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Interim report

Research and Monitoring Activities on Litter in Groundwater, Rivers, Lakes, Transitional Waters and Soil

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Protection of the Seas and Polar Regions

On behalf of the German Environment Agency

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Abstract: Research and Monitoring Activities on Litter in Groundwater, Rivers, Lakes, Transitional Waters and Soil

This report is based on the results of a questionnaire on current and planned research and monitoring activities on litter in various environmental compartments, which was distributed to European countries via the Federal Environment Agency (UBA). It analyses current and planned research, monitoring activities, and mitigation strategies related to litter in groundwater, rivers, lakes, transitional, coastal and marine waters and soils. The report emphasizes the urgent need for widespread, standardized monitoring, intensive research, and coordinated efforts to mitigate litter pollution's far-reaching impacts. Despite some promising activities and practices, significant gaps persist in understanding the origins and pathways as well as effect of litter in the environment, especially in groundwater and soil environments, with few countries conducting research or implementing monitoring programs in these areas. The findings underscore the importance of an integrated European approach, the need for financial support, long-term studies, and strengthening the research and policy framework in line with EU environmental objectives.

Kurzbeschreibung: Research and Monitoring Activities on Litter in Groundwater, Rivers, Lakes, Transitional Waters and Soil

Dieser Bericht basiert auf den Ergebnissen eines Fragebogens zu aktuellen und geplanten Forschungs- und Monitoringaktivitäten zu Abfällen in verschiedenen Umweltbereichen, der über das Umweltbundesamt (UBA) an europäische Staaten verteilt wurde. Er analysiert aktuelle und geplante Forschungs- und Monitoringaktivitäten sowie Minderungsstrategien in Bezug auf Abfälle in Wasser und Boden. Der Bericht unterstreicht die dringende Notwendigkeit einer umfassenden, standardisierten Erfassung, intensiver Forschung und koordinierter Bemühungen, um die weitreichenden Auswirkungen der Verschmutzung durch Abfälle besser zu verstehen und folglich effektiver eindämmen zu können. Trotz einiger vielversprechender Aktivitäten und Praktiken bestehen erhebliche Lücken im Verständnis der Herkunft und Pfade von M ll sowie deren Effekte in der Umwelt, insbesondere in Grundwasser und Bodenumgebungen, mit wenigen Ländern, die in diesen Bereichen Forschung durchführen oder Überwachungsprogramme implementieren. Die Ergebnisse unterstreichen die Bedeutung eines integrierten europäischen Ansatzes, die Notwendigkeit finanzieller Unterstützung, langfristiger Studien und der Stärkung des Forschungs- und Politikrahmens im Einklang mit den EU-Umweltzielen.

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List of abbreviations

AT	Austria
BG	Bulgaria
BE	Belgium
CR	Croatia
CY	Cyprus
CZ	Czechia
DK	Denmark
DE	Germany
EC	European Commission
EE	Estonia
EL	Greece
ES	Spain
EU	European Union
FI	Finland
FR	France
HU	Hungary
IE	Ireland
IT	Italy
IS	Iceland
LT	Lithuania
LU	Luxembourg
LV	Latvia
MS	Member State
MSFD	Marine Strategy Framework Directive
MT	Malta
NL	The Netherlands
NGO	Non-governmental organisation
NO	Norway
PL	Poland
PT	Portugal
QA	Quality assurance
RO	Romania
SI	Slovenia
SE	Sweden
SK	Slovakia
UBA	German Environment Agency
WFD	Water Framework Directive

Summary

The EU Water Frame Work Directive (WFD) is in force since 2000. A Common Implementation Strategy (CIS) process was established to support EU Member States. Specific working groups are in place to exchange information and agree on solutions needed for a joint implementation. Working Group A ECOSTAT is the group dealing with questions related to the ecological status of surface waters. In its current working programme it has inter alia been agreed that ECOSTAT serves as information platform on litter (focus plastics) in European waters. The co-lead Germany volunteered to steer this activity. To obtain the information a specific questionnaire has been developed and distributed to ECOSTAT members. 28 countries reported back. The responses have been evaluated and summarised in this report.

This report is based on the results of a questionnaire on current and planned research and monitoring activities on litter in groundwater, rivers, lakes, transitional, coastal and marine waters and soils, which was distributed to European countries via the German Federal Environment Agency (UBA). Among transitional, coastal and marine waters, this report primarily focuses on transitional waters. Coastal and marine waters are included only where relevant for litter sources and pathways between freshwater and sea. By presenting the various activities of ECOSTAT members through quantitative analyses of responses, as well as presentation of a number of case studies focusing on research and monitoring methods, the report aims to build a more coherent European picture of activities, research studies and monitoring related to litter in water and soil.

The report begins by discussing the escalating issue of litter pollution, underlining the dramatic increase in global and European domestic material consumption and the resultant surge in littering to the environment, especially plastic pollution. The far-reaching impact of litter pollution on terrestrial and aquatic ecosystems is underscored by the complexities brought about by the transboundary nature of water and air flows.

A range of EU policies and actions have been instigated to confront the litter problem. These include the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the Water Framework Directive (WFD, 2000/60/EC), the revised Drinking Water Directive (2020/2184/EU), and the Waste Framework Directive (2008/98/EC). Specific reference is also given to the EU Directive on single-use plastics (2019/904/EU) and the EU Circular Economy Action Plan, both of which are aimed at reducing waste and promoting a more circular economy.

The report highlights both promising practices and prominent gaps in litter monitoring and management across European countries. Notably, several countries have implemented large-scale monitoring programs such as the Joint Danube Survey, the proposed Dutch river monitoring program, and the German monitoring of litter in the water column of German North Sea estuaries. In addition, numerous European countries are formulating or considering strategies to mitigate litter input and clean existing litter from surface water environments. These initiatives often include specific action plans targeting plastic pollution, incorporated within broader waste prevention and reduction strategies. Non-governmental organizations play an active role in several countries, spearheading cleanup drives in beach and river areas.

However, significant gaps persist. The origins and pathways of litter into water and soil environments remain largely unknown, with groundwater monitoring being particularly lacking. Although litter-related research studies are more prevalent in freshwater environments, there is a marked lag in monitoring and effect studies, suggesting many

countries are still in the preliminary stages of understanding the scale of their litter pollution. Monitoring efforts tend to be limited and fragmented, largely confined to selected European rivers, lakes, and transitional waters, with a scarcity of national-level studies.

Groundwater and soil environments present unique challenges. Only a few countries have pursued or are currently conducting research on microlitter in groundwater, and none report having monitoring studies. In fact, just two countries have reported plans for future monitoring activities for microlitter in groundwater. For soil, despite some research on microlitter, very few countries report having monitoring studies or future plans for such monitoring. A consistent trend across freshwater environments, transitional waters, and soil is the lack of systematic litter monitoring programs. Information collection and results are fragmented, often dispersed among various institutions within countries. For freshwater environments, reported challenges include inadequate financial support, scarcity of long-term research, and lack of a clear legal framework for regular monitoring activities. Transitional waters largely lack structural or systematic monitoring programs. Soil monitoring is constrained to a limited number of European soil systems, with national-level monitoring largely absent.

The findings reinforce the need for widespread, standardised monitoring including uniform analysis methods and intensive research to determine the extent and causes of litter pollution - both key prerequisites for formulating effective policies. This comprehensive overview highlights the crucial role of harmonised monitoring initiatives on litter across Europe. It illuminates current best practices and knowledge gaps. The challenges outlined, such as the need for financial support and long-term studies, underscore the importance of a coordinated, integrated European approach and of strengthening research and policy framework in line with EU environmental objectives. Promoting standardized monitoring and analysis methods and applying them consistently will help to obtain comparable results over Europe and to develop robust and effective policies that address this complex, multidimensional problem. This will level the path to a healthier and cleaner environment while providing uniformity and consistency to enable more effective data comparison and shape more efficient policy responses.

Zusammenfassung

The EU Wasserrahmenrichtlinie (WRRL, 2000/60/EG) ist seit 2000 in Kraft. Zur Umsetzung der Richtlinie wurde auf EU-Ebene eine gemeinsame Umsetzungsstrategie eingerichtet (Common Implementation Strategy (CIS)), um die EU-Mitgliedstaaten zu unterstützen. Spezifische Arbeitsgruppen wurden eingerichtet, in denen Informationen ausgetauscht und Vereinbarungen zu L sungen für eine gemeinsame Umsetzung in Europa getroffen werden. Die Working Group A ECOSTAT befasst sich mit Fragestellungen zum ökologischen Zustand von Oberflächengewässern. In ihrem aktuellen Arbeitsprogramm ist u.a. festgelegt, dass ECOSTAT als Informationsplattform zu Müllaufkommen in europäischen Gewässern und Einträgen in die Meere dient (Fokus Kunststoffe). Die Ko-Leitung Deutschland hat sich bereit erklärt, diese Aktivität federf hrend zu leiten. Zum Erhalt relevanter Informationen wurde ein Fragebogen gemeinschaftlich entwickelt und in ECOSTAT verteilt. 28 Staaten haben den Fragebogen beantwortet. Die Antworten wurden ausgewertet und in diesem Bericht zusammengefasst.

Der Bericht basiert auf den Ergebnissen des Fragebogens zu aktuellen und geplanten Forschungs- und Monitoringaktivitäten zu Abfällen in Grundwasser, Fl ssen, Seen, Übergangs-, K sten- und Meeresgewässern sowie Böden, der über das Umweltbundesamt (UBA) an europäische Staaten verteilt wurde. Bei den Übergangs-, K sten- und Meeresgewässern konzentriert sich dieser Bericht in erster Linie auf die Übergangsgewässer. K sten- und Meeresgewässer werden nur dann berücksichtigt, wenn sie für die Quellen und den Weg der Abfälle zwischen Süßwasser und Meer relevant sind. Durch die Darstellung der verschiedenen Aktivitäten der ECOSTAT-Mitglieder anhand quantitativer Analysen der Antworten sowie durch die Präsentation einer Reihe von Fallstudien, die sich auf Forschungs- und Monitoringmethoden konzentrieren, soll der Bericht dazu beitragen, ein kohärenteres europäisches Bild der Forschungs- und Monitoringaktivitäten in den genannten Kompartimenten zu erstellen.

Der Bericht beginnt mit einer Erörterung des sich verschärfenden Problems der Abfallverschmutzung und unterstreicht den dramatischen Anstieg des weltweiten wie europäischen Materialverbrauchs und den daraus resultierenden Anstieg der Umweltverschmutzung durch Abfälle, insbesondere der Verschmutzung durch Kunststoffe. Die weitreichenden Auswirkungen der Verschmutzung durch Abfälle auf terrestrische und aquatische Ökosysteme werden durch die Komplexität der grenz berschreitenden Wasser- und Lufteinträge noch unterstrichen.

Eine Reihe von EU-Politiken und -Maßnahmen wurde eingeleitet, um das Abfallproblem anzugehen. Dazu gehören die Meeresstrategie-Rahmenrichtlinie (MSRL, 2008/56/EU), die Wasserrahmenrichtlinie (WRRL, 2000/60/EU), die überarbeitete Trinkwasserrichtlinie (2020) und die Abfallrahmenrichtlinie (2008/98/EG). Besondere Erwähnung finden auch die Richtlinie über Einwegkunststoffe (2019/904/EU) und der EU-Aktionsplan für die Kreislaufwirtschaft, die beide auf die Verringerung von Abfällen und die Förderung einer stärker kreislauforientierten Wirtschaft abzielen.

Der Bericht hebt sowohl gegenwärtige vielversprechende Praktiken als auch ausgeprägte L cken bei dem Monitoring von Abfällen in europäischen Ländern hervor. Mehrere Staaten haben umfassendere Monitoringprogramme eingeführt, wie z.B. der Joint Danube Survey, ein anlaufendes großangelegtes niederländisches Flussmonitoringprogramm und das Monitoring der Abfälle in der Wassersäule von deutschen Nordsee-Ästuaren. Darüber hinaus formulieren oder erwägen zahlreiche europäische Länder Strategien, um den Eintrag von Abfällen zu verringern und vorhandene Abfälle aus Oberflächengewässern zu entfernen.

Diese Initiativen umfassen häufig spezielle Aktionspläne zur Bekämpfung der Plastikverschmutzung, die in umfassendere Strategien zur Abfallvermeidung und -reduzierung eingebunden sind. In mehreren Staaten spielen Nichtregierungsorganisationen eine aktive Rolle, die Säuberungsaktionen in Strand- und Flussgebieten häufig organisieren und durchführen. Es bestehen jedoch noch erhebliche Lücken. Die Herkunft und der Weg von Abfällen in die Gewässer und die Böden sind nach wie vor weitgehend unbekannt, wobei es vor allem an Monitoring von Abfall in Grundwassers mangelt. Obwohl Forschungsstudien über Abfälle in Süßwasserumgebungen häufiger durchgeführt werden, gibt es deutlich weniger Monitoring- und Wirkungsstudien, was darauf hindeutet, dass viele Staaten noch im Anfangsstadium sind, das Ausmaß ihrer Abfallverschmutzung zu messen und nachzuvollziehen. Bemuu ngen sind in der Regel begrenzt und fragmentiert und beschränken sich weitgehend auf ausgewählte europäische Fl sse, Seen und Übergangsgewässer, wobei es wenig Studien auf nationaler Ebene gibt.

Grundwasser und Böden stellen besondere Herausforderungen dar. Nur wenige Länder haben Forschungsarbeiten über Mikroplastik im Grundwasser durchgeführt oder führen sie derzeit durch, und kein Staat berichtet über laufende Monitoringstudien. Tatsächlich haben nur zwei Staaten Pläne für künftige Monitoringaktivitäten für Mikroplastik im Grundwasser angegeben. F r Böden berichten trotz einiger Forschungsarbeiten über Mikroplastik nur sehr wenige Staaten über laufende Aktivitäten oder Pläne hierf r. Ein allgemeiner Trend in den Bereichen Süßwasser, Übergangsgewässer und Böden ist das Fehlen systematischer Monitoringprogramme für Abfälle. Die Sammlung von Informationen sind fragmentiert und oft auf verschiedene Institutionen innerhalb der Staaten verteilt. Für Flüsse und Seen sowie Übergangsgewässer werden u.a. unzureichende finanzielle Unterstützung, ein Mangel an langfristiger Forschung und das Fehlen eines klaren rechtlichen Rahmens f r regelmäßige Moitoringaktivitäten genannt. Für Übergangsgewässer gibt es wenig strukturelle oder systematische Monitoringprogramme. Bei Böden beschränkt es sich auf eine begrenzte Anzahl europäischer Bodensysteme, wobei Monitoring auf nationaler Ebene weitgehend fehlt.

Die Ergebnisse bestärken die Notwendigkeit f ein flächendeckendes, standardisiertes Monitoring einschließlich einheitlicher Analysemethoden sowie intensiver Forschung zur Bestimmung des Ausmaßes, der Ursachen und der Umwelteffekte der Abfallverschmutzung - zentrale Voraussetzungen f europaweit vergleichbare Ergebnisse und die Formulierung wirksamer politischer Maßnahmen. Dieser Bericht verdeutlicht die entscheidende Bedeutung harmonisierter Erkenntnisse und Monitoringinitiativen zur Verschmutzung der Umwelt durch Abfälle in Europa. Er beleuchtet gegenwärtige bewährte Praktiken und offenbart Wissensl cken. Die dargelegten Herausforderungen, wie der Bedarf an finanzieller Unterstützung und Langzeitstudien, betonen die Wichtigkeit einer koordinierten, integrierten europäischen Vorgehensweise sowie einer Stärkung des Forschungs- und Politikrahmens im Einklang mit den Umweltzielen der EU. Die Förderung von standardisierten Überwachungs- und Analysemethoden und deren konsequente Anwendung wird dazu beitragen, europaweit vergleichbare Ergebnisse zu erhalten und robuste und wirksame politische Maßnahmen zu entwickeln, die dieses komplexe, mehrdimensionale Problem angehen. Dies wird den Weg zu einer gesünderen und saubereren Umwelt eben und gleichzeitig f r Einheitlichkeit und Konsistenz sorgen, um einen effektiveren Datenvergleich zu ermöglichen und effizientere politische Maßnahmen zu entwickeln.

1 Introduction

1.1 Background

1.1.1 Litter pollution: a growing issue - why and how?

The **root causes of litter pollution** to the environment lie in the consumption and production system and our waste management. Global domestic material consumption, i.e. the total amount of materials used by all economies, has risen sharply, increasing by more than a third between 1998 and 2018 (UNEP, 2019). The litter problem affects all types of terrestrial and aquatic ecosystems, distributed and exacerbated by the interconnectedness of water and air flows, leading to its complex transboundary nature.

A large proportion of litter consists of **plastics (including microplastics[1])**, which are a particular global problem (Hale et al. 2020). Since the 1950s, when large-scale production of plastics began, the use of plastics to replace conventional materials in society has increased almost exponentially. In 2018, plastic production amounted to 395 million tonnes (UNEP, 2018). Pollution by (micro)plastics has recently gained attention, especially with regard to marine pollution. Estimates suggest that over 8 million tonnes enter the oceans annually (mainly via lakes, rivers and transitional waters) (UNEP, 2016).

However, in recent years, the focus of microplastic research has begun to observe a shift from the marine towards terrestrial and freshwater environments (Kallenbach et al. 2021; de Souza Machado et al. 2018). Studies suggest that land-based microplastic pollution in soils and freshwater systems may be even greater than that estimated for the marine environment (Horton et al. 2017; Boucher & Friot, 2017).

The **sources of litter** (including plastics and microplastics) are diverse, but the actual quantities in terrestrial and aquatic environments are still largely unknown. Reliable quantitative comparisons between the inputs of macro-, meso- and micro-litter, as well as their sources, are often not yet comprehensively available, which represents a significant knowledge gap. We currently lack a coherent European picture of activities, research studies and monitoring related to litter in water and soil.[2] Existing monitoring methods need to be expanded and replicated in other regions to enable uniform monitoring.

Concerning marine and coastal litter in the EU, Addamo et al. (2018) made an EU-wide analysis of beach litter data including findings of monitoring programmes, clean-up campaigns and research projects. A harmonised EU beach litter data set from 2016 provided up-to-date information on the most abundant items at different geographical and seasonal scales.[3] Further, there are already several research and monitoring programmes for marine and coastal litter in place in EU countries.

On the issue of **plastics in the freshwater environment**, Breuninger et al. (2017)[4] concluded that our knowledge of the distribution and abundance of micro-, meso and

[1] Microplastics are routinely defined as small particles or fragments of plastic measuring less than 5 mm in diameter. However, there is still some variance among the definitions (ECHA, 2020).

[2] Reliable baseline data on the stocks, flows, pathways and time-dependent trends of microplastics in different environmental compartments are not yet established (European Commission, 2019)

3 European Commission, Joint Research Centre, Addamo, A., Laroche, P., Hanke, G., Top Marine Beach Litter Items in Europe: a review and synthesis based on beach litter data, Publications Office of the European Union, 2018, https://data.europa.eu/doi/10.2760/496717.

[4] Breuninger et al. (2017), Plastics in European Freshwater Environments, ISSUE PAPER (Final Version), Addendum to Summary Paper of Conference on Plastics in Freshwater Environments, Umweltbundesamt Dokumentationen 05/2017.

macroplastics in freshwater environments is far from complete. Reasons for this are that previous monitoring projects and studies on plastics in rivers and lakes did not cover all European countries. Second, the pathway of inputs from major rivers into the connecting seas has yet to be adequately investigated. Third, an important problem hampering further monitoring activities is the lack of standardised sampling, sample processing and sample identification. Water samples and sediments are currently investigated using different methods and the results are therefore not directly comparable. Further research is needed to establish standard procedures to ensure consistency in monitoring water and other aquatic compartments.

There are serious implications for the environment (e.g. biodiversity and ecosystems) through litter pollution (particularly plastic) which is why the **effects of litter pollution** are increasingly becoming a research focus (Gall & Thompson, 2015; European Commission, 2019).

1.1.2 EU policies and actions on litter including overarching/relevant Directives with research/monitoring obligations for Member States

The Marine Strategy Framework Directive (MSFD) requires EU Member States to ensure that, by 2020, "properties and quantities of marine litter do not cause harm to the coastal and marine environment" (Descriptor 10 marine litter).[5] For example, while MSFD monitoring methods related to sources, pathways and impacts of microplastics are already applied for certain aspects, there are still gaps which inhibit many (sub-)indicators from being operational. The MSFD has been undergoing a review after an initial assessment identified how the Directive could be improved to protect the marine environment more effectively and efficiently and align with the EU agenda under the European Green Deal.; at the time of writing, the targeted consultations have not yet been completed. Marine litter is also monitored via the EEA Marine Litter Watch initiative which aims to combat plastic pollution by using research conducted, at least partly, by members of the public and mobile-phone technology.

In some countries, litter may also be monitored or be the subject of pilot studies as part of the Water Framework Directive implementation. Further, the revised Drinking Water Directive (2020) requires stricter monitoring procedures for protecting potable water as a resource. The European Commission (EC) is to establish a watch list of health elements in drinking water that are of concern to citizens and scientists. This involves microplastics, pharmaceutical products, and endocrine disruptors. EU Technical Groups are responsible for establishing methodologies to measure microplastics by 2024. Member States are encouraged to pay particular attention to microplastics and other emerging compounds when carrying out risk assessments of the use of surface water for human consumption.

As for **actions**, the Waste Framework Directive (2008/98/EC) set a legal obligation for Member States to adopt waste prevention programmes which is annually reviewed by the EEA[6]. The EU's Directive on single-use plastics (2018) aims to prevent and reduce the impact of certain plastic products on the environment, in particular the marine environment. It also

[5] A technical group on marine litter (DG Environment/TSG ML) was created to provide scientific and technical background for the implementation of MSFD requirements and support to Member States with regard to Descriptor 10. The work of TSG ML focuses on the specification of monitoring methods through the development of monitoring protocols for litter in the different marine compartments, including microplastics and litter in biota. A dedicated core group is working on the development of guidance for microlitter monitoring.

[6] https://www.eea.europa.eu/themes/waste/waste-prevention

promotes the transition to a circular economy thereby ensuring less waste, as does the new EU Circular Economy Action Plan, which paves the way for a cleaner Europe.

1.2 Purpose and scope of the report

This report is based on the results of a questionnaire on research and monitoring activities on litter in groundwater, rivers, lakes, transitional, coastal and marine waters and soils, which was distributed to ECOSTAT countries via the German Federal Environment Agency (UBA) (questionnaire available in Annex II of this report). Among transitional, coastal and marine waters, this report primarily focuses on transitional waters. Coastal and marine waters are included only where relevant for litter sources and pathways between freshwater and sea (e.g. questions 15, 16 & 20 on litter input from freshwater to the sea, sources and pathways). In response to feedback from the ECOSTAT consultation, the term "saline waters" was removed from the final report to avoid misunderstanding, although it was included in the original questionnaire.

By presenting the various activities of ECOSTAT members through quantitative analyses of responses, as well as presentation of a number of case studies focusing on research and monitoring methods, the report aims to help build a more coherent European picture of activities, research studies and monitoring related to litter in water and soil. While the report does not claim to be exhaustive, as not all sources provided could be retrieved and analysed in detail, it provides a good picture of activities and a starting point for further mapping of the overall research and monitoring landscape. In this way, key stakeholders, including ECOSTAT representatives, researchers and practitioners, can get an overview of the activities and have a basis for replication in other regions to enable uniform and consistent monitoring across the EU.

During the design of the questionnaire it has been decided to include the compartments groundwater and soil (as possible pathway for microplastics) although both are not topic of ECOSTAT.

This activity is aligned with the co-lead Georg Hanke of the MSFD Technical Group on Marine Litter (TG ML) to avoid double work and seek for synergies. Therefore, as indicated above, the focus in addition to freshwater, groundwater and soil is on transitional waters, as detailed work on litter in marine and coastal waters is carried out in the MSFD Technical Group on Marine Litter (TG ML).

1.3 Structure of the report

The report breaks down the answers by types of ecosystems and thus corresponds to the structuring of the questions in the questionnaire.

Chapter 3 presents the results in terms of sources and pathways to groundwater, freshwater, transitional, coastal and marine waters and soils. Tables are used to give a comprehensive and clear picture of ECOSTAT country responses, including simple checkmarks as well as supplements and additional explanations in text form. **Chapter 4** provides an overview of research, monitoring and effects studies. Again, comparative tables are used to show which countries have conducted or are currently conducting research, monitoring and effects studies, and where further monitoring plans are in place. The tables also include information on the elements being monitored (e.g. microplastics) and show geographical levels to see exactly where monitoring is taking place. Information on methodology (sampling and analysis) is not provided for all countries as not all questionnaire responses addressed this with specific information. In some responses, the

relevant linked documents are often not accessible or written in the local language and therefore not evaluable by the authors of this paper**.** For the effects studies, the marine species on which the effects of litter were investigated are listed, where this was indicated in the responses to the questionnaire or accessible through the linked studies. Other focal aspects such as impacts on human health or the freshwater and terrestrial environment as a whole (e.g. biophysical impacts) are also listed where applicable. Links to the studies are included wherever they have been made available to provide ECOSTAT members with a useful and valuable overview of the sources so that they can quickly find the relevant, detailed documents. UBA and DG ENV work on a solution to make the separate literature depository publicly available (e.g. on CIRCA). **Chapter 5** presents the activities of water management in relation to litter and micro-litter in the environments of scope.

