Policy Brief

Microplastics in Water: Advancing Prevention, Monitoring, and Cross-Border Cooperation

Project MicroDrink – Interreg Danube Region Programme
Project Microplastics – Interreg IPA Hungary-Serbia

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Foreword

Access to safe drinking water is a cornerstone of public health and societal well-being, where healthy water ecosystems play a crucial role in sustaining livelihoods. Yet alongside the progress achieved in water management across Europe, new and complex challenges are emerging — few more pressing than the issue of microplastic contamination. Their ubiquitous presence in the water environment, diverse composition, and capacity to transport other pollutants raise important questions that science, policy, and practice are only beginning to systematically address.

This policy brief draws on the findings and operational experience of two EU projects, namely *"Capacity building for management and governance of MICROplastics in DRINKing water resources of Danube Region – MicroDrink"* implemented under the Interreg Danube Region Programme and *"MInimizing CROssborder water contamination of microPLASTICS – MICROPLASTICS"* carried out under Interreg VI-A IPA Hungary Serbia. Bringing together researchers, regulators, water suppliers, and public health professionals from across the Danube River Basin, *MicroDrink* has generated the first coordinated evidence base for microplastic occurrence in drinking water across the region, demonstrating that harmonised, cross-country monitoring is achievable and necessary. Uniting experts, public official, schools and communities across the cross-border area, *MICROPLASTICS* identifies pollution sources, measures contamination in key ecosystems and pilot filtration solutions and awareness-raising initiatives to reduce microplastic contamination in water and sediment. These activities are already contributing to active and effective pollution reduction and will ultimately lead to improved drinking water quality.

The evidence confirms that while microplastic concentrations in drinking water are generally low, they vary meaningfully according to water source type and are subject to upstream pressures. The technical and regulatory landscape remains in transition: the EU has established a harmonised measurement methodology, yet binding thresholds and corrective actions are still to be defined. This moment calls for proactive and informed preparedness. Findings show that water ecosystems in the cross-border area of Bačka and Baja are significantly affected by microplastics. Pollution levels and types are directly linked to human activities and the hydrological characteristics of the water bodies. For long-term regional protection, necessary activities include stricter waste management, regular macro-waste cleanup, innovative filtration solutions in wastewater treatment, standardized protocols, continuous assessment, and a multi-tiered educational strategy.

The recommendations presented in this brief are intended to support decision-makers, regulators, and water management professionals in navigating this transitional period — translating scientific knowledge into protective action, strengthening institutional readiness, and safeguarding water resources for generations to come. Addressing microplastics effectively requires coordinated effort across disciplines, sectors, and national boundaries. It is precisely this spirit of transnational cooperation that underpins both the *MicroDrink* and *MICROPLASTICS* projects and the guidance offered here.

MicroDrink project coordinator

Dr. sc. Jasmina Lukač Reberski

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Project MicroDrink
11 project partners and 19 associated strategic partners in 8 Danube Region countries
January 2024 – June 2026
2.3 million € budget
Lead Partner Croatian Geological Survey
https://interreg-danube.eu/projects/microdrink

MicroDrink project began implementation under the Interreg Danube Region Programme in January 2024, and lasted for two and a half years until June 2026. Throughout project lifetime, 11 partners and 19 associated partners worked together to assess the state of the art of microplastics in drinking water across the Danube Region, conduct a one-year long pilot sampling and analysis campaigns in drinking water facilities, and build capacity for the eventual potential implementation of mandatory monitoring for microplastics in drinking water. The project has produced several key documents guiding stakeholders, water operators and practitioners, and decision makers, when dealing with this novel concern of drinking water contamination.

Project MICROPLASTICS
Four project partners
July 2024 – October 2026
1.37 million € budget
Lead Partner Institute of Public Health of Vojvodina
https://hungary-serbia.eu/projects/microplastics

The MICROPLASTICS project started in July 2024, bringing together four partner institutions across the cross-border area of Bačka/Bács-Kiskun. Its primary objective was to enhance environmental protection and reduce pollution by identifying sources of microplastic pollution in the water ecosystem. Training public health experts among partners, along with the public procurement of equipment for sampling and analyzing microplastics in the water ecosystem, built capacity to recognize their presence. An invented filter system to reduce microplastics in already-treated wastewater was also established. The activities further focused on raising public awareness among children and students about microplastics in water ecosystems. Future activities will focus on decision-makers and local authorities to implement preventive measures and actions to reduce pollution in water ecosystems, and on implementing monitoring protocols using the same methods and prevention measures.

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1. Introduction

Microplastics, tiny polymer particles, fibres and fragments between 5 mm and 1 µm, are increasingly recognised as an emerging concern for public and environment health, especially in the context of drinking water management. Microplastic can be either primary, directly produced for its abrasive properties and used in products such as detergents or cosmetic products, or secondary, created via biological, photochemical or mechanical decomposition of plastic products. Although generally considered inert, microplastic particles can adsorb contaminants that may pose health risks, leach chemical additives and plasticizers, or pass cell membranes and trigger inflammatory responses (Lechner, 2020). **Microplastics are ubiquitous, found in all environment spheres** (Figure 1).

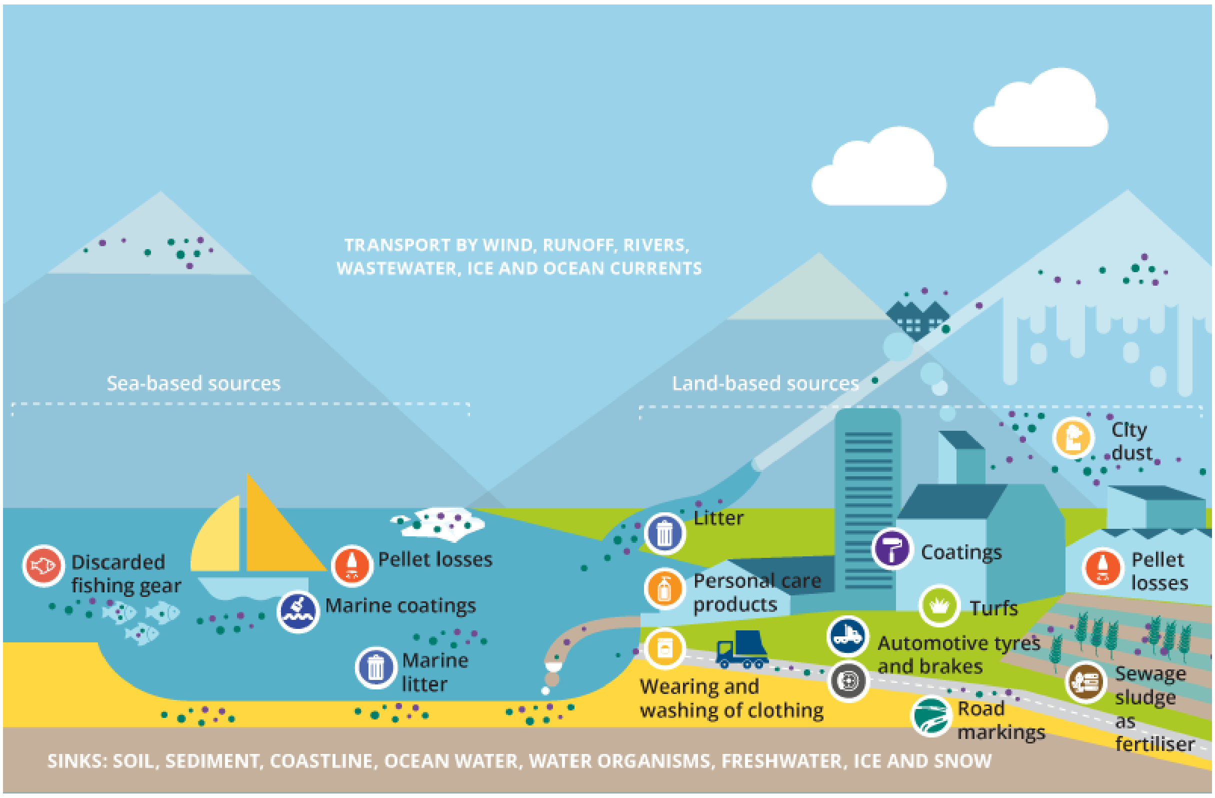


Figure 1. Sources and pathways of microplastics in the environment. Source: Illustration by the Collaborating Centre on Sustainable Consumption and Production (CSCP) for the European Topic Centre on Circular Economy and Resource Use (ETC/CE) and the EEA.

