PROJECTS – EIB SECTOR PAPERS

Microplastics and micropollutants in water

Contaminants of emerging concern

European Investment Bank

Microplastics and micropollutants in water

Contaminants of emerging concern

European Investment Bank

Microplastics and micropollutants in water: Contaminants of emerging concern

Project - EIB sector paper - ENR/Water Management
February 2023

Author
Juan Bofill (European Investment Bank)

This is a publication of the EIB Projects Directorate.
www.eib.org/projects

About the EIB Projects Directorate
The Projects Directorate appraises and monitors projects financed by the Bank, assessing their economic, environmental, social and technical sustainability and their compliance with EU and EIB sector policies. It also provides advice to promoters on the preparation and implementation of projects, either directly or through external consultants.

For further information on the EIB's activities, please consult our website, www.eib.org. You can also contact our InfoDesk, info@eib.org.

Published by the European Investment Bank.
Printed on FSC® Paper.

Content

A study from the Medical University of Vienna has revealed that five grams of plastic particles on average enter each person’s gastrointestinal track every week. This is roughly equivalent to the weight of a credit card.

1. MICROPLASTICS AND MICROPOLLUTANTS IN WATER: EMERGING CONCERNS

Life on earth is facing unprecedented, existential threats. Climate change, pollution, ocean acidification and nature loss pose a series of interconnected problems that may lead to economic and social development reversals. This global environmental crisis directly affects human health, well-being, and economic prosperity. And for the first time in our history the most serious and immediate risks are human-made and unfolding on a planetary scale. More needs to be done at the European and global level to restore or avoid further degradation to the environment. This sector paper discusses in particular the emergence of two potentially severe health hazards — microplastics and micropollutants in water — and the role of the European Investment Bank in helping to reduce the emission of these "contaminants of emerging concern".

Microplastics are tiny solid plastic particles (smaller than five millimetres), which are increasingly polluting our soils, rivers, lakes, and oceans. The effect of microplastics on small fish or aquatic invertebrates depends on the size of the organism and the particle. While the effect of bigger particles is similar to that of a plastic bag ingested by a turtle (it harms and often kills the animal), very small particles accumulate in the digestive system and therefore end up in the food chain. Just like aquatic animals, humans ingest microplastics. According to a recent estimate, a person who eats seafood will swallow, on average, 11 000 pieces of microplastics every year.[1] Very small microplastics have even been found in human blood.[2] In addition, the COVID-19 pandemic has increased plastic and microplastic pollution. It is therefore not surprising that the majority of EU citizens are concerned about the impact of plastic products on their health (89%) and on the environment (88%)[3].

Micropollutants are small, almost invisible parts of products that are used daily, such as in pharmaceuticals, industrial chemicals, cosmetics, and pesticides. Unlike microplastics, most micropollutants cannot be removed by conventional wastewater treatment plants and thus find their way into the environment and potentially back into our food chain. The effects of micropollutants on public health are not yet fully understood but are a cause of increasing concern among health authorities in the European Union.

This sector paper first describes the adverse impacts of microplastics and micropollutants on human and animal life, as well as recent policy developments to address these problems. This is followed by a summary of the costs and benefits of investments needed to mitigate these adverse impacts, and an overview of what the EIB is doing to help reduce the release of micropollutants and microplastics in water. The report ends with a summary and conclusions.

---

1 University of Ghent, Van Cauwenberghe L, Janssen C, 2014. Microplastics in bivalves cultured for human consumption. Environmental Pollution, 193, 65-70.

2 Nano-particles (microplastics with a diameter of less than 0.001 cm) were discovered in 77% of healthy adult blood donors tested in the Netherlands in 2021.

3 Eurobarometer. Special Eurobarometer 501, March 2020. Attitudes of European citizens towards the environment.

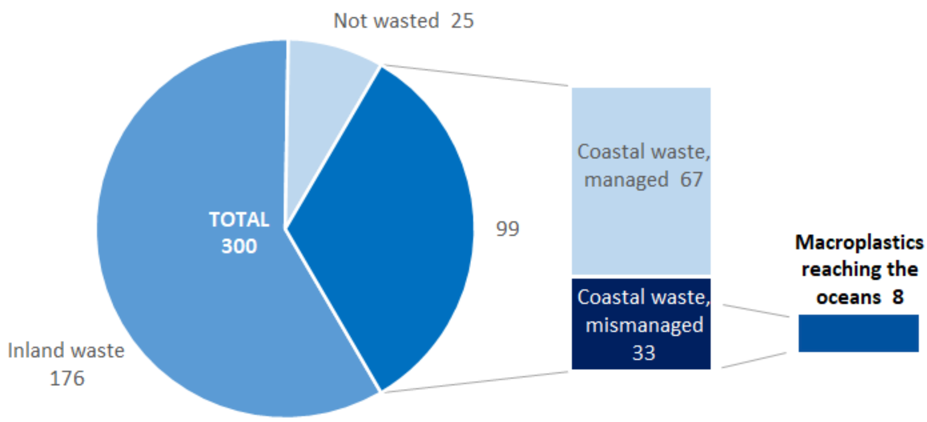
2. MICROPLASTICS: POLLUTING THE OCEANS AND ENTERING THE FOOD CHAIN THROUGH AQUATIC LIFE

Background: Microplastics are usually classified as "primary" or "secondary".[4] Primary microplastics are specifically manufactured to be of a small size (such as microbeads) but can also originate from the abrasion of large plastic objects during manufacturing, use or maintenance (such as tyre wear or abrasion of synthetic textiles during washing). Secondary microplastics are those formed from the breakdown of items into smaller plastic fragments once exposed to the environment (photodegradation or unintentional losses such as fishing nets).

