Mind the Gap: Why microplastics escape European Stormwater Systems

Mind the Gap: pourquoi les microplastiques échappent aux systèmes européens de gestion des eaux pluviales

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RÉSUMÉ

Les systèmes de gestion des eaux pluviales urbaines ont été identifiés comme une voie majeure par laquelle les microplastiques s'échappent dans l'environnement. Notre étude a examiné les pratiques de gestion des eaux pluviales dans sept pays européens afin d'évaluer le niveau de sensibilisation, les cadres réglementaires, les installations de traitement et le suivi liés à la pollution par les microplastiques. Les résultats révèlent un écart important : aucun pays n'applique actuellement de réglementation ou de normes spécifiques concernant les microplastiques dans les eaux pluviales, et l'élimination intentionnelle des microplastiques est pratiquement inexistante dans tous les pays étudiés. Les infrastructures de traitement des eaux pluviales (par ex. bassins de sédimentation, étangs, filtres) existent à des degrés divers, mais elles sont conçues pour des polluants conventionnels (comme les matières en suspension) avec des taux d'élimination < 50 % (sédimentation), et en particulier la sédimentation n'est pas optimisée pour la capture des microplastiques. La sensibilisation à la problématique des microplastiques augmente parmi les professionnels de l'eau et le public, mais les actions concrètes peinent à suivre. Le suivi des microplastiques dans les eaux de ruissellement reste rare, ce qui entraîne un manque de données et une forte incertitude concernant les performances d'élimination.

ABSTRACT

Urban stormwater systems have been identified as a major pathway by which microplastics escape into the environment. Our study surveyed stormwater management practices in seven European countries to evaluate awareness, regulatory frameworks, treatment facilities, and monitoring related to microplastic pollution. The findings reveal a significant gap: no country currently enforces specific regulations or standards for microplastics in stormwater, and intentional removal of microplastics is virtually absent across all surveyed nations. Stormwater treatment infrastructure (e.g. sedimentation tanks, ponds, filters) is in place to varying degrees, but these are designed for "conventional pollutants" (like suspended solids) with removal rates < 50 % (sedimentation) and especially sedimentation is not suitable for microplastic capture. Awareness of the microplastic issue is growing among water professionals and the public, but practical actions lag behind. Monitoring of microplastics in runoff is rare, resulting in scarce data and uncertainty about removal efficiencies. These results highlight an urgent need for developing guidelines, improving treatment technologies, and implementing monitoring programs for microplastics in urban stormwater. Bridging this regulatory and knowledge gap is crucial for reducing emissions of microplastics.

KEYWORDS

Microplastics, Regulations, Stormwater, Suspended Solids, Treatment

1 INTRODUCTION AND MOTIVATION

Traditionally, stormwater treatment policies focused on metals and suspended solids; microplastics (MP) have only recently been recognized as an emerging contaminant (Celma et al., 2025). Due to their small size and buoyancy, microplastics are not efficiently captured by standard grit chambers or sedimentation processes. Captured by chance in Blue-Green Infrastructure (BGI) microplastic stay in the environment. Untreated stormwater carries microplastics to rivers and oceans, where they accumulate and have deleterious effects on the natural environment (Wang et al., 2022).

2 METHOD: A QUESTIONNAIRE TO SEVEN EUROPEAN COUNTRIES

To investigate the status quo of stormwater treatment and how microplastics are addressed or overlooked, we conducted an expert questionnaire survey covering seven European countries. The questionnaire was distributed to eight stormwater professionals in Austria, Denmark, England (UK), France, Germany, the Netherlands, and Switzerland followed by interviews. We chose these countries to represent a range of Central and Western European contexts, each with advanced urban drainage infrastructure but different legal frameworks.

3 RESULTS: AWARENESS, REGULATIONS, FACILITIES AND MICROPLASTIC REMOVAL

3.1 Awareness

Awareness of microplastic pollution in stormwater is uneven but generally increasing. In all surveyed countries, the issue of microplastics in the environment has gained more (media) attention in recent years, primarily focused on plastics in oceans and drinking water. However, specific awareness of stormwater's role is still limited outside specialist circles. Only in **England (UK)** did respondents report strong public pressure related to sewer overflows and river water quality (this has indirectly raised microplastic awareness through NGOs highlighting "sewage" debris, which includes synthetic fibers and pellets). **France** and **Germany** have growing scientific interest – e.g. publications and pilot studies on urban microplastics – but this is not yet translated into broad public campaigns. In **Austria, Denmark, Netherlands, Switzerland**, awareness was described as moderate: experts know microplastics are present in runoff, yet it is not a top priority for regulators compared to nutrients or combined sewer overflows. Respondents in most countries believed that awareness is significantly higher in 2025 than a few years ago due to EU-wide discussions (e.g. during the revision of the EU Directive 2024/3019 concerning urban wastewater treatment) and high-profile scientific reports.