The Danube River Basin covers more than 800,000 km² and serves as a vital water resource for over 80 million people (ICPDR, 2021). The river originates in Germany, which contains a large share of the Upper Danube catchment and was the largest producer of plastics in Europe in 2024 (Figure 2). As rivers are major transport pathways for microplastics, plastic waste and emissions generated within the Upper Danube region have the potential to enter the river system and be carried downstream across much of the basin. This highlights the **transboundary character of**

microplastic pollution and underscores the importance of coordinated management efforts across the Danube Region.

Due to the interconnected nature of river systems, pollution released in one area can rapidly affect downstream ecosystems, communities, and economic sectors (Lechner, 2020). Consequently, microplastics governance increasingly intersects with drinking water protection, wastewater treatment, river basin management, and pollution prevention policies. Effective solutions therefore require harmonized monitoring methods, evidence-based policymaking, stakeholder cooperation, and stronger public awareness.

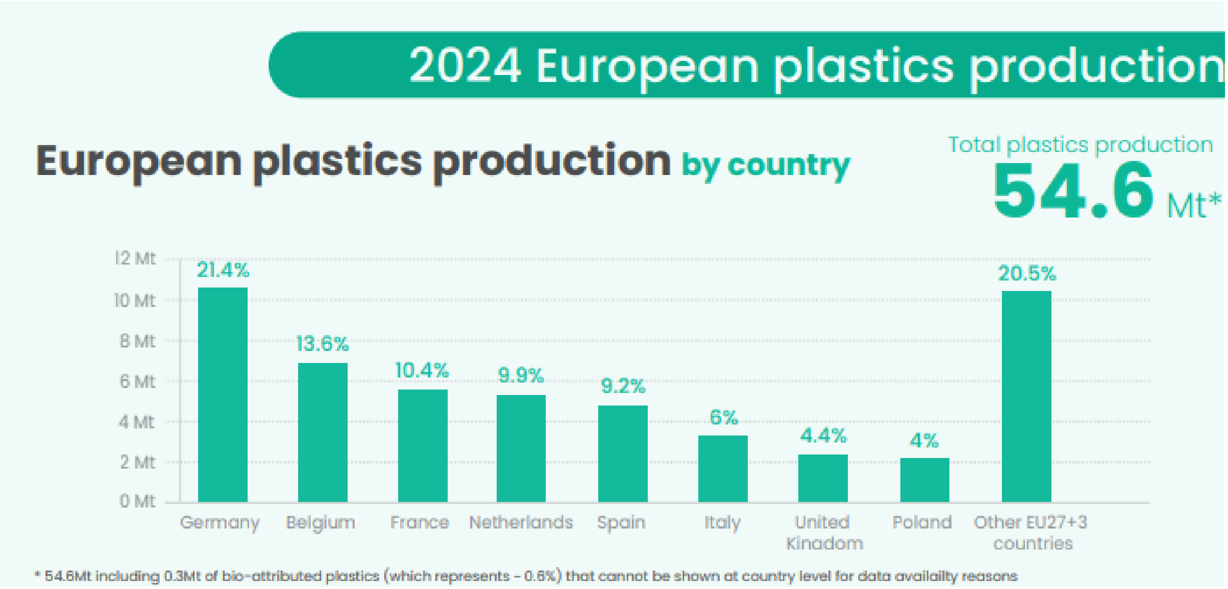


Figure 2. Production of plastics in European countries in 2024. Source: Plastics Europe (2025).

According to the OECD (2024), the proliferation of plastic production, use and waste will further expand by 70% by 2040 if more ambitious policies are not implemented. However, existing environmental regulations often address macroplastic waste while lacking targeted measures for microplastic prevention, monitoring, and industrial accountability.

In 2024, the most common polymers produced in Europe were polypropylene (PP), polyethylene (PE), polyvinyl chloride (PVC) – together constituting nearly half of all plastic polymers produced (Figure 3). These polymers have a number of applications: PP is primarily used for food containers, packaging, furniture, pipes and fittings, etc., PE is used in reusable bags, food packaging, film, and PVC is widely used in the medical field, for insulation, floor and wall coverings, window profiles, etc. (Figure 4).

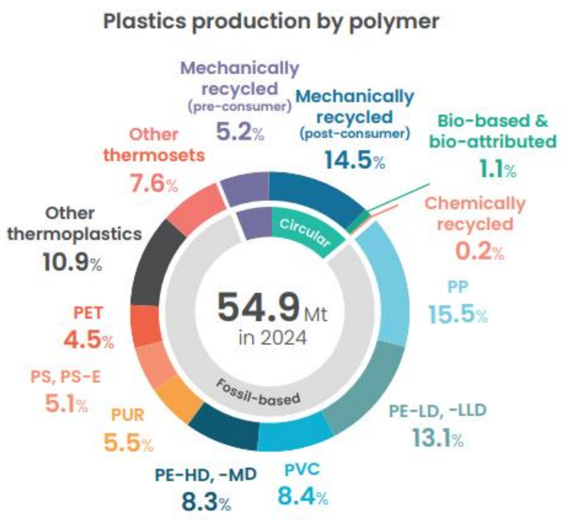


Figure 3. Plastics production in Europe in 2024 by polymer type. Source: The Circular Economy for Plastics, May 2026: A European Analysis.

Figure 4. Plastics products by polymer type. Source: The Circular Economy for Plastics, May 2026: A European Analysis.

The Zero Pollution Action Plan Target 5b aims to reduce microplastics released into the environment by 30%. This represents a significant challenge, particularly due to the wide use of plastics and plastic materials in everyday products. Despite growing efforts, the Outlook 2030 indicates that the EU is currently off track to meet the target by 2030 (Figure 5), and the analysis conducted by **EAA and JRC (2025)** indicates that there was a 7 – 9% increase in microplastics release between 2016 and 2022.

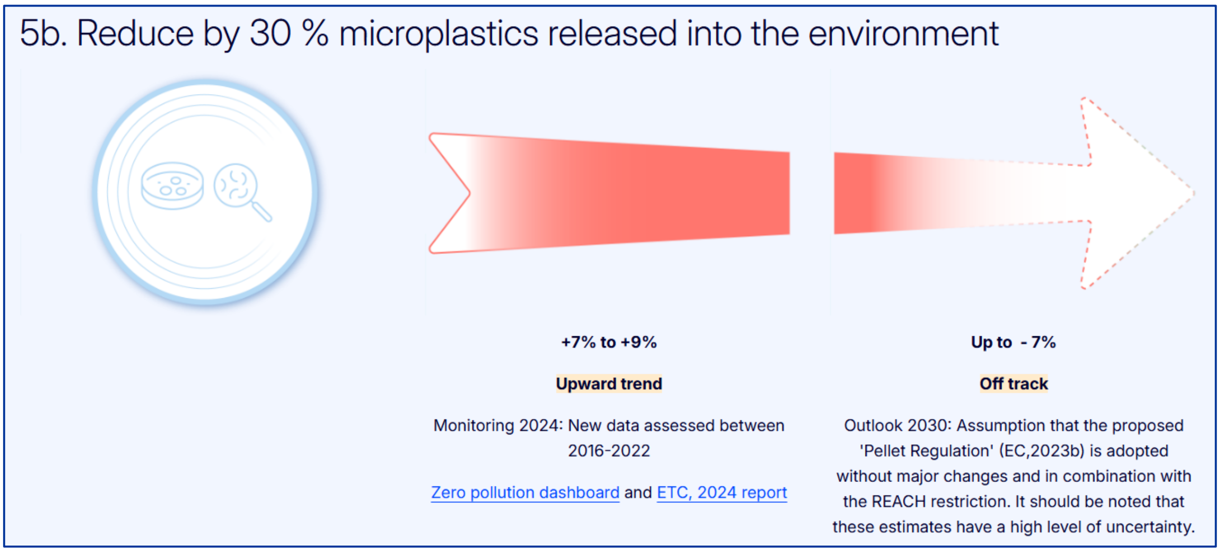


Figure 5. Zero Pollution Action Plan status on target 5b. on the reduction of microplastics release into the environment. Source: https://environment.ec.europa.eu/strategy/zero-pollution-action-plan/zero-pollution-targets_en