Pollution by large plastic waste ("macroplastics") is also a major problem, but one that could be solved with sufficient political will to implement a more circular approach to plastic management.[5] In contrast, microplastics are, by their nature, a relatively invisible problem that has not yet been widely studied and for which technical solutions are still being developed.

At present, global "consumption" of plastics is conservatively estimated at 300 million tonnes per year, of which about 8 million tonnes end up in the oceans as macroplastics (Figure 1). In addition, about 1.5 million tonnes of primary microplastics end up in the oceans as well. About 98% of this volume is generated by land-based activities, and the remaining 2% by sea-based activities. The main pathways of microplastics from land to sea are stormwater, untreated sewage water (96%) and wind (4%). The biggest sources of microplastics are synthetic textiles, tyres, and city dust (Figure 2 and Table 1). Taken together, these three sources account for over 80% of all microplastics pollution.

Figure 1: Composition of macroplastic waste
(millions of tonnes per year)

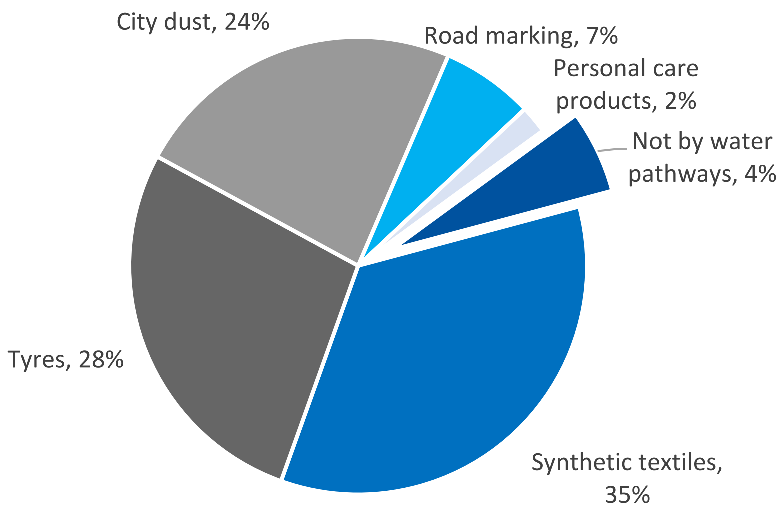


Source: GIZ (2018)

4 This definition is from Sundt et al. (2014), which is linked to effects in the blue economy.

5 For more details, see The EIB Circular Economy Guide.

Figure 2: Microplastics released into the oceans, by source
(per cent of total)



Source: Boucher, J. and Friot D. (2017)

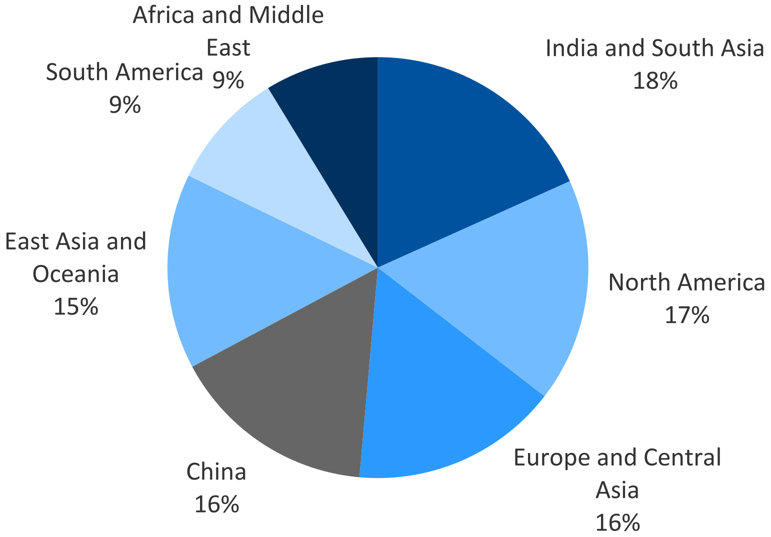
Table 1: World plastic consumption and microplastics released into the oceans, by source
(millions of tonnes per year)

Source	Plastic consumption	Microplastics in oceans	Pathway to oceans
Synthetic textiles	42.5	0.53	Abrasion through laundry and discharged in **sewage water**
Tyres	6.4	0.42	Abrasion while driving and washed off road by **stormwater**
City dust	-	0.36	Abrasion from infrastructure spread by wind or washed by **stormwater**
Road marking	0.6	0.10	Abrasion while driving and washed off road by **stormwater**
Marine coating	0.5	0.06	Release from boats during building, maintenance, repair or use
Personal care products	0.0	0.03	Direct discharge in **sewage water**
Plastic pallets	257.0	0.01	Spilled through incidents along the entire plastic value chain
TOTAL	307.0	1.50	>96% of microplastics discharged into oceans by water pathways

Source: Boucher, J. and Friot D. (2017)