3.2 Stormwater treatment regulations for separate (and combined) systems

None of the seven countries currently has effluent standards or legally binding limits specifically for microplastics in stormwater. Austria, Denmark, England and Netherlands reported no explicit national regulations governing discharges from separate storm sewers. In these cases, stormwater is often addressed only through broad environmental protection laws or local permits; there is typically an obligation to use "BMP : Best management practice " to avoid pollution, but no quantifiable criteria. France, Germany, and Switzerland and Austria have more developed rules for separate stormwater: for example, France uses the EU Water Framework Directive's objectives to require that new developments control runoff pollution; in Germany and Switzerland, many regions require at least sedimentation or infiltration facilities to treat stormwater runoff.

However, these rules focus on traditional pollutants (suspended solids, oils, metals). Microplastics are not mentioned, even in countries with advanced combined sewer overflow (CSO) policies (e.g. detailed CSO spill frequency standards in Germany, Switzerland, UK). Respondents noted that, if anything, current regulations indirectly reduce microplastic emissions by targeting the particles as part of overall suspended solids. For instance, France's limit of 35 mg/L TSS on some storm discharges encourages removal of road dirt which contains microplastics. Germany's design guidelines for stormwater treatment (DWA-A 102 :2020) will lead to further installation of sedimentation tanks and (bio)filters that will also trap an undefinded portion of microplastics. But none of these regulations define success in terms of microplastic counts, concentrations or removal rates.

This might change with the implementation of the EU Directive 2024/3019 concerning urban wastewater treatment in the future (EU, 2024). The revised ÖWAV Guideline 45 and 45-2:2025 provide a comprehensive technical framework for the sustainable management of surface water infiltration into the subsoil, detailing legal requirements, pollutant assessment, treatment technologies and an overview of the sources, composition,

environmental pathways, analytical challenges, risk assessment, and potential mitigation strategies for microplastics and tire wear particles in urban runoff, emphasizing the importance of integrated approaches for pollution control and groundwater protection.

3.3 Stormwater treatment management & facilities

In all surveyed countries, stormwater from urban areas is managed with similar types of facilities, but deployment levels vary, and treatment facility implementation differs markedly:

Germany and Switzerland have invested in stormwater quality control; for example, Germany has thousands of sedimentation installations, (bio)filters and decentralised systems on separate sewers. These primarily target suspended solids but likely capture some microplastic bound to particles. Both countries also have first experience pilot projects (e.g. Switzerland tested fibrous media for tire-wear particles and pilot projects on flotation and filters in Germany).

France and Austria use stormwater ponds and basic settling basins in many cities, though often sized for flood control rather than water quality. No specific microplastic features were reported.

Denmark and the Netherlands rely extensively on infiltration and source control (e.g. permeable pavements, swales) for new developments, which can reduce runoff volume and associated pollutant transport. These green infrastructure practices (may) incidentally trap microplastics in soil, but it's not quantified.

England (UK) historically built few stormwater treatment facilities (most efforts went into combined sewer overflow management). Separate storm sewer outlets in the UK usually discharge untreated; recent policy is pushing nature-based solutions, yet again without explicit microplastic considerations.

No country has implemented dedicated "microplastic treatment facilities" at scale. Table 1 (below) highlights the presence or absence of various facility types in each country.

3.4 Monitoring, data availability and pilot projects

Findings showed that monitoring tends to focus on regulatory parameters, and since microplastics aren't regulated, they are not routinely measured. In **France**, some research-driven monitoring has been done in Paris and Lyon, quantifying microplastic in stormwater sediments and outflows, but this is not continuous monitoring – it consisted of time-limited studies. In **Germany, Austria and Switzerland** research studies measured tire-wear particles in roadside runoff and in storm pond sediments and WWTP. In **England (UK)** water companies monitor storm overflows duration and frequency, while this doesn't measure microplastics, the open publication of data has indirectly raised interest in what pollutants are in those spills (microplastics included). There is also a citizen science initiative in the UK analysing river water for microplastics downstream of urban areas. In **Netherlands & Denmark** there are ongoing EU research projects (e.g. on tire wear), but data are not yet publicly integrated into policy. Respondents unanimously pointed out that microplastic analyses are expensive and methodologically complex, which discourages routine monitoring. Furthermore, standardized methods (e.g. for sampling and identifying microplastics in water) are only now being developed, causing comparability issues.