Unlike conventional pollutants regulated under established strategies and frameworks, **microplastics present substantial regulatory difficulties**. Scientific uncertainty remains regarding toxicity thresholds, sampling and analytical methods, exposure pathways, and long-term human health impacts. This uncertainty has complicated the development of harmonized legal standards within EU drinking water law. Nevertheless, public health institutions, decision making bodies and water operators across the Danube Region must begin preparing for systematic monitoring and risk assessment.

Recently, two key EU-funded projects tackled the issue of microplastics: **project MicroDrink and project MICROPLASTICS.**

Project MicroDrink, funded by the Interreg Danube Region Programme, implemented from January 2024 to June 2026, **focused on microplastics in drinking water**. Eight Danube Region countries worked jointly on assessing the current state of the art of microplastics in typical drinking water resources, implementing a harmonized approach to sampling and analysis and building capacity for the potential introduction of mandatory monitoring into EU legislation.

Project MICROPLASTICS, funded by the Interreg VI-A IPA Hungary Serbia Program and implemented from July 2024 to October 2026, **focuses on microplastics in water ecosystems** – open surface water, wastewater, and sediments – of the Bačka/Bács-Kiskun cross-border area. The four partners, one from the Hungarian side and three from the Serbian side, work together to enhance environmental protection and reduce pollution by identifying sources of microplastic pollution in the water ecosystem. Cross-border cooperation built the technical and knowledge capacities needed for sampling, identifying microplastics, and finding the best methods in the absence of legislation. Within the project, a new, innovative filtration model to eliminate microplastics from already-treated wastewater was implemented, demonstrating that filtration systems should be designed according to each source rather than uniformly. Analysis of the water ecosystem showed that microplastics found in the Bačka/Bács-Kiskun cross-border area are of secondary origin, meaning they are a product of human activities, and that raising public, stakeholder, and authority awareness about microplastics in water ecosystems, one of the project's activities, is necessary.

This policy brief delivers main recommendations for the future efforts in addressing the challenges related to microplastics pollution, alongside an overview of the development of legislation tied to microplastics. The recommendations are based on the scientific evidence and findings from both projects involved in drafting the policy brief, as well as frequent and regular feedback loops with water operators, managers, decision-makers, public health workers and other crucial actors working to safeguard water resources across the Danube Region and beyond. Within this context, the main recommendations are extracted here, and a more detailed breakdown for each recommendation is described later in this document.

MAIN RECOMMENDATIONS for managing microplastics

1. **Prevent microplastics pollution at source.**
2. **Harmonize monitoring of microplastics in drinking water resources and water ecosystems.**
3. **Strengthen protection of water ecosystems and drinking water resources.**
4. **Understand and relieve financial constraints.**
5. **Improve public awareness, transnational governance, and data sharing.**

1. Policy overview

European microplastics policy developed gradually from targeting broad waste, chemicals, water and marine pollution law into more targeted regulation. Early EU action did not regulate microplastics directly; instead, it addressed macroplastics through waste management, marine litter, product safety, and chemicals control. From the 2000s onward, concern shifted from visible plastic waste to fragmented secondary microplastics and intentionally added primary microplastics. Regulations now frequently specifically target microplastics, restricting the production and use of primary microplastics, and addressing secondary microplastics through wastewater treatment, drinking water monitoring and potential inclusion into surface and groundwater watch lists. The overview given below presents a deep dive into the history and evolution of key legislation related to or relevant for microplastics, from the earliest inception, to the most recent developments as of the date of publishing this policy brief.

MARINE AND FRESHWATER PROTECTION

The **Water Framework Directive (WFD) 2000/60/EC** established the foundation of modern European water governance. Adopted in 2000, the Directive introduced an integrated river basin management approach aimed at achieving “good ecological and chemical status” for European waters. Although microplastics were not explicitly recognized at the time, the WFD created the institutional and legal architecture later used to address emerging pollutants.

In December 2019, the Fitness Check of the WFD addressed microplastics as pollutants of emerging concern and the directive was characterized as sufficiently prescriptive and flexible enough to reinforce its implementation as necessary with regard to such emerging challenges.

The **Groundwater Directive (GWD) 2006/118/EC** supplements the WFD by specifically protecting groundwater bodies from pollution and deterioration. Groundwater is particularly important in the Danube Region because it constitutes a major source of drinking water for many Member States. Groundwater contamination by microplastics presents major regulatory challenges because particles are difficult to detect, monitor, and remove once they enter subsurface systems. Existing groundwater legislation was primarily designed to regulate dissolved chemical contaminants such as nitrates and pesticides rather than particulate pollutants like synthetic polymers. Nevertheless, the Groundwater Directive remains central to future microplastics governance because it provides the legal basis for source protection and pollution prevention measures related to drinking water resources.

The **Environmental Quality Standards Directive (EQSD) 2008/105/EC** complements the Water Framework Directive by establishing environmental quality standards for priority substances and other pollutants in surface waters, with the aim of achieving good chemical status and protecting aquatic ecosystems and human health. Although microplastics are not explicitly included among the regulated substances, the Directive is relevant because it provides the framework through which emerging pollutants can be assessed, monitored, and potentially regulated as scientific evidence of their environmental risks develops.

In 2008, the **Marine Strategy Framework Directive (MSFD) 2008/56/EC** was enacted, calling for the protection, preservation, and restoration of marine habitats and representing the first major EU framework through which microplastics entered environmental governance discussions. The Directive aimed to achieve "Good Environmental Status" of European marine waters and introduced Descriptor 10 on marine litter.

The Marine Strategy Framework Directive did not initially explicitly regulate "microplastics" in its original 2008 legal text. However, subsequent guidance documents and technical reports, such as the Galgani et al. (2010) Task Group 10 Report Marine Litter 2010 interpret microplastics as a component of marine litter, thereby formally integrating microplastics into EU marine environmental policy. Additionally, this document represents the first use and definition of the term "microplastics" in EU regulation.

In 2022, the Directorate-General for Environment issued a **Proposal for a Directive amending the Water Framework Directive, the Groundwater Directive and the Environmental Quality Standards Directive.** The proposal identifies microplastics as a potential risk to human health, while emphasizing the need for more monitoring data to confirm the need for setting an environmental quality standard for microplastics in surface and groundwaters. The Proposal recommends including microplastics in the surface and groundwater watch lists and monitor their occurrence as soon as the Commission identifies suitable monitoring methods.

This proposal represented a key movement in the microplastics legislative world when it was adopted via the **Directive (EU) 2026/805** of March 30th 2026 **amending the Water Framework Directive, Groundwater Directive and the Environmental Quality Standards Directive**. Aside from introducing new pollutants to the priority lists within the aforementioned Directives, the Directive also highlights microplastics as having been *"identified as a potential risk to human health, but more monitoring data are required to confirm the need for setting an environmental quality standard [...]."* The Directive therefore states that on the basis of the scientific reports prepared by the European Chemicals Agency (ECHA), microplastics and appropriate indicators of antimicrobial resistance, evolution or transmission shall be included in the watch list provided that reliable methods of sampling and analysis not entailing excessive costs are available. The Commission shall identify such methods no later than the first day of the month following 18 months after the date of entry into force of this directive.