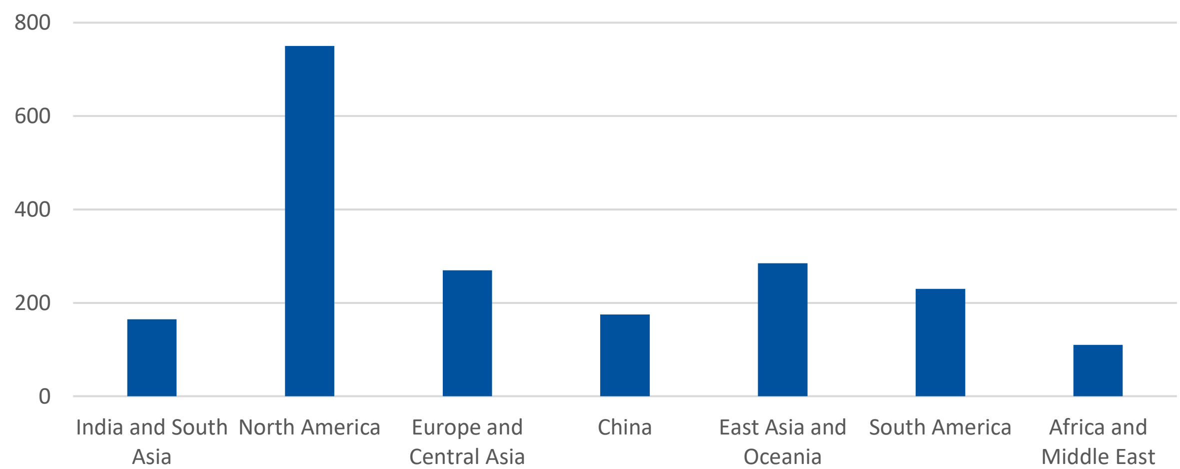
Microplastics are released into oceans all over the world. At present, Europe, and Central Asia account for about 16% of the world's release of microplastics into the oceans (Figure 3). The European Union's share is estimated at 10% of the global total, or about 150 000 tonnes per year. 1.5 million tonnes per year are equivalent to 200 grams per person per year (which, in turn, is equivalent to the weight of 40 plastic bags). There is, however, considerable geographical variation in per-capita microplastic generation. On a per-capita basis, North America is by far the largest generator, followed by East Asia and Oceania, and Europe and Central Asia (Figure 4).

Figure 3: Microplastics released into the oceans, by region
(% of total)



Source: Boucher, J. and Friot D. (2017)

Figure 4: Microplastics released into the oceans, by region
(grams per capita per year)



Source: Boucher, J. and Friot D. (2017)

Box 1: Impact of COVID-19 on microplastics

Personal protective equipment (such as masks, face shields, gowns, and gloves) are all made of plastic and has become another major source of microplastics pollution. The impact has not yet been evaluated; however, in China alone, 200 million face masks were produced per day in June 2020, which represents a 20-fold increase from pre-COVID production volumes. In use, a facial mask releases over 1 500 fibres.[6]

Box 2: Microplastics pollution in figures

- Amount of microplastics that have accumulated on the world's ocean floor to date: at least 14 million tonnes.[7]
- Amount of microplastics released by households and businesses every year: 3.2 million tonnes, of which almost half enters the world's oceans.[8]
- Amount of textile microfibres released into Europe's surface waters every year: 13 000 tonnes.[9]
- Proportion of soft drinks containing microplastics: 84%.[10]
- Number of microfilaments emitted by 6 kilograms of acrylic clothing (such as sportswear) in a single cycle of a washing machine: 700 000.[11]

Adverse impacts of microplastics. There is clear evidence that microplastics harm aquatic life: particles are mistaken for food, then block digestive tracts, or take up space in these tracts, which may result in incorrect feeding signals. In addition, microplastic ingestion adversely affects the fertility of organisms, and some types of microplastics break down into persistent, carcinogenic compounds since plastics contain a wide range of additives classified as hazardous according to the EU regulation on classification and labelling[12]. In contrast, there is limited evidence about the impact of microplastics pollution on terrestrial life and on people. However, recent studies have found microplastics in air, drinking water and food. A recent study found 440 microplastics in a kilo of sugar, 110 microplastics in a kilo of salt, and 90 microplastics in a litre of bottled water.[13]

Despite limited evidence about the adverse impacts of microplastics pollution on human life, there is nonetheless a consensus on the need to act, partly because of increased public awareness about microplastics and moral opposition to microplastics entering the food chain, but also because of the precautionary principle. This principle applies when there is scientific uncertainty about suspected risks to human health or the environment emanating from a certain action or situation. If after an objective scientific evaluation uncertainty persists, policy measures must be taken to stop that action or situation.[14]

6 M. Lee and H. Kim (2022).

7 Barret et al. (2020).

8 Boucher and Friot (2017).

9 Eunomia and ICF (2018).

10 Shruti et al. (2020). A finding of 84% based on 57 samples.

11 University of Plymouth (2021).

12 Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006

13 Environ. Sci. Technol. 2019, 53, 12, 7068–7074

14 Evidence Review Report N-4. (SAPEA, 30 April 2019).

Current and future EU policies aimed at reducing microplastics in water. Due to the excellent functional properties of plastic materials (durability, malleability, lightweight and low cost), it seems likely that plastic use will increase in the future[15] , particularly in lower-income countries as their economies grow. This makes it more important than ever to control and mitigate plastics pollution. In the European Union, addressing plastic pollution is a high political priority and the following EU legislation and policies explicitly refer to the reduction of microplastics in the environment.

- **EU Plastics Strategy.** Adopted in January 2018, this is part of the European Green Deal and Circular Economy Action Plan.[16] Microplastics are defined as potential threats to both the environment and human health. Concrete actions in the strategy to address microplastics pollution include: (i) start the process to restrict the intentional addition of microplastics to products; (ii) evaluate the Urban Wastewater Treatment Directive in order to assess the effectiveness with respect to microplastics capture and removal; and (iii) examine policy options for reducing the unintentional release of microplastics from tyres, textiles, and paint. The European Commission published in August 2022 a regulation[17] that will ban the addition of microplastics to products. Moreover, the European Commission has evaluated and published a proposal for revision of the Urban Wastewater Treatment Directive (see below for more details). The Commission also announced a new initiative to address the unintentional release of microplastics in the environment (due to be published in May 2023)
- **Zero Pollution Action Plan.** On 12 May 2021, the European Commission adopted the EU action plan “Towards a Zero Pollution for Air, Water and Soil”, which is considered a key deliverable of the European Green Deal. The action plan contains a target of reducing microplastics pollution by 30% by 2030.
- **Single-use Plastics Directive.** Directive (EU) 2019/904, which targets reducing the impact of certain plastic products on the environment, entered into force on 3 July 2019, and Member States had two years to transpose it into national law. The Directive introduces market restrictions, promotes consumption reduction, and sets recycling targets for single-use plastics. Although the Directive does not specifically regulate microplastics pollution, market restrictions are expected to reduce the mismanaged disposal of products that do not properly biodegrade and in turn can become microplastics by fragmentation.
- **Drinking Water Directive.** The EU recently adopted the Drinking Water Directive (EU) 2020/2184, which considers microplastics as a matter of emerging concern, which must be regularly monitored in water bodies used for the abstraction of drinking water.[18] In such cases, Member States must find and propose solutions to mitigate the possible risks.