In England, the Water Resource Centre, in France, the National Research Agency and in Austria (University of Vienna and Technical University of Graz), are advancing work on microplastic sampling, analysing methodologies and removal technologies. In Germany, pilot projects on microflotation for microplastic separation and filter installed in gullies to capture tire-wear particles at the source are being tested. Denmark and the Netherlands are also conducting studies, with pending results on the effectiveness of detention ponds for microplastic removal and on whether increased gully-pot cleaning frequency improves microplastic capture.

4 CONLCUSION

There is a clear "gap" in European urban water management: microplastics are largely escaping stormwater systems unchecked due to gaps in regulation, technology design, and monitoring. Despite rising awareness, current stormwater infrastructure and policies in the surveyed countries do not specifically address microplastic pollution. As a result, considerable loads of microplastics continue to be released into rivers via storm drains. This undermines broader plastic pollution mitigation efforts and could hinder the achievement of ecological quality objectives. Given the transboundary nature of microplastic pollution, a Europe-wide strategy or exchange of best practices would be beneficial. By addressing microplastics in urban runoff now we can significantly reduce the flux of these persistent pollutants from city streets to the world's oceans. The evidence gathered here

informed the following recommendations: **Developing regulatory guidance:** Policymakers should integrate microplastic criteria into stormwater discharge permits or environmental quality standards. Even if setting numeric limits is premature, requiring the assessment and reduction of microplastic discharge (through best practices) would drive progress beside a consequent implementation of the EU Directive 2024/3019 concerning urban wastewater treatment. **Enhancing treatment technologies:** Stormwater treatment innovation is needed to target fine particles. This could involve retrofitting existing basins with filtration/microflotation modules or using absorbent media that capture microplastics. Green infrastructure can also be optimized to trap microplastics. **Mandatory monitoring and research:** We urge agencies to support systematic monitoring of microplastics in stormwater and combined overflow discharges. Standard methods (for sampling, lab analysis) should be adopted widely so that data from different regions are comparable. Building a shared knowledge base will reduce uncertainty and help evaluate the effectiveness of interventions. **Knowledge sharing and public engagement:** Finally, making data on urban microplastic pollution openly available can foster public support for necessary investments (as seen in the UK, where disclosure of overflow data spurred funding for upgrades). Educating the public that "stormwater is a plastic pathway" may improve urban litter control and support local remediation projects.

Table 1: Comparative overview of microplastic (MP)-related status in stormwater management.

Country	Public/Policy Awareness	Stormwater treatment regulations	Dedicated MP removal in practice	Monitoring & Data on MP in stormwater
Austria	**Moderate** – MPs seen as emerging issue, but not prominent in policy or public debate.	**No specific laws** for stormwater quality; general duty to prevent pollution. New Guideline RB 45 mentions MP	None – uses conventional sedimentation/infiltration; no MP-focused tech.	No routine monitoring; no data on MPs in runoff (research samples e.g. University Vienna/Graz in WWTP).
Denmark	**Moderate** – focus on holistic urban water management; microplastics not singled out.	**No explicit regulations** on separate storm discharges (focus on combined sewer management).	None – reliance on green infrastructure (swales, etc.) which incidentally trap some debris.	No MP monitoring program; stormwater MPs not assessed in practice.
England (UK)	High **public attention** on sewage/storm overflows; MPs in runoff gaining recognition via NGOs. High among experts.	**No dedicated standards** for stormwater outfalls; new policy requires monitoring CSO spills (not for separate systems), not MP-specific.	None – very few stormwater treatment facilities historically; some pilots (gully filters) starting.	**Emerging:** real-time CSO spill data published (indirectly reveals pollution); a few studies measuring river microplastics downstream.
France	**Increasing** – High among experts; authorities aware of MP issue; included in some water forums.	**Yes (partial):** Stormwater subject to Water Framework Directive goals; facilities must self-monitor. No MP limit.	None – standard use of ponds, separators; no special MP devices yet.	**Limited research data:** some urban catchments studied for MP, not continuous; data not systematically open.
Netherland	**High among experts**; public awareness but not advocating for change.	**No dedicated standards** for stormwater outfalls;	None – BGI are becoming more popular; stormwater sewer without treatment	No monitoring/data
Switzerland	**High among experts**; moderate/no public awareness.	Mandatory performance assessments of SABAs based on data - not applicable to retention ponds and CSOs	None	No monitoring/data
Germany	**Increasing** - High among experts – ongoing research; moderate but increasing public awareness (also in schools).	**Yes:** Guidelines (DWA-A 102) require treatment of stormwater in sensitive areas; regulate TSS, nutrients but MPs is not regarded yet	None at scale – widespread sedimentation technologies help remove particles; microplastic filters only in pilot trials.	**Limited Research data:** e.g. studies on tire wear

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