EMISSION PATHWAYS

The **Urban Wastewater Treatment Directive (UWWTD) 91/271/EEC** originally only mandated that all agglomerations must be provided with systems for collecting urban waste water, which shall be subject to treatment before discharge. At the time of adoption, microplastics were not yet recognized as a significant pollutant category. Microplastics instead became increasingly important later on when wastewater treatment plants were identified as major pathways for microplastics emissions into aquatic environments. The UWWTD was therefore updated in 2024 with the **recast of the Urban Wastewater Treatment Directive (EU) 2024/3019**, wherein microplastics are recognized as components of non-domestic wastewater that should be controlled at source. Member States are advised to take preventive measures to limit the risk of microplastics occurrence in urban wastewater and sludge. Moreover, the Directive mandates that Member States must ensure that competent authorities monitor the concentration, load and presence of microplastics in urban wastewaters, storm water overflow and urban runoff discharges, and sludge, particularly when sludge is reused in agriculture.

In 2025, the **Regulation (EU) 2025/2365 on preventing plastic pellet losses** to reduce microplastic pollution was enforced, specifying microplastics as detrimental to the environment and human health, and representing one of the first major European measures specifically targeting unintentional industrial microplastic emissions. Plastic pellets are small industrial polymer granules intended to be used in plastic manufacturing. According to the Regulation: „Plastic pellet losses constitute the third largest source of microplastics unintentionally released to the environment in the Union and occur due to poor handling practices at all stages of the plastic pellet supply chain…" Due to their size and mobility, pellets are frequently lost during production, transport, storage, and processing activities, allowing them to enter rivers, wastewater systems, and marine environments. The regulation introduces preventative obligations across the plastics supply chain, including loss prevention, risk management procedures, spill containment and prevention protocols, transport obligations, and reporting systems.

During consultations with stakeholders across 8 Danube Region countries, the MicroDrink Board found that stakeholders consistently identified pollution within catchment areas as the main source of microplastics entering water resources.

CIRCULAR ECONOMY

The **2015 Circular Economy Action Plan** and the **2018 European Strategy for Plastics in a Circular Economy**, one of the first major EU policy documents to explicitly discuss microplastics and propose restrictions on intentionally added synthetic particles, shifted EU policy from solely waste control toward prevention, product design, recycling, and producer responsibility. This was further strengthened in the **Zero Pollution Action Plan** and the **Chemicals Strategy for Sustainability**. Specifically, the Zero Pollution Action Plan set the Target 5b toward a 30% reduction of microplastics released into the environment.

PLASTICS, PLASTIC PRODUCTS, AND WASTE

The **Single-Use Plastics Directive 2019/904/EU** targets common plastic items found on beaches, including cutlery, plates, straws, cotton bud sticks, beverage containers, and fishing gear, reducing sources of secondary microplastics by targeting products likely to fragment in the environment.

Beyond the European Union, a significant milestone was reached in March 2022 when the **United Nations Environment Assembly (UNEA-5.2) adopted Resolution 5/14 "End Plastic Pollution: Towards an International Legally Binding Instrument"**, in which the UNEA noted with concern that *"the high and rapidly increasing levels of plastic pollution represent a serious environmental problem at a global scale"* and recognized that *"plastic pollution includes microplastics."* This launched negotiations for a legally binding international instrument on plastic pollution. Several negotiating sessions were held; however, a consensus was not reached due to disagreements on several major issues, such as limits on plastic production, financing mechanisms, or regulation on chemicals used in plastics. Nevertheless, the process represents the most significant global effort to date to establish a comprehensive framework for preventing plastic pollution, including microplastic emissions, and reflects growing international recognition of the transboundary nature of the challenge.

The Scientists' Coalition for an Effective Plastics Treaty was formed in 2022, following the decision of the United Nations Environment Assembly (UNEA) specifically to support the negotiations of the Intergovernmental Negotiating Committee (INC) responsible for drafting the global plastics treaty. Bringing together researchers from diverse disciplines and regions, the coalition helps ensure that negotiations on the future global plastics treaty are informed by the best available scientific evidence regarding plastic pollution, including microplastics, across the full lifecycle of plastics.

The most direct EU action was the **Commission Regulation 2023/2055** which amended Annex XVII to the **REACH Regulation to restrict the sale and use of synthetic polymer microparticles** (microplastics) intentionally added to products such as cosmetics, detergents, fertilizers, plant protection products, medical devices, and artificial sports turf infill. This marked a shift from indirect plastic-waste governance to direct source control. However, this regulation still mainly targets primary microplastics, whereas major sources of secondary microplastics, such as tire abrasion, textile fibres, road runoff and packaging remain less comprehensively regulated.

As of November 2025, companies must begin reporting their annual microplastics emissions to the European Chemical Agency (ECHA) under the REACH restriction. The annual reporting obligation applies to synthetic polymer microplastics that are exempt from the REACH ban. The first reports must be submitted by 31 May 2026 covering estimated emissions for year 2025. This obligation applies to manufacturers, importers and downstream users alike.

The **Packaging and Packaging Waste Regulation (EU) 2025/40** also entered into force in 2025 and will begin applying from August 2026, aiming to reduce packaging waste generation, improve recyclability, increase reuse systems, and minimize environmental leakage of plastic materials. The regulation recognizes plastic packaging as a waste not only a waste problem, but also a source of microplastic pollution, therefore packaging policy is framed as part of microplastic prevention. Considering that 40% of the total non-fibre plastic production in Europe belongs to packaging products (Figure 6), this Directive is expected to make a significant impact on the reduction of pollution sources and minimization of secondary microplastics entering into the environment, and consequently, water resources.

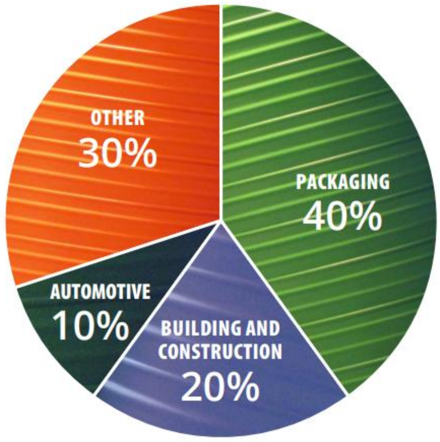


Figure 6. Total non-fibre plastic production in Europe. Source: World Health Organisation, 2019: Microplastics in drinking water.

DRINKING WATER

In the context of drinking water, a major development was the recast of the **Drinking Water Directive (EU) 2020/2184**. The recast Directive acknowledged microplastics as emerging contaminants and included microplastics on the Watch list of substances that are not regulated, but should be monitored, as they present potential detrimental health risks to consumers. In 2024, this Directive was supplemented by the **Commission Delegated Decision 2024/1441**, which **lays down the methodology to measure microplastics in drinking water**. However, these regulations are not binding, and Member States incorporate the methodology into their existing drinking water systems at will, without formal transposition.

When the Drinking Water Directive was enacted and entered into force, no suitable standardised or harmonised methodologies for the monitoring of microplastics in drinking water were available. Thus, the JRC was requested by the Directorate-General for Environment to develop and test an appropriate methodology (Bucher et al., 2025), which was eventually formally adopted within the Delegated Decision.

Project MicroDrink tested for the first time on a transnational scale a harmonized approach to sampling and analysis of microplastics in drinking water resources, in full alignment with the Commission Delegated Decision 2024/1441. This approach was tested at nine pilot locations across the Danube Region in karst and intergranular aquifers and surface and river bank filtration water. The full process is described in brief in the MicroDrink project Monograph, and detailed in Output 1.1. Harmonised MP approach at EU and non-EU level.

2. Key Findings of Project MicroDrink

As part of project MicroDrink, quarterly sampling and analysis campaigns were conducted over a one-year period at nine pilot sites in karst, intergranular aquifers and surface / river bank filtration water resources. The purpose of the campaigns was to **assess the approach prescribed in the Commission Delegated Decision 2024/1441, gather experiences and transfer knowledge to water operators and decision makers** for the eventual mandatory obligation of monitoring for microplastics in water facilities.