Significantly, there is currently no reference to microplastics in either the Water Framework Directive or the Urban Wastewater Treatment Directive, although it is anticipated that this will change in the near future. In summary:

- **Water Framework Directive.** This Directive, which came into force in December 2000, does not currently explicitly address microplastics. However, the ongoing fitness check by the European Commission may lead to a long-term revision that might include microplastics as it is relevant to determining the good ecological status of freshwater systems. In this case, it would become compulsory for Member States to monitor water quality for microplastics pollution and formulate appropriate mitigation measures.
- **Urban Wastewater Treatment Directive.** After 25 years of implementation, the Directive has led to significant positive impacts, for instance improvement of the quality of EU waters, particularly downstream of the EU’s urban areas. The European Commission completed an evaluation in 2019. During public consultations, academia and the general public raised concerns about microplastics. These concerns are addressed in the proposal for a revision of the Directive, which was published in October 2022.[19] The proposal

---

15 “Breaking The Plastic Wave: Top findings for preventing plastic pollution,”, July 2020, Reddy, Simon, and Winnie Lau, predicts that by 2040, the volume of plastic on the market will double compared to 2016.

16 For details, refer to http://ec.europa.eu/environment/waste/plastic_waste.htm, and http://ec.europa.eu/environment/circular-economy/index_en.htm.

17 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907

18 The revised Directive will also likely encourage a reduction in bottled water consumption. In March 2018, the World Health Organization announced that it would review the potential risk of plastic in drinking water after studies found microplastics in popular bottled brands.

19 Proposal for a revised Urban Wastewater Treatment Directive (europa.eu)

provides for improved stormwater management and expands the scope of the Directive to the collection and treatment of wastewater to smaller conurbations (the threshold size was lowered from 2 000 population equivalent to 1 000 population equivalent). This is expected to lead to further monitoring and reduction in microplastic discharge into water bodies. The revised Directive is likely to be adopted by the Member States in 2025.

- **EU Taxonomy for sustainable finance[20].** Regulation (EU) 2020/852 on sustainable finance specifically mentions that to ensure the sustainable use and protection of water and marine resources, it is necessary to reduce emissions of contaminants such as microplastics. This can be achieved by integrated urban wastewater treatment management, which should also cover stormwater. The definition of the taxonomy is ongoing; however, in the recommendations included in the Technical Platform published in March 2022[21] microplastic issue is covered under Urban Wastewater Treatment since it requires the fulfilment of the Urban Wastewater Treatment Directive and thus sufficient treatment is required to remove a critical portion of microplastics.

As the implementation of the above measures will take time and will in any case not fully eliminate the production of microplastics, it remains necessary to collect microplastics using "end-of-pipe" solutions (involving cleaning of contaminated flows of water at the point where effluent enters the environment).

As mentioned earlier, the main sources of microplastics in the oceans are sewage water (37%) and stormwater (59%).

Conventional wastewater treatment plants can capture up to 99% of microplastics (mainly originating from synthetic textiles) in sewage water[22], meaning that almost all microplastics originating from wastewater can, in theory, be diverted. In the EU, at least 90% of wastewater already receives conventional treatment, whereby the microplastics end up in the sludge stream, which is ultimately disposed of in a number of ways, typically incineration, landfill or fertiliser after drying (45% in the EU).[23] There is, however, a significant knowledge gap about the impact of microplastics in sludge used as fertiliser, and what percentage could find its way into the oceans through runoff. The Sewage Sludge Directive 86/278/EEC is also being reviewed and is expected to propose solutions aimed at avoiding contamination from this source.

To prevent microplastics reaching natural waterways through runoff of rainwater in streets (tyres, road marking and city dust), urban stormwater management systems are required to intercept these particles. The proposal for a revised the Urban Wastewater Treatment Directive specifically provides for detailed regulation of stormwater systems, which makes it a legal requirement for agglomerations above 10 000 PE, based on a risk management model.

If all stormwater and sewage water in the world were collected and treated in accordance with international best practices, most of the 1.5 million tonnes of microplastics would never reach the oceans. The update of the relevant Directives (Urban Wastewater Directive, Sewage Sludge Directive and Water Framework Directive) and the implementation of the new Drinking Water Directive will be a major step towards this goal in the EU.

[20] Sustainable Finance and EU Taxonomy (europa.eu)

[21] Annex to the report by the Platform on Sustainable Finance with recommendations for technical screening criteria for the four remaining environmental objectives of the EU taxonomy (europa.eu)

[22] Marine and Freshwater Research Centre (MFRC), Galway-Mayo Institute of Technology, Dublin Road, Galway, Ireland.

[23] 45% is reused as fertiliser — however, other uses such as in landscaping and forestry would increase this percentage to 60%. "Overview of legislation on sewage sludge management in developed countries worldwide.", A. Christodoulou and K. Stamatelatou. IWA Publishing 2016.