2 Questionnaire on research and monitoring activities on litter in groundwater, rivers, lakes, transitional, coastal, marine waters and soil

2.1 Scope of the Questionnaire

ECOSTAT serves as platform to exchange information on litter related surveys in water. Germany as ECOSTAT co-lead is leading this activity. A questionnaire has been developed to support this information exchange. The questionnaire asks for information on recent and planned research, monitoring and water management activities related to litter in groundwater, rivers, lakes, transitional, coastal and marine waters. In addition, it asks for similar activities related to soil which is relevant as pathway of possible inputs of microlitter from the surface to groundwater with the risk of groundwater contamination.

Together with the EU COM and JRC as co-leads of ECOSTAT, it was agreed to broaden the scope of the questionnaire over the ECOSTAT focus, to achieve a European wide picture comprising of information pieces for the media water (groundwater, rivers, lakes, transitional, coastal and marine waters) and soil (as link/pathway from surface waters to groundwater. Coastal and marine waters are excluded from this questionnaire where appropriate and with regard to saline waters its focus is on transitional waters.

This report is published after consultation with ECOSTAT without naming a specific person, and the countries that participated in the survey are listed as participants.

2.2 Responses to the Questionnaire

An overview of the responses to the survey is provided by the following map (Figure 1), with the countries coloured in green having provided a response in the form of a completed questionnaire.

For Spain, the questionnaire response provided at national level has been considered. A separate response provided for the region of Cantabria has not been considered.[7]

For Germany, four out of 16 federal states responded to the questionnaire. For the purpose of statistical and graphical presentations in this paper, the YES/NO responses of the four federal states have been combined to provide an answer at national level. In the tables, however, the individual answers of the federal states are still listed separately under the following abbreviations:

- DE-NI: Lower Saxony
- DE-MV: Mecklenburg-Western Pomerania
- DE-BY: Bavaria
- DE-TH: Thuringia

[7] Not considered due to the very specific scope and the fact that only questions 1, 3, 7 & 11 without any explanation have been answered.

Figure 1 **Map of countries that responded to questionnaire**

3 Sources and Pathways

Question 16. What are the main sources and pathways for litter into groundwater, surface waters and soil in your country?

ECOSTAT experts were asked to indicate what are the main sources and pathways for litter into groundwater, surface waters and soil in their country. For the purpose of this questionnaire, the following size thresholds for micro-, meso-, and macrolitter have been used (< 5 mm, 5 - 200 mm, > 200 - 500 mm).[8]

3.1 Freshwater

The sources and pathways of litter into freshwater differ for micro-/meso-/macrolitter (< 5 mm, 5 - 200 mm, > 200 - 500 mm).

- For macrolitter, landscape littering is the most common source reported, followed by stormwater.
- For mesolitter, no sources can be singled out as most common, as the sources reported are rather equally distributed between countries.
- For microlitter, most common sources reported are landscape littering and tire abrasion, followed by wastewater and other sources.
- Overall, for all three categories of litter, the majority of countries responded unknown sources, without being able to provide information on any specific sources and pathways.

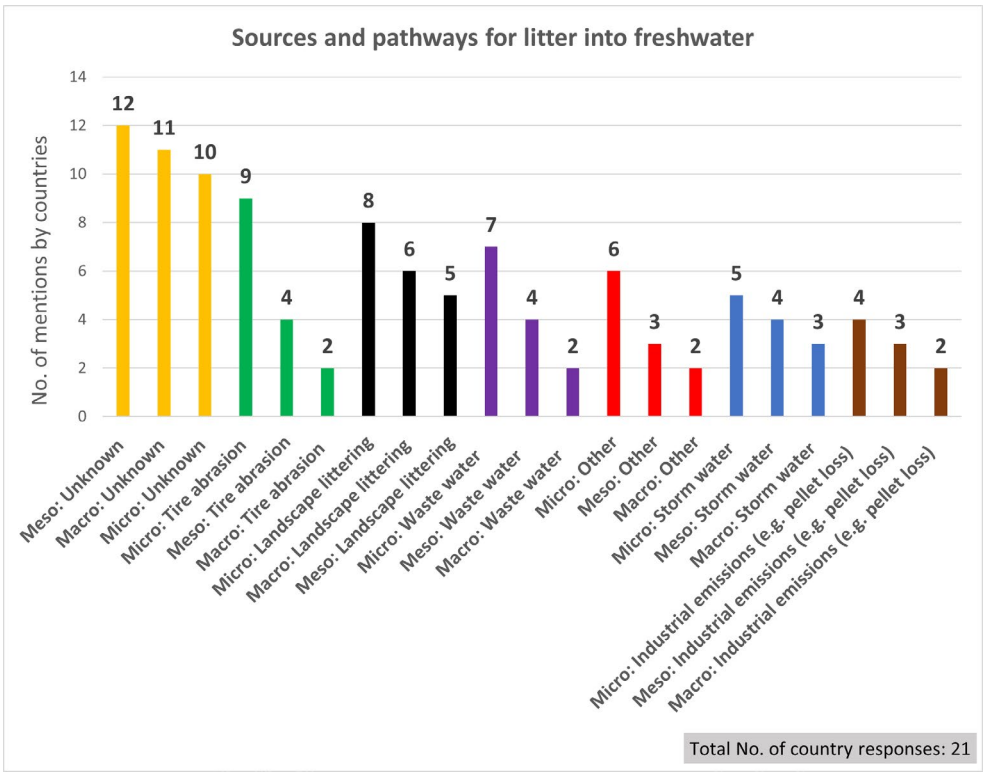
Responses on sources and pathways for freshwater were provided by 21 countries for microlitter, 18 countries for mesolitter and 18 countries for macrolitter.

No relevant studies are available in LV, LT, SK and FR, while in LU, information will be available after a planned research campaign.

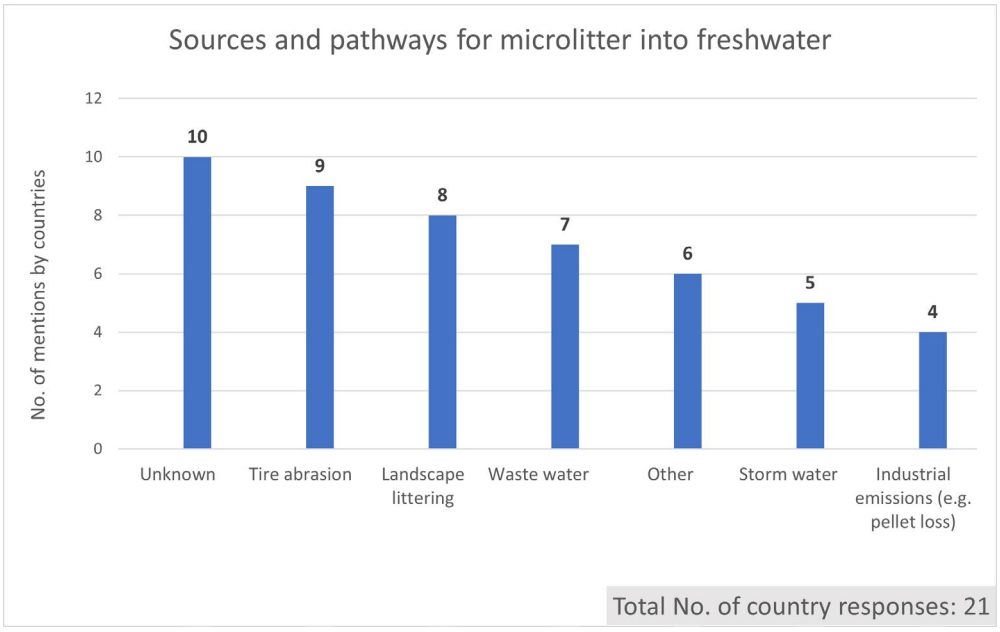
[8] It is noted that these thresholds can differ across countries and/or studies. For example, in the Dutch roadmap on litter monitoring the thresholds are (< 5 mm, 5 – 5cm, > 5 cm). https://edepot.wur.nl/537439.

Figure 2 Responses to question 16 Freshwater Sources & Pathways

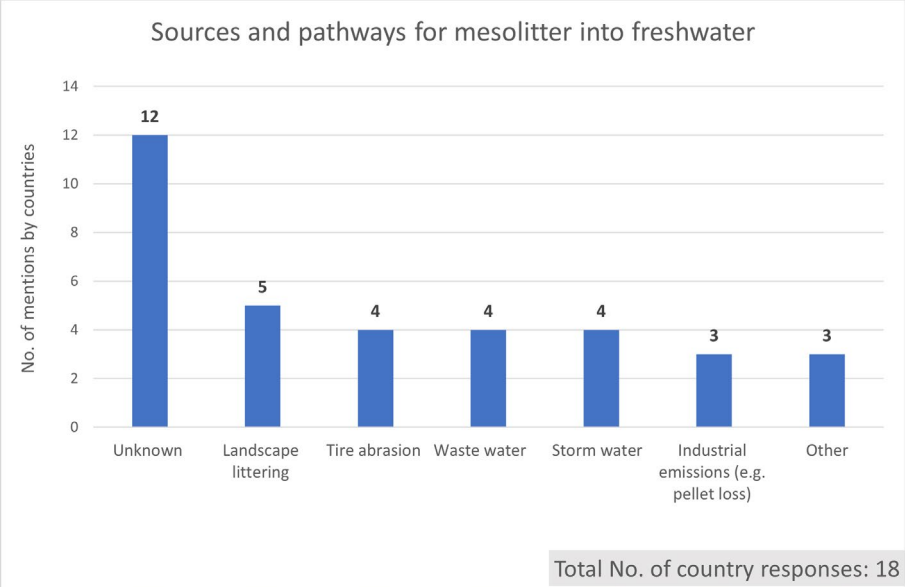
a) Overview



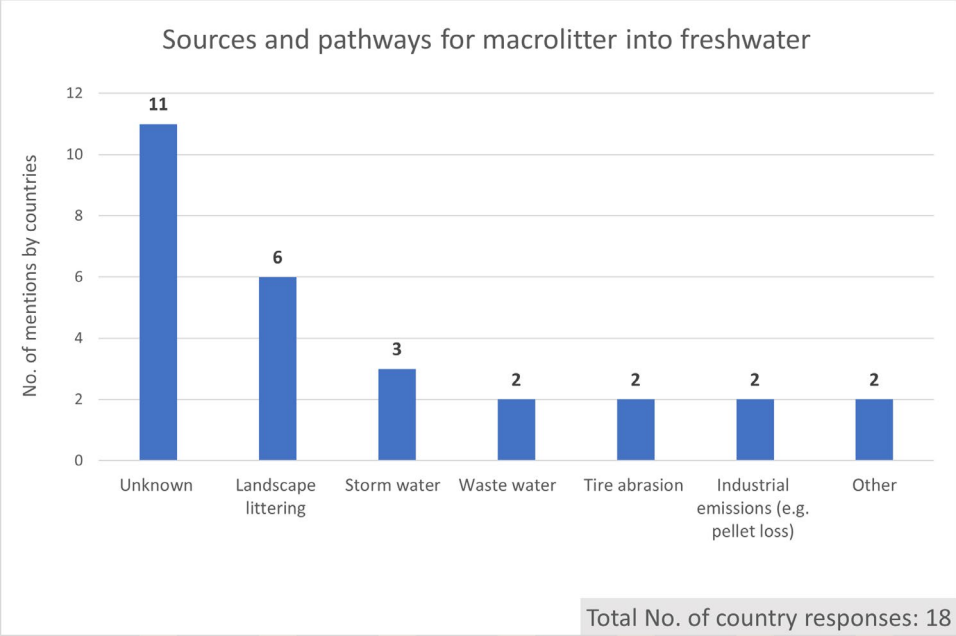
b) Microlitter



c) Mesolitter



d) Macrolitter



Sweden reports that for microplastics (particles below 5 mm), the following are considered to be the main sources:

- Tyre and roadwear particles: ca 8000 tonnes/year
- Textile washing: ca 8-950 tonnes/year
- Boat hull paints: ca 160-740 tonnes/year
- Artificial turf: ca 475 tonnes/year
- Industrial production and handling of primary plastics including pellets: ca 310-530 tonnes/year

Littering has not been quantified but is also considered a large source of microplastics. The main pathways for microplastics are considered stormwater, waste water and air, with stormwater being the main one. In Sweden, no distinction has been made so far between emissions to soil, freshwater or sea, but investigations have looked at emissions to the environment in total.

In **Finland**, information on microlitter is only available from a single Finnish lake (Uurasjärvi et al. 2020)[9]. The research has identified areas close to the wastewater treatment plant discharge pipe, snow dumping site and harbors to have higher concentration of microplastics than in the other studied areas. No information exists of the sources and pathways of meso- and macrolitter.

For the **Netherlands**, the Figure 3 below shows estimated emissions of microplastics.

Figure 3 Estimated emissions of microplastics in the Netherlands

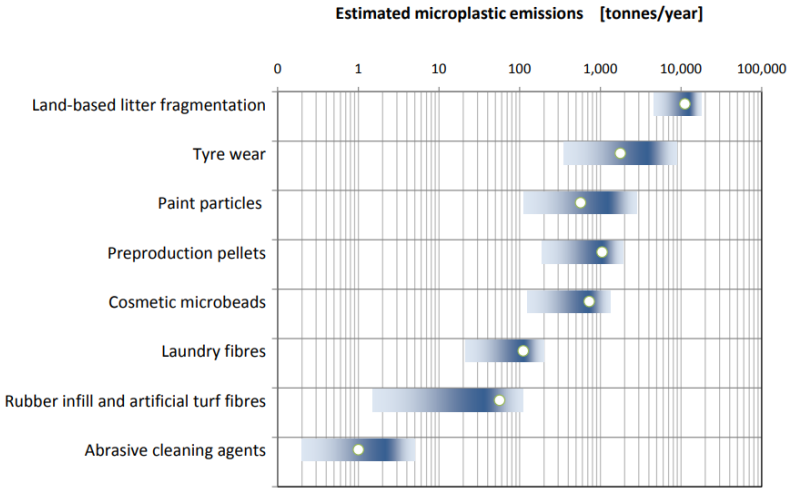


Figure 1 Estimated emissions of microplastics in Netherlands in tonnes/year. Derived from (OSPAR 2017). The columns show the uncertainty margins, and the white dot shows the average value.

Source: Verschoor et al. (2016)[10]

[9] Uurasjärvi et al. 2020. Microplastic concentrations, size distribution, and polymer types in the surface waters of a northern European lake. Water Environment Research 92 (1), 149–156. https://onlinelibrary.wiley.com/doi/10.1002/wer.1229

[10] Verschoor et al. (2016) Emission of microplastics and potential mitigation measures : Abrasive cleaning agents, paints and tyre wear. RIVM 2016 report 0026, https://rivm.openrepository.com/handle/10029/617930

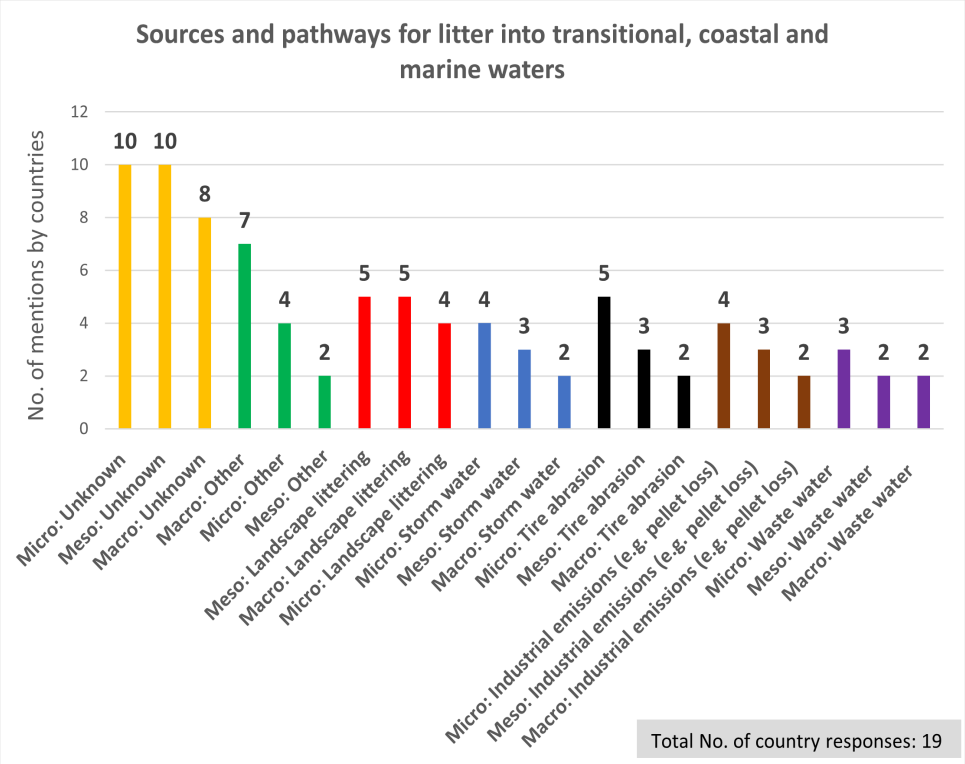
3.2 Transitional, coastal, marine waters

For micro- and mesolitter, no sources can be singled out as most common, as the sources reported are quite equally distributed between countries. The majority of countries though responded unknown sources of these litter categories into transitional, coastal and marine waters.

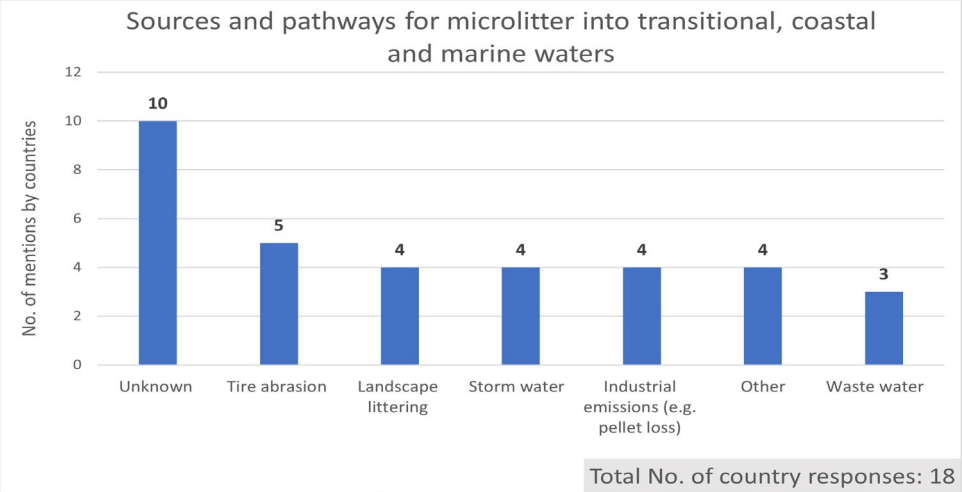
For macrolitter, landscape littering and other sources are the most common source reported, with "other" included snow, illegal landfills, fisheries and shipping, tourism, transboundary litter. Responses on sources and pathways for transitional, coastal and marine waters were provided by 18 countries for microlitter, 17 countries for mesolitter and 19 countries for macrolitter.

Figure 4 Sources & Pathways: Transitional, coastal and marine waters (Question 16)

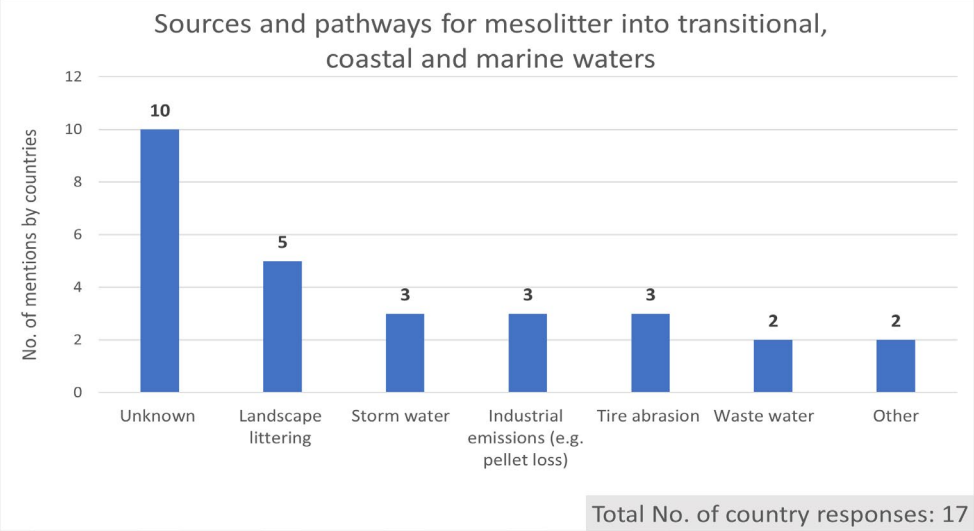
a) Overview



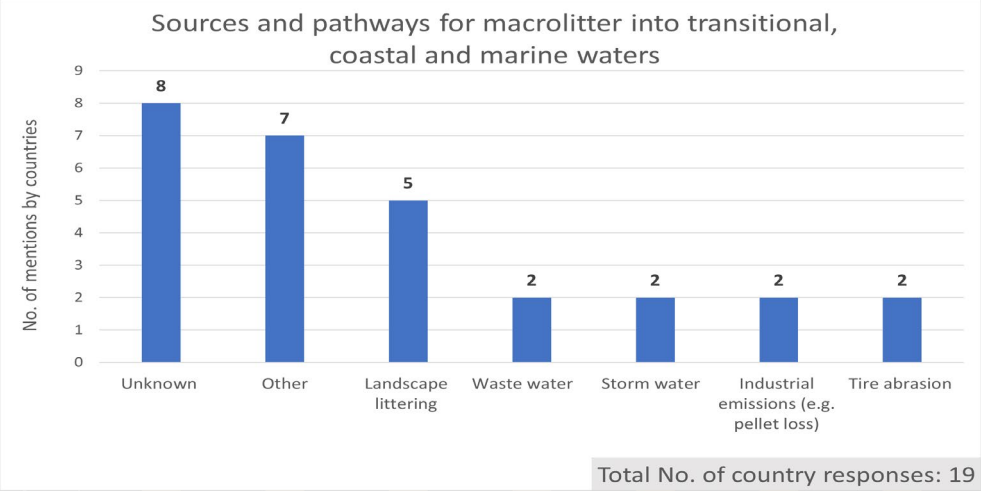
b) Microlitter



c) Mesolitter



d) Macrolitter



Note: The countries with no response tò this question included teạ land-loceạd.cotri es AT, CZ, LU.

A ranking of litter sources and pathways and/or quantitative information was provided by few countries, for example:

For beach macrolitter in **Germany**, Federal State of Mecklenburg-Vorpommern (Schäfer, 2018): [11]

- Tourism and leisure activities (incl. beach-related water sports) 44 %
- Recreational boating & marinas 10 %
- Cargo and passenger shipping 9 %
- Fishing & -ports 9 %
- Cargo and passenger ports 8 %
- land-based industry and commerce 6 %
- offshore industry 5 %
- Wastewater treatment & stormwater drainage 4 %
- Waste management 4%

In **Finland**, in most cases, the sources of different-sized litter have only been recognized, but the amounts of litter produced by each source cannot be estimated. In several coastal cities, the litter management of stormwaters was found not to be at a satisfactory level (Setälä & Suikkanen, 2020).[12] According to the beach litter surveys, on average 55% of the litter originates from recreational use of beaches, 23% from maritime traffic, 11% from the stormwaters, 6% from fishing, 3% from construction and 1 % from illegal dumping.

In Finland, the extent of microplastic emissions to the environment was estimated for some commonly known sources (e.g. tyre abrasion, artificial turfs, pellet loss and textile fibres), among which traffic (tyre abrasion) was estimated as the greatest one (Setälä & Suikkanen 2020).

In **Iceland**, in 2019 a study was done on the origins of microlitter in the environment, estimated quantities and main pathways. The main source of microlitter was from tire abrasion (over half of the estimated amount). Further, there was paint both from houses, ships and road markings and then laundry.[13]

In **Malta**, sources of macrolitter are monitored under the framework of the monitoring programme for Malta‘s marine waters under the MSFD. The updated initial assessment under the MSFD reported that fishing, public litter, shipping and run-off from land were identified as some of the main contributors to litter in coastal and marine waters.[14] Microlitter has not yet been monitored within the MSFD framework. This will be addressed in the upcoming monitoring programme for Descriptor 10. However, under the Programme

[11] Schäfer, E. (2018). Quellenanalyse anhand der Strandm lldaten aus dem Spülsaummonitoring M-V: Praxisanwendung der Matrix-Scoring-Methode auf die Ostseeküste Mecklenburg-Vorpommerns. - Bericht erstellt im Auftrag des Landesamtes für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern (LUNG). https://muell-im-meer.de/aktivitaeten/quellenanalyse-anhand-der-strandmuelldaten-aus-dem-spuelsaummonitoring-m-v

[12] Setälä & Suikkanen, 2020. Suomen merialueen roskaantumisen lähteet. Suomen ympäristökeskuksen raportteja 09/2020. (report in Finnish, summary available in English, “Sources of litter in the Finnish sea areas”) https://helda.helsinki.fi/handle/10138/313542

[13] https://harkanatta.github.io/orplastskyrslaUAR/helstu-uppsprettur-orplasts-a-islandi.html

[14] For further information, see https://era.org.mt/wp-content/uploads/2020/06/MSFD-Art.-17-Update-Malta_FINAL.pdf.

