use of PFOS is restricted in the EU under Directive 2006/122/EC, and a similar decision for PFOA is pending.

3. The SOLUTIONS project is supported by the European Commission via the 7th Framework Programme. See: http://www.solutions-project.eu/

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The storage of a chemical in a catchment and its export to the ocean depends on hydrological features, such as the area-specific run-off (ASR, the ratio between amount of river discharge and catchment area). Catchments with higher levels of run-off have lower rates of retention and can more quickly 'flush out' chemicals into the sea. For example, the Po, Rhine and Rhone rivers have high ASRs, while the Don, Oder and Seine have lower ASRs and so are likely to retain more of the chemicals.

Over 4 tonnes of PFOS are estimated to be moved from these 11 rivers to the sea per year; the figure for PFOA is just under this (3.7 tonnes per year). The highest quantities exported to the sea were from the Rhine (1 tonne per year) and the Danube (0.7–0.9 tonnes per year). For seas that receive input from rivers, riverine discharge of PFOS was up to 30 times more important than input from the atmosphere, although for PFOA the opposite was true — atmospheric input to seas was up to 10 times more important than that from rivers.

Of perhaps greatest concern, the modelling suggests that the surface water environmental quality standard (EQS) for PFOS set by the EU (0.65 nanograms per litre) is exceeded in all of the river catchments, and by a wide margin. There is currently no EQS for PFOA.

Overall, this European-wide picture of PFOS and PFOA contamination suggests that many of Europe's biggest rivers are contaminated, and that PFOS levels are likely to be well above the EU limit. The concentrations predicted by the model were generally in agreement with real-life measurements, which suggests it is reliable.

These findings could be valuable in the context of active efforts to reduce contamination. To increase the rate of contamination reduction, the researchers recommend, in particular, installing more effective treatment technologies at wastewater-treatment plants. Full removal of these substances via wastewater treatment is, however, difficult and expensive, which reinforces the importance of preventive action on the production and use of PFOS and PFOA.

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