The experiences gathered during the sampling campaigns provide a detailed picture of the practical challenges and strengths of the harmonised microplastic monitoring approach. Prior to the start of the campaigns, minimum criteria for sampling and analysis were defined to ensure methodological harmonization across the consortium. This harmonized approach was designed in full compliance with the Commission Delegated Decision 2024/1441. A minimum of 1000 L of raw and treated water using a stainless-steel closed cascade filtration system equipped with 20 µm filters was sampled, directly from the source without intermediate storage in order to minimise contamination risks. For analysis, RAMAN or FTIR were used, and 10 priority polymers were reported and classified according to shape (particle and fiber) and size (20 – 100 µm and >100 µm). The only variance from the Commission Delegated Decision 2024/1441 concerned the filter arrangement. In the MicroDrink approach, two 20 µm filters were used instead of the prescribed combination of two sets of 100 µm and 20 µm filters. This decision was based on operational and financial considerations, as the 20 µm filters already capture the 100 µm size category, and as clogging was not expected, 100 µm filters were seen as significant cost increases while providing little benefit.

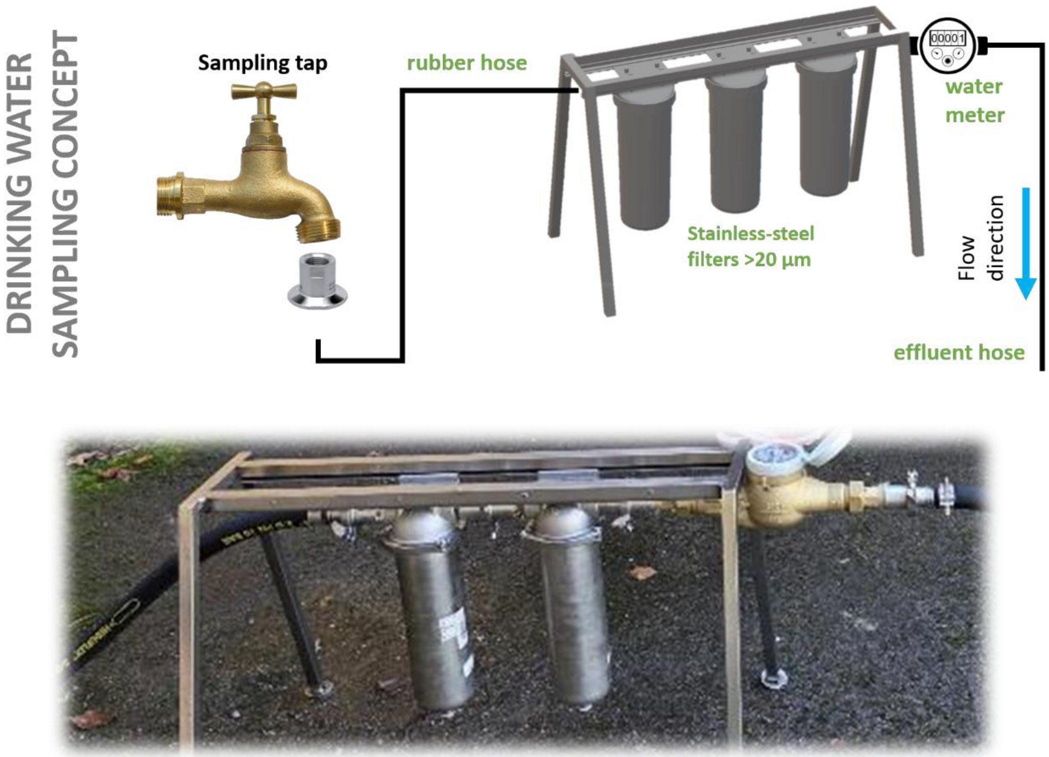


Figure 7. Concept schematic and on-field deployment of the cascade filtration sampling system used in the MicroDrink project for the detection of microplastics in drinking water resources.

During each campaign, duplicate samples of raw and treated water were collected and analysed by two laboratories: the project central laboratory in Hungary, and national laboratories selected by project partners in each of the partner country. Generally, the **results show a low concentration of microplastic particles, primarily in the 20 – 100 µm size category, mainly PP and PE**. The highest abundance, although still low, was found in surface waters and river bank filtration resources (Figure 8), followed by karst (Figure 9) and finally intergranular aquifers (Figure 10).

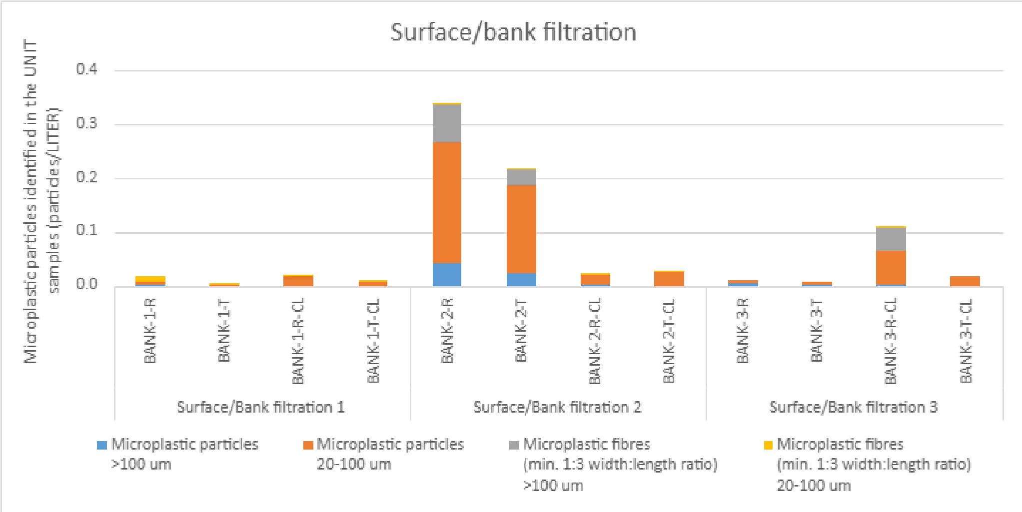


Figure 8. Average microplastics particles per litre in three MicroDrink pilots representing surface/river bank filtration water resources from four sampling and analysis campaigns over a one-year period.

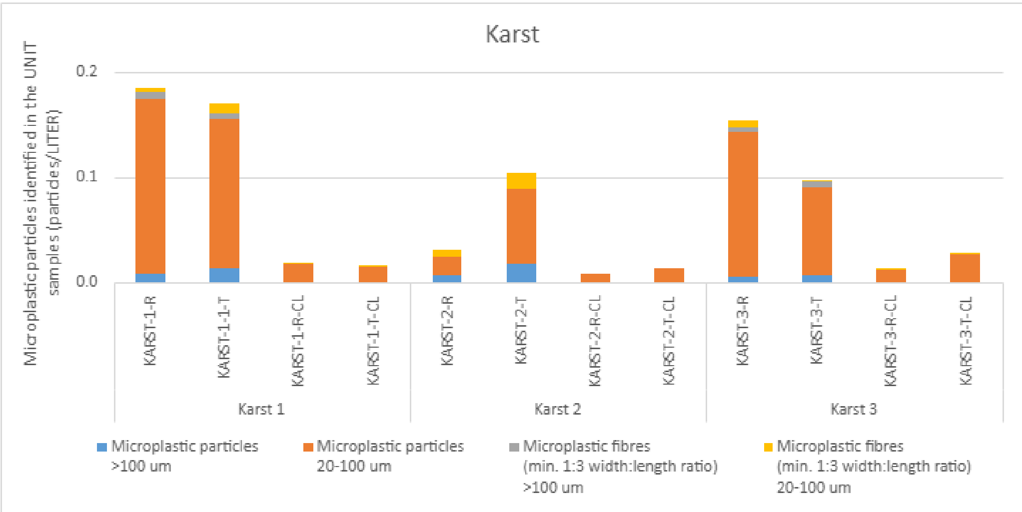


Figure 9. Average microplastics particles per litre in three MicroDrink pilots representing karst water resources from four sampling and analysis campaigns over a one-year period.