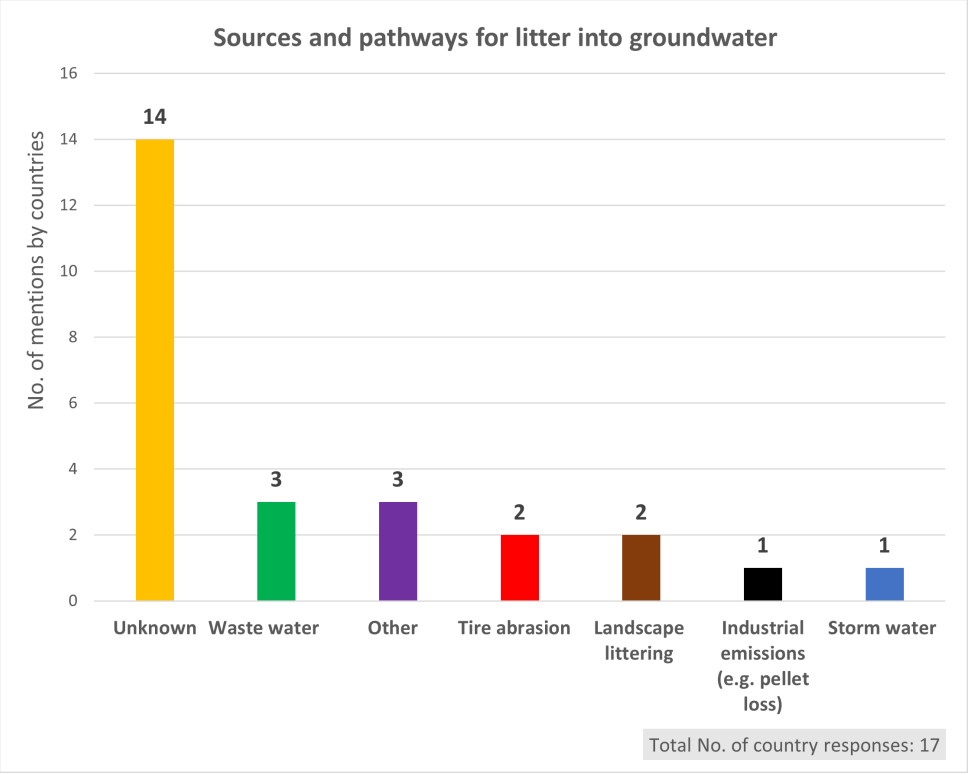
of Measures within the Water Framework Directive, listed in Malta's 2nd RBMP, Malta has studied microplastics in sediments of Malta's spoil ground.

In **Denmark**, concerning microlitter, the Danish Environmental Protection Agency has focused research and monitoring activities on sampling methodology and spatial distribution. Sources and pathways for microlitter input to transitional, coastal and marine waters are only addressed indirectly through these activities. Results are for the most part in preparation. No specific monitoring is available for the mesolitter size fraction. For the macrolitter size fraction, Danish monitoring in the marine environment is composed of monitoring of beach litter and sea floor litter. 2015-2019 sources of litter on Danish beaches varied but are for the most part unknown. On North Sea facing beaches, the dominant known source was fisheries and for inner Danish waters and the Baltic area, the main known source was tourism (Feld et al., 2019).[15]

3.3 Groundwater

Responses on litter sources and pathways for groundwater were provided by 17 countries. The majority of countries responded that the sources and pathways for litter into groundwater are unknown, and only few countries reported some specific sources as indicated in the Figure below. HU, LV, SK and SE reported to have no research or specific studies on sources of litter for groundwater.

Figure 5 Sources & Pathways: Groundwater (Question 16)



[15] Feld L, Metcalfe RA & Strand J. 2019. Mængder, sammensætning og trends i udviklingen af marint affald på danske referencestrande. Aarhus Universitet, DCE – Nationalt Center for Miljø og Energi, 44 s. - Videnskabelig rapport nr. 359 http://dce2.au.dk/pub/SR359.pdf

3.4 Soil

For microlitter, a few countries report tire abrasion, landscape littering and stormwater as sources into soil. The majority of countries report unknown sources and pathways.

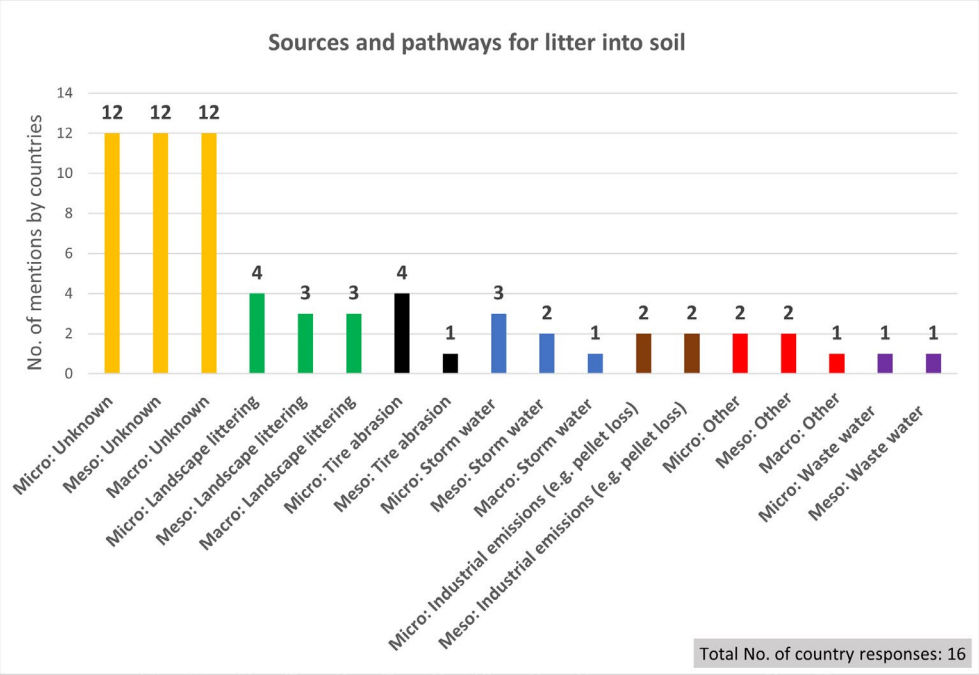
For mesolitter, a few countries report landscape littering, stormwater and industrial emissions as sources into soil. Similarly to microlitter, the majority of countries report unknown sources and pathways.

For macrolitter, a few countries report landscape littering as source but for the vast majority, the sources into soil are unknown.

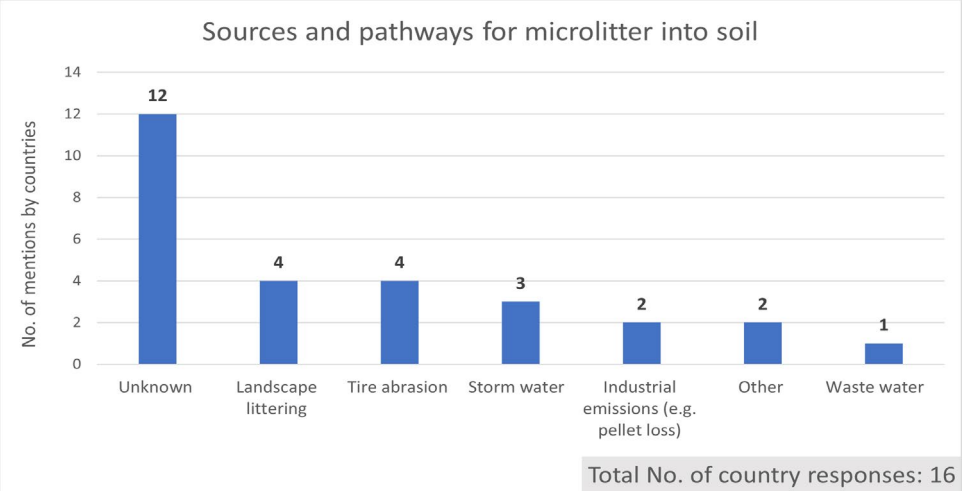
Responses on sources and pathways for soil were provided by 16 countries for microlitter, 15 countries for mesolitter and 15 countries for macrolitter. For several countries, data and information from relevant research is currently not available (e.g. FI, MT, LV, SK).

Figure 6 Sources & Pathways: Soil (Question 16)

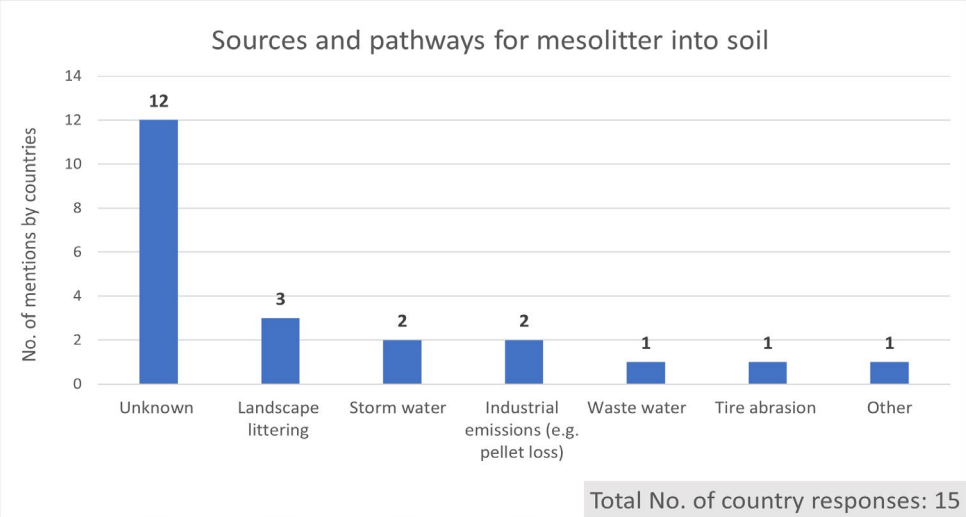
a) Overview



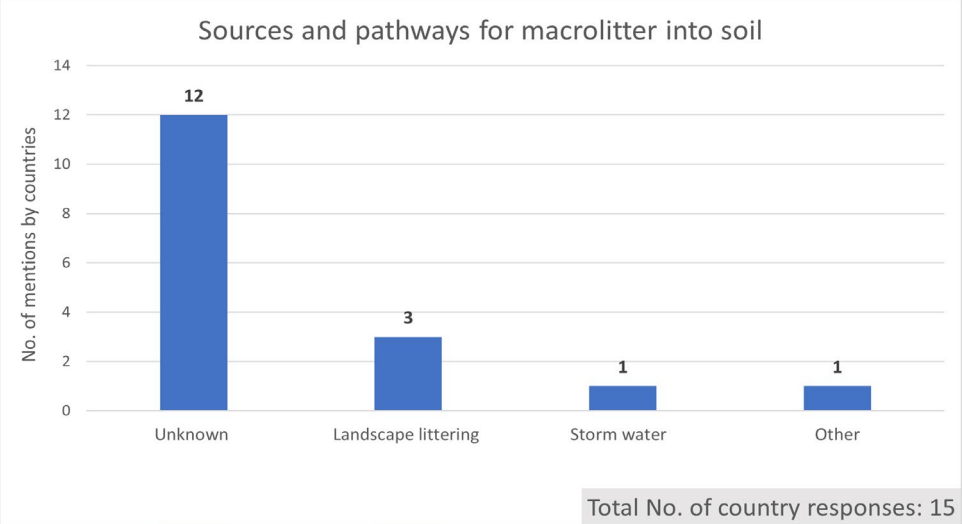
b) Microlitter



c) Mesolitter



d) Macrolitter



4 Overview of research, monitoring and effect studies

4.1 Litter in freshwater environments

ECOSTAT experts were asked to indicate the availability of research and monitoring studies on litter as well as on studies on effects of litter in their country. Table 1 summarises responses on the availability of these types of studies per country.

Research studies have been reported by a larger number of countries compared to monitoring and effect studies. 20 of 28 countries report one or more research studies performed or planned on litter in freshwater environments.

More than one-third of countries (12 of 28) report completed or ongoing monitoring studies, but more than one-third of countries (10 of 28) report to have studies available on effects of litter in freshwater environment.

Also more than one-third of countries (12 of 28) report to have (further) plans for monitoring activities on national/regional/other level for litter in freshwater environments.

Table 1 **Availability of research, monitoring and effect studies of litter in freshwater environments, and (further) monitoring plans, by country.**

Country (alphabetically)	Research studies (Y/N), Q2	Monitoring studies (completed and ongoing) (Y/N), Q6	Studies on effects of litter, (Y/N), Q10	(Further) plans for monitoring litter, (Y/N), Q17	
AT	Y	Y	Y	N	
BE	Y	Y	Y	N	
BG	N	N	N	Y	
CY	Y	N	N	N	
CZ	Y	Y	N	Y	
DE	Y	Y	Y	Y	
DK	N	N	N	N	
EE	Y	Y	N	Y	
EL	N	N	N	N	
ES	Y	Y	Y	Y	
FI	Y	N	Y	N	
FR	Y	Y	N	Y	
HR	N	N	N	N	
HU	N	Y	N	N	
IE	Y	N	Y	n.a.	
IS	N	N	N	N	
IT	Y	Y	N	Y	
LT	N	N	N	n.a.	
LU	Y	N	N	N	
LV	Y	N	n.a.	N	
MT	Y	N	N	Y	
NL	Y	Y	Y	Y	
NO	Y	N	N	Y	
PL	n.a.	n.a.	n.a.	n.a.	
PT	Y	N	Y	N	
RO	Y	Y	Y	Y	
SE	Y	Y	Y	N	
SK	Y	Y	N	Y	
Total Y responses	20	12	10	12	
Total N responses	7	15	16	13	

Notes on table:

Y	= Yes (available)
N	= No (not available)
n.a.	= N.a. = no answer (no details in text response in MS questionnaire).
unclear (Y & N)	The question was answered yes and no by the respondent and is therefore unclear and treated as n.a..

Q2, Q6, Q10, Q17 =

Q2. Is research on litter in freshwater environments performed/planned in your country?

Q6. Are there details available on completed and ongoing monitoring studies on litter in freshwater environments?

Q10. Are there studies available on effects of litter in freshwater environments?

Q17. Are there (further) plans for monitoring activities on national/regional/other level for litter in freshwater environments?

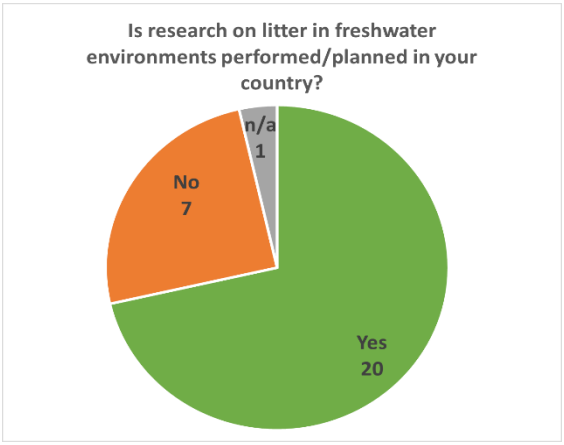
4.1.1 Research studies on litter in freshwater environments (Question 2)

Q2. Is research on litter in freshwater environments performed/planned in your country?

20 countries, i.e. more than two-thirds of the respondents, report to have performed or to plan research on litter in freshwater environments. Research studies are carried out by a variety of actors, including both researchers and regulatory authorities.

Countries were also asked to indicate the methods which are/were used in research performed or planned. Information on the methods is summarised in Table 2 below.

Figure 7 Freshwater Research Studies (Question 2)



N.a. = no answer (no details in text response in MS questionnaire).

Table 2 Research studies on litter in freshwater environments (Question 2)

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
AT Plastic in the Danube	Aim to investigate micro plastic particles larger than 500 µm in the flow of the Danube river in Austria. A method specifically developed to investigate the horizontal and vertical variability of plastic transport by multi spot sampling was applied and an annual average of plastic transport was calculated.	Sampling by > 500 µm net; visual preselection; ATR-FT-IR spectroscopy.	Hohenblum et al. 2015, https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0547.pdf
AT Joint Danube Survey 2019		a) Sampling – sedimentation box, thermoanalytical detection (TED-GC/MS) by UBA Berlin. 2 sampling sites in Austria; b) Microplastic in Asian clam; MicroFTIR sprectroscopy. 1 sampling site in Austria	Detail see Chapter 42 and 44: http://www.danubesurvey.org/jds4/about
AT PlasticFree Danube	Macro plastic waste in and along the Danube which focused on macro-plastic pollution, i.e. plastic particles larger than 5 mm, in and along the Danube. The aim of the project was to establish a sound level of knowledge on plastic pollution and to define standardised methods for assessing sources of input, quantities, transport behaviour and environmental hazards. Data collection and analysis will be followed by the development of measures to reduce releases.	n.a.	https://plasticfreeconnected.com/

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
BE	To inventorise the occurrence of microplastics in inland waters and its sources (such as municipal wastewater treatment plants and runoff from highways).	Sampling: samples were collected using a telescopic arm, in 10 litre-bottles. Sample preparation: digestion of organic matter, followed by density separation to remove sediment particles, and filtration Detection: extraction of microplastics and detection with FTIR spectroscopy Quality control: sampling was performed wearing a cotton overall; control samples were processed to estimate any contamination during sampling and preparation	Vercauteren, M., Semmouri, I., Van Acker, E., Pequeur, E., Van Esch, L., Uljee, I., Asselman, J., Janssen, C. (2021). Onderzoek naar verspreiding, effecten en risico's van microplastics in het Vlaamse oppervlaktewater. Opdrachtgever: Vlaamse Milieumaatschappij. Universiteit Gent & VITO. https://www.vmm.be/publicaties/onderzoek-naar-verspreiding-effecten-en-risico2019s-van-microplastics-in-het-vlaamse-oppervlaktewater-kernrapport/@@download/attachment/Kernrapport-microplasticonderzoek-finaalUGent_TW.pdf (Short summary of this report in English: https://vito.be/en/news/microplastics-flemish-surface-water)
CY		n.a.	Academia might occasionally have relevant projects. Research paper in https://doi.org/10.1016/j.ecoenv.2022.113213 is relevant.
CZ CEVOOH project	Project underway as part of the national program "Environment for Life", which focuses among other things, on research into the content of microplastics in sewage sludge and sediments. The research includes a case study for which sampling is currently underway at 11 wastewater treatment plants. The first results	Analytical methods such as IR microscopy, Raman microscopy and GC-MS are used.	https://cevooh.cz/en

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
	of this research are to be completed by the end 2022.		
CZ Joint Danube Survey 2019		Sampling – sedimentation box, thermoanalytical detection (TED-GC/MS) by UBA Berlin. 3 sampling sites in the Czech Republic.	Detail see Chapter 42: http://www.danubesurvey.org/jds4/jds4-files/nodes/documents/jds4_scientific_report_45mb.pdf
DE Bavaria		n.a.	Bavarian lakes: https://www.lfu.bayern.de/analytik_stoffe/mikroplastik/bayerische_seen/index.htm Rivers in Southern and Western Germany: https://www.lfu.bayern.de/analytik_stoffe/mikroplastik/laenderbericht_2018/index.htm Small Bavarian Rivers: https://www.micbin.de/ (report will be published in 2022) Recently started project: Risk assessment of microplastics in Bavarian surface waters
DE Thuringia		n.a.	Projects/studies: Exemplary investigation of Microplastic contamination in the river Saale

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			https://tlubn.thueringen.de/fileadmin/000_TLUBN/Wasser/Fluesse_und_Baeche/Dokumente/Gewaesserguete_UEberwachung/Ergebnisbericht_FINALE_VERSION_30.04.2020.pdf
EE		Microplastic was measured in rivers, stormwater and wastewater. Quantitative information is given as piece per m3. Also different kind of plastic were identified (FTIR spectroscopy). Samples were collected using Manta net and 200 l of water. In lab the samples sieved through 4 different metal sieve (5 mm, 1 mm, 0,3 mm, 0,1 mm). The litter particles analysed using stereomicroscope and categorized (size, type, color)	Mikroplasti allikad ja levikuteed Eesti rannikumerre, m_ju pelaagilistele ja bentilistele organismidele.pdf (envir.ee)
ES		n.a.	Research on litter in freshwater environments has been mostly developed in Spain as part of the implementation of MSFD. Link: https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/23-414-5-010_informe_identificaciondefuentesyestimaciondeaportesdemicroplasticos_tcm30-486438.pdf https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/estrategias-marinas/default.aspx

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			Below some evidence from scientific works being currently conducted in Spain about microplastics in riverine areas: Dalmau-Soler, J., Ballesteros-Cano, R., Boleda, M. R., Paraira, M., Ferrer, N., & Lacorte, S. (2021). Microplastics from headwaters to tap water: occurrence and removal in a drinking water treatment plant in Barcelona Metropolitan area (Catalonia, NE Spain). *Environmental Science and Pollution Research*, 1-11. Muez, D. L., Pe alver-Duque, P., Muo z, M., Infante, O., Santos, S. G., Giráldez, R. P., & Serrano, L. (2020). Primer muestreo de microplásticos en arroyos y ríos de la Espa a peninsular. *Ecosistemas*, *29* (3), 2087-2087. Schell, T., Hurley, R., Nizzetto, L., Rico, A., & Vighi, M. (2021). Spatio-temporal distribution of microplastics in a Mediterranean river catchment: The importance of wastewater as an environmental pathway. *Journal of Hazardous Materials*, *420*, 126481. Schirinzi, G. F., Köck-Schulmeyer, M., Cabrera, M., González-Fernández, D., Hanke, G., Farré, M., & Barceló, D. (2020). Riverine anthropogenic litter load to the Mediterranean Sea near the metropolitan area of Barcelona, Spain. *Science of The Total Environment*, *714*, 136807.

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			Franco, A. A., Arellano, J. M., Albendín, G., Rodríguez-Barroso, R., Zahedi, S., Quiroga, J. M., & Coello, M. D. (2020). Mapping microplastics in Cadiz (Spain): Occurrence of microplastics in municipal and industrial wastewaters. *Journal of Water Process Engineering*, *38*, 101596.
FI		Sampling: - Water: Manta trawl and pump filtration (Uurasjärvi et al. 2020), Limnos water sampler (Viitala 2021). - Sediment: sediment traps (Saarni et al. 2021), Ekman grab sampler (Scopetani et al. 2019) and freeze core (Meronen 2020), Limnos sediment core sampler (Viitala 2021). - Ice and snow: metallic ice drill and spoon (Scopetani et al. 2019) - Fish: trawl and beach seine (Uurasjärvi et al. 2021) Sample pre-treatment: - Organic material digestion: NaOH (Uurasjärvi et al., 2020), enzymatic	Scopetani et al. 2019. Assessment of microplastic pollution: occurrence and characterisation in Vesijärvi lake and Pikku Vesijärvi pond, Finland. Environmental Monitoring and Assessment 191, 652. https://doi.org/10.1007/s10661-019-7843-z Meronen, 2020. A density separation method for microplastics implemented to varved sediments of Lake Kallavesi, eastern Finland. Master's thesis, Department of Geography and Geology, University of Turku. https://core.ac.uk/download/pdf/347181109.pdf Uurasjärvi et al. 2020. Microplastic concentrations, size distribution, and polymer types in the surface waters of a northern European lake. Water Environment Research 92 (1), 149–156. https://doi.org/10.1002/wer.1229 Uurasjärvi et al. 2021. Validation of an imaging FTIR spectroscopic method for analyzing microplastics ingestion by Finnish lake fish (*Perca fluviatilis* and *Coregonus albula*). Environmental Pollution 288, 117780. https://doi.org/10.1016/j.envpol.2021.117780

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
		purification (Uurasjärvi et al. 2021, Viitala 2021), H2O2 (Viitala 2021) - Density separation: lithium heteropolytungstate and centrifugation (Meronen 2020, Saarni et al. 2021), NaCl (Scopetani et al. 2019), sodium tungstate dihydrate (Viitala 2021) Particle quantification and identification: stereomicroscopy coupled with FTIR (Uurasjärvi et al. 2020, Meronen 2020, Saarni et al. 2021), FTIR (Uurasjärvi et al. 2021), visual identification coupled with FTIR (Scopetani et al. 2019), Raman micro-spectroscopy and pyrolysis-gas chromatography-mass spectrometer (Viitala 2021)	Saarni et al. 2021. Sediment trapping – An attempt to monitor temporal variation of microplastic flux rates in aquatic systems. Environmental Pollution 274, 116568. https://doi.org/10.1016/j.envpol.2021.116568 Viitala, 2021. The heterogenous nature of microplastics and the subsequent impacts on reported microplastic concentrations. PhD thesis. Lappeenranta-Lahti University of Technology. https://lutpub.lut.fi/handle/10024/163466
FR LEESU		Laboratoire Eau Environnement et Systèmes Urbains (LEESU) uses visual counting, statistics, GPS tracking;	Comprehensive list of the research projects on litter by the LEESU: https://www.leesu.fr/debris-plastiques-du-macro-au-micro-plastique-presentation?lang=en
FR CEREMA	In order to identify the devices to avoid and/or recover macro-waste in waterways as well as in wastewater, CEREMA (Centre d'études et d'expertise sur les risques, l'environnement, la	This study presents the method used by CEREMA to produce estimates of macro-waste flows discharged by wastewater treatment. This method is based on the	https://www.seine-aval.fr/projet/macroplast/ https://www.cerema.fr/fr/actualites/macrodechets-anthropiques-assainissement-enjeux-leviers

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
	mobilité et l'aménagement) carried out a study: "Macrodéchets anthropiques et assainissement : Enjeux et leviers d'action pour une reduction des flux dans les milieu récepteurs".	mean concentration of macro-waste that arrive to the sewage plant apply to the flow of water discharged.	
FR CEDRE	Collects macrolitter on riverbanks which are then sorted, identified and counted by categories, using the MSFD joint list of litter categories	n.a.	The CEDRE's first report on this action is in preparation. The monitoring method used is adapted from: https://mcc.jrc.ec.europa.eu/main/dev.py?N=41&O=439 https://mcc.jrc.ec.europa.eu/main/dev.py?N=41&O=459 https://www.ospar.org/documents?v=44122
IE	Current project Sources, Pathways and Environmental Fate of Microplastics, aiming at improved understanding of the sources of microplastics and furthermore the pathways, from the sources to aquatic receptors, dispersal within the freshwater system and transfer along the biological food chain.	This study will investigate in detail, through a series of controlled experiments and field monitoring, the effects of abiotic factors, such as rainfall, soil type, river flow, velocity and depth on the pathway attenuation. Information collected will be used to identify critical source areas using the Catchment Characterisation Tool (CCT) ensuring outputs are easily incorporated into the EPA's catchment characterisation toolbox. It also will characterise the potential for point source microplastics derived from treatment plants to be transported long distances and to deposit in stream beds or	

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
		lake sediments and the potential for subsequent re-mobilisation.	
IT ISPRA	ISPRA has set up, in Italy, a survey scheme on 10 rivers monitoring floating macrolitter in station nearby the river mouth starting from 2022. ISPRA regularly monitors floating macrolitter on the Tiber river since 2017. In order to assess the macrolitter flux from source to sea, GPS floating trackers, simulating the behavior of floating waste in river, are in place in several rivers. Track can be followed remotely.	Method: Visual census of floating macro-litter larger than 2.5 cm to be carried out on at least half the width of the river (the observation strip) and from a height not exceeding 10 m. Frequency: Five monitors per season (20 monitors per year).	Protocol RIMMEL (JRC): https://mcc.jrc.ec.europa.eu/main/dev.py?N=simple&O=380&title_page=RIMMEL
IT Eastern Alps RBD	Two research projects recently designed to provide a preliminary framework about plastic litter contamination in the densely-populated area of the Venice Lagoon watershed, providing new methods, data and tools: financed by Veneto Region, it aims to assess the environmental occurrence of microplastics in the Venice lagoon and its watershed; the research program is focused on experimental monitoring of microplastics in both the lagoon and at its main river mouths; to be completed at the end of 2024.		