3. MICROPOLLUTANTS: CONTAMINATING FRESHWATER SOURCES WITH POTENTIALLY SEVERE ADVERSE IMPACTS ON PUBLIC HEALTH

Background. Micropollutants are potentially hazardous particles that are found in small concentrations (of less than one microgram per litre) in water bodies. Micropollutants originate from products that are used daily, including but not limited to industrial chemicals, pharmaceuticals, cosmetic products, pesticides, and hormones. The variety of the substances constitutes one of the main challenges to assess and control micropollutants. Unlike for macropollutants (for example, organic matter), which can be characterised by indicators such as biological oxygen demand (BOD) or chemical oxygen demand (COD), there is no single indicator that can be used to identify all micropollutants. In addition, micropollutants can be transformed into other compounds, which can be more mobile and toxic than the original compound.

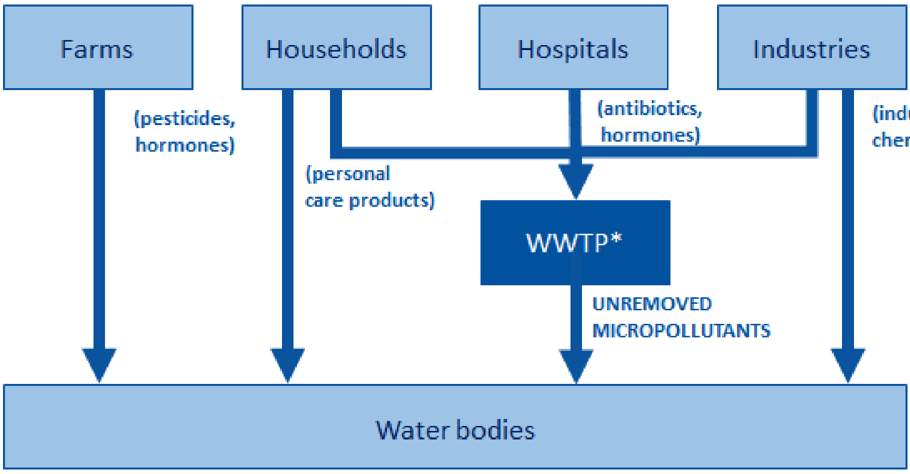
Antibiotics form a class of micropollutants that are of particular concern. On the positive side, the discovery of antibiotics is considered one of the most important events in the history of medicine. Their use in human and farm animal healthcare has ensured the treatment of many bacterial infections for years. However, antibiotics are now becoming less effective due to antimicrobial resistance. Antibiotic-resistant bacteria (often called “superbugs” in the media) get flushed into the sewer system or enter the water cycle from farms (73% of all antibiotics used worldwide are used in animal rearing)[24]. Wastewater treatment plants are therefore a vector for spreading antibiotic-resistant bacteria to people, which is a matter of public concern.

Micropollutants enter water bodies through several pathways (Figure 5). In most EU Member States, the biggest pathway is through wastewater treatment plants. Unfortunately, conventional wastewater treatment methods are designed to eliminate macropollutants (that are in concentrations of milligrams per litre, as opposed to micrograms per litre), and do not fully remove micropollutants from treated wastewater. For example, in the Netherlands, for many micropollutants the removal rate in wastewater treatment plants is less than 40%.[25] For some pharmaceuticals, removal rates are high, but bacterial treatment — biological degradation in the secondary treatment process in wastewater treatment plants — leads to the formation of different compounds, which may be hazardous in their own right.

[24] AMR and the water cycle, Global Water Intelligence (GWI), April 2019.

[25] STOWA (Foundation for Applied Water Management Research) (2019). Please note that 40% is an average. Ibuprofen contamination might be reduced by 60-96% (Bendz et al., 2005). However, the level of carbamazepine removal is much lower.

Figure 5: Pathways of micropollutants into water bodies



Source: EIB.
* WWTP: wastewater treatment plant

Adverse impacts of micropollutants. Despite their low concentrations, micropollutants may cause serious disruptions to life in and around water bodies. The effects of a special class of micropollutant (endocrine disrupting compounds, or EDCs) on animals include feminisation of male organisms (such as the presence of female egg proteins in male fish), as well as inhibition of growth and lower egg production.[26] Some EDCs have been detected in the human body (in blood, fat, and breast milk), indicating that the impact of micropollutants is not limited to animals. There is reason to believe that EDCs are associated with altered reproductive functions in men and women, increased incidence of breast cancer, abnormal growth patterns and neurodevelopmental delays in children, as well as changes in immune functions.[27] Other micropollutants like polyfluoroalkyl substances (which are found in cleaning products, Teflon pans, firefighting foams and other household items) can accumulate and stay in the human body for long periods of time and lead to adverse health outcomes such as effects on the immune system, thyroid hormone disruptions and even cancer.[28]

Current and future EU policies aimed at reducing micropollutants in water. The European Commission recently published a study that recognises that current EU legislation does not have sufficient specific provisions on micropollutants, and that further work is needed to address contaminants of emerging concerns in the current revision of policy legislation packages (for instance in EU directives).[29] In October 2022, the European Commission published a proposal for a Urban Wastewater Treatment Directive, which provides for ambitious micropollutant removal (see Box 3 below).

---

26 Endocrine disruptors are found in everyday products, such as plastic bottles, metal food cans, detergents, flame retardants, food, toys, cosmetics and pesticides.

27 State of the Science of Endocrine Disrupting Chemicals (World Health Organization, 2012).

28 What is Endocrine Disruption? See United States Environmental Protection Agency (see https://www.epa.gov/endocrine-disruption/what-endocrine-disruption)

29 Micropollutants in the water systems-KI0722120ENN.pdf (Feb 2022)

The Water Framework Directive addresses micropollutants, albeit partially. It also includes a so-called Watch List, a mechanism to monitor and control selected chemicals that pose a significant environmental risk across river basins in the EU.[30] The first Watch List was established in 2015 and includes 17 substances (mostly hormones, insecticides, and antibiotics) that must be monitored by EU Member States at least once per year. In the last update in 2018, two types of antibiotics (ciprofloxacin and amoxicillin) were added to the Watch List.