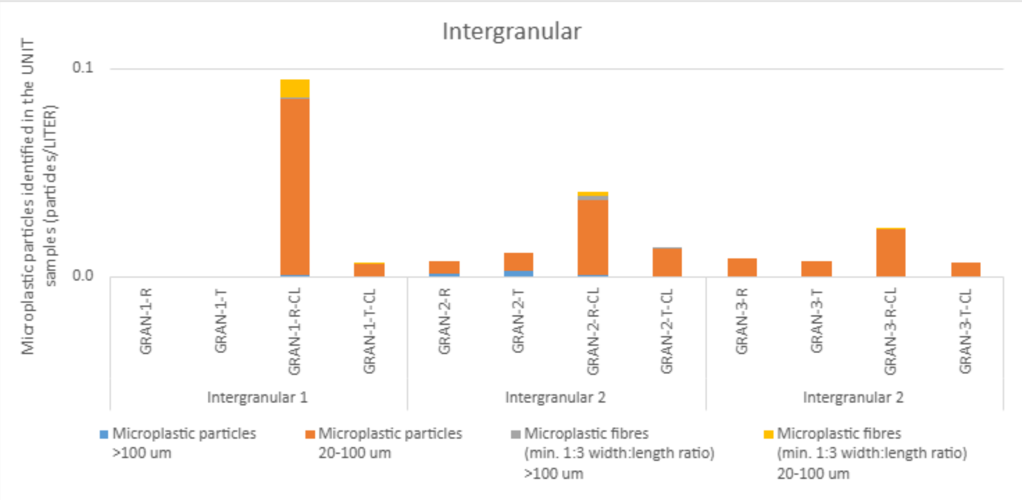
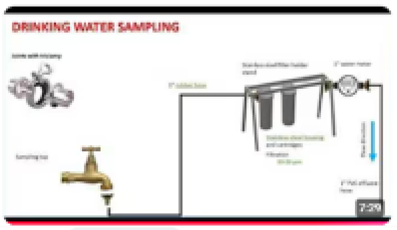


Figure 10. Average microplastics particles per litre in MicroDrink pilots (surface/river bank filtration, karst and intergranular water resources) from four sampling and analysis campaigns over a one-year period.

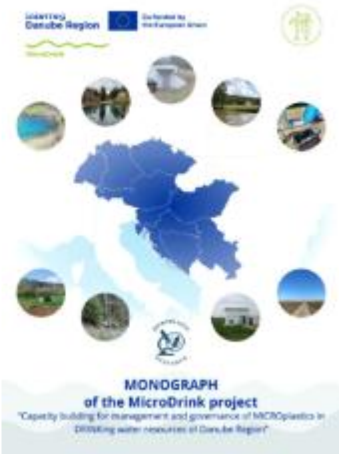
Although all partners successfully conducted sampling in accordance with the provisions, challenges remain both with the sampling and analytical aspects of the monitoring approach. **There is a lack of standardized and validated equipment commercially available for purchase at a reasonable price, and analysis costs remain high**. Furthermore, concerns remain regarding reliability and comparability of results, even when the entire process is in complete compliance with the Delegated Decision. One of the most valuable outcomes of the project was the interlaboratory comparison. The results showed considerable variability between laboratories, highlighting that significant work still remains before fully reliable and comparable microplastic monitoring data can be achieved across different analytical facilities. This limits the ability to set threshold values and implement large scale monitoring at drinking water facility.

In addition to the assessment of the harmonized approach and identification of stakeholder needs, project MicroDrink worked diligently on building capacity in the region for the potential implementation of monitoring for microplastics in drinking water, both at facility level as well as at decision-making and authority level. Project MicroDrink has produced several resources (Table 1), all with the goal of assisting stakeholders in the transition toward better management of microplastics in DRB water resources and building capacity for the eventual implementation of monitoring microplastics in drinking water resources.

Table 1. MicroDrink project technical, guidance and educational materials and tools.

Technical and guidance documents		
Video guidelines for sampling		

[Project Monograph]

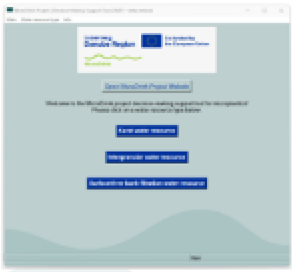


[Roadmap Towards Microplastics in Drinking Water Strategy]

Tools and solutions

[MicroDrink Knowledge Base]

[Decision Making Support Tool]

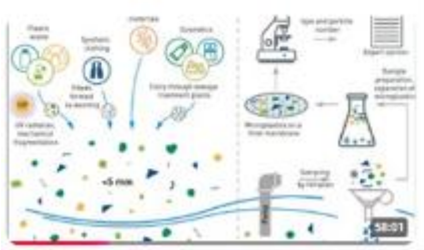


Output 1.1. Microplastics approach harmonized at EU and non-EU level

Educational videos on microplastics

Micro(knowledge) transfer webinar on general state of the art of microplastics in drinking water

Micro(knowledge) transfer webinar on sampling, laboratory instruments and analytical techniques



3. Key Findings of Project MICROPLASTICS

Based on the research and pilot action conducted within the **MICROPLASTICS** project in the Bačka/Bács-Kiskun cross-border area, the key findings are as follows:

1. **Sampling methods**

- In the **Hungarian** section of the Danube near Baja, a **specialized pump system** (Figure 11) was used across the river's entire cross-section. Water was transported through a closed system, with large debris removed by a 2-mm stainless-steel pre-filter. The boat was moved repeatedly back and forth between the banks to provide stable sampling conditions and minimize external contamination, filtering 1,000 liters per sample. For collecting microplastics from river or lake sediments, **grab samplers** (Figure 12) were employed.

Figure 11. Microplastic sampling of the Danube

Figure 12. Grab sampler

- In **Serbia**, the **Manta Net** was used to sample open-surface water. It had a mesh size of 300 µm (0.3 mm) and was guided horizontally along the water surface to capture particles larger than the mesh size, yielding a sample volume of approximately 10,000 liters per sample. For wastewater sampling, **automatic 24-hour pumps** were used to collect representative samples, with a standard sample volume of approximately 10 liters.
- **Contamination control** of used equipment was implemented on both sides to prevent cross-contamination. All equipment was rinsed with 70% ethanol or deionized water after each use and covered with aluminum foil.

2. **Laboratory Preparation**

- After collection, all samples underwent rigorous laboratory preparation. This included **fractionation** using stainless-steel sieves (typically 5.6 mm, 1 mm, and 0.3 mm), **digestion** to remove organic matter, and density **separation**.

3. **Analytical methods and results**

- **Visual identification and gravimetry were used, followed by microscopy** to observe particle shape and color, and to determine total mass, expressed in µg/L. Most particles in open-surface waters fall within the 50–300 µm range in Hungary, and in Serbia within 100-1000 µm range. In protected open-surface waters near Novi Sad particles were smaller than 100 µm. The most frequently identified shapes were fragments, fibers, and films, while the colors varied: white, transparent, blue, red, and green.

- **Micro-FTIR spectroscopy** is the primary method for polymer identification. It includes the Thermo Nicolet Apex FTIR with a RaptIR microscopic imaging system and the Thermo Nicolet iS20 FTIR spectrometer coupled with a Nicolet iN5 microscope, with applicable software for polymer identification and spectral matching of particles.
- **Identified polymers covered** a wide range, including polyethylene (PE), polypropylene (PP), alkyd resins, polyethylene terephthalate (PET), and ethylene-vinyl acetate (EVA), with **polyethylene (PE)** and **polypropylene (PP)** dominating surface waters. In the Hungarian open surface waters, alkyd polymers were significantly present, while in Serbia, ethylene-vinyl acetate (EVA) and polyethylene terephthalate (PET) were also detected in significant amounts. **Characterization and sources of pollution** showed that pollution in the Danube is **heterogeneous**, indicating that microplastics originate from multiple and diverse sources directly related to **human activities and the hydrological characteristics** of the water bodies. Most particles are of **secondary origin**, formed through the environmental degradation of larger plastic items.
- There is a clear distinction between the pollution profiles of open river flows and **protected** still waters in Serbia. Protected zones show smaller amounts, smaller particles, and fewer polymer types, but they pose a **greater ecological risk** because these particles (Figure 13) enter the aquatic food web more easily, making them potentially endangered despite lower overall concentrations.