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
	Conceived and proposed by the Eastern Alps RBD Authority, with the aim to assess the occurrence, fate and transport of microplastics in surface water, in the area of Venice lagoon watershed. It is now being examined by the Italian Ministry of Environment for funds allocation. It will integrate literature review, monitoring and numerical modelling.		
IT Po RBD		Direct observation (RIMMEL), satellite observation, use of floating containers containing geolocation system, floating barriers	https://www.adbpo.it/progetto_adbpo/po-damare/ https://www.adbpo.it/progetto_adbpo/mapp-monitoraggio-applicato-plastiche-po/
LU	Work is carried out on the basis of the microplastics investigations in German country studies in order to ensure the greatest possible comparability	Sampling is carried out using Manta-Trawl for the microplastic fraction and using pump-stands and stainless steel large-area filters with a mesh size of 10 µm for the microplatsic fraction 10-500 µm. Sampling using pump-stands is carried out as a double determination. Potential microplastic particles from the fraction >500 µm are sorted out from the samples under the microscope, individually photo-documented and stored until analysis. The preparation of the size fraction < 500 µm for subsequent analysis is carried out by means of a sequential enzymatic	Löder, M. G. J.; Imhof, H. K.; Ladehoff, M.; Löschel, L. A.; Lorenz, C.; Mintenig, S.; Piehl, S.; Primpke, S.; Schrank, I.; Laforsch, C.; Gerdts, G., Enzymatic Purification of Micro-plastics in Environmental Samples. Environ Sci Technol 2017, 51, (24), 14283-14292

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
		purification process (Löder et al, 2017). At present, spectroscopic methods such as FTIR (Fourier-Transformations-Infrarot) - spectroscopy allow an unambiguous identification and characterization of individual microplastic particles. Indeed the polymer composition, shape and size of the microplastic particles are determined. Depending on the size class, two different FTIR methods are used: Particles larger than 500 µm are individually optically sorted out of the samples and measured by ATR(Attenuated Total Re-flectance)-based FTIR-spectroscopy. Smaller particles < 500 µm are applied to filters after enzymatic purification and subsequently identified by FPA (Focal Plane Ar-ray)-based Micro-FTIR-spectroscopy.	
LV		Manta trawling, sediment cores	https://talsunovads.lv/wp-content/uploads/2021/02/LVAF-mikroplastmasa-atskaite-rekomendacijas_LHEI-2021.pdf Over the time period of 2019-2020 Latvian Institute of Aquatic Ecology carried out a Latvian Environmental Protection Fund project "Development of recommendations for acquisition and analysis of data on the presence of microplastic pollution in freshwater

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			ecosystems with different protection statuses and degrees of pollution".
NL		Randomized OSPAR plastics monitoring for urban riverbanks	IPCR-report Plastics in de Noordzee en de bijdragen van de rivieren - een update (2019) (in Dutch)
NO		n.a.	The Norwegian Research Council is part of an ongoing four-year collaboration with the Norwegian Retailers' Environment Fund to announce donations of NOK 20 million to research on the environment and society. The Research Council has strengthened its commitment to a circular economy, where plastics are one of several important focus areas. The Research Council's strategy, "Empowering ideas for a better world", aims to invest in research and innovation to achieve a "circular economy with sustainable production, services and consumption systems".
PT		n.a.	Some projects/research groups which collect data on this subject, as in the example provided below: Rodrigues, M.O., Abrantes, N., Gonçalves, F.J.M., Nogueira, H., Marques, J.C., Gonçalves, A.M.M., Spatial and temporal distribution of microplastics in water and sediments of a freshwater system (Antuã River,

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			Portugal)",Science of The Total Environment, Volume 633, 15 August 2018, Pages 1549-1559.
RO	Microplastic quantitative and qualitative evaluation in water and sediments in Danube River, Danube Delta, Buzău River and Siriu (artificial) Lake.	Sampling cca. 1 litre of sediment, extraction of plastic particles after digestion and gravitational separation, visual inspection for quantification and qualitative analysis using spectrometric equipment (FT-iR and GC-MS)	Microplastic pollution evaluations (2018-2020) on Danube and deltaic areas https://agrolifejournal.usamv.ro/pdf/vol.X_2/Art18.pdf EGU2019-8357.pdf (copernicus.org); Sedimentary microplastic concentrations from the Romanian Danube River to the Black Sea | Scientific Reports (nature.com)
SE Various studies		n.a.	- Microplastic surveys in the 4 largest lakes in Sweden. https://miljobarometern.stockholm.se/content/docs/tema/vatten/miljogifter/webb%20Rapport%20Mikroplaster%20i%20Stora%20sj%C3%B6ar%20slut.pdf - Towards the Control of Microplastic Pollution in Urban Waters. http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-171095 - Pathways of Microlitter from road traffic in Gothenburg city, studied runoff to a creek: Link - Drinking water – The Swedish Food Agency has compiled knowledge about health risks with micro plastics and plastic nanomaterials. The Agency has looked into how much such pollutants there are in the drinking water in Sweden. The work was carried out as part of a government assignment. The conclusion in the report to the

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			Government in April 2020 was that amounts are relatively low and therefore not assumed to affect health according to current knowledge. https://www.livsmedelsverket.se/globalassets/om-oss/regeringsuppdrag/rapport-mikro-och-nanoplast-i-dricksvatten.pdf - Drinking water from Vomb waterworks, Scania, Sweden, has been analyzed for microplastics: number of particles, mass and polymer type. No real difference between the two distribution pipes, of different age, could be observed. The results indicate no considerable load of polyethylene from the long pipes. The content of microplastics appears to be 500 to 5000 times lower than in packaged drinking water. http://vav.griffel.net/filer/svu-rapport-2020-14.pdf - The report contains methods and results from an initial survey of microplastics in the wastewater engineering cycle. The results give a picture of how the content of microplastics can appear in the analyzed fractions influent wastewater (after screen), effluent wastewater, sludge, soil fertilized with sludge and digestate, as well as the types of microplastics that may occur in the fractions. http://vav.griffel.net/filer/svu-rapport-2018-13.pdf - Bondelind, M., Sokolova, E., Nguyen, A. et al (2020), Hydrodynamic modelling of traffic-related microplastics discharged with stormwater into the Göta River in Sweden. Environmental Science and Pollution Research,

Country (alphabetically)	Aims/other information	Methods	Research studies, sources
			27(19): 24218-24230, http://dx.doi.org/10.1007/s11356-020-08637-z

Source: Based on questionnaire responses

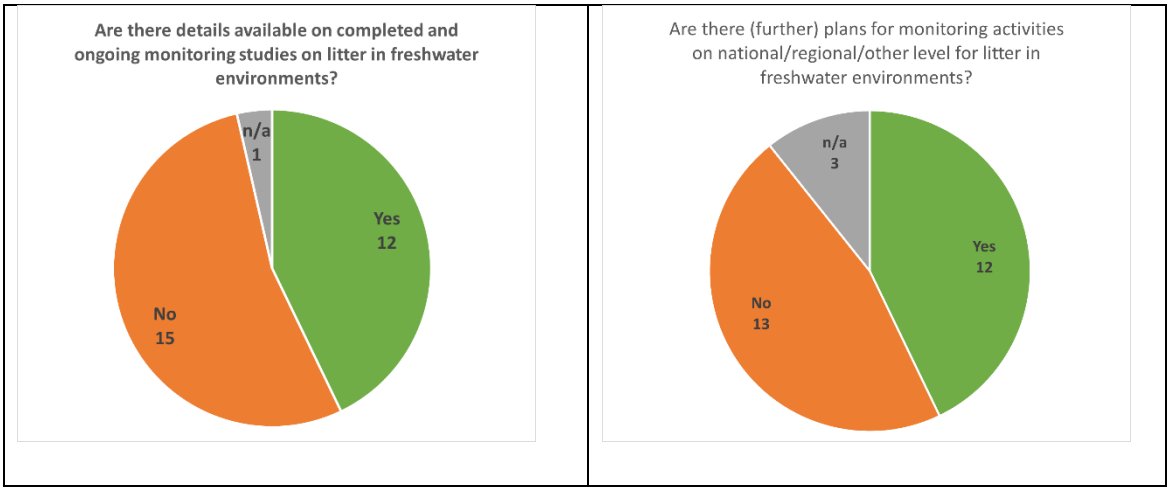
N.a. = no answer (no details in text response in MS questionnaire).

4.1.2 Completed, ongoing and planned monitoring studies on litter in freshwater environments (Questions 6 and 17)

Q6. Are there details available on completed and ongoing monitoring studies on litter in freshwater environments?

Q17. Are there (further) plans for monitoring activities on national/regional/other level for litter in freshwater environments?

Figure 8 Freshwater Monitoring (Questions 6 and 17)



N.a. = no answer (no details in text response in MS questionnaire).

12 of 28 countries reported to have completed or ongoing monitoring studies on litter in freshwater environments. Some of these countries provided details on sampling, sample preparation and litter detection methods, while others provided only links to available documentation in national language for further details.

Table 3 below summarises information provided in the questionnaire responses on sampling and analytical methods used in the monitoring studies reported in the questionnaires.

Overall, monitoring studies on litter in freshwater environments still seem to cover only selected European rivers and lakes, and relevant monitoring studies on national level are missing, as similarly concluded by Bänsch-Baltruschat et al. (2017)[16]. There are few exceptions of national and transnational river monitoring programmes, e.g. the Dutch river monitoring programme and the Joint Danube Survey.

Some countries without monitoring studies provided explanations on gaps and challenges faced, in particular:

In **Portugal**, there are no systematic litter monitoring programs in freshwater. There are some projects and NGO volunteer actions collecting information, but the results are still scarce and dispersed by institutions, being only known to a limited number of people (i.e. not displayed officially)

[16] Bänsch-Baltruschat et al. (2017), Conference on Plastics in Freshwater Environments, on behalf of German Environment Agency DOKUMENTATIONEN 05/2017.

In **Latvia**, microlitter monitoring is currently not financially supported by the government and extensive research covering a longer timeline has not been performed.

In **Hungary**, no regular monitoring activity is planned at the moment since the legal background is still completely missing.

Concerning future developments, almost half of countries (12 of 28) report to have (further) plans for monitoring activities on national/regional/other level for litter in freshwater environments. In the majority of cases, these are countries that already have completed or ongoing monitoring studies. Only three countries (BG, MT, RO) that have no existing monitoring studies mention further monitoring plans, in specific:

Bulgaria: In the scope of the 2nd Black Sea RBMP under the WFD, there had been specific measures planned for linking WFD and MSFD related to marine litter (Descriptor 10), e.g. cleaning and removal of unregulated coastal dumps; annual campaigns (spring and autumn seasons) to clean estuaries; implementation of control over waste management in the areas of fishing villages on the territory of coastal municipalities. These measures are also some kind of monitoring, because cleaning activities include also information about the type of waste collected. However, the status of implementation of these measures is unknown or not implemented. Main reasons (problems): non-recognition of measure activities and non-planning of funds in the annual budgets of the responsible institutions (coastal municipalities); lack of human, technical and financial capacity to implement the measures.

Malta: As part of an upcoming LIFE-IP project, with overall objective to develop and implement monitoring strategies addressing the presence of Chemicals of Emerging Concern (CECs) in surface water, rainwater runoff, groundwater and new water, some of monitored CECs are chemicals that are used widely in the residential context, in particular in the plastic industry.

Romania: See details in Table 3 below.

ECOSTAT experts were also asked to indicate whether the quality of the results in their monitoring studies has been or will be assured and how. Only the Netherlands and France addressed this issue with reference to their planned monitoring activities. In the Netherlands, Quality assurance (QA) has not yet been applied to the monitoring results, but this will be part of the Dutch riverine monitor programme that is to be in place in 2023/2024. In France, the QA of results in future monitoring activities is planned as 1) cross checking results between monitored sites to detect potential anomalies, and 2) opportunistic triplicate sampling for litter captured at the outlet of sewage systems.

In the following paragraphs, some of the monitoring studies reported are presented in more detail.

Austria, study "Plastic in Danube" (Hohenblum et al. 2015):[17] The aim of the study was to investigate microplastic particles larger than 500 µm in the flow of the Danube River in Austria. Two sampling sites were chosen at Aschach (Upper Austria) and Hainburg (Lower Austria) and five samples were taken at different discharges at each site. A method specifically developed to investigate the horizontal and vertical variability of plastic transport by multi spot sampling was applied and an annual average of plastic transport was calculated. Methods applied were: Sampling by > 500 µm net; visual preselection; ATR-FT-IR

[17] Hohenblum et al. (2015). Plastik in der Donau. Untersuchung zum Vorkommen von Kunststoffen in der Donau in Österreich. https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0547.pdf

spectroscopy. The study concluded that plastic particles show properties of suspended particles rather than floating particles and can be encountered in the entire river profile. It could also be shown that higher concentrations occur banksides. The majority of plastic particles sampled in the Danube River were identified as polyethylene and polypropylene. They are the most abundant plastic types and amount to up to 70% of the 280 Mio. tons of plastics produced annually worldwide. 90% of the plastic particles in the Danube river are emitted by diffuse sources by avulsion, aeolian transport, waste water and by littering. Around 10% of the particles found can be attributed to industrial activities such as production, conversion or transport/logistics.

Several countries, Austria, Bulgaria, Czechia, Germany, Hungary, Romania and Slovakia were involved in the **Joint Danube Survey 4**, performed in 2019 (ICPDR, 2020).[18] The Survey included a first comprehensive screening of microplastics over the entire course of the Danube River. Sampling was performed by means of deploying sedimentation boxes into the river for 14 days. Sieving was used for sample preparation. Thermo-analytical detection (TED-GC/MS) was used for determination of the total content of various plastic polymers in the collected suspended particulate matter samples. For the first time, a baseline of pollution by microplastics in the Danube River Basin has been established. In all samples almost, all analyzed polymers were detected and quantified, whereas there is no clear trend along the Danube with increasing or decreasing contents. The study concludes that due to the lack of data on microplastics in suspended particulate matter (SPM) in other rivers, a comparison with other studies is difficult. Such comparison is also hampered by the lack of harmonized investigation concepts and methods. There is an obvious need to obtain further data using the same methodology in the Danube river basin, but also in other large European rivers, such as the Rhine and Elbe.

Netherlands, National macrolitter monitoring strategy[19]: A report by van Emmerik & Vriend (2021) presented a Roadmap for a national macrolitter monitoring strategy in Dutch rivers as a tool for decision-making and planning of steps required to develop a national monitoring strategy. To date, monitoring in the Netherlands are limited to riverbanks and ad hoc projects on local scales. The Roadmap consists of three level of knowledge. Level 1 focuses on monitoring methods. Level 2 focuses on Baseline measurements of the river components. Level 3 relates to long-term monitoring. Based on the Roadmap, van Emmerik & Vriend (2021) identified 24 specific projects that are required to address all remaining open questions. These projects have been prioritized and clustered: (1) innovative sensing, (2) monitoring protocols, (3) national baseline, (4) long-term monitoring, (5) collaboration & integration, and (6) guidelines & solutions. On the short term (1-3 years), cluster 1 and 2 have the highest priority. These projects will deliver suitable monitoring tools and protocol for the next phase. On the medium term (3-5 years), projects related to cluster 3 should be prioritized to arrive at a first order of magnitude estimate of litter in each river component and its relative importance. In parallel, a start can be made with clusters 5 and 6 to allow smoothen the path for collaboration and integration of monitoring at local, national and international scales. On the long term (>5 year) the main focuses will remain with the long-term monitoring efforts, to allow for reliable hotspot mapping, trend analyses, and evaluation of measures.

[18] ICPDR (2020). Joint Danube Survey 4 Scientific Report: A shared analysis of the Danube River, https://www.icpdr.org/flowpaper/viewer/default/files/nodes/documents/jds4_scientific_report_20mb.pdf

[19] Van Emmerik & Vriend (2021). Roadmap Litter Monitoring in Dutch Rivers, available: https://edepot.wur.nl/537439

Table 3 Specific monitoring studies on litter in freshwater environments (Questions 6 and 17)

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
Completed or ongoing monitoring studies					
AT Plastic in Danube, 2015[20]	Micro plastic particles > 500 µm	Flow of river Some sampling in river biota (fish)	Sampling by > 500 µm net	Visual preselection; ATR-FT-IR Spectroscopy	Two sampling sites in Upper and Lower Austria
AT Plastic in fish, study Upper Austria, 2015 [21]	Plastic particles >500 µm in stomach and intestinal of selected fish species	River biota (fish)	Electrofishing	Binocular: plastic particles classified using classification scheme of Federal Environment Agency	three study stretches in Upper Austrian Danube
CZ and SK Joint Danube Survey 4, 2019[22]	Microplastic	Suspended particulate matter	Sedimentation box was used to sample SPM from the river Danube	Sieving was used for sample preparation. Pyrolysis GC-MS (TED-GC/MS) was used as detection method.	Danube, Morava, Dyje and Svratka
DE-MV	Macrolitter	Water column	Flowed wide-spanned fish trap (mesh size 2 cm)	Sorting according to the OSPAR-protocol, counting and weighing (dry)	Federal State Mecklenburg

[20] Plastic in the Danube (Hohenblum et al. 2015), https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0547.pdf

[21] https://www.land-oberoesterreich.gv.at/Mediendateien/Formulare/Dokumente%20UWD%20Abt_WW/Mikroplastik_in_Fischen_Pilotstudie_in_der_ooe_Donau_2015.pdf

[22] http://www.danubesurvey.org/jds4/jds4-files/nodes/documents/jds4_scientific_report_45mb.pdf

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
River Warnow, since 2016					Vorpommern, river Warnow
DE-TH River Saale[23]	Microplastic	n.a.	n.a.	n.a.	Federal State Thuringia, river Saale
EE Microplastic transmission to the Estonian coastal sea[24]	Microplastic	n.a.	n.a.	n.a.	Estonian coastal sea
FR MACRO-Plast[25] (completed)	Macrolitter	n.a.	n.a.	n.a.	From the Seine River Basin into the ocean
FR	Plastic debris	in urban runoff and fresh water	n.a.	n.a.	n.a.

[23] https://tlubn.thueringen.de/fileadmin/000_TLUBN/Wasser/Fluesse_und_Baeche/Dokumente/Gewaesserguete_UEberwachung/Ergebnisbericht_FINALE_VERSION_30.04.2020.pdf

[24] https://envir.ee/keskkonnakasutus/merekeskkonna-kaitse/uuringud#mikroprgi-uuringud „Mikroplasti allikad ja levikuteed Eesti rannikumerre, mõju pelaagilistele ja bentilistele organismidele“

[25] https://www.seine-aval.fr/projet/macroplast/

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
PLASTOC[26] (ongoing)					
FR PlastiNet	Plastic debris	In urban runoff	Using nets	n.a.	n.a.
HU	n.a.	n.a.	Sampling: suction/pump filter to 50 um	Preparation: H2O2 oxidation, separation based on specific density Analysis: FPA-FTIR microscopy	n.a.
NL various studies	n.a.	River banks Some projects on water surface (floating litter) and water column	n.a.	n.a.	There has been some local (regional) initiatives in freshwater environments (16 studies listed in van Emmerik & Vriend, 2021[27]), many focused on river deltas
NO Mikronor	Microplastic	coastal areas, rivers, lakes and air	Vertical plankton nets (~150 litres; 200 µm), a FerryBox system linked to the seawater intake of a cruise ship (~5000 litres; 100, 200 and 500µm	Combination of scanning micro-fourier-transform infrared spectroscopy (µFTIR) and pyrolysis GC-MS	Broad geographical span from large parts of the Norwegian environment (coastal sites, open marine waters, lakes and

[26] https://www.leesu.fr/projet-plastoc

[27] See list in Table 2 of Roadmap Litter Monitoring in Dutch Rivers, available: https://edepot.wur.nl/537439

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
			meshes), high-volume surface pumps (1000 litres; 200 µm and 50 µm), urban runoff (~2 litres; 50 µm), wastewater treatment plants (~70 litres; 20µm) and one urban river (1000 litres; 200 µm and 50 µm). Soft bottom sediments samples (~600 ml; 50µm also collected, as well as biota		air). Rivers and additional lakes will be sampled in 2022.
SE[28]	Microplastic	great lakes	n.a.	n.a.	n.a.
Planned monitoring studies					
DE DE-MV, River Warnow	micro-, meso- and macroplastic	Water surface and water column	monthly recording - macroplastic on the water surface: observation - macroplastic in the water column: flowed wide-spaned fish trap (mesh size 2 cm) - micro-/mesoplastic in the water column: neuston net 300 µm	n.a.	Federal state Mecklenburg Vorpommern, River Warnow

[28] http://extra.lansstyrelsen.se/vanern/SiteCollectionDocuments/sv/Rapporter-publikationer/2018-2020/Rapport_nr_110_Mikroplaster_Stora_sjoar.pdf

https://www.niva.no/en/projectweb/impasse

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
			- hydrological parameters		
EE	Microlitter and nano particles	Lake, groundwater	n.a.	n.a.	Peipsi lake and cross-border groundwater waterbodies
FI	Litter (including microplastics)	Rivers	n.a.	n.a.	Finnish rivers that belong to the catchment area of the Arctic Ocean
FR			n.a.	1. Capturing litter from sewage systems and analyse according to OSPAR/TSG-ML classifications. Fluxes by count and by mass relative to inhabitants and surface for extrapolations to sites without monitoring. 2. River-OSPAR protocols. Fluxes by count relative to a linear riverbank. 3. Automatic visual counting by cameras on rivers.	
IT	Macrolitter	Riverine inputs of litter entering the sea (floating litter)	n.a.	Visual census of floating macro-litter larger than 2.5 cm to be carried out on at least half the width of the river (the observation strip) and from a height not exceeding 10 m.	