The European Parliament recently adopted Drinking Water Directive (EU) 2020/2184, which includes new limitations to the content of potentially harmful substances in water intended for human consumption (polyfluoroalkyl substances and EDCs). The full elimination of micropollutants in water is currently not a legal requirement in the EU, but Switzerland has already passed a law (in force since March 2014) to reduce micropollutant loads from wastewater treatment plants serving at least 2 000 people.[31] The need to remove micropollutants from treated wastewater is reinforced by the trend of increased reuse of wastewater for irrigation, especially in water-scarce countries.

Several Member States (notably France, Germany, and the Netherlands) are considering the reduction of micropollutants in treated wastewater through additional treatments to the traditional primary, secondary, and tertiary treatment processes. These additional treatments are collectively known as the "fourth step or quaternary treatment".[32] Common techniques of advanced treatments are ozonation, powdered activated carbon, and granular activated carbon. As will be shown, the costs of implementing the fourth step are considerable.

Box 3: Micropollutants in the new proposal for the Urban Wastewater Treatment Directive

The proposal for a revised Urban Wastewater Treatment Directive requires large wastewater treatment plants (defined as having a capacity of at least 100 000 person equivalents) to add a fourth stage to the wastewater treatment process by 2030 at the latest. This requirement would also apply to wastewater treatment plants with a capacity of at least 10 000 person equivalents that discharge effluent into water bodies that are classified as "being at risk". The so-called fourth step or quaternary treatment would remove at least 80% of certain micropollutants, notably pharmaceuticals.

Box 4: The impact of COVID-19 on micropollutants

According to a recent study, the COVID-19 pandemic resulted in an increase of the influent load of most organic micropollutants reaching wastewater treatment plants.[33] Restrictions to movement led to an increase in the consumption rate of cocaine, trimethoprim, sulfamethoxazole, sulfadiazine, carbamazepine and above all caffeine, which eventually found their way into wastewater.

---

30 Monitoring of substances on the Watch List started in September 2015, six months after the list was first established, based on about 35 800 water samples. On a scale from 0 ("no concern") to 3 ("very high concern"), various pesticides and pharmaceuticals were rated 0.90 (close to "concern").

31 The Swiss Water Protection Law of 2014 requires the removal of at least 80% of micropollutants from treated wastewater in conurbations of at least 2 000 person equivalents.

32 Some wastewater treatment plants in Germany (notably in North-Rhine Westphalia and Baden-Württemberg) have already been constructed including additional steps for micropollutant removal.

33 Sci Total Environ. 10 March 2022.

4. REDUCING MICROPLASTICS AND MICROPOLLUTANTS IN WATER: COSTS AND BENEFITS

Costs. The reduction of microplastics and micropollutants from water requires different approaches. To reduce microplastics in water, it is necessary to invest in conventional wastewater treatment plants, which can eliminate up to 99% of microplastics from treated wastewater. At present, over 90% of the EU population is already served by conventional wastewater treatment plants. Continued implementation of the current and proposed Urban Wastewater Treatment Directive will further reduce the EU's already modest share of the release of global microplastics into the oceans.[34] The Organization for Economic Co-operation and Development estimates the annual capital investment cost of achieving and maintaining full compliance with the current Urban Wastewater Treatment Directive in the EU at about €30 billion per year. This amount does not include additional investment in sludge treatment facilities, which may need to be upgraded to prevent microplastics from entering the soil, a possible pathway to the oceans. The cost of such investments is presently unknown. It also does not include the additional costs of stormwater management systems (as required by the proposed Urban Wastewater Treatment Directive) that would remove microplastics originating from urban runoff of rainwater.

Regarding micropollutants, conventional wastewater treatment plants are unable to efficiently remove antibiotics and other hazardous micropollutants from wastewater. To increase the removal rate from less than 40% (the level currently achieved by wastewater treatment plants in the Netherlands) to at least 80% (the legally required level in Switzerland, which is proposed under the revised Urban Wastewater Treatment Directive), it is necessary to upgrade wastewater treatment plants so that they can implement "quaternary treatment". According to a study of wastewater treatment plants in Germany and Switzerland, the capital investment cost of adding the fourth step to a wastewater treatment plant with a treatment capacity of 100 000 person equivalents would range from €70 per capita to €95 per capita, depending on the selected technology.[35] Energy consumption would increase by between 5% and 15%. Increased energy costs, and the additional cost for maintenance and treatment products (such as activated carbon), would increase the operating cost by between €2.5 and €7.5 per capita per year, according to a German study.[36] According to an assessment prepared for the proposed Urban Wastewater Treatment Directive, the investment cost required to establish quaternary treatment in wastewater treatment plants with a capacity of at least 10 000 person equivalents was estimated at about €2.6 billion per year in the EU. [37]

34 The current Urban Wastewater Treatment Directive required secondary treatment in agglomerations of at least 2 000 PE. The proposed Directive would reduce the threshold to 1 000 PE.

35 Cost of Removal of Micropollutants from Effluents of Municipal Wastewater Treatment Plants (STOWA, 2015). The study considered five technological options: (1) ozonation, (2) ozonation plus sand filtration, (3) ozonation plus one-step filtration, (4) powdered activated carbon (PAC) plus sand filtration, and (5) GAC granular activated carbon.