Figure 13. Microplastic contamination from the Danube River

4. **Pilot microplastic filtration systems**

- Pilot microplastic filtration systems were installed at the effluent channels of the Baja Wastewater Treatment Plant (Hungary) and the Sombor Wastewater Treatment Plant (Serbia). The pilot installations aimed to **evaluate the practical applicability of tertiary microplastic removal** under real operating conditions and demonstrate the feasibility of this technology in a cross-border context.
- Operational experience collected during the pilot operation at the Baja Wastewater Treatment Plant demonstrated that **the filtration concept is technically feasible**; however, several operational factors significantly influenced system performance. Hydraulic loading, suspended solids concentration, and changing wastewater conditions proved to be key parameters affecting reliable operation, shaping the pilot results.
- Stable operation required limiting the hydraulic load reaching the filtration system, indicating that **hydraulic design should be considered a critical aspect during future**

implementation. Operational experience also demonstrated that elevated suspended solids concentrations can considerably reduce filtration performance, further linking operating conditions to results.

- The pilot installations demonstrated that **tertiary microplastic filtration is technically feasible under real operating conditions**. At the same time, the experience showed that long-term reliability depends not only on filtration efficiency but also on robust hydraulic design, adequate pretreatment, operational flexibility, and ease of maintenance. These practical findings provide valuable engineering input for future implementation of microplastic removal technologies at wastewater treatment plants.

5. **Educational and promotive activities**

There was a strong emphasis on raising public awareness through educational programs and promotional activities that engaged children, youth, experts, and the general public.

- **The education of public health experts** included 80 public health experts from Novi Sad, Sombor, and Baja who participated in specialized training sessions on best practices and protocols for monitoring plans, sampling methods, sample preparation, and laboratory analysis.
- **School workshops and innovation activities** reached 12 schools across the cross-border region, including Novi Sad, Sombor, Bačka Palanka, and the Baja area. They included expert lectures and creative art sessions for approximately 240 students in 3rd and 4th grade at elementary schools. Students created artworks and slogans to promote reduced plastic use, with the most prominent slogan being **"Microplastics are not the salvation – protect nature"**. In **high schools**, around 150 students, primarily those studying biology and chemistry, participated in **innovation competitions**. They developed creative, highly realistic solutions to combat plastic pollution, and the winning teams received vouchers for laboratory equipment.
- **Promotion and public engagement were** achieved through events and high-visibility materials designed to educate a target group of 300 people. This included the project's official opening conference and a one-day conference dedicated to microplastics at the long-standing Water Workshop, both held in Novi Sad, Serbia. The project also received the **DKMT Euroregion Award for Excellence** for its cross-border cooperation. The promotional materials were **eco-friendly,** reflecting the "Greener Region" priority, including paper bags, wooden cutlery, metal cups with carabiners, wooden bottles, and organic t-shirts.
- **Digital reach includes a** dedicated **web platform**, project film, and social media presence on Facebook and Instagram to maintain visibility and provide ongoing educational resources.

Facebook:

Instagram:

Programme website

4. Policy recommendations

Despite substantial progress, **European microplastics regulation remains fragmented and incomplete in relation to drinking water protection**. Policy improvements are necessary, and future progress will depend on interconnected developments. The MicroDrink and MICROPLASTICS projects put considerable effort in gathering feedback from stakeholders facing the issue of drinking water management daily, through a variety of channels: workshops, webinars, roundtable discussions, interviews, targeted meetings, focused educations with competition and special awards for the best art and idea among children and students, social media, and other forms of networking and knowledge exchange. These interactions helped establish concrete recommendations based both on scientific evidence as well as real stakeholder needs, outlined below.

1. Prevent microplastics pollution at source.

Before the challenge of microplastics presence in drinking water resources can even be tackled, pollution generation must be addressed. Current evidence demonstrates that preventing emissions before they enter aquatic systems is more effective and economically sustainable than removal during wastewater or drinking water treatment. While pollution prevention is already included in several legislative acts (REACH Regulation, Regulation on preventing plastic pellet losses, Packaging and Packaging Waste Regulation etc.), **stakeholders generally consider current measures to be insufficient**.

In particular, illegal waste disposal remains a challenge, with few and fragmented clean-up and prevention efforts, mainly driven by citizens or independent communities. More focus should therefore also be placed on remediation, ideally in an organised manner with targeted working groups. In 2019, the Directorate-General for Research and Innovation drafted the Scientific Opinion 6/2019 which specifically recommends that "*The Commission should exploit current provisions in existing legal instruments to prevent and attenuate microplastics in air, soil and water.*" The 2021 EU Commission Scientific Opinion on Microplastic Pollution also recommends to target the most polluting activities through current or new legal actions.

2. Harmonize monitoring of microplastics in drinking water resources and water ecosystems.

Consistent, reliable and comparable results are of utmost importance. Monitoring efforts should prioritize use of standardized, validated and certified sampling equipment and analytical methodologies. While this has been addressed for drinking water through the Commission Delegated Decision 2024/1441, **additional testing into the prescribed methodologies with built sampling and analytical methods for water ecosystems is necessary to assess the viability of large-scale implementation**. Limiting factors, including the lack of commercially available sampling equipment, variations in practices across laboratories, and lack of microplastics standards for analysis still remain.

3. Strengthen protection of water ecosystems and drinking water resources.

Once sufficient data on microplastics in drinking water resources becomes available, comprehensive risk assessments must be conducted to evaluate human exposure and potential health impacts.

Implementing microplastics management involves preparing for the future integration of parameters into routine drinking water monitoring programmes. **Monitoring results should be reviewed systematically and at regular intervals to identify trends, evaluate the effectiveness of interventions, and adjust strategies** as necessary. Integration of microplastics into Water Safety Plans will support proactive risk management, linking catchment protection, treatment optimisation, and infrastructure assessment.

Strengthening drinking water protection may also include **promoting nature-based solutions** where appropriate. While conventional wastewater treatment remains the primary barrier for microplastic removal, nature-based solutions such as constructed wetlands, green infrastructure and macrophytes and microphytes are increasingly recognized as complementary measures capable of retaining microplastics while delivering additional ecosystem benefits (Agaton, 2025). While widespread adoption of nature-based solutions still faces a number of barriers, they represent a promising and cost-effective potential response to the challenge of the pervasiveness of microplastics in all environmental spheres.

Lastly, more focus should be shifted to the investigation into the occurrence and impacts of nanoplastics. While **nanoplastics research remains constrained** by inadequate detection and analysis methods, there is growing concern that nanoplastics pose an even higher risk to human and environment health than microplastics, with increasing toxicity and concentrations with decreasing particle sizes (Directorate-General of Research and Innovation, 2019). Therefore, per the recommendations of the Scientific Opinion 6/2019, *"The Commission should take steps to enable the scientific community to fill knowledge gaps regarding the presence, concentration, and behaviour of nanoplastic pollution in different situations."*

4. Understand and relieve financial constraints.

Throughout MicroDrink and MICROPLASTICS projects lifetime, stakeholders repeatedly emphasized that routine monitoring is often not feasible without significant financial support due to the high costs associated with sampling equipment, laboratory analysis, and specialist expertise. Investment in laboratory capacity, **reasonably priced sampling equipment and analysis costs, trained personnel, and accredited or validated procedures will be necessary** to meet emerging regulatory expectations. Stakeholders frequently brought up their financial constraints, rising year-after-year with growing regulatory requirements and inadequate financial support.