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
				Frequency. Five monitors per season (20 monitors per year). Protocol RIMMEL (JRC)[29]	
NL National macrolitter monitoring strategy[30]	Macrolitter		River bank monitoring using the OSPAR method Monitoring from bridges (using volunteers and (in the future) cameras (mainly counting of different sizes of plastics) Monitoring in the water column (using nets)	n.a.	National
NL Waddensea[31]	Various types of plastics, mass, form and structure	n.a.	n.a.	n.a.	Waddensea-area: Waddenfonds-Eems Dollard canal
RO	n.a.	Water Sediment	Sediment and water sampling, see Campanale et al., 2020	Sediment and water sample processing, see Campanale et al., 2020; for visual identification and	

[29] https://mcc.jrc.ec.europa.eu/main/dev.py?N=simple&O=380&titre_page=RIMMEL

[30] Roadmap Litter Monitoring in Dutch Rivers, available: https://edepot.wur.nl/537439

[31] Waddenfonds steekt geld in aanpak plastic soep –Waddenfonds (in Dutch)

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
				polymer determination, see Pojar et al., 2020, 2021[32]	
SK	Microplastic	n.a.	n.a.	Method for microplastic detection is planned to be developed - in connection with EU newly developed Guidance or regulations	

Source: Based on text responses in MS questionnaires.

N.a. = no answer (no details in text response in MS questionnaire)

[32] References provided:

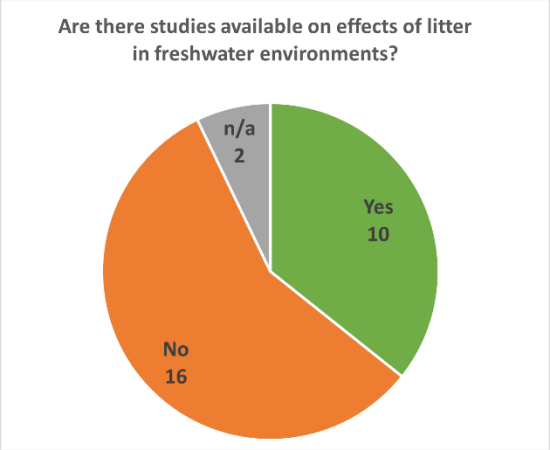
- Campanale, C., Savino, I., Pojar, I., Massarelli, C., & Uricchio, V. F. (2020). A Practical Over-view of Methodologies for Sampling and Analysis of Microplastics in Riverine Environ-ments. Sustainability, 12(17), 6755.
- Pojar, I., Kochleus, C., Dierkes, G., Ehlers, S. M., Reifferscheid, G., & Stock, F. (2020). Quantitative and qualitative evaluation of plastic particles in surface waters of the Western Black Sea. Environmental Pollution, 115724.
- Pojar, I., Stănică, A., Stock, F., Kochleus, C., Schultz, M., & Bradley, C. (2021). Sedimentary mi-croplastic concentrations from the Romanian Danube River to the Black Sea. Scientific re-ports, 11(1), 1-9.

4.1.3 Studies on effects of litter in freshwater environments (Question 10)

Q10. Are there studies available on effects of litter in freshwater environments?

Only ten (out of 28) countries report to have studies available on effects of litter in freshwater environment. The majority of questionnaire responses do not provide details on the methods that were used in these effect studies, but they provide references to the relevant studies for further details (see table 4 below).

Figure 9 Freshwater Effect Studies (Question 10)



N.a. = no answer (no details in text response in MS questionnaire).

In the pilot study Plastic in fish – Study Upper **Austria** (Lumesberger-Loisl & Gumpinger, 2015)[33], electrofishing was carried out in three study stretches in the Upper Austrian Danube and a total of 791 individuals of the fish species chub (*Squalius cephalus*), bleak (*Alburnus alburnus*) and the neozoan gobies (*Ponticola kessleri, Babka gymnotrachelus, Neogobius melanostomus*), in order to examine their stomach and intestinal for the presence of plastic particles. In addition, different individuals of different "food fish species" were examined. All particles >500 µm were analysed under the binocular and the plastic particles found were classified using the classification scheme of the Austrian Federal Environment Agency. The contents of the digestive tract were examined in a total of 840 fish. Only in two individuals, a bleak (*Alburnus alburnus*) and a chub (*Squalius cephalus*) from the Grein region, plastic particles of the categories "pellet" and "film/foil", were detected.

Several of the country responses indicate that overall, there are only very few studies about the impacts of plastic on freshwater biota [34].

[33] Lumesberger-Loisl & Gumpinger (2015). Mikroplastik in Fischen. Pilotstudie in der oberösterreichischen Donau, https://www.land-oberoesterreich.gv.at/Mediendateien/Formulare/Dokumente%20UWD%20Abt_WW/Mikroplastik_in_Fischen_Pilotstudie_in_der_ooe_Donau_2015.pdf

[34] Some references provided:

- The oral intake of polyethylene microparticles represent a risk to rainbow trout's (Oncorhynchus mykiss) health (https://www.isvavai.cz/riv?s=jednoduche-vyhledavani&ss=detail&h=RIV%2F62157124%3A16270%2F20%3A43878835%21RIV21-MSM-16270___)
- Microplastics in water - their analysis and toxicity to aquatic organisms (https://www.isvavai.cz/riv?s=jednoduche-vyhledavani&ss=detail&h=RIV%2F60460709%3A41320%2F20%3A82122%21RIV21-MPO-41320___)

Table 4 Studies on effects of litter in freshwater environments (Question 10)

Country (alphabetically)	Biota and other types of effects	Methods	Study links
AT Plastic in the Danube	Fish	Electrofishing Examination of stomach and intestinal for the presence of plastic particles Examination of parasites	Hohenblum et al. 2015
AT Plastic in fish – Study Upper Austria (2015)	Fish	Electrofishing Examination of stomach and intestinal for the presence of plastic particles Particles >500 µm analysed under the binocular and plastic particles found classified using the classification scheme of the Austrian Federal Environment Agency	https://www.land-oberoesterreich.gv.at/Mediendateien/Formulare/Dokumente%20UWD%20Abt_WW/Mikroplastik_in_Fischen_Pilotstudie_in_der_ooe_Donau_2015.pdf
BE	n.a.	Measured numbers of microplastic particles per litre compared to PNEC values from literature. All measured concentrations in surface water were below these PNEC values.	Vercauteren, M., Semmouri, I., Van Acker, E., Pequeur, E., Van Esch, L., Uljee, I., Asselman, J., Janssen, C. (2021). Onderzoek naar verspreiding, effecten en risico's van microplastics in het Vlaamse oppervlaktewater. Opdrachtgever: Vlaamse Milieumaatschappij. Universiteit Gent & VITO. https://www.vmm.be/publicaties/onderzoek-naar-verspreiding-effecten-en-risico2019s-van-microplastics-in-het-vlaamse-oppervlaktewater-kernrapport/@@download/attachment/Kernrapport-microplasticonderzoek-finaalUGent_TW.pdf (Short summary of this report in English: https://vito.be/en/news/microplastics-flemish-surface-water)

Country (alphabetically)	Biota and other types of effects	Methods	Study links
DE Bavaria	Freshwater mussels Rainbow trout	n.a.	Freshwater mussels Rainbow trout
FI	Whitefish larvae	A full-factorial breeding experiment (Huuskonen et al. 2020) and an exposure study with Daphnia magna (Rotko 2016)	Huuskonen et al. 2020. Do whitefish (*Coregonus lavaretus*) larvae show adaptive variation in the avoidance of microplastic ingestion? Environmental Pollution 262, 114353. https://doi.org/10.1016/j.envpol.2020.114353 Rotko, 2016. Effect of micro- and nanoplastics on lipid soluble pollutants behavior in fresh water environment. Master's thesis. University of Eastern Finland. (in Finnish, summary in English) https://erepo.uef.fi/handle/123456789/16588?show=full
IE	Human health Freshwater environment	n.a.	Research 361 ; 2021 ; Water ; The State of the Art on the Potential ; Human Health Impacts of Microplastics and Nanoplastics ; Imen Gdara, Jenny Lawler, Anthony Staines and Sandra O'Neill Research 377 ; 2021 ; Water ; Impacts of Microplastics in the Irish Freshwater Environment ; Alicia Mateos Cárdenas, Alexandra R.J. Jansen, John O'Halloran, Frank N.A.M. van Pelt, Marcel A.K. Jansen ;
LV	n.a.	n.a.	See "An overview of the results of initial assessments of Finnish, Estonian and Latvian marine areas" at http://gesreg.msi.ttu.ee/en/news
NL	n.a.	n.a.	See for general information and articles website of WUR:

Country (alphabetically)	Biota and other types of effects	Methods	Study links
			https://www.wur.nl/nl/Dossiers/dossier/Microplastics-en-nanoplastics.htm
PT	Benthic invertebrates	n.a.	Silva, C. J., Machado, A. L., Campos, D., Rodrigues, A. C., Silva, A. L. P., Soares, A. M., & Pestana, J. L. (2022). Microplastics in freshwater sediments: Effects on benthic invertebrate communities and ecosystem functioning assessed in artificial streams. Science of The Total Environment, 804, 150118.
RO	n.a.	Microplastic quantitative and qualitative evaluation in water and sediments in Danube River, Danube Delta, Buzău River and Siriu (artificial) Lake. The methodology comprises sampling cca. 1 litre of sediment, extraction of plastic particles after digestion and gravitational separation, visual inspection for quantification and qualitative analysis using spectrometric equipment (FT-iR). The effects of microplastic present in the freshwater bodies are implying transport, provenance, fate and behaviour of the particles in each environment.	
SE	Organisms and environment	n.a.	EFFECTS OF MICROPLASTICS ON ORGANISMS AND IMPACTS ON THE ENVIRONMENT: BALANCING THE KNOWN AND UNKNOWN Giedrė Ašmonaitė, Bethanie Carney Almroth https://gup.ub.gu.se/publication/277179 Exploring the ecotoxicity of microparticle debris by Zandra Gerdes. http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-196762

Source: Based on questionnaire responses

N.a. = no answer (no details in text response in MS questionnaire

4.1.4 Riverine loads of litter and riverine inputs into transitional, coastal and marine waters (Questions 14, 15 and 20)

Question 14. Are there data on riverine loads (mass, particle numbers) of litter available?

Question 15. Are there data on riverine inputs into transitional, coastal and marine waters available?

Question 20. Are there (further) plans for monitoring activities on national/regional/other level on inputs of litter from freshwater systems into saline (transitional, coastal and marine) environments?

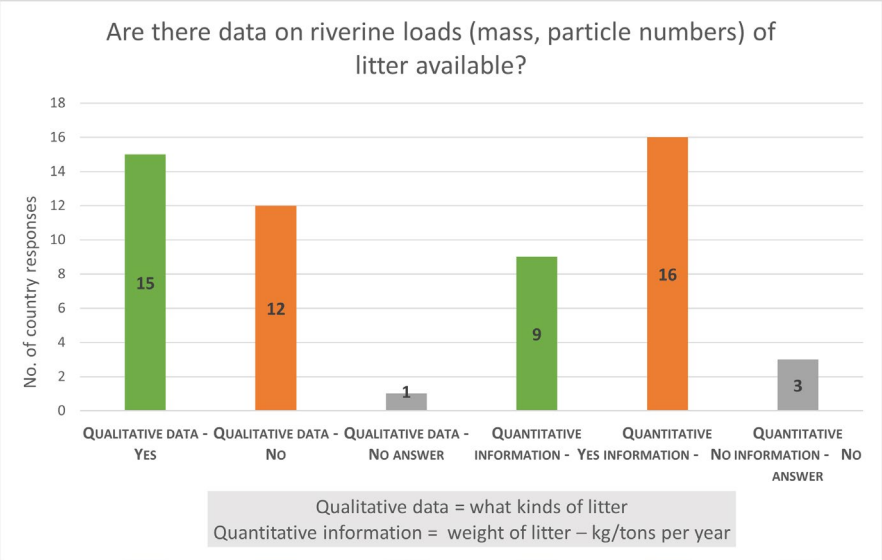
Overall, more qualitative **data on riverine loads** and riverine inputs into transitional, coastal and marine waters are available than quantitative data. 15 of 28 countries have qualitative data on the riverine litter loads (e.g. what kinds of litter), while only 9 countries have quantitative information available, e.g. in terms of weight of litter loads (see Figure 10a)).

Data on riverine inputs into transitional, coastal and marine waters were reported by even fewer countries, namely 8 (of 28) countries have qualitative data and only 6 countries have quantitative data (see Figure 10b)).

Eight countries (BG, ES, LT, LU, MT, PL, SE, NO) indicate to have **(further) plans to monitor inputs of litter** from freshwater systems into saline environments (responses to Q20). Seven of these countries (BG, LT, LU, MT, PL, SE, NO) do not have existing qualitative or quantitative data on riverine inputs (responses to Q15), therefore further plans to monitor such inputs will be a step towards closing this data gap (see Figure 11). ES (Spain) has monitoring activities for litter in freshwater environments in place under the Marine Strategies, and based on the questionnaire response, it is assumed that these are planned to continue.

Figure 10 Riverine loads & Riverine inputs (Questions 14 and 15)

a) Question 14



b) Question 15

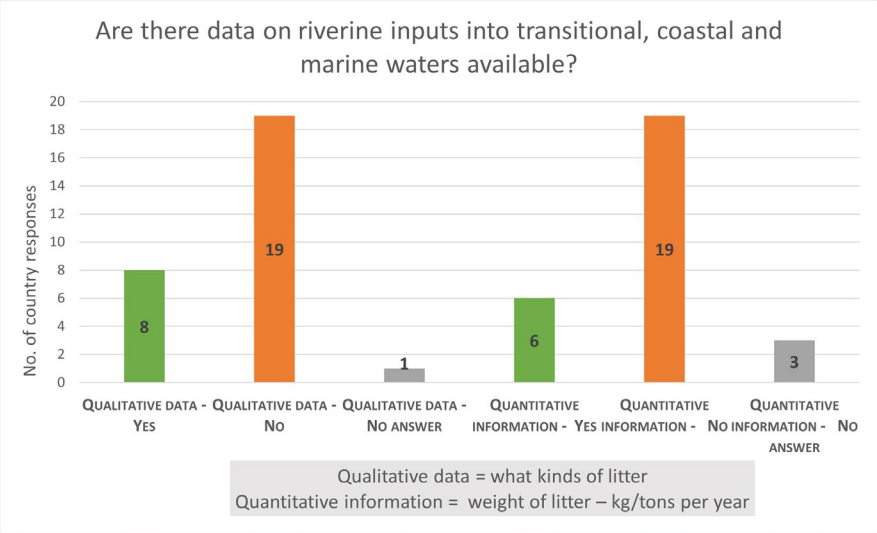
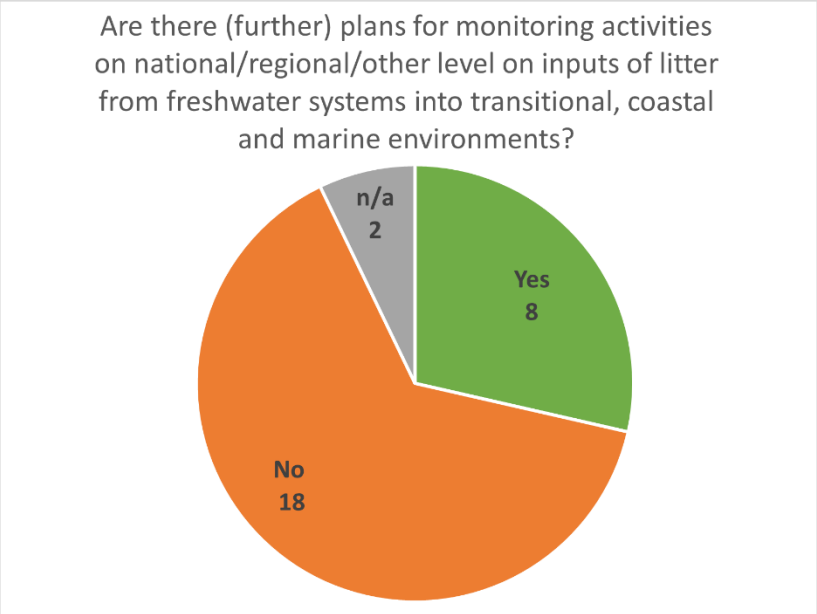


Figure 11 Plans to monitor riverine inputs (Question 20)



N.a. = no answer (no details in text response in MS questionnaire).

Table 5 gives an overview of information sources reported by countries on riverine litter loads and riverine inputs into coastal, transitional and marine waters.

Table 5 Sources of information and data on riverine litter loads and riverine inputs

Country	Source
AT	- Plastic in the Danube (Hohenblum et al. 2015) The study by Hohenblum et al. gave detailed data of distribution and quantities (focus microplastic) for 2 Danube sites. The study gave a more detailed insight into the horizontal and vertical distribution of the different particles in the Danube. Based on annual hydrographs curves an average plastic load was estimated with < 41 tons per year at Hainburg. (Details see report https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0547.pdf - Joint Danube Survey 4, https://www.icpdr.org/flowpaper/viewer/default/files/nodes/documents/jds4_scientific_report_20mb.pdf - Plastic in fish – Study Upper Austria (2015), https://www.land-oberoesterreich.gv.at/Mediendateien/Formulare/Dokumente%20UWD%20Abt_WW/Mikroplastik_in_Fischen_Pilotstudie_in_der_ooe_Donau_2015.pdf
BE	Riverine loads of litter In the study by Vercauteren et al. (2021), the average measured concentration was 0,36 ± 0,81 microplastic particles per litre, or 2,1 x 10-5 ± 8,8 x 10-5 grams of microplastics per litre. These microplastics mainly consisted of polypropylene (52%), polystyrene (46 %), PVC (1%) and polyurethane (1%). Vercauteren, M., Semmouri, I., Van Acker, E., Pequeur, E., Van Esch, L., Uljee, I., Asselman, J., Janssen, C. (2021). Onderzoek naar verspreiding, effecten en risico's van microplastics in het Vlaamse oppervlaktewater. Opdrachtgever: Vlaamse Milieumaatschappij. Universiteit Gent & VITO. https://www.vmm.be/publicaties/onderzoek-naar-verspreiding-effecten-en-risico2019s-van-microplastics-in-het-vlaamse-oppervlaktewater-kernrapport/@@download/attachment/Kernrapport-microplasticonderzoek-finaalUGent_TW.pdf (Short summary of this report in English: https://vito.be/en/news/microplastics-flemish-surface-water) Riverine inputs into transitional, coastal and marine waters In the study by Everaert et al. (2022), a baseline measurement of the influx of litter from Flanders into the marine environment was carried out. In the surface water of the Scheldt they measured 42,9 microplastic particles/m³, and 14.2 g macroplastic/1000 m³. The sediment in the Scheldt contains on average 2757.7 microplastic particles/kg DW. The study also concludes that plastic particles in suspension in the Scheldt estuary move up and down with the tide, but their travel does not extend beyond 20 km from its point source. This suggests that the Scheldt estuary is a major sink for plastics. The most prevalent polymer types in the surface water of the Scheldt are polystyrene (47 %) and polypropylene (41 %). Everaert, G., Asselman, J., Bouwens, J., Catarino, A.I., Janssen, C.R., Shettigar, N.A., Teunkens, B., Toorman, E., Van Damme, S., Vercauteren, M., Devriese, L. (2022). Plastic baseline (t0) measurement in the scope Flemish Integral Action Plan on Marine Litter (OVAM). Plastic t0 study 2020-2021. Flanders Marine Institute, Ostend, Belgium. https://dx.doi.org/10.48470/26

Country	Source
DE	- Federal state Mecklenburg-Vorpommern: Macrolitter monitoring in the water column of the river Warnow. The pilot detection of the "plastic load" of the river Warnow allows an estimate on litter input into coastal waters. - Federal state Bavaria: BMBF-Project MicBin (qualitative and quantitative Study) https://www.bkv-gmbh.de/studien/marine-litter-bericht-vom-land-ins-meer-modell-zur-erfassung-landbasierter-kunststoffabf%C3%A4lle-conversio.html
EE	https://envir.ee/keskkonnakasutus/merekeskkonna-kaitse/uuringud#mikroprgi-uuringud In study „*Mikroplasti allikad ja levikuteed Eesti rannikumerre, mõju pelaagilistele ja bentilistele organismidele*“ [*Sources and routes of microplastic transmission to the Estonian coastal sea, effects on pelagic and benthic organisms*]. Quantitative information is given as piece per m^3. Also different kind of plastic were identified (FTIR spectroscopy). Samples were collected using Manta net and 200 l of water. In lab the samples sieved through 4 different metal sieves (5 mm, 1 mm, 0,3 mm, 0,1 mm). The litter particles analysed using stereomicroscope and categorized (size, type, colour). Mikroplasti allikad ja levikuteed Eesti rannikumerre, mõju pelaagilistele ja bentilistele organismidele.pdf (envir.ee)
ES	https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/23-414-5-010_informe_identificaciondefuentesyestimaciondeaportesdemicroplasticos_tcm30-486438.pdf
FI	Only pilot monitoring of floating riverine litter in rivers discharging into the Baltic Sea has been conducted (Haikonen & Fråne 2018, Haikonen et al. 2018). The pilot monitoring did not produce estimations on the riverine inputs to the sea. Haikonen & Fråne, 2018. Guidelines for the BLASTIC riverine plastic litter monitoring method. https://www.blastic.eu/wp-content/uploads/2019/02/blastic-guidelines-riverine-litter-monitoring.pdf Haikonen et al. 2018. Results and experiences from the plastic litter monitoring in the BLASTIC pilot areas. https://www.blastic.eu/wp-content/uploads/2019/02/blastic-monitoring-report.pdf
FR	https://www.seine-aval.fr/projet/macroplast/ https://www.sciencedirect.com/science/article/abs/pii/S0956053X22000162
IT	Crosti, R., Arcangeli, A., Campana, I., Paraboschi, M., Gonzalez-Fernandez, D., 2018. 'Down to the river': amount, composition, and economic sector of litter entering the marine compartment, through the Tiber river in the Western Mediterranean Sea. Rend. Lincei - Sci. Fis. 29 (4), 859–866. Arcangeli et al., 2021.Floating marine macro litter: Density reference values and monitoring protocol settings from coast to offshore. Results from the MEDSEALITTER project Marine Pollution Bulletin 2020-11 | Journal article, DOI: 10.1016/j.marpolbul.2020.111647 https://www.adbpo.it/progetto_adbpo/po-damare/ https://www.adbpo.it/progetto_adbpo/mapp-monitoraggio-applicato-plastiche-po/

Country	Source
LV	In the framework of project FanpLESStic-Sea, microplastic in two rivers of Latvia was studied (agricultural river Lielupe and industrial river Daugava), registering the number of particles and characteristics (type/shape, size, colour and polymer) of large particles (>500um) and polymer of small particles (10-500um) https://www.swedenwaterresearch.se/en/projekt/fanplesstic-2/project-news/rivers-vectors-for-microplastics-transport-in-marine-environments/ All project reports https://www.swedenwaterresearch.se/en/projekt/fanplesstic-2/outputs-and-reports/
NL	There is a first result from the Rijkswaterstaat monitoring program (Appendix 14.2). Appendix 14.1 - overview made for MSFD Overview plastics Dutch rivers to North Sea for MSFD, J. Worm, 2016 Appendix 14.2 - pilot_monitoring_drijvend_zwerfafval_en_macroplastics (in Dutch) And project LIVES has been carried out (2019-2021): The primary goal of LIVES is realisation of a coordinated cross border approach in reduction of plastic waste in the river Meuse basin. Analysis of the current waste situation, measures for waste reduction such as awareness campaigns and testing litter traps and agreements on sustainability. Although there are several initiatives on a local level, LIVES' objective is to stimulate a coherent cross border approach by determining the broad impact of litter in the river Meuse basin. LIVES – reports: Project results of Litter Free Rivers and Streams, https://litterfreeriversandstreams.eu/project-results/
PT	Some data are available in the project RIMMEL, in which Portuguese institutions participate, and in other projects, but the information is not obtained in a continuous way. https://mcc.jrc.ec.europa.eu/main/dev.py?N=simple&O=380&titre_page=RIMMEL
RO	Microplastic studies of Danube River (Iron Gates area) reveal high concentrations of PET, 31% and PP, 26%. Sedimentary microplastic concentrations from the Romanian Danube River to the Black Sea | Scientific Reports (nature.com) Microplastics found in Danube Delta lacustrine sediments are quantitative ranged between 16 and 381 particles per 1 Kg, microfibers being the dominant morphology. https://agrolifejournal.usamv.ro/pdf/vol.X_2/Art18.pdf
SK	Macrolitter only in highly impacted reservoir Ružín / use of submerged walls (Pilot project: https://www.ruzin.eu/nase-projekty/)
SE	https://intranat.lidkoping.se/download/18.5ec0539a17115437fe6322a6/1587116060141/Rapport%20Mikroplast%20Lidk%C3%B6ping%20Jordn%C3%A4ra%20inkl%20bilagor%20200414%20total.pdf Mapping microplastic flows from Lidköping city. Discussions on a conceptual stage has been made on linking microplastic quantities in river mouths with modelling by linking this initiative to ongoing river basin monitoring. An indicator is being developed on inputs of microlitter (kg/year) from main sources and pathways.

4.2 Litter in transitional waters

ECOSTAT experts were asked to indicate the availability of research and monitoring studies on litter as well as on studies on effects of litter in their country. Table 6 summarises responses on the availability of these types of studies per country.

Research studies have been reported by a larger number of countries compared to monitoring and effect studies. 13 of 28 countries report one or more research studies performed or planned on litter in transitional waters.

More than one-third of countries (11 of 28) report completed or ongoing monitoring studies, but just under one-sixth of countries (5 of 28) report to have studies available on effects of litter in transitional waters.

Also more than one-third of countries (10 of 28) report to have (further) plans for monitoring activities on national/regional/other level for litter in transitional waters.

