Call for better management of micropollutants in wastewater

Urban wastewater treatment plants are important collection points for many chemical contaminants, often called micropollutants, which are widespread in the aquatic environment. Currently, this issue is not being sufficiently addressed by regional policy and EU-wide legislation. The EU's Zero Pollution Ambition, the Chemicals Strategy for Sustainability and the likely revision of the Urban Wastewater Treatment Directive now provide opportunities to address this issue. Measures to prevent the emissions of micropollutants via wastewater treatment plants are needed both up- and downstream, to ensure policy coherence between EU water and chemicals legislation.

Thousands of chemicals are emitted from materials and products in our homes, workplaces and industries. Both well-known environmental pollutants and less studied Contaminants of Emerging Concern (CECs), i.e. chemicals that have only recently been identified as potentially harmful to the environment, risk contaminating both inland waterways and the sensitive coastal zones of the Baltic Sea [1–4]. These coastal zones are home to marine organisms during vulnerable life stages, including spawning and juvenile development [5–7], when their sensitivity to toxic chemicals is particularly high.

There is increasing concern in the research community and society at large regarding the overall ecotoxicological effects of this chemical mixture in our waters.

Facts about micropollutants

Micropollutants is a collective term for a wide range of chemicals that are present in the aquatic environment as a result of human activities. These substances are used for example as ingredients in pharmaceuticals, pesticides, personal care products, food additives and household products, or as components or by-products in industrial processes and various materials.

Important collection points

Micropollutants have many different sources and transport pathways. One important pathway are urban wastewater treatment plants (UWWTPs). These function as collection points for many of the micropollutants that are diffusely emitted in urban environments [8–10]. Although primarily designed to reduce levels of nutrients and organic matter, conventional treatment plants also lower the concentration of several but not all micropollutants [11].

Unfortunately, conventional treatment is ineffective in particular for mobile and persistent substances, i.e. highly water-soluble compounds that do not attach to particles and are resistant to biodegradation [12,13]. Short chained per- and polyfluoroalkyl substances, PFASs, are one example. These substances have the potential to travel long distances in catchment waterways [14].

Additionally, due to the continuous flow of micropollutants through these plants, high concentrations of substances that are not particularly persistent can still be maintained in receiving waters. Field studies show that concentrations of multiple micropollutants, for example many pharmaceuticals, are elevated in coastal waters but are less frequently detected in the open sea [3,4,15].

Contaminated freshwater systems increase concern

Little is known about the effects of the chemical mixture released from wastewater treatments plants on Baltic Sea ecosystems. The few existing studies are ambiguous, but show that marine organisms are potentially affected by micropollutants [16–18]. However, it is difficult to show the long-term effects at population level and to know the extent to which the effects are derived from wastewater plants compared to other sources. The ecotoxicological effects of micropollutants are often obscured by other environmental factors, making the connection between chemical emissions and negatively impacted organisms difficult to discern [19].

However, a lack of knowledge is no reason not to act. An unambiguous connection between chemical pollution and adverse effects at population level in the Baltic Sea have previously been proven in only a few cases, and only when serious damage had already occurred [20].

There is increasing evidence that chemical pressure on European river systems exerted by the small fraction of micropollutants being monitored are likely having negative effects on aquatic organisms. A recent study indicated that the combined effects of only a subset of prioritised substances significantly limited the ecological status of freshwater bodies, as assessed under the Water Framework Directive [21]. Previous studies covering a wider range of monitored chemicals have also shown that micropollutants cause both acute and long-term effects in river systems [22]. This suggests that marine organisms in coastal zones may also be negatively impacted.

The dilution of river water discharged into the Baltic Sea is significant. However, coastal zones are continuously exposed to contaminated river water or direct coastal discharge of wastewater. Since the semi-enclosed Baltic Sea is also the final destination for many persistent and mobile substances moving through the catchment area, considerable caution must be exercised.

Micropollutants in wastewater must be regulated

Currently, micropollutant emissions from urban wastewater treatment plants are poorly assessed and regulated. Neither EU legislation nor regional agreements such as HELCOM include criteria for the quality of treated wastewater regarding micropollutants. The Urban Wastewater Treatment Directive (UWWTD) only specifies requirements for acceptable levels and the removal of nutrients and organic matter. Since the directive is currently under consideration for revision, there is now a window of opportunity to address this.

The European Commission evaluated the directive in 2019. It recognised that it did not address CECs as a shortcoming and emphasised that further treatment requirements to remove them would be a way of addressing this issue [23]. This has also been highlighted by scientific networks and water associations [24–26].

Collectively, this strongly suggests that there is a need to introduce criteria for minimum chemical wastewater quality that address micropollutants and their mixtures.

Ensure better policy coherence

The Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) set requirements for defining and assessing the status of European fresh and marine waters. Implementation of the UWWTD is specifically mentioned in these directives as a measure to achieve good ecological and environmental status.

However, as long as the UWWTD fails to include any requirements for micropollutants or their toxic effects, the effectiveness of this measure regarding the many contaminants that are not properly removed from conventional plants will be limited.

By introducing criteria for minimum chemical wastewater quality under a future revised UWWTD, there will be a need to establish a better connection between these three directives. This connection should also enhance the functioning of the UWWTD as a means of achieving good chemical and ecological status of surface water regarding micropollutants.

Incorporate new criteria in REACH

The European chemicals legislation REACH, in conjunction with the numerous directives specifically targeted at pharmaceuticals, pesticides and other usage categories or substance groups, are key to preventing hazardous substances from polluting the environment.