Pilot operations also demonstrated that operational costs extend beyond monitoring and laboratory analyses. Maintenance activities, including periodic cleaning, temporary removal and reinstallation of filtration units under adverse operating conditions, should be considered when assessing the lifecycle costs of future full-scale implementations.

5. Improve public awareness, transnational governance and data sharing.

Microplastic pollution is inherently transboundary in nature. Rivers, groundwater systems, wastewater discharges, and atmospheric transport pathways frequently cross national borders, making isolated national approaches insufficient. **Continued transnational cooperation** will be crucial for building a coherent evidence base, sharing best practices, and supporting policy development at regional and EU levels.

Communication, awareness, and education are essential components of effective microplastics management. Engaging stakeholders begins with public information and education initiatives that raise awareness about plastic management, identify the main sources of microplastics, and promote actions to limit these sources. This is also emphasized in the 2021 EU Commission Scientific Opinion on Microplastic Pollution, which recommends to **establish a global scientific platform to promote microplastic research and agreed standards**.

EU-funded projects have become increasingly important contributors to environmental policymaking by providing the scientific evidence, stakeholder engagement, and practical implementation experience needed to support legislative development. Working closely with macro-regional governance bodies such as the ICPDR and EUSDR, these initiatives help ensure that emerging policies are informed not only by research, but also by the operational realities faced by water managers, regulators, municipalities, and other stakeholders.

The AQUATIC PLASTIC *Position Paper on the Implementation of the EU Water Framework Directive*, for example, draws on evidence and consultations across nine countries to identify common challenges in governance, monitoring, enforcement, waste management, and public engagement, translating these findings into policy recommendations for the WFD. Likewise, the ICPDR and Tid(y)Up *Policy Guidance on Tackling Riverine Plastic Pollution* in the Danube River Basin provides a strategic, basin-wide framework for addressing riverine plastic pollution through coordinated monitoring, prevention, waste management, education, and transboundary cooperation.

Similar conclusions have recently been highlighted by the Horizon Europe project NIAGARA, which in its policy brief *NIAGARA: A New Wave for Safe Drinking Water* identifies micro- and nanoplastics among emerging pollutants of concern for drinking water sources. The project recommends strengthening and coordinating monitoring obligations across the Drinking Water Directive, Water Framework Directive, Groundwater Directive and Environmental Quality Standards Directive, while maintaining and expanding watch lists to improve early detection and risk assessment of emerging contaminants. Simultaneously, the policy brief highlights the importance of keeping innovative solutions cost-effective, prioritizing the 'polluter pays' principle.

HORIZON project PlastChem has also recently highlighted the importance of understanding the chemicals used or present in plastics, which in its policy brief *State of the science on plastic chemicals* highlights that plastic chemicals should be regulated more comprehensively and efficiently, transparency on plastic chemicals is necessary, safety and sustainability should be achieved through simplification of plastics, and capacity needs to be built to create safer and more sustainable plastics.

5. Conclusions

Microplastic pollution has evolved from a largely unrecognized environmental issue into an emerging policy priority across Europe. While significant progress has been made through recent legislative developments, important knowledge gaps remain regarding environmental exposure, long-term ecological impacts and human health implications. The findings of the ***MicroDrink* and *MICROPLASTICS* projects demonstrate that coordinated transnational action, harmonized monitoring methodologies and strong stakeholder engagement can substantially improve preparedness for future regulatory requirements**.

MicroDrink project shows that while commercially available sampling devices are needed and financial aids for implementing facilities should be considered, data can and should be generated cross-nationally whenever possible, in order to obtain comparable results and accurately assess the state of microplastics occurrence in a cross-border context.

The pilot installations carried out within the MICROPLASTICS project demonstrate that tertiary microplastic filtration technologies are technically promising. However, successful long-term application requires appropriate pretreatment, hydraulic optimization and consideration of operational conditions encountered in full-scale wastewater treatment plants.

The Danube River Basin provides a unique opportunity to address microplastic pollution through integrated river basin management and cross-border cooperation. Given the transboundary nature of river systems, effective responses must combine source prevention, harmonized monitoring, innovation, public awareness and coordinated governance. Continued collaboration between policymakers, researchers, water operators, regulators and regional organizations such as the ICPDR and EUSDR will be essential for reducing microplastic pollution and protecting drinking water resources for future generations.

Closing Remarks

EU Strategy for the Danube Region (EUSDR) Priority Area 4: Water Quality

[*https://waterquality.danube-region.eu/*](https://waterquality.danube-region.eu/)

The findings presented in this publication confirm that addressing microplastic pollution requires more than scientific excellence or technological innovation—it requires sustained cooperation across borders, sectors and governance levels.

The Danube Region has repeatedly demonstrated that macro-regional cooperation can accelerate the development of common approaches to shared environmental challenges. Through initiatives such as MicroDrink and MICROPLASTICS, partners have not only generated valuable evidence but have also built trust, strengthened institutional capacity and established networks that will continue to support implementation long after the projects have concluded.

As European policies on microplastics continue to evolve, the experience gained through these projects provides an important reference for decision-makers, water managers and public authorities across the region. It also reinforces the role of the EU Strategy for the Danube Region as a platform for connecting research, policy and practice, ensuring that emerging challenges are addressed through coordinated and evidence-based action. This is why the issue of tackling and mitigating plastic pollution on our waters is an important quest of EUSDR Priority Area 4 (water quality).

Protecting the waters of the Danube is a shared responsibility. By continuing to invest in transnational cooperation, harmonised monitoring, knowledge exchange and prevention, we can strengthen the resilience of our water resources and contribute to a healthier environment for present and future generations.

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References

1. Agaton, C. (2025): Nature-based Solutions to Wastewater Treatment of Microplastics: Technologies, Challenges, and Prospects. 10.20944/preprints202507.1779.v1.
2. International Commission for the Protection of the Danube Region (2021): Danube River Basin Management Plan (DRBMP), Update 2021. https://www.icpdr.org/tasks-topics/tasks/river-basin-management/danube-river-basin-management-plan-2021
3. A. Lechner (2020): "Down by the River": (Micro-) Plastic Pollution of Running Freshwaters with Special Emphasis on the Austrian Danube. *Springer Nature, Mare Plasticum - The Plastic Sea p. 141-185.* https://link.springer.com/chapter/10.1007/978-3-030-38945-1_8#DOI
4. Bucher, G., Mehn, D., Cella, C., Fumagalli, F., El Hadri, Gilliland, D. (2025): *Analysing microplastics in drinking water – Practical considerations*, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2760/1240697
5. Plastics Europe (2025): Plastics the Fast Facts 2025. Global and European plastics production and economic indicators. https://plasticseurope.org/wp-content/uploads/2025/09/PE_TheFacts_25_digital-1pager-scrollable.pdf
6. OECD (2024): Policy Scenarios for Eliminating Plastic Pollution by 2040. *OECD Publishing, Paris*, https://doi.org/10.1787/76400890-en.
7. Galgani, F., Fleet, D., Van Franeker, J., Katsanevakis, S., Maes, T., Mouat, J., Oosterbaan, L., Poitou, I., Hanke, G., Thompson, R., Amaton, E., Birkun, A., and Janssen, C. (2010): Marine Strategy Directive Framework - Task 10 Report Marine Litter. *Publications Office of the European Union, JRC58104.* 10.2788/86941
8. European Environment Agency, Joint Research Centre (2025): Zero pollution monitoring and outlook 2025. *EEA-JRC Report 13/2024.* doi:10.2800/6470682
9. Directorate-General of Research and Innovation (2019): Environmental and Health Risks of Microplastic Pollution. *Group of Scientific Advisors, Scientific Opinion 6/2019*. https://research-and-innovation.ec.europa.eu/knowledge-publications-tools-and-data/publications/all-publications/environmental-and-health-risks-microplastic-pollution_en