Cyprus states to have no transitional waters, as do Estonia, Denmark, Czechia and Finland, and Germany for the German Baltic Sea. Slovakia and Sweden also argue that this is not relevant to them.

Table 6 **Availability of research, monitoring and effect studies of litter in transitional waters, and (further) monitoring plans, by country.**

Country (alphabetically)	Research studies (Y/N), Q3	Monitoring studies (completed and ongoing) (Y/N), Q7	Studies on effects of litter, (Y/N), Q11	(Further) plans for monitoring litter, (Y/N), Q19
AT	N	N	N	N
BE	Y	Y	N	N
BG	N	N	N	Y
CY	N	N	N	N
CZ	N	N	N	N
DE	Y	Y	N	Y
DK	N	N	N	N
EE	N	N	N	N
EL	N	N	N	N
ES	Y	Y	Y	Y
FI	N	N	N	N
FR	Y	Y	Y	Y
HR	N	N	N	Y
HU	N	Y	N	N
IE	Y	Y	Y	n.a.
IS	N	N	N	N
IT	N	N	N	N
LT	Y	Y	N	Y
LU	N	N	N	N
LV	Y	Y	N	Y
MT	Y	N	N	Y
NL	Y	Y	Y	N
NO	Y	N	N	Y
PL	Y	N	N	n.a.
PT	Y	N	N	N
RO	Y	Y	Y	Y
SE	N	Y	N	N
SK	N	N	N	N
Total Y responses	13	11	5	10
Total N responses	15	17	23	16

Notes on table:

Y	= Yes (available)
N	= No (not available)
n.a.	= N.a. = no answer (no details in text response in MS questionnaire)

Q3, Q7, Q11, Q19 =

Q3. Is research on litter in transitional waters performed/planned in your country?

Q7. Are there details available on completed and ongoing monitoring studies on litter in freshwater environments?

Q11. Are there studies available on effects of litter in transitional waters?

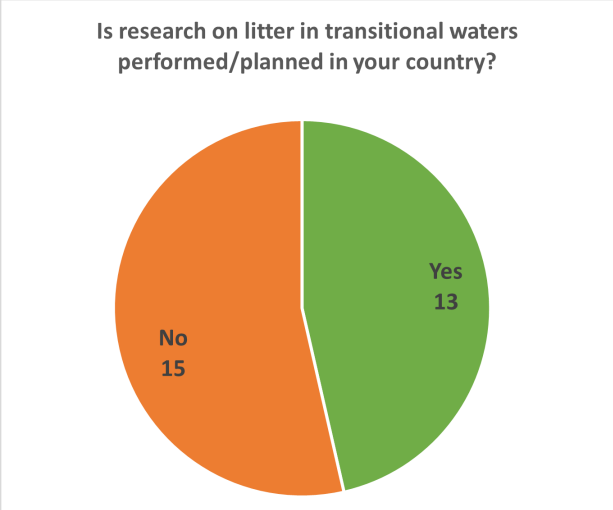
Q19. Are there (further) plans for monitoring activities on national/regional/other level for litter in transitional waters?

4.2.1 Research studies on litter in transitional waters (Question 3)

Q3. Is research on litter in transitional waters performed/planned in your country?

13 countries, i.e. more than one-third of the respondents, report to have performed or to plan research on litter in transitional waters (Figure 12). Research studies are carried out by a variety of actors, including both researchers and regulatory authorities.

Figure 12 Transitional Waters Research Studies (Question 3)



Finland added: "Research activities in the marine environment and research methods are briefly presented in question 23". **Malta** stated that this research on litter in transitional waters is currently under discussion as part of the 3rd RBMP.

Countries were asked to indicate the methods which are/were used in research performed or planned. Information on the methods is summarised in table 7 below.

Table 7 Research studies on litter in transitional waters (Question 3)

Country (alphabetically)	Methods	Research studies, sources	Other information
BE research project PLUXIN (2020-2023)	A baseline measurement of the influx of litter from Flanders into the marine environment was carried out in 2020-2021	Short description in English: https://www.pluxin.be/nl/innovatieve-observaties https://www.pluxin.be/nl/plastic-flux-modellering Everaert, G., Asselman, J., Bouwens, J., Catarino, A.I., Janssen, C.R., Shettigar, N.A., Teunkens, B., Toorman, E., Van Damme, S., Vercauteren, M., Devriese, L. (2022). Plastic baseline (t0) measurement in the scope Flemish Integral Action Plan on Marine Litter (OVAM). Plastic t0 study 2020-2021. Flanders Marine Institute, Ostend, Belgium. https://dx.doi.org/10.48470/26	Aims to quantify the amount of litter that flows to the sea through rivers and ports by developing innovative detection methods (such as remote sensing) and modelling.
DE "Macroplastics-Pollution-in-the-Southern-North-Sea-Sources-Pathways-and-Abatement Strategies"	Macroplastics: Visual observations at the river embankment and surface, stow net (water column), bottom trawl for the river bottom	http://portal.macroplastics.de/index.php?page=Project-description-EN Results e.g. Schöneich-Argent et al. (2020). Wasting the North Sea? – A field-based assessment of	The region studied in this project encompasses the coastline of Lower Saxony, used new monitoring and modelling strategies, but also the larger river systems Ems, Weser and Elbe as well as the open German Bight with its waterways, from the Channel to the northern North Sea.

Country (alphabetically)	Methods	Research studies, sources	Other information
		anthropogenic macrolitter loads and emission rates of three German tributaries. Env. Poll, 263. DOI: 10.1016/j.envpol.2020.114367	
DE	n.a.	Trobisch A., Schulz M. (in prep.): Tidal estuaries – sinks or sources of macroplastics to the ocean?	n.a.
DE Various studies Research focus: "Plastics in the Environment – Sources • Sinks • Solutions"	Microplastics: surface nets, filtration system	PLAWES: http://www.bayceer.uni-bayreuth.de/PLAWES/en/ MicroCatch_Balt: https://www.io-warnemuende.de/microcatch-home.html Roscher et al (2021). Microplastic pollution in the Weser estuary and the German North Sea. Environmental Pollution, 288, doi.org/10.1016/j.envpol-2021.117681	Germany's Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung – BMBF) addresses the issue of plastic pollution with its current research focus. Some of the projects address transitional water and river mouth, e.g. PLAWES. https://bmbf-plastik.de/en/background
FR Macro-waste flows in the Seine	Litter collection on riverbanks, GPS tracking	https://www.seine-aval.fr/projet/macroplast/ link to the Preventing Plastic Pollution Project website:	

Country (alphabetically)	Methods	Research studies, sources	Other information
		https://preventingplasticpollu-tion.com/about-the-project	
HR NET4mPLASTIC	Drone images will be used to identify the presence of plastic in areas pre-identified by numerical model simulating the marine transport processes. Sampling will be done at the river mouth, in marine environment, on the beach and collecting biota samples.	International project within the program Interreg Italy Croatia NET4mPLASTIC (https://www.italy-croatia.eu/web/netformplastic)	A numerical model will simulate the marine transport processes of the Microplastic in the Adriatic Sea to identify possible Microplastic concentration zones in the pilot areas according to fluvial discharge and marine conditions. The drone images will be used to identify the presence of plastic, while some other parameters will be measured in real time by installing a specific platform on boats or on marine drones. Sampling will be done at the river mouth, in marine environment, on the beach and collecting biota samples.
HR DeFIshGear (Derelict Fishing Gear Management System in the Adriatic Region)	n.a.	(https://hrcak.srce.hr/file/345678; https://defishgear.net/)	The Institute of Oceanography and Fisheries from Split conducts a project DeFIshGear. Activities are carried out by a team involving research institutes, national and local authorities and NGOs from all countries of the Adriatic-Ionian region. The project is designed to approach the regional development of monitoring and assessing the presence of microplastics and its distribution in the marine environment, as well as identifying possible sources. he nature and composition of microplastics were investigated in the central Adriatic and at the mouth of the Neretva River, which represent areas of potential accumulation of this type of waste.
IE 2018-ET-CP-94: Marine Plastic Waste - Closing the Loop (MARplas)	Lifecycle analysis of Irish fishing net manufacturers and existing net re-use market ready products	https://www.seasynergyresearch.org/marplas	At the core of MARplas is a design-thinking methodology; a solution-based approach to creative problem-solving, particularly wicked problems (Rittel and Webber, 1973). MARplas will use this methodology with a 5-phase project process to encourage circular co-design into the production,

Country (alphabetically)	Methods	Research studies, sources	Other information
			development and demonstration of innovative and novel approaches to the re-use of fishing nets and related fishing industry plastic waste. By looking at the whole system of marine plastic waste, focussed on Irish Fishing waste we being to see broader opportunities and avenues to develop solutions. The integration of 3 design experts with 3 marine environment experts facilitates a focused creative and systemic investigation including the feasibility of phasing out synthetic nets. To achieve this MARplas will focus on the following actions; 1. Through a lifecycle analysis of Irish fishing net manufacturers and existing net re-use market ready products MARplas will identify a clear route to developing prototypes for a specific area – health e.g. safety, protective wear e.g. sailing and rigging / bio-medical and well-being e.g. sport / adventure) 2. Development of new materials / prototypes for an Irish context 3. Development of micro and larger scale business models for the Irish market through a disruptive innovation and p2p model
IE Marine Institute Ireland via the JPI Oceans Various studies	n.a.	Andromeda: Analysis techniques for quantifying nano- and microplastic particles and their degradation in the marine environment Andromeda: A JPI Oceans Microplastics Project (andromedaproject.net)	An important useful document Roisin Nash (GMIT Researcher) published earlier this year, while marine orientated there is also information on freshwater MPs as it covers sources. Microplastics in the marine environment: Sources, Impacts & Recommendations (thea.ie) https://research.thea.ie/handle/20.500.12065/3593

Country (alphabetically)	Methods	Research studies, sources	Other information
		MicroplastiX: Integrated approach on the fate of MicroPlastics (MPs) towards healthy marine ecosystems presented by João Frias (Galway-Mayo Institute of Technology)MicroplastiX - GMIT Marine & Freshwater Research Centre (mfrc-gmit.ie) RESPONSE: Towards a risk-based assessment of micro-plastic pollution in marine ecosystems RESPONSE (response-jpioceans.eu)	
LT Project "Marine Litter monitoring", 2020-2022	In one monitoring station 3*10 litter are filtered throw 300 µm mesh.	https://aaa.lrv.lt/lt/apie-agentura-1/projektai/vykdomi-projektai/projektas-juros-siuksliu-monitoringas	Project partners Lithuanian Environmental Protection Agency (EPA) and Klaipeda university. Project granted from the Norwegian Financial Mechanism. The main task of the Project to perform marine litter investigations in the Baltic Sea. It is the first research of such type on pollution of microplastics. The project includes: 1) development of methodologies for qualitative and quantitative evaluation of marine litter including microplastics in water column, sediments and transitional waters zones; identification of the sources of the litter; 2) Baseline data on actual amounts of the macro- and micro-litter emission to the Baltic Sea from sources; 7 different entry pathways of litter from Lithuanian coast will be investigated: 4 wastewater treatment plants, 2 surface wastewater systems and 1 surface water body. Project

Country (alphabetically)	Methods	Research studies, sources	Other information
			benefit: The expected outcome of the project to identify and monitor environmental pressures caused by marine litter, including microplastics. The methodologies of mapping and monitoring of the microplastics and other marine litter would serve as a basis for creation of a database that would permit to compare and analyse data, to forecast the trends and enable scientifically-based decision making on response measures. The project forms an important of the Lithuanian government's efforts for compliance with the EU Marine Strategic Framework Directive. The project will contribute to an increased understanding of the ecological consequences of marine littering in Lithuanian waters as well as their sources and location. Description and Introductory and first interim report (national language) are available.
LT Project "Marine litter investigation, determination of their amount, type, sources and other characteristics, granted by European Maritime and Fisheries Fund, 2020-2022	In one monitoring station 3*10 litter are filtered throw 300 µm mesh.	https://aaa.lrv.lt/lt/apie-agentura-1/projektai/vykdomi-projektai/projektas-priemoniu-programos-atnaujinimas-ir-priemoniu-gerai-lietuvos-baltijos-juros-aplinkos-buklei-pasiekti-igyvendinimas.	Project partners EPA and Klaipeda university. Activities: marine litter monitoring in the Baltic Sea beaches, research in the Curonian Lagoon (transitional waters), what impact of the Curonian Lagoon as a potential source of litter on seafront pollution. Introductory and first interim report (national language) are available (national language)
LV	Sampling was performed by using a Manta net (mesh size 300 µm, HydroBios)	Study about microplastics in the Latvian marine waters. It can be	Aigars, J., Barone, M., Suhareva, N., Putna-Nimane, I., & Dimante-Deimantovica, I. (2021). Occurrence and spatial

Country (alphabetically)	Methods	Research studies, sources	Other information
Aigars et al. (2021)	that was towed at 7 m distance (in parallel to the research vessel) from the side of the R/V MARE or R/V SALME for 1 h at a speed of approximately 2 knots.	accessed through the following link - https://doi.org/10.1016/j.marpolbul.2021.112860	distribution of microplastics in the surface waters of the Baltic Sea and the Gulf of Riga. *Marine Pollution Bulletin*, *172*, 112860.
NL 'Stichting de Noordzee'	River-OSPAR method is used to collect data on Dutch riverbanks mainly carried out by volunteers (citizen science).	n.a.	'Stichting de Noordzee' has their bank-litter-protocol (River-OSPAR) based on the Beach-OSPAR. Mainly in tide and brakes water systems that are mostly directly connected to the North Sea (or Wadden Sea) or harbors. These are not literally transitional waters but they provide some insight about used methods and first results.
NO EUROqCHARM	Establishment of standardised methods of monitoring and assessing macro-, micro, and nano plastics in the environment.	https://www.euroqcharm.eu/en/	The project is led by the Norwegian Institute for Water Research (NIVA) and has 14 key participants from Europe, including Norway. The project covers important areas in need of more knowledge. Standardised methods are important as they allow environmental monitoring data to be compared between different countries and regions. It is an important basis for plastic pollution regulations to be put in place.
NO FACTS project (Fluxes and Fate of Microplastics in Northern European Waters)	FACTS examines microplastic concentrations, include particles from car tyre wear, measured from the river Elbe through to the North Sea, Skagerrak, the Norwegian Sea, and the Barents Sea to the Arctic. Water, sediment, air, and fish samples are taken. Data is compared with	https://jpi-oceans-facts.eu/	FACTS is made up of partners from Denmark, Germany, Italy, and Norway The European research collaboration, Joint Programming Initiative on Healthy and Productive Seas and Oceans (JPI Oceans), which was established in 2011 as a Norwegian initiative, also includes research on plastic pollution. 10 microplastic projects have so far been financed by JPI Oceans, of

Country (alphabetically)	Methods	Research studies, sources	Other information
	a dispersion model of the transport of plastic particles.		which 7 have had Norwegian participation, with a total of 17 Norwegian actors involved. Norwegian participation is funded by the Norwegian Research Council.
NO Dsolve	n.a.	Various studies: Dsolve is a centre for research driven innovation, which studies biodegradable plastics for use in fisheries and aquaculture. https://uit.no/research/dsolve-en	It was established in 2020 as an eight-year initiative, supported by the Norwegian Research Council. Dsolve is led by the Arctic University of Norway (UiT). Four national and four international research institutes, 14 industry partners from the fisheries and aquaculture industries, fishing gear and equipment suppliers, and two fishing industry organisations are participating.
PT Rodrigues, S.M., Almeida, C.M.R. & Ramos, S. (2020).	n.a.	https://www.sciencedirect.com/science/article/pii/S2666016420300542	There are some projects/research groups which collect data on this subject, as in the example provided below: Rodrigues, S.M., Almeida, C.M.R. & Ramos, S. (2020). Microplastics contamination along the coastal waters of NW Portugal. Case Studies in Chemical and Environmental Engineering 2 (2020) 100056.
RO	Microplastic pollution evaluations (2019-2021) on sediments and water samples from transitional areas – in front of the Danube delta: Sampling circa 1 litre of sediment / filtration of more than 100 cmc of surface water (using a neustonic net - 200µm), extraction of plastic particles after digestion and gravitational separation (for sediment samples), visual inspection	Sedimentary microplastic concentrations from the Romanian Danube River to the Black Sea | Scientific Reports (nature.com)	This information has been provided by GEOECOMAR

Country (alphabetically)	Methods	Research studies, sources	Other information
	for quantification and qualitative analysis using spectrometric equipment (FT-iR and GC-MS).		
RO	Seasonal assessment of abundance and composition of macrolitter (> 2.5 cm) and microplastics (1-5 mm) along the Romanian Black Sea beaches during 2018 – 2019, following the monitoring methodology described in the EU MSFD TG10 guidance	Stoica, E., Nenciu, M., Creangă, S.-M., Tănase, M.-C., Marin, D., Ciucă, A.-M., & Pătrașcu, V. (2021). Assessment of the Marine Litter on the Romanian Black Sea Beaches. *Revista Cercetări Marine - Revue Recherches Marines - Marine Research Journal*, *51*(1), 49-63. https://doi.org/10.55268/CM.2021.51.49	This information has been provided by NIMRD (INCDM) Constanta

Source: Based on questionnaire responses

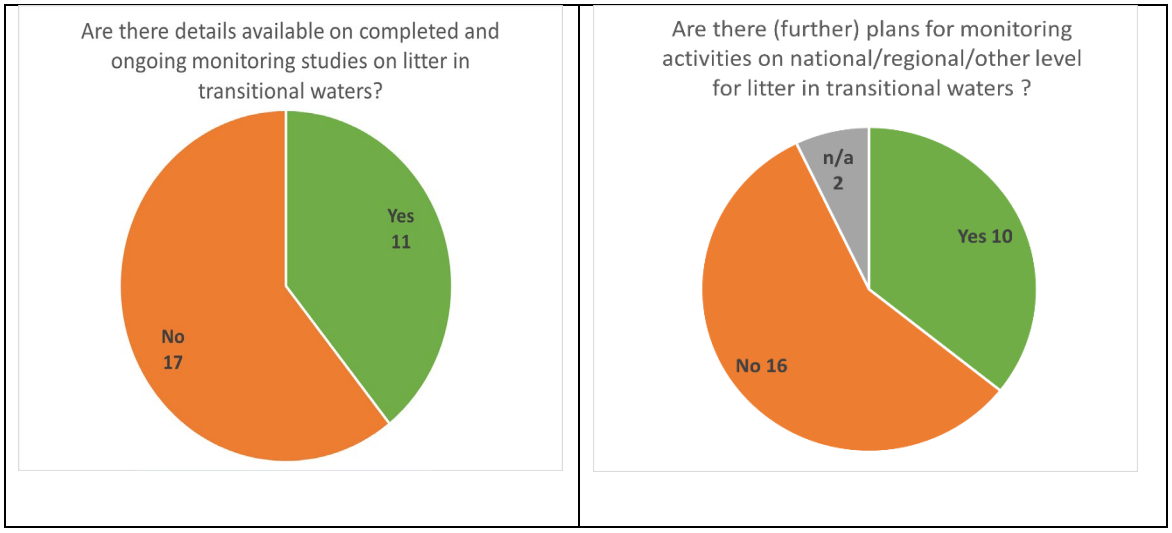
N.a. = no answer (no details in text response in MS questionnaire

4.2.2 Completed, ongoing and planned monitoring studies on litter in transitional waters (Questions 7 and 19)

Q7. Are there details available on completed and ongoing monitoring studies on litter in transitional waters?

Q19. Are there (further) plans for monitoring activities on national/regional/other level for litter in transitional waters?

Figure 13 Transitional Water Monitoring (Questions 7 & 19)



N.a. = no answer (no details in text response in MS questionnaire).

11 of 28 countries reported completed or ongoing monitoring studies on litter in transitional waters.

Some of these countries provided details on sampling, sample preparation and litter detection methods, while others provided only links to available documentation in national language for further details. Table 9 summarises the information provided in the questionnaire text responses on sampling and analytical methods used in the monitoring studies reported.

Overall, monitoring studies on litter in transitional waters still seem to cover only selected European transitional waters (these can be estuaries and bays, coastal inlets or fjords, and intermittently closed and open lagoons and lakes, etc.). Relevant monitoring studies on national level are mostly missing.

There are few exceptions of national and transnational transitional waters monitoring programmes, e.g. the German Monitoring of litter in the water column of German North Sea estuaries.

Some countries without monitoring studies provided explanations on gaps and challenges faced.

In **Hungary**, monitoring is done through visual watching by camera and AI recognition of floating PET bottles. However, this is an early warning system to enable the removal facilities, the purpose is not scientific research and there are no studies available, however according to the survey response the amount (thousands of metric tons annually) is recorded.

Finnish national monitoring (MSFD) includes sampling only in the open ocean and coastal sites. These are presented in the Question 23.

In the **Netherlands**, no structural monitoring is yet in place, while ad hoc monitoring exists, mainly in the context of student projects. In addition, QA is mainly based on the OSPAR method for qualitative analyses, while there is no QA for quantitative data yet.

For **Portugal**, as stated above, there are no systematic monitoring programs under development for inland, transitional and ground waters or soils, although research is ongoing under different settings.

Concerning future developments, more than one-third of countries (10 of 28) report to have (further) plans for monitoring activities on national/regional/other level for litter in transitional waters. In the majority of cases though, these are countries that also report completed or ongoing monitoring studies. Only 1 country (BG) without existing monitoring studies mentions further monitoring plans, however these were already presented under chapter 4.1.2.

ECOSTAT experts were also asked to indicate whether the quality of the results in their monitoring studies has been or will be assured and how. Only Germany, Latvia and France addressed this issue with reference to their planned monitoring activities. In **Latvia**, QA for transitional waters is "in accordance with microplastic work". In **France**, quality of the results be assured by cross checking results between monitored sites to detect potential anomalies. In **Germany**, the information on QA include:

a) Pilot-monitoring of litter in the water column of German North Sea estuaries (litter caught as bycatch during the WFD-monitoring of fish in transitional waters, using stownets) since 2013: the litter caught as bycatch is classified according to the OSPAR 100m beach litter sampling protocol (OSPAR 2010),

b) Sampling of fish in transitional waters and tidally influenced freshwater is intercalibrated through the WFD. First steps towards a pilot-monitoring of microplastics in the sediments along a transect extending from estuaries to coastal waters: sampling method according to the recommendation the OSPAR expert group on microplastics. No further QA procedure introduced as the method is still under development.

In the following paragraphs, some of the monitoring studies reported are presented in more detail:

Germany, study "Wasting the North Sea? – A field-based assessment of anthropogenic macrolitter loads and emission rates of three German tributaries" (Schöneich-Argent et al., 2020): The aim of the study was to assess the quantities and composition of litter deposited and transported by the Ems, Weser, and Elbe, to investigate potential differences in litter abundance and diversity between the river compartments, and to estimate litter emission rates into the respective estuary from surface-floating litter and negatively buoyant, suspended debris. In order to achieve this, riverbank surveys were combined with surface litter monitoring, water column sampling and riverbed sampling. Methods applied were:

- For riverbank surveys, Macrolitter (>0.5 cm) sampling was carried out irrespective of the tides at nine locations per river; surveys followed the Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area (OSPAR Commission, 2010) for areas of 100 m in length.

- For surface litter monitoring, items floating downstream within 20 m of the survey point were recorded via application of electronic identification devices (Android operating system, version 2.0). A track width of 20 m was chosen, as this was the maximum distance across which a minimum-sized litter object of 2–2.5 cm, e.g. a cigarette butt, could be clearly identified under different weather and light conditions.
- For water column sampling, stow nets with a mesh size of 6–12 mm at the cod end were deployed over the course of one tidal cycle while at anchor, resulting in one ebb and one flow haul. The sampled water column ranges from just below the surface to a maximum depth of 10 m. Each position is sampled once per season, and the respective through-flow volume is documented by a flowmeter.
- Riverbed samples were collected using a 2 m bottom trawl with a mesh size of 5 mm that was towed for 10 min with approx. 2 knots at three estuarine positions per river.

Without going into details on the results for each river compartment and cross-river comparisons, the study concluded that the vast majority of discarded debris in fact likely accumulates on land, along the riverbanks, and on the riverbed, while only a fraction is transported into the sea via the Ems, Weser, and Elbe. If this turned out to be a recurring observation in other river systems, management strategies should preferably target on-land and riverside waste accumulation.

France, project "MACRO-Plast" documented in study Tramoy et al. (2018)[35]: The aim of the study was to quantify macroplastic input from the Seine River into the oceans. But, most importantly, the aim of this study is to develop a methodology replicable in other rivers. The methods applied were GPS tracking of floating debris, tagged plastic waste and data from the collection of plastic waste along the banks of the Seine estuary carried out since 2008. The first results concluded that ~800 t/year of plastic is entering the oceans from the Seine, which is an order of magnitude lower than previous results based on statistical and field approaches.

