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## New dual screening method for emerging pollutant chemicals in urban wastewater, Lyon, France

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**Urban wastewaters contain a number of chemical contaminants — including plasticisers, flame retardants, pharmaceuticals and pesticides.** These chemicals are often ecotoxic — for example, those which disrupt hormones in organisms — and are a potential threat to aquatic life. This study aimed to establish a large-scale, environmental risk assessment (ERA) on emerging chemical pollutants continually released in effluent into local watercourses from 10 urban waste-water treatment plants (WWTP) in France.

Over the last few decades, synthesis and use of chemicals have grown significantly, resulting in thousands of chemicals being discharged in urban wastewater. WWTPs were installed primarily to reduce phosphorous, nitrogen and organic matter from wastewater, and so perform poorly at removing contaminants of emerging concern (CECs).

Most ERAs on CECs are carried out on single WWTP plants, for just a few common CEC molecules. However, for a truly accurate assessment of the level of environmental risk posed by waste-water pollutants, large-scale territorial ERAs are needed — on the most complete identification possible of those CECs that are emitted in wastewater. When detecting the ecotoxic effect of a pollutant, the degradation products of the chemicals — metabolites — should always be assessed, as these can be more ecotoxic than the parent chemical (even if the parent is harmless).

The European Urban Waste Water Directive (UWWD), 1991, made vast improvements on water quality of effluents from WWTP in Member States. In 2019 a review of the UWWD noted some gaps in its coverage, including inadequate removal of micropollutants — both CECs and microplastics — and the potential for these to be present in sewage sludge used for agriculture[1]. Research in identification of CECs, therefore, is essential in the quest to find effective ways to remove them from sewage effluent.

Suspect screening analysis (SSA) is a new technique employed to identify potential chemical pollutants (and metabolites) present in waste-water effluent — using various chemical analysis

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techniques, and a catalogue of information on thousands of chemicals[2]. In this study SSA of wastewater is combined with a targeted quantification of identified pollutants emitted from WWTP into water catchments. This dual method enables a fuller assessment of environmental risks associated with wastewater.

An innovative ERA framework was applied to CECs identified by SSA in effluents of 10 WWTPs in Lyon, France. These WWTPs discharge wastewater into nearby fresh-water courses — five into the Rhône River, four into the Saône River, and one into the small, intermittent Gorges stream. The results of the SSA were used to evaluate the associated ecotoxicological risk, following two ERA methods: 1) a single-substance ERA method, assessing each pollutant in isolation, based on Predicted Environmental Concentrations (PEC) and Predicted No Effect Concentration (PNEC) values (i.e. the concentration of a substance in any environment below which adverse effects will most likely not occur); and 2) a method that considered the 'cocktail effect' of CECs in WWTP effluents and was able to detect hidden risks.

Around 2 000 pharmaceutical residues and pesticides were searched by the SSA in wastewater samples collected at the outlet of the WWTPs, during three time periods in 2019.

The researchers found that 22 of the 41 identified CECs are quite ecotoxic (PNEC aquatic ≤ 1 micrograms per litre (µg/L) with a wide range of PNEC values observed — ranging from 0.019 nanograms per litre (ng/L) for terbutryn, an ecotoxic pesticide — to 704 µg/L for irbesartan, a less toxic blood-pressure drug. Terbutryn's inhibition of algal growth at very low concentrations generated its high ecotoxicity rating. Three pharmaceuticals: methocarbamol, atorvastatin and venlafaxine are also highly ecotoxic — with PNEC levels below 1 ng/L.

The researchers found that, on at least one occasion, 19 CECs from the first WWTP posed a significant risk for the receiving water course. The following molecules: venlafaxine (antidepressant drug), terbutryn (pesticide), methocarbamol (muscle relaxant) and statin (drugs to lower cholesterol), frequently posed a significant risk. These CECs can have highly ecotoxic effects on ecosystems — for example venlafaxine has an adverse effect on fresh-water snails at only the ng/L level.

Sampled effluent from nine of the WWTPs generated a significant mixture risk, with some individual CECs with a negligible risk causing a significant threat when combined. The territorial ERA showed a diversity of risk situations, with the highest concern for three WWTPs: the two biggest which discharge into the River Rhône, and the smallest WWTP which releases into the Gorges stream.

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This study demonstrates that using chemical data from suspect screening analyses, in conjunction with the two ERA methods, provides a useful tool for improved water-quality management. The researchers highlighted the lack of ecotoxicological data for 17 out of the 41 identified CECs. They suggest that this data gap, alongside research on bioaccumulation/biomagnification and persistence/biodegradation of pollutants in streams, are a critical priority to achieve a more robust ERA using this approach.

The researchers also posit that part of current CECs (such as pharmaceutical residues) need to be considered as priority pollutants, based not just on persistent, bioaccumulative and toxic (PBT) criteria, but also on their risk to ecosystems. Finally, the researchers flag the import of the 'dilution factor' of WWTP effluents into the receiving watercourse, as it has a major influence on the risk of CECs to the aquatic ecosystem, and at present isn't allowed for — yet, with climate change many watercourses are diminishing and even drying up.

1. https://ec.europa.eu/environment/water/water-urbanwaste/pdf/UWWTD%20Evaluation%20SWD%20448-701%20web.pdf

2. See discussions on mixtures in the EU's *Chemicals Strategy for Sustainability Towards a Toxic-Free Environment* (2020) and development of guidelines for new monitoring methods — such as effect-based techniques — which do not depend on single-substance analysis.