However, there are a number of well-known weaknesses in implementation, enforcement and lack of environmental risk assessments, meaning that hazardous substances can slip through the regulatory net [27].

A more fundamental flaw is that the criteria used in risk assessments do not cover the type of micropollutants that are most likely to escape from conventional wastewater treatment plants, namely, persistent and mobile substances. Thus, these have not been legally identified as being harmful to the environment. Recent scientific studies have shown that this legislative gap has resulted in the risk of water bodies being contaminated by chemicals that are currently not regulated [13].

The EU Chemicals Strategy for Sustainability Towards a Toxic-Free Environment states that the European Commission will work to widen the definition of hazardous substances to include persistent, mobile and toxic substances (PMTs) and very persistent and very mobile substances (vPvM). Introducing these criteria into, for example, REACH would ultimately reduce the presence of these substances in wastewater and in the environment in general.

Facilitate screening of micropollutants

The EU Action Plan Towards a Zero Pollution Ambition for air, water and soil is an important part of the Green Deal and aims to present better ways of preventing, remedying, monitoring and reporting pollution in 2021. This requires data on chemical emissions.

An important part of the action plan could be to further investigate the importance of wastewater as a transport pathway for chemicals from the technosphere to the aquatic environment. There is currently a lack of data because monitoring micropollutants is an expensive and time-consuming activity. Also, legal incentives to obtain this information are weak.

A recent study led by the Stockholm University Baltic Sea Centre showed significant differences between the Baltic Sea countries regarding both the number of wastewater analyses conducted and the types of chemicals analysed. In most of these countries it is unusual to look for micropollutants in effluents for the purpose of assessing the presence of CECs.

In a Baltic Sea context, HELCOM should be tasked with organising regular joint screening campaigns to assess the presence of CECs in wastewater. This would help to proactively identify potential marine pollutants and improve the understanding of the extent to which UWWTPs are contributing to the total input of various chemicals into the Baltic Sea.

Such knowledge is of great importance for pressure analysis under the Water Framework Directive, the Marine Strategy Framework and the HELCOM Baltic Sea Action Plan.

Policy recommendations

- **In the revision of the Urban Wastewater Treatment Directive, UWWTD:**
  - **develop criteria for minimum chemical wastewater quality** that address micropollutants and their mixtures.
  - **establish a clear connection to the Water Framework Directive and the Marine Strategy Framework Directive (WFD and MSFD)** ensuring that the UWWTD functions as a means of also achieving good chemical/ecological/environmental status of surface waters with regard to CECs and other micropollutants. The connection should allow for flexibility in the definition of good status as science and policy progress.
- **Ensure that the Chemicals Strategy fulfills the ambition to include *persistence* combined with *mobility* as additional criterion in, for example, REACH** in order to identify hazardous substances. Chemicals with such properties are particularly prone to escape from wastewater treatment processes and contaminate waterways.
- **Organise regular joint screening campaigns under HELCOM to assess the presence of chemicals of emerging concern in wastewater**, with the aim of improving our understanding of the extent to which wastewater treatment plants are contributing to the total input of various types of chemicals into the Baltic Sea region and identify potential marine pollutants.

About this policy brief:

This policy brief is based on work carried out in the project *Status of Chemical emissions via WWTP effluents and impact in the Baltic Sea Catchment* (CHEMPACT). The purpose of the project is to establish what is currently known about different types of micropollutants in wastewater discharged into the Baltic Sea catchment and which could consequently reach the Baltic Sea via rivers or coasts. The project is funded by the Nordic Council of Ministers.

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Figures:

Micropollutants are measured in few urban wastewater treatment plants in the Baltic Sea catchment area

There are more than 3000 urban wastewater treatment plants (UWWTPs) of different sizes around the Baltic Sea. Micropollutants are rarely analysed (any data available for less than a foruth of them) and few substances are regularly monitored. There are significant differences between countries regarding both the number of analyses made in the wastewater and the types of chemicals typically analysed.

Unknown, but large, masses of organic micropollutants are emitted from these UWWTPs every year

Only 342 different organic chemicals have been analyzed in at least five different UWWTPs in the region since 2010. The pie chart shows the estimated contribution from various chemical categories to the total annual emissions (ca 84 tonnes) of these chemicals. This is an

underestimation, particularly for industrial chemicals and household and personal care products, since the estimated mass is dependent on the number of chemicals that have been analyzed. The amount of micropollutants that actually reaches the Baltic Sea is unknown.

Data on UWWTP size and location from the EU Waterbase (2019 and 2020 edition). Information regarding a limited number of facilities in St Petersburg and Kaliningrad regions provided by the John Nurminen Foundation and Helcom.

Sources of micropollutants

In urban areas, thousands of micropollutants flow via wastewater treatment plants (UWWTPs) to surrounding waters, making these facilities major collection points for chemical flows in urban areas. For example, micropollutants enter the sewers when we wash textiles, wet wipe surfaces, rinse off personal care products, flush pharmaceuticals that have passed through our bodies or dispose of household chemicals. The UWWTPs collect wastewater from private households, workplaces, public buildings, industries and, in some cases, also stormwater. The chemical mixture in wastewater is complex and not well defined.

Pathways for micropollutants to the sea

Micropollutants reach the Baltic Sea via several different pathways: via deposition from air, surface runoff, eroded soil, waterways, direct emissions along the coast or at sea. The pathway used depends on how the chemicals are emitted and their inherent properties, e.g. water solubility, volatility and tendency to sorb to organic materials.

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