[35] https://hal.archives-ouvertes.fr/hal-03710158/

Table 8 Specific monitoring studies on litter in transitional waters (Questions 7 and 19)

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
Completed or ongoing monitoring studies					
BG 2nd Black Sea RBMP under WFD			Annual campaigns (spring and autumn seasons) to clean estuaries (some of the river mouths are determined as transitional waters).	Activities also include information about the type of waste collected.	
DE-NI Monitoring of litter in the water column of German North Sea estuaries: Brandt et al. (2014)[36] Schulz, M. (2015).[37] Schöneich-Argent et al. (2020).[38]	Macrolitter	Suspended litter loads and emission rates of three German tributaries	Stow net (water column) / bottom trawl Surface litter monitoring via visual identification (electronic devices) Water column sampling via flowmeter	The litter caught as bycatch during the WFD-monitoring of fish in transitional waters (active since 2013) is classified according to the OSPAR 100m beach litter sampling protocol (OSPAR 2010). Items identification according to the OSPAR litter categorization.	German North Sea estuaries
DE (DE-NI)	Microplastics	Microplastics in the sediments	The sampling method varies slightly per transect. Sampling method according to the	Samples are currently processed.	At the German North Sea coast a total number of five transects extending

[36] Brandt et al. (2014): Mülleintrag in die Nordsee über die Ästuare von Elbe, Weser und Ems und Müllvorkommen im Jadebusen im Jahr 213 anhand von Hamenfängen. Bericht erstellt im Auftrag des NLWKN, 33 S.

[37] https://www.nlwkn.niedersachsen.de/download/179714/Schulz_Marcus_2015_A_comparative_study_of_suspended_litter_in_the_Elbe_Weser_and_Ems_Estuaries_southeastern_North_Sea_.pdf

[38] https://www.sciencedirect.com/science/article/pii/S0269749119370071?via%3Dihub

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
Pilot-monitoring of microplastics in the sediments along a transect extending from estuaries to coastal waters: the pilot monitoring covers the German North Sea and the Baltic Sea and started in 2021.[39]			recommendation the OSPAR expert group on microplastics. No further QA procedure introduced as the method is still under development. In Lower Saxony, the pilot is integrated in the WFD-sampling scheme for macrozoobenthos using a grab-sampler.		from the estuary to coastal waters were sampled (respectively Ems, Weser, Elbe, Eider, north of Sylt), at the German Baltic Sea a total number of 6 transects (respectively Flensburger F rde, Schlei, Kieler Bucht, Lcc ker Bucht (Trave), Warnow, Peene/Oder).
ES[40]	n.a.	Monitoring of marine litter both on beaches and in the water column and seabed, as well as litter ingested by some marine indicator species or the entanglement/ entanglement of living organisms in marine litter. Specific sub-programmes on microplastics on	n.a.	n.a.	n.a.

[39] No link provided

[40] https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/basuras-marinas/basura-programas.aspx

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
		beaches, in surface waters and in marine sediments are also included.			
FR CEDRE[41]	Macrolitter	River Banks	n.a.	Sorted, identified and counted by categories, using the MSFD joint list of litter categories.	n.a.
FR LEESU (Laboratoire Eau Environnement et Systèmes Urbains) MACRO-Plast (completed)[42]	Macrolitter	Estuary	Marked waste and daily collections quantified to generate reliable estimates	GPS beacons	Seine estuary
HU	n.a.	n.a.	There is an ongoing activity to remove the litter, but there are no studies, only the amount (thousands of metric tons annually) is recorded.	n.a.	n.a.
IE Litter surveys have been undertaken by	n.a.	n.a.	n.a.	n.a.	n.a.

[41] See also in Table 2, Section Freshwater

[42] https://www.leesu.fr/trajectoire-de-dechet-flottant-dans-l-estuaire-de-la-seine?lang=fr; https://hal.archives-ouvertes.fr/hal-03710158/

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
Coastwatch Ireland volunteers[43]					
IE OSPAR Convention Beach Litter Monitoring programme[44]					
IE Seafloor litter data monitoring since 2010 as part of the Irish Groundfish Survey (IGFS)[45]	n.a.	Seafloor	Litter collected from 65m research vessel, the R.V. Celtic Explorer. These surveys are undertaken over 42 days in the autumn/winter. Each year, the Marine Institute randomly selects approximately 170 stations to be surveyed by trawl (30 minutes each at 4 knots).	The litter collected in the trawl is collected and identified based on protocols agreed by ICES (ICES, 2020). This data is then uploaded to the ICES's DATRAS database.	n.a.
LT State Environmental Monitoring Programme for 2018–2023	Marine litter pollution, including micro-litter	4 monitoring sites in coastal zone, surface water, sediment.	Monitoring of amount, composition Frequency - 3 times per year.	n.a.	Baltic Sea

[43] http://coastwatch.org/europe/wp-content/uploads/2020/09/Coastwatch-Marine-Litter-Autumn-2019-Survey-Results_draft_v4.pdf

[44] https://www.ospar.org/work-areas/eiha/marine-litter

[45] https://www.sciencedirect.com/science/article/abs/pii/S0025326X15302241#f0040

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
LV[46]	n.a.	n.a.	n.a.	Methods are still under development but will be based on https://doi.org/10.1016/j.marpolbul.2021.112860 and https://doi.org/10.1021/acs.est.7b03055	n.a.
LV, 2021 (results will be made available at the first part of 2022)	Microplastics	Beach sand and waters across the whole Latvian coastline	Citizen Science	n.a.	Latvian coastline
LV, ongoing project	Microplastic	In algal wracks on the shore or in algal scum.	n.a.	n.a.	n.a.
RO[47]	Micro- and meso-plastics	Black Sea water	horizontally hauled plankton nets		Black Sea
Planned monitoring studies					
DE-NI	Microplastics	Sediments in estuaries	Monitoring method follows the recommendation of the OSPAR expert group on microplastics in	Details still have to be developed.	German estuaries

[46] https://doi.org/10.1016/j.marpolbul.2021.112860

[47] https://www.researchgate.net/publication/346242970_Distribution_of_micro-and_mesolitter_in_the_southwestern_part_of_the_Black_Sea

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
			sediments, details still have to be developed.		
DE-NI	Microplastics	Biota	n.a. "First steps towards a potential monitoring of microplastics in biota"	n.a.	Wadden Sea of Lower Saxony, some of the stations are within transitional waters.
FR	n.a.	n.a.	Fluxes by count relative to a linear riverbank.	River-OSPAR protocols. Cross checking results between monitored sites to detect potential anomalies.	n.a.
LT	n.a.	n.a.	100 meters method - Baltic Sea beaches; Curonian Lagoon beaches - 40 square meters	n.a.	Baltic sea beaches; Curonian Lagoon beaches
LV	n.a.	n.a.	Sediment coring and Manta trawling	QA in accordance with microplastic work.	n.a.
MT LIFE 16 IPE MT 008 project (LIFE-IP RBMP-Malta)	Chemicals of Emerging Concern (CECs); some of the CECs that will be monitored are chemicals that are used widely in the residential	Surface waters (coastal, transitional and inland surface waters)	n.a.	n.a.	n.a.

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
	context, in particular the plastic industry.				
NO, Mikronor	Microplastic	coastal areas	See already in Table 3	See already in Table 3	See already in Table 3
LV, planned for 2022	microplastics	surface waters, water column and sediments, as well as riverine and beach-borne inputs.	n.a.	n.a.	Gulf of Riga
RO, ongoing national project, planned for 2023	Microplastics	surface waters, water column, sediments and biota (molluscs, fish, birds, dolphins)	Monitoring method follows the recommendation of the TG ML expert group on microplastics in water, sediments, and biota details still have to be developed	Details still have to be developed	Romanian Black Sea beaches; Romanian coastline; Proximity of Danube Delta

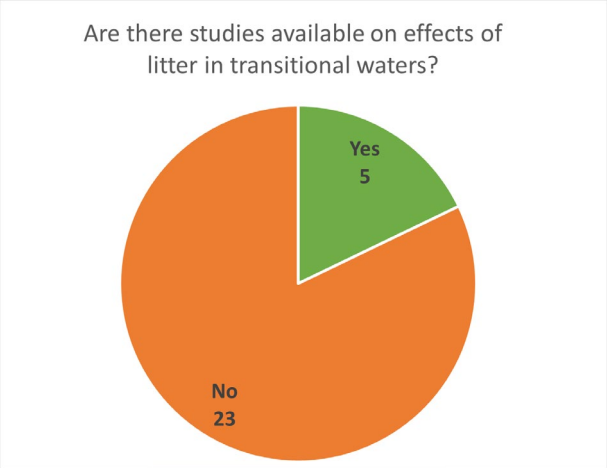
Source: Based on questionnaire responses; N.a. = no answer (no details in text response in MS questionnaire).

4.2.3 Studies on effects of litter in transitional waters (Question 11)

Q11. Are there studies available on effects of litter in transitional waters?

Only five countries (out of 28) report to have studies available on effects of litter in transitional waters. None of the questionnaire responses provide details on the methods that were used in these effect studies, but they provide references to the relevant studies for further details (see table 10 below).

Figure 14 Transitional Waters Effects Studies (Question 11)



The INDICIT project[48], funded by the European Commission, started in February 2017 with the main objective of developing the monitoring of litter in biota, with a special focus on sea turtles as indicators. The INDICIT project has 10 public sector partners from 5 Member States (**France, Spain, Italy, Greece and Portugal**) and 2 non-Member States that are Contracting Parties to the Barcelona Convention (Tunisia and Turkey).

The INDICIT project focused on three litter impact indicators:

Indicator 1: 'Litter ingested by sea turtles'
Indicator 2: 'Entanglement with debris by marine biota'
Indicator 3: 'Micro-plastic ingestion in fish and sea turtles'

The main goal was to allow litter impact indicators to be implemented in a standardized way in the framework of the MSFD and the Regional Sea Conventions OSPAR (NE Atlantic), Barcelona (Mediterranean) and HELCOM (Baltic), using sea turtles as bioindicator. The specific objectives were to develop a common approach for monitoring litter ingested by sea turtles by 1) developing a set of standardized tools, 2) creating a network and providing training sessions to stakeholders, 3) collecting and analysing data on living and dead turtles, 4) analysing the indicator's spatial and temporal limits, biological constraints and GES criteria. Contrary to the GES Decision which establishes the 5 mm threshold for distinguishing micro- from macroplastics, litter was defined as items >1mm, including both. A further objective was to assess the relevance and feasibility of two other litter impact

[48] https://indicit.cefe.cnrs.fr/

indicators: one related to entanglement (MSFD Criteria D10C4), for which all taxa were evaluated, and one related to the ingestion of micro-plastics (litter items <1mm) (MSFD Criteria D10C3) by fish and sea turtles. In data obtained from 2013 to 2018, findings showed that 53.84% of leatherbacks had ingested litter, with an average of 1.7 0.73 g per individual at the population level (N = 13 individuals, all from France's Atlantic waters); 57.94% of living loggerheads excreted litter (N=254; 1.06 ±0.44 g with N = 185); and 63.03% of dead loggerheads (N = 522) were found with litter, with a mean of 0.78 ± 0.11 g (N = 480) at the population level. The follow-up project, INDICIT II, started in February 2019 and project results are expected for Q3 2022.

Table 9 Studies on effects of litter in transitional waters (Question 11)

Country (alphabetically)	Biota and other types of effects	Methods	Study links
ES	n.a.	n.a.	https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/basuras-marinas/basura-programas.aspx Evidence of additional research being currently conducted: Bermúdez, M., Vilas, C., Quintana, R., González-Fernández, D., Car , A., & Díez-Minguito, M. (2021). Unravelling spatio-temporal patterns of suspended microplastic concentration in the Natura 2000 Guadalquivir estuary (SW Spain): Observations and model simulations. *Marine Pollution Bulletin*, *170*, 112622. Díez-Minguito, M., Bermúdez, M., Gago, J., Carretero, O., & Viñas, L. (2020). Observations and idealized modelling of microplastic transport in estuaries: The exemplary case of an upwelling system (Ría de Vigo, NW Spain). *Marine Chemistry*, 222, 103780.
FR	n.a.	n.a.	http://www.cestmed.org/wp-content/uploads/2015/01/ClaroHubert_2011.pdf http://www.cestmed.org/wp-content/uploads/2015/01/DellAmicoGambaiani_20131.pdf http://www.cestmed.org/wp-content/uploads/2015/01/Darmon_etal_20141.pdf https://archimer.ifremer.fr/doc/00346/45697/45317.pdf https://indicit-europa.eu/cms/wp-content/uploads/2020/10/Final-presentation-Final-meeting-2019.pdf https://www.ineris.fr/fr/etude-filieres-collecte-traitement-megots-cigarettes https://hisaproject.org/wp-content/uploads/2021/01/RiverSe- -Surveillance-Macro-D%C3%A9chets- -HISA-project- -2020.pdf
IE	n.a.	n.a.	https://research.thea.ie/handle/20.500.12065/3593 Roisin Nash published earlier this year, while marine orientated there is also information on freshwater MPs as it covers sources. Microplastics in the marine environment: Sources, Impacts & Recommendations

RO	n.a.	Microplastic quantitative and qualitative evaluation in water and sediments in the front Danube Delta. The methodology comprises sampling ca. 1 litre of sediment, extraction of plastic particles after digestion and gravitational separation, visual inspection for quantification and qualitative analysis using spectrometric equipment (FT-iR).	n.a.

Source: Based on questionnaire responses

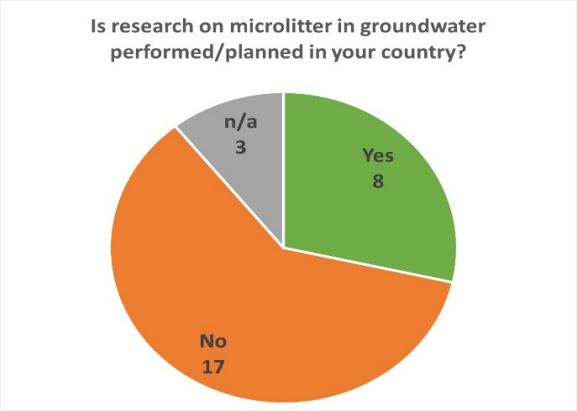
N.a. = no answer (no details in text response in MS questionnaire).

4.3 Microlitter in groundwater

Groundwater research studies on microlitter have been reported by few countries (8 of 28) while monitoring studies and studies on microlitter effects are not available in any country so far. Further, only two countries report to have future plans for monitoring microlitter in groundwater (Estonia and Slovakia).

Table 11 below gives an overview of the availability of research studies and monitoring plans in European countries. Table 12 gives further information on the research studies available on microlitter in groundwater. Only few country responses provided information on the actual methods used in these research studies; for the majority, links are provided to relevant national reports and publications for further details.

Figure 15 Groundwater research studies (Question 4)



N.a. = no answer (no details in text response in MS questionnaire).

Table 10 Availability of research, monitoring and effect studies of microlitter in groundwater, and (further) monitoring plans, by country.

Country (alphabetically)	Research studies (Y/N), Q4	Monitoring studies (completed and ongoing) (Y/N), Q8	Studies on effects of microlitter, (Y/N), Q12	(Further) plans for monitoring microlitter, (Y/N), Q18
AT	N	N	N	N
BE	N	N	N	n.a.
BG	N	N	N	N
CY	N	N	N	N
CZ	Y	N	N	N
DE	N	N	N	N
DK	Y	N	N	N
EE	Y	N	N	Y
EL	N	N	N	N
ES	Y	N	N	N
FI	Y	N	N	N
FR	n.a.	n.a.	n.a.	n.a.
HR	N	N	N	N
HU	N	N	N	N
IE	n.a.	N	N	n.a.
IS	Y	N	N	N
IT	N	N	N	n.a.
LT	N	N	N	n.a.
LU	N	N	N	N
LV	N	N	N	N

Country (alphabetically)	Research studies (Y/N), Q4	Monitoring studies (completed and ongoing) (Y/N), Q8	Studies on effects of microlitter, (Y/N), Q12	(Further) plans for monitoring microlitter, (Y/N), Q18
MT	N	N	N	N
NL	N	N	N	N
NO	N	N	N	N
PL	n.a.	n.a.	n.a.	n.a.
PT	N	N	N	N
RO	N	N	N	N
SE	Y	N	N	N
SK	Y	N	N	Y
Total Y responses	8	0	0	2
Total N responses	17	26	26	20

Notes on table:

Y	= Yes (available)
N	= No (not available)
n.a.	= no answer in questionnaire

Q4, Q8, Q12, Q18 =

Question 4. Is research on microlitter in groundwater performed/planned in your country?

Question 8. Are there details available on completed and ongoing monitoring studies on microlitter in groundwater?

Question 12. Are there studies available on effects of microlitter in groundwater?

Question 18. Are there (further) plans for monitoring activities on national/regional/other level for microlitter in groundwater?

Denmark reports that, based on a review of existing literature, it is considered very unlikely that microplastics pose a risk of contamination of groundwater in Denmark. However, it cannot be ruled out that transport of smaller plastic particles (<1 µm) may occur. In addition, there may be local conditions, such as cracks, which can enable the transport of even larger microplastic particles to groundwater. Such cracks will generally occur in the upper clay layers in areas with moraine clays, with larger ones or less density. It is still considered that intermediate soil layers will function as an effective filter and barrier for transporting microplastics to groundwater. All in all, based on the results obtained through the study referenced in the questionnaire[49], it can be concluded that microplastic particles detected in

[49] https://mst.dk/media/148257/bilag-3-notat-mikroplast-i-grundvand.pdf

the groundwater samples with overwhelming probability depict pollution due to sampling and sample processing rather than the presence of microplastics in groundwater.

In **Sweden**, a recently started research project addresses plastic and pesticides in agricultural soils as a hazardous combination for groundwater systems and drinking water supplies. Large loads of pesticides and plastics are annually introduced to agricultural soils leading to plastic-pesticides interactions such as pesticides sorption to plastic. Of concern is the decomposition of plastics in agricultural soils to hardly detectable and mobile sub-micrometer-sized particles potentially enhancing the transport of sorbed pesticides into underlying groundwater systems and drinking water supplies. However, the migration of sub-micrometer-sized plastic particles and sorbed pesticides through agricultural soils is poorly evaluated due to the lack of appropriate analytical tools. This project aims to develop a new plastic tracer method based on 13C labelled plastic material, which will allow the detection of sub-micrometer-sized plastic particles in soils. The project will be conducted over 4 years. The novel plastic tracer method will be developed based on a stepwise research approach including laboratory batch and column experiments combined with analytical modelling. The new method will open-up the possibility to determine for the first time the fundamental processes that govern the transport of sub-micrometer-sized plastic particles and sorbed pesticides through agricultural soils. This will be vital to determine the exposure of groundwater systems and drinking water supplies to plastic particles and associated pesticides from agricultural soils and to evaluate the related risks for human health.

Table 11 Research studies on microlitter in groundwater

Country (alphabetically)	Methods	Research studies, sources	Other information
CZ	n.a.	n.a.	Only few studies which deal with occurrence of microplastics in raw drinking water
DK	Light microscopy and FPA FT-IR (Focal plane array detector-based micro-Fourier transform infrared spectroscopy)	https://mst.dk/media/148257/bilag-3-notat-mikroplast-i-grundvand.pdf	
EE	n.a.	n.a.	Research planned on microlitter and nano particles related with Peipsi lake and cross-border groundwater waterbodies
ES	n.a.	https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/23-414-5-010_informe_identificaciondefuentesyestimaciondeaportesdemicroplasticos_tcm30-486438.pdf https://www.miteco.gob.es/es/costas/temas/proteccion-medio-marino/estrategias-marinas/default.aspx	

Country (alphabetically)	Methods	Research studies, sources	Other information
FI Microplastics in domestic waters	One pilot study has been conducted on microplastics in Finnish domestic waters originating from different sources, including groundwater (Sillanpää et al. 2018). The study filtered 30 L of water onto 20 µm filter, and quantification was done with a stereomicroscope and FTIR.	Sillanpää et al. 2018. Esiselvitys mikromuovien esiintyvyydestä Suomen talousvesissä. (report in Finnish, "A preliminary survey on the occurrence of microplastics in water for domestic use in Finland") https://www.vvy.fi/site/assets/files/2429/talousveden_mikromuovit_raportti_www-sivuille.pdf	
FI Artificial groundwater	Another study focused on the artificial groundwater (Kolari 2019). Different fractions (>300 µm, 100–300 µm ja 20–100 µm) were filtered from the water samples and quantified with FTIR	Kolari, 2019. Developing a method for analysing microplastics in drinking water produced by communal waterworks. Master's thesis. University of Eastern Finland. (in Finnish, summary in English) https://erepo.uef.fi/handle/123456789/20941	
IS	n.a.	Microplastics in drinking water sources and distribution systems in Iceland. https://www.resource.is/wp-content/uploads/2020/01/Microplastics-in-drinking-water-sources-and-distribution-systems-in-Iceland-1.pdf	No research performed on a regular basis but the largest utility companies in Iceland did research in 2020 on microplastics in drinking water. Drinking water in Iceland is mainly from groundwater.
SE	new plastic tracer method based on 13C labelled plastic material	Recently started research project: University of Gothenburg, Dept of Earth Sciences, Title of research project: Plastic and pesticides in agricultural soils – A hazardous combination for groundwater systems and drinking water supplies worldwide?	
SK	n.a.	n.a.	Planning to employ groundwater monitoring once EC will publish a method of

Country (alphabetically)	Methods	Research studies, sources	Other information
			analysis as announced in Drinking Water Directive

Source: Based on questionnaire responses

N.a. = no answer (no details in text response in MS questionnaire).

4.4 (Micro)litter in soil

ECOSTAT experts were asked to indicate the availability of research and monitoring studies on litter as well as on studies on effects of litter in their country. The following table summarises responses on the availability of these types of studies per country.

Research studies have been reported by a larger number of countries compared to monitoring and effect studies. 12 of 28 countries report one or more research studies performed or planned on litter in soil.

Less than one-sixth of countries (4 of 28) report completed or ongoing monitoring studies, but just over one-sixth of countries (5 of 28) report to have studies available on effects of litter in soil.

Further plans for monitoring activities on national/regional/other level for litter in soil were not asked for in the questionnaire.

Table 12 **Availability of research, monitoring studies and effect studies of litter in soil, by country.**

Country (alphabetically)	Research studies (Y/N), Q5	Monitoring studies (completed and ongoing) (Y/N), Q9	Studies on effects of litter, (Y/N), Q13
AT	Y	Y	N
BE	N	N	N
BG	n.a.	n.a.	n.a.
CY	N	N	N
CZ	Y	Y	Y
DE	Y	N	N
DK	Y	N	Y
EE	Y	Y	N
EL	N	N	N
ES	Y	N	N
FI	Y	N	Y
FR	Y	n.a.	n.a.
HR	N	N	N
HU	N	N	N
IE	Y	N	N
IS	N	N	N
IT	N	N	N
LT	N	N	N
LU	N	N	N
LV	N	N	N
MT	N	N	N
NL	Y	Y	Y
NO	Y	N	n.a.
PL	n.a.	n.a.	n.a.
PT	N	N	N
RO	N	N	N
SE	Y	N	Y
SK	Y	N	N
Total Y responses	13	4	5
Total N responses	13	21	19

Notes on table:

Y	= Yes (available)
N	= No (not available)
n.a.	= no answer in questionnaire
unclear (Y & N)	The question was answered yes and no by the respondent and is therefore unclear and treated as n.a..

Q5, Q9, Q13 =

Q5. Is research on (micro)litter in soils performed/planned in your country?

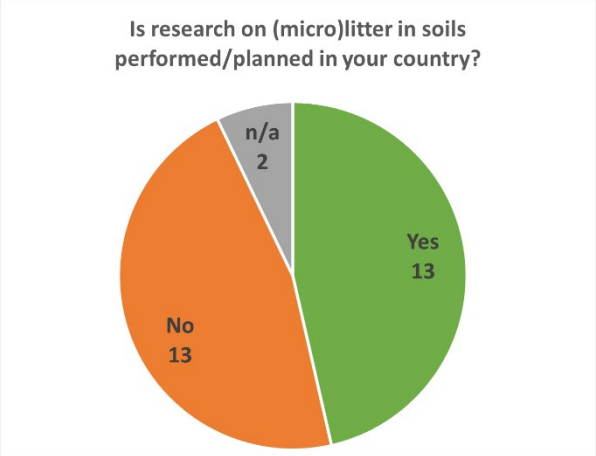
Q9. Are there details available on completed and ongoing monitoring studies on (micro)litter in soil?

Q13. Are there studies available on effects of (micro)litter in soil?

4.4.1 Research studies on (micro)litter in soil (Question 5)

Q5. Is research on (micro)litter in soil performed/planned in your country?

Figure 16 Soil Research Studies (Question 5)



N.a. = no answer (no details in text response in MS questionnaire).

13 countries, i.e. almost half of the respondents, report to have performed or plan research on litter in soil. Research studies are carried out by a variety of actors, including both researchers and regulatory authorities.

Countries were asked to indicate the methods which are/were used in research performed or planned. Information on the methods is summarised in table 14 below.

Table 13 Research studies on (micro)litter in soil (Question 5)

Country (alphabetically)	Methods	Research studies, sources	Other information
AT	Method for sampling and analysis of plastics > 1mm Sieving and TIR Microspectroscopy	Plastic in soils - Investigations on plastic contamination in agricultural soils of Vorarlberg (2019 Since no standardised methods to investigate contaminated soils existed, a method for sampling and analysis of plastics > 1mm has been developed. The focus of the developed determination method is the detection of large microplastics to mesoplastics. https://vorarlberg.at/documents/302033/472824/Kunststoffe+im+Boden.pdf/94e510ee-974e-c8db-0f0b-0b784d9f43ba PLASBo In a research project led by the Federal Environment Agency, in which the BMLRT, the federal provinces and the AGES are involved, an Austria-wide harmonised concept for the determination of plastics and microplastics in soils has to be developed and tested by autumn 2023 and initial Austria-wide data collected. https://www.bodeninfo.net/projekte/plasbo/	A new soil protection regulation in Vorarlberg with threshold and precautionary levels for soils has been implemented.
CY	n.a.	Not officially, but academia might occasionally have relevant projects. Research paper in https://doi.org/10.1016/j.ecoenv.2022.113213 may be relevant	n.a.