36 Die vierte Reinigungsstufe, VDI Nachrichten, 23 June 2017.

37 Proposal for a revised Urban Wastewater Treatment Directive (europa.eu). See Impact Assessment

Benefits. The direct benefits of reduced amounts of microplastics in water bodies mainly consist of reduced mortality and increased fertility of aquatic animals in oceans, which is not only a benefit in its own right but also increases the value of fisheries and aquaculture. A potentially important indirect benefit is the avoided reduction of an adverse impact on public health, which may be caused by microplastics that enter the human body through the consumption of seafood. At present, there is limited information about the economic benefits of reduced microplastics pollution. There is, however, a small but growing body of literature on the economic benefits of avoided "marine litter", a term that encompasses pollution by macroplastics, microplastics and other synthetic objects. A study on marine litter in the United Kingdom found that the cost of controlling and preventing marine litter was significantly lower than the damage caused by marine litter (with the benefit/cost ratios ranging from 1.2 to 1.8).[38] Stated differently, preventing marine litter would generate net economic benefits.

The benefits of reduced amounts of micropollutants in water mainly consist of avoided reductions in biodiversity, fewer hormonal changes to aquatic life, and reduced risks to public health. These benefits have been studied most extensively in Switzerland, where the implementation of "quaternary treatment" in wastewater treatment is mandatory. The economic benefits were quantified indirectly, through willingness-to-pay surveys. Households were willing to pay about CHF 100 per year for reducing the potential environmental risk of micropollutants to a low level, which was significantly higher than the annual cost of adding "quaternary treatment" to municipal wastewater treatment plants (CHF 86 per household per year), which implies a benefit/cost ratio of about 1.2. This suggests that reducing micropollutants from treated wastewater is economically justified.[39]

[38] Economic valuation of marine litter and microplastic pollution in the marine environment: An initial assessment of the case of the United Kingdom. Lee, Jeo. (2015). Discussion Paper 126 | Centre for Financial & Management Studies | SOAS, University of London.

[39] Cost-Benefit Analysis of the Swiss National Policy on Reducing Micropollutants in Treated Wastewater. Ivana Logar, Roy Brouwer, Max Maurer, and Christoph Ort. Environmental Science & Technology 2014 48(21), 12500-12508.

5. WHAT IS THE EIB DOING TO HELP REDUCE MICROPLASTICS AND MICROPOLLUTANTS IN WATER?

As explained earlier in this paper, the potential benefits of reducing microplastics and micropollutants in water are significant. Most microplastics end up in the oceans, where they are a direct threat to aquatic life that ingest the particles, and an indirect threat to organisms that eat aquatic life — including humans. Micropollutants are a more direct threat to public health and are known to accumulate in human blood, fat, and breast milk. The investments required to reduce microplastics and micropollutants are estimated at several billions of euros per year in the EU alone.

At present, the wastewater utilities do not have an incentive to invest in facilities that would reduce the release of microplastics or micropollutants into the environment, as the benefits of these investments cannot be captured in the form of higher tariffs (with the exception of Switzerland, a country where micropollutant removal is currently mandatory). To address this market failure, there is therefore a strong rationale for involving the public sector in the regulation of microplastics and micropollutants, in the form of imposing stricter effluent emission standards (as is currently envisaged by impending revisions to EU legislation), a credible system of fines for their violation, taxes on pollutants, and the provision of low-cost financing to the water sector.

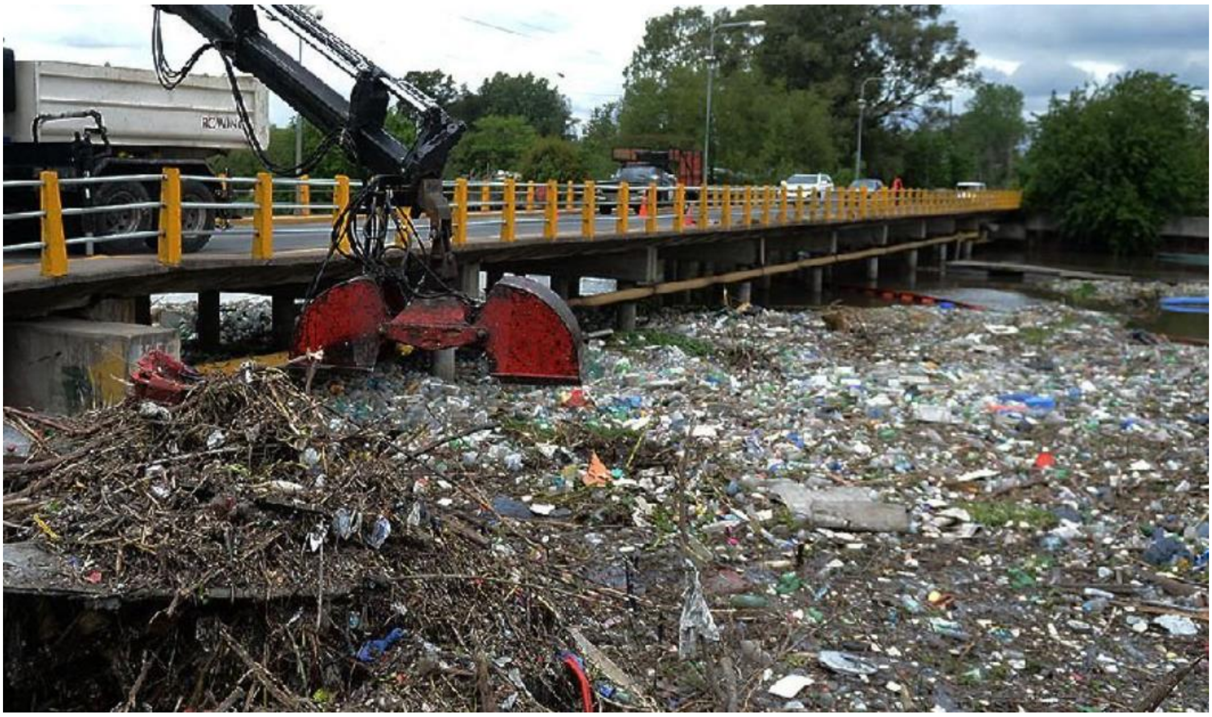
The EIB supports the development of this new and emerging field, through long-term financing to water utilities, water resource managers and industrial wastewater users. In addition, the Bank may support project preparation and implementation through dedicated technical assistance.

In October 2018, the EIB launched the **Clean Oceans Initiative** jointly with the KfW Group and Agence Française de Développement . Extended to Spanish and Italian promotional banks (Instituto de Crédito Oficial, and Cassa Depositi e Prestiti, respectively) and the European Bank for Reconstruction and Development, the initiative now aims to provide up to €4 billion in lending by 2025 to help the public and private sectors implement sustainable projects that collect plastic and other waste and remove microplastics by collecting and cleaning wastewater before it reaches the oceans. An example of a project supporting the Clean Oceans Initiative is the wastewater treatment plants of Las Catonas in Buenos Aires.

Box 5: Wastewater treatment plant of Las Catonas in Buenos Aires.

An $80 million EIB loan is financing the extension of the wastewater treatment plant Las Catonas, that will benefit 350 000 habitants. The project will reduce plastic pollution in the Río Reconquista (Image 1), and thereby contribute to reducing microplastic pollution in the Atlantic Ocean. The project includes an anaerobic digestion process, that also reduces the microplastic contamination in the sewage sludge while capturing methane thus reducing the emissions of greenhouse gases.

Image 1: Plastic Pollution in Río Reconquista, Argentina



Source: Municipality of Tigre (Buenos Aires)

In addition, the Bank also supports projects in the EU that reduce micropollutant discharge into water bodies, beyond to the current legal obligations, such as the extension of the wastewater treatment plant "Köhlbrandhöft-Dradenau" in Hamburg.

Box 6: Extension of the wastewater treatment plant "Köhlbrandhöft-Dradenau"

The EIB is supporting the extension of the main wastewater treatment plant in Hamburg, which treats 96% of the wastewater produced in the city. The project includes the construction of a fourth treatment stage which will allow the removal of micro-pollutants using ozonation and granular activated carbon. The expected investment amount is €100 million for a capacity of 2,5 million population equivalent. There are less than twenty wastewater treatment plants in Germany, which have implemented the fourth treatment stage and Hamburg will be the largest one.

In addition to financing and technical assistance, the EIB also supports the reduction of microplastics and micropollutants in water through its participation in sector dialogues with its partners and other international institutions (for example, the Organization for Economic Co-operation and Development).

6. SUMMARY AND CONCLUSIONS

While presenting different characteristics and behaviours (see the annex for a summary of key technical features), microplastics and micropollutants may create severe health hazards for human and animal life and require dedicated approaches to mitigate their environment and social impacts.

Most microplastics are picked up by stormwater or wastewater collection systems. In the EU, conventional wastewater treatment plants are an effective means to reduce pollution, as they capture up to 99% of microplastics. The proposed new Urban Wastewater Treatment Directive could help reduce microplastics pollution in the EU further by requiring continued investment in new and expanded conventional wastewater treatment plants and stormwater management systems. More sizable investments would be needed in emerging and development countries, which account for a significant amount of the world's total microplastic pollution.

At present, the full elimination of micropollutants in water is not yet a legal requirement globally except in some countries such as Switzerland, although this may change in the EU with the adoption of upcoming legislation. Several EU Member States (notably France, Germany, and the Netherlands) are considering the reduction of micropollutants in treated wastewater through additional treatment steps.

The involvement of the public sector is needed to mitigate the potentially adverse impacts of microplastics and micropollutants, both through regulation and the provision of public financing. But tackling end-of-pipe solutions might not be enough. Enhanced public awareness of the issues related to microplastics and micropollutants, sustainable behaviours, technological innovation, and more circularity in the economic models of production and consumption, are approaches that could help tip the scales.

ANNEX. KEY FEATURES OF MICROPLASTICS AND MICROPOLLUTANTS

Feature	MICROPLASTICS	MICROPOLLUTANTS
Visible to the human eye?	Possibly (up to 5 millimetres)	No (less than 1 microgram per litre)
Primary origin	Synthetic textiles, tyres and city dust	Industrial chemicals, pharmaceuticals, cosmetics, pesticides, and hormones
Main location of pollution	Oceans	Freshwater bodies
Main impact on animal life	Increased mortality, reduced fertility	Feminisation of male fish, hormonal imbalances in aquatic life, reduced biodiversity
Main impact on human life	Unknown, but concerns about microplastics entering the food chain	Unknown, but evidence exists of accumulation of micropollutants in human blood, fat, and breast milk
Main means to reduce adverse impacts	Expand coverage of conventional wastewater treatment plants and stormwater systems, especially outside the European Union	Increased level of treatment in conventional wastewater treatment plants (“quaternary treatment”)
Anticipated policy changes within the European Union	Restrict intentional addition of microplastics to products, and revise the Urban Wastewater Treatment Directive and the Water Framework Directive to reduce microplastics pollution	Expand Watch List to monitor and control micropollutants, and make additional treatment (“quaternary treatment”) mandatory
Investment needs inside the European Union (€ billion/year)	30 (mandatory to comply with existing European Commission legislation)	About 2.6 (not mandatory until 2025 at the earliest)

Source: EIB.

Microplastics and micropollutants in water

Contaminants of emerging concern

European
Investment Bank

Projects Directorate
www.eib.org/projects

European Investment Bank
98-100, boulevard Konrad Adenauer
L-2950 Luxembourg
+352 4379-22000
www.eib.org – info@eib.org