Country (alphabetically)	Methods	Research studies, sources	Other information
CZ	n.a.	Research project SOPLAS "Macro and Microplastic in Agricultural Soil Systems" (H2020-MSCA-ITN-2020) was started by consorcium and the Czech partner is České vysoké učení technické v Praze. (see https://cordis.europa.eu/project/id/955334) People in the institution Vysoké učení technické v Brně / Fakulta chemická also study microplastic in soil within the research projects (eg. David, J.; Steinmetz, Z.; Kučerík, J.; Schaumann, G. E. Quantitative Analysis of Poly(Ethylene Terephthalate) Microplastics in Soil Via Thermogravimetry-Mass Spectrometry. Anal. Chem. 2018, 90, 8793– 8799, DOI: 10.1021/acs.analchem.8b00355)	In the period 2022-2023, the CEVOOH project will realise a study of the microplastics detection in soils, especially agricultural soil, which are exposed to the entry of microplastics due to the use of sludge as fertilizers. The obtained data will be used for a comprehensive assessment of the negative impacts of microplastics on agricultural soil in the Czech Republic.
DE	n.a.	SOPLAS training network (coordinated by Augsburg University: https://www.soplas.org/) BLfU: partner organisation Bertling, J.; Bertling, R. & Hamann, L. (2018), 'Plastics in the environment: micro- and macroplastics. Causes, quantities, environmental fates, effects, approaches, recommendations', Technical report, Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT. Plastics in the Environment: Micro- and Macroplastics (fraunhofer.de). Link: https://www.umsicht.fraunhofer.de/content/dam/umsicht/d	So far, there have been only a few case studies on plastic contents in soils. The estimated input quantities still have to be verified by measurements. Standardized analytics are still lacking, to determine and quantify plastic particles in soils and solids and to quantify them. Nanoparticles in particular can so far not be measured empirically. In addition, there is a lack of a uniform definition of particle types and sizes.

Country (alphabetically)	Methods	Research studies, sources	Other information
		e/dokumente/publikationen/2018/kunststoffe-id-umwelt-konsortialstudie-mikroplastik.pdf Conversio (2018), From land to sea - model for the collection of land-based plastic waste , Technical report, Conversio GmbH, Commissioned by BKV GmbH. Link: https://muell-im-meer.de/aktivitaeten/vom-land-ins-meer-modell-zur-erfassung-landbasierter-kunststoffabfaelle Plastics in the environment - development of a system for initial estimates of the fate of waste and other products made from plastics in various environmental compartments. UBA Texts | 198/2020. Link: https://www.umweltbundesamt.de/publikationen/kunststoffe-in-der-umwelt-erarbeitung-einer Fraunhofer Umsicht: Plastics in the environment: Emissions in agricultural soils (2021). Link: https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/publikationen/2021/umsicht-studie-plastikemissionen-landwirtschaft.pdf	
DK	n.a.	2019 – Knowledge gap analysis on microplastics in soils due to use of sludge from wastewater treatment plants (WWTP) as fertilizers. Report in English: https://plastikviden.dk/media/212209/knowledge-gaps-in-microplastics-research.pdf 2021 – Ongoing project 2021-2022 on standardization of analysis methods for microplastic contamination in	n.a.

Country (alphabetically)	Methods	Research studies, sources	Other information
		soils. Determination of background levels af microplastics in Danish soils.	
EE		Microplastic study in beach sand has been conducted a part of the study *„Mikroplasti allikad ja levikuteed Eesti rannikumerre, mõju pelaagilistele ja bentilistele organismidele* [Sources and routes of microplastic transmission to the Estonian coastal sea, effects on pelagic and benthic organisms]. Mikroplasti allikad ja levikuteed Eesti rannikumerre, m ju pelaagilistele ja bentilistele organismidele.pdf (envir.ee)	
ES	n.a.	n.a.	See question 2
FI	Application of sewage sludge-based fertilizers; usage of plastic films and covers in agriculture.	Microplastics in soil are studied in two on-going projects, one concerning microplastic contamination via application of sewage sludge-based fertilizers, and the other concerning macro- and microplastic contamination via usage of plastic films and covers in agriculture. Finland is also involved in European-wide project PAPILLONS (H2020), where the microplastics in agricultural soils is studied also in Finland. https://www.syke.fi/en-US/Research__Development/Research_and_development_projects/Projects/Microplastics_in_Agricultural_soil_MicrAgri https://www.syke.fi/fi-FI/Tutkimus__kehittaminen/Tutkimus_ja_kehittamishankkeet/Hankkeet/Biotestit_puhdistamolietteen_lannoitekayton_tur	n.a.

Country (alphabetically)	Methods	Research studies, sources	Other information
		vallisuuden_arviointiin__tarkastelussa_haittaaineet_ja_mikromuovit_BIOLTA https://www.papillons-h2020.eu/ Karjalainen, 2021. Landscaping's synthetics materials might be a source of microplastics. MSc thesis. Häme University of Applied Sciences. (in Finnish, summary in English) https://www.theseus.fi/bitstream/handle/10024/504028/Tea_Karjalainen_YAMK_BIO_AI19A3.pdf?sequence=2&isAllowed=y	
FR	n.a.	At least 1 research project in progress in soils: https://www.irdl.fr/wp-content/uploads/2021/02/Poster_MICROSOF_2020.pdf Also 1 research project in sediments: https://anr-sedi-plast.univ-gustave-eiffel.fr/ https://www.irdl.fr/wp-content/uploads/2021/02/Poster_MICROSOF_2020.pdf https://anr-sedi-plast.univ-gustave-eiffel.fr/	n.a.
IE	n.a.	New EPA Funded Research 2021-GCE-1035 Identifying the Sources and Scale of Plastic in Compost Derived from Household and Commercial FoodWaste: Lead: Percy Foster Environmental Limited	In order to best develop strategies to reduce contamination before it reaches the organic recycling system it is essential to know exactly what the sources of contamination are, e.g. specific packaging formats and their quantity. Furthermore,

Country (alphabetically)	Methods	Research studies, sources	Other information
		In a recent study for the EPA it was determined that the greatest risk to achieving a compost and digestate standard is contamination of the input feedstock. The results of the study will be most likely be used as a reference standard in the development of a future National End of Waste position for compost and digestate. If adopted, the standard will set limits for impurities (glass, plastic, metal, stones) based on size. Due to the practicalities of testing, the minimum measurable size of impurities in composts and digestates globally is 2mm. Since they cannot currently be economically and efficiently extracted or identified, any impurities smaller than 2mm present in compost and digestate will be released into the environment.	comparatively little is known about the plastic embedded in food waste. The best known of these specific waste streams are tea/coffee bags and the labels stuck onto fruit and vegetables. The plastic in many styles of tea and coffee bags and fruit labels are such that by the time they have been through composting or digestion processes they will have broken down into small (<2mm) microplastics particles and fibres. Technology is unable to remove such small particles and fibres and therefore once they enter the system as used tea and coffee bags or stuck to peelings, the embedded plastic will enter the environment 'hidden' in otherwise high-quality composts and digestates. Research may grow in this area in the EPA Research 2022 call.
NL	n.a.	Microplastics in soil systems – RIVM 2021 report 0224 (to be published Q1 2022) https://rivm.openrepository.com/handle/10029/625810 EU project MINAGRIS: MIcro- and NAno-Plastics in AGRIculturalSoils – https://www.minagris.eu/index.php	

Country (alphabetically)	Methods	Research studies, sources	Other information
		Measurement of Microplastics in LUCAS samples PAPILLONS (Plastic in Agricultural Production: Impacts, Lifecycles and LONg-term Sustainability): an EU Horizons project will elucidate ecological and socioeconomic sustainability of agricultural plastics (APs) in relation to releases and impacts of micro- and nanoplastics (MNPs) in European soils. – https://cordis.europa.eu/project/id/101000210 Both projects are EU-projects and only recently (in 2021) started. Dutch universities participate in it. See also (from Wageningen University (WUR)): https://www.wur.nl/nl/Onderzoek-Resultaten/Onderzoeksinstituten/Environmental-Research/show-wenr/EUproject-om-de-effecten-van-plastic-afval-op-de-gezondheid-van-de-bodem-ende-productiviteit-van-de-landbouw-te-onderzoeken.htm (in Dutch)	
SE	n.a.	https://www.slu.se/en/ew-calendar/2020/12/no-regrets-the-accumulation-of-micro-plastics-in-agricultural-soils/ https://www.slu.se/en/departments/aquatic-sciences-assessment/research/forskningsprojekt/completed-research-project/gh/impasse/	n.a.

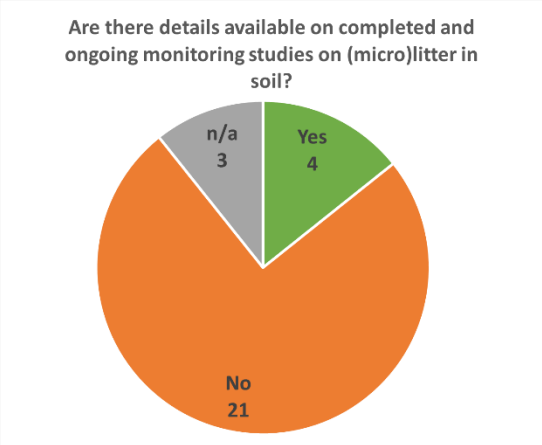
Source: Based on questionnaire responses

N.a. = no answer (no details in text response in MS questionnaire).

4.4.2 Completed and ongoing monitoring studies on (micro)litter in soil (Question 9)

Q9. Are there details available on completed and ongoing monitoring studies on (micro)litter in soil?

Figure 17 Soil Monitoring (Question 9)



N.a. = no answer (no details in text response in MS questionnaire).

Four of 28 countries reported completed or ongoing monitoring studies on litter in soil. Some of these countries provided details on sampling, sample preparation and litter detection methods, while others provided only links to available documentation in national language for further details. Table 15 below summarises the information provided in the questionnaire text responses on sampling and analytical methods used in the monitoring studies reported in the questionnaires.

Overall, monitoring studies on litter in soil still seem to cover only very few European soil systems and relevant monitoring studies on national level are mostly missing.

There are few exceptions of (national) soil monitoring programmes, e.g.

Czechia, study by David et al. 2018[50] applied thermogravimetry–mass spectrometry (TGA–MS) to develop a method for the direct quantitative analysis of poly(ethylene terephthalate) (PET) without further sample pretreatment. Soil samples containing organic matter were spiked with PET bottle recyclate microplastics. dl-Cysteine was used as the internal standard. Sample mixtures were pyrolyzed with a 5 K min^{-1} ramp (40–1000 °C), while sample mass loss and mass spectrometry (MS) signal intensity of typical PET pyrolysis products were recorded. The study found mass spectrometry signal intensities linearly responding to microplastic concentrations. The results suggest that TGA–MS can be an easy and viable complement to existing methods such as pyrolysis or thermogravimetry–thermal desorption assays followed by gas chromatography/mass spectrometry detection or to spectral microscopy techniques.

France, "MICROSOF" project:[51] The MicroSof projects aims to establish first national references on the contamination of French soils by microplastics. To do so, soil samples from

[50] https://pubs.acs.org/doi/full/10.1021/acs.analchem.8b00355

[51] https://www.irdl.fr/wp-content/uploads/2021/02/Poster_MICROSOF_2020.pdf

42 different sites under different land uses (crop lands, forests, grasslands, vineyards and orchards) will be analyzed. A protocol for the extraction and characterization of microplastics is currently being set up, in a six-step process: 1) Pre-treatment - Drying 40°C, Sieving 5 & 2mm 2) subsampling - Triplicates of 50g 3) Wet sieving - Remove the finest fraction (<50µm) 4) Soil Organic Matter digestion with Fenton's reagent following the methodology outlined by Hurley et al. (2018)[52] 5) microplastic will be extracted by density separation - Saturated NaI solution 6) Vacuum filtration of the supernatant with 300µm and 50µm filters before Analysis - Pictures + image processing program, FTIR. The study will thus allow to quantify (mass, number) and to qualify (chemical nature) the accumulated plastic fragments, as well as the size and the shape of these fragments. The project is currently in validation phase of the first version of the protocol, recovery experiments using aged polymers. There is a need to adapt the protocol according to the type of soil.

Some countries without monitoring studies provided explanations on gaps and challenges faced:

In **Latvia**, according to the response, Microlitter monitoring is currently not financially supported by the government and extensive research covering a longer timeline has not been performed.

Cyprus pointed to a study investigating how the plastic-associated bacterial community changes during its lifecycle from its initial point of use towards receiving environments.[53]

[52] https://pubs.acs.org/doi/abs/10.1021/acs.est.8b01517

[53] https://doi.org/10.1016/j.ecoenv.2022.113213

Table 14 Specific monitoring studies on litter in soil (Question)

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
Completed or ongoing monitoring studies					
AT	See question 5				
CZ, SOPLAS "Macro and Microplastic in Agricultural Soil Systems" (H2020-MSCA-ITN-2020)[54]	microplastics	Agricultural Soil Systems	n.a.	n.a.	n.a.
CZ, various studies by institution Vysoké učení technické v Brně / Fakulta chemická[55]	Poly(Ethylene Terephthalate) Microplastics	Soil	n.a.	Thermogravimetry-Mass Spectrometry	n.a.
DK	Not any further than the project mentioned in question 5.				
EE, Sources and routes of microplastic transmission to the Estonian coastal sea, effects on pelagic and benthic organisms	Microplastic	Beach sand	On active use 100 m long sampling site was chosen and 12 samples from two each beach were collected. Eight beaches were sampled. Sand samples were collected on area 25x25 cm, the 5 cm of the surface sand was sifted through 5- and 1-mm sieve. Olympus SZX16 stereomicroscop	Following Rocha and OSPAR methods	Estonian coastal sea

[54] The Czech partner is České vysoké učení technické v Praze (https://cordis.europa.eu/project/id/955334)

[55] David, J.; Steinmetz, Z.; Kučerík, J.; Schaumann, G. E. Quantitative Analysis of Poly(Ethylene Terephthalate) Microplastics in Soil Via Thermogravimetry-Mass Spectrometry. Anal. Chem. 2018, 90, 8793– 8799, DOI: 10.1021/acs.analchem.8b00355

Country, name of study, year	Type/size of litter	Compartment	Sampling method	Analytical technique	Geographic level/locations
			e was use for microplastic analyses. Results were expressed as mean particles amount per m^3 of the sand.		
EE, Microplastic and macroplastic analysis methodology development of coastal garbage monitoring[56]	Microplastic and macrolitter (particles : <2,5 cm, 2,5-50 cm, >50 cm)	n.a.	n.a.	plastic was detected using MicroPHAZIR PC analyser	n.a.
NL, RIVM report 2021-0224, 2022[57]	Microplastics	Soil systems	No sampling, however, study reports on sampling, extraction and identification and quantification methods for microplastics in soils.	Not applicable	Not applicable
NO Impacts of MicroPlastics in AgroSystems and Stream Environment (IMPASSE)	Loads, fluxes and impacts of microplastics	Agro Systems	n.a.	n.a.	Farmlands

Source: Based on questionnaire responses

N.a. = no answer (no details in text response in MS questionnaire).

[56] Merekeskkonna uuringud | Keskkonnaministeerium (envir.ee); Mikro- ja makroplasti analüüsimetoodika arendamine rannikumere pr gi seireks.pdf (envir.ee)

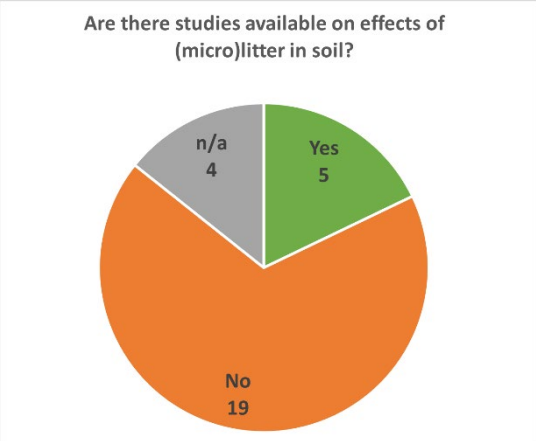
[57] https://rivm.openrepository.com/handle/10029/625810

4.4.3 Studies on effects of (micro)litter in soil (Question 13)

Q13. Are there studies available on effects of litter in transitional waters?

Only five countries (out of 28) report to have studies available on effects of litter in soil. The majority of questionnaire responses do not provide details on the methods that were used in these effect studies, but they provide references to the relevant studies for further details (see table 16 below).

Figure 18 Soil Effects Studies (Question 13)



N.a. = no answer (no details in text response in MS questionnaire).

To date, few studies are available on the effects of plastics on soil organisms are available. These indicate that plastic particles are taken up by organisms and can accumulate in tissues and organs. In addition, plastics can be released along marine and terrestrial food chains, up to and including humans. Plastic particles can contain harmful additive substances and bind other pollutants from their environment.

In the **Lithuanian** study on the influence of PET and tyre-based microplastics on soil Properties (2021)[58], effects of microplastics from polyethylene terephthalate (PET) and from car tyres on properties of water and soil organic matter in three different soils including chernozem, cambisol and phaeozem are studied. The study analysed changes in soil organic matter thermal properties, soil respiration, amount of water and soil aggregation over the period of 15 months to observe their transformation and effects on soil properties. The results revealed that the effect of microplastics on soil properties are soil-type and microplastic-type dependent. Also, it was confirmed that the microplastics were not inert but influenced all the measured parameters. Probably the most important observation was the effect of microplastics on soil organic matter stability. The contamination influenced the soil microbiological activity, which led to the decomposition of soil organic matter and loss of organic carbon. In addition, contaminated soils appeared to have an adverse effect on water holding capacity. Therefore, the microplastics based on non-biodegradable polymers significantly influence the soil ecosystem functions.

[58] https://www.isvavai.cz/riv?s=jednoduche-vyhledavani&ss=detail&n=0&h=RIV%2F00216305%3A26310%2F21%3APU141265

In the **Danish** study "Microplastics in soil: Studies on long-term effects and avoidance behaviour of *Aporrectodea caliginosa*" (2019)[59], the aim of the project was to investigate whether the use of sewage sludge and composted household waste as fertilizer, including specifically microplastics in the fertilizer, affects the behavior, survival, growth and reproduction of earthworms. The results show that there was no indication that the presence of microplastics in soil (up to 0.1% by weight) affected *A. caliginosa* in terms of survival, growth or reproduction. The choice of soil type for both the species tested in the behavioral experiments was primarily driven by food availability and/or food quality (type and amount of organic matter) rather than a need to avoid impurities in the form of microplastics in the soil. However, if the food quality was the same, *E. veneta* could detect microplastic and the worms chose to dodge added plastic at a concentration of 0.1% by weight. Therefore, there is nothing in this study to indicate that the microplastic content of organic resources will have negative consequences for the earthworm population by the application of these resources to agricultural land in accordance with applicable rules. Of course, as earthworms are not the only key organisms on agricultural land and in the terrestrial environment in general, there is a need to carry out further tests with other key species in the terrestrial environment before it can be concluded, whether the application of organic resources containing microplastics can have environmental consequences. There is also a need for more comprehensive studies on the presence of microplastics in the terrestrial environment, both on agricultural land and in other terrestrial environments.

[59] https://www.danva.dk/media/6037/palmqvist-et-al-2019_-effekter-paa-regnorme-af-mikroplast-i-jord_final.pdf

Table 15 Studies on effects of litter in soil (Question 13)

Country (alphabetically)	Biota and other types of effects	Methods	Study links
NL	n.a.	n.a.	In the RIVM-report (to be published in 2022) there is a reference to: https://doi.org/10.1002/etc.5072 Li, L., Luo, Y., Li, R., Zhou, Q., Peijnenburg, W.J.G.M., Yin, N., Yang, J., Tu, C., Zhang, Y. (2020b) Effective uptake of submicrometre plastics by crop plants via a crack-entry mode. Nature Sustainability 3(11): 929-937
FI	n.a.	n.a.	Selonen et al. 2020. Exploring the impacts of plastics in soil – the effects of polyster textile fibers on soil invertebrates. Science of the Total Environment 700, 134451. https://doi.org/10.1016/j.scitotenv.2019.134451 Selonen et al. 2021. Exploring the impacts of microplastics and associated chemicals in the terrestrial environment – Exposure of soil invertebrates to tire particles. Environmental Research 201:111495.
CZ	n.a.	n.a.	Only one result of a study was reported till the end 2021: „TG study on the influence of PET and tyre-based microplastics on soil properties“ https://www.isvavai.cz/riv?s=jednoduche-vyhledavani&ss=detail&h=RIV%2F00216305%3A26310%2F21%3APU141265%21RIV21-MSM-26310___
SE	n.a.	n.a.	Impacts of MicroPlastics in AgroSystems and Stream Environment (IMPASSE) IMPASSE - NIVA
DK	earthworms	n.a.	Link: https://www.danva.dk/media/6037/palmqvist-et-al-2019_-effekter-paa-regnorme-af-mikroplast-i-jord_final.pdf

Source: Based on questionnaire responses

N.a. = no answer (no details in text response in MS questionnaire).

5 Water management activities in relation to litter and microlitter in surface waters

European countries provided information on ongoing and planned actions for the reduction of plastic inputs and the removal of existing litter from surface waters in relation to regulations and other activities of national governments, NGOs and industry. The results are summarised in the sections below. Overall, most countries have taken or are planning actions to reduce the input of litter as well to remove existing litter from surface water environments. Actions to reduce the input of litter are more frequently linked to regulations and other governmental activities, while actions to remove existing litter are in the majority of countries related to NGOs followed by government activities.

Disclaimer: The information presented below on national programmes for litter reduction is based on responses to the ECOSTAT questionnaire on "Research and Monitoring Activities on Litter in Groundwater, Rivers, Lakes, Transitional, Coastal, Marine Waters and Soil". The national programmes mentioned are not an exhaustive list of all actions taking place in the European countries. As for EU Member States, more complete information may be available in reports that summarise the actions taken by in the context of relevant EU reporting requirements.

5.1 Actions to reduce input of litter

Question 21 Are there existing or planned actions in your country to reduce input of litter?

25 out of 28 countries answered to this question and all reported measures to reduce the input of litter, with most frequently reported actions related to regulations and to NGO activities.

Regulations and other activities of national governments

24 countries indicated efforts related to regulations and other activities of national governments.

In **Hungary**, there is a national waste management plan in place for the period 2017-2022. Also in **Czechia**, there is a "Waste Prevention Program", which describes in detail the measures for waste prevention at national level. The most important instrument of financial support for waste prevention projects is the "Operační program životní prostředí" (OPŽP). Within the OPŽP, it is possible to draw subsidies for projects related to waste prevention, including projects such as the construction of waste prevention sites (for furniture, textiles, biodegradable waste), the introduction of domestic waste prevention systems for citizens, construction and modernization equipment for waste collection, sorting and treatment, building "door to door" collection system, construction of new collection yards, re-use centers etc.

In **Finland**, there is a Plastics Roadmap "Reduce and Refuse, Recycle and Replace" and actions included in the operational programme of measures of the Finnish Marine Management Plan for the years 2022-2027. **Luxembourg** has developed a strategy known as "'Null Offall Lëtzebuerg" with the objective of drastically reducing waste and managing its resources more responsibly and sustainably while relying on principles of circular economy. The strategy includes a roadmap with waste prevention as one of its main pillars. **Austria** reports an Action Plan on Microplastics 2022-2025.

Italy is taking actions as part of the MSFD Programme of measures and national legislative measures.

In Bavaria **Germany**, certain single-use plastic items have been banned since 2021 and plastic carrier bags since 2022 and further measures are to follow in 2023 (to-go food and drinks will be offered in reusable packaging).[60] There are also several advising and consulting platforms on waste prevention and collections of waste.[61]

Romania transposed the Single Use Plastic Directive in 2021 and has approved an Action Plan to reduce and eliminate single use plastic. The National Strategy for litter also has some provisions for plastic. Actions are also included in the National Programme of Measures set up under articles 13 and 14 of MSFD.

Malta issued the Single-Use Plastic Products Strategy for Malta 2021-2030 – Rethink Plastic, that contains measures which aim at reducing the consumption of certain single-use plastic products and increasing the quality and quantities of plastic waste collected for recycling.

In the **Netherlands**, there have been successful pilots to reduce the input of litter into the rivers, mainly at recreational areas (for example, bins given a bright blue and striking colour, and placing them in the right locations near walking areas). The local government, as well as the "Dutch Schone Rivieren" (Clean Rivers) initiative, gets in touch with main river polluters to take precautions.

In **Iceland**, the government has launched numerous projects under the Plastic strategy such as the reduction of the use of plastic bags and a ban on 10 single use plastics.

In **Lithuania,** one of the objectives of National Water Development Programme 2017–2023 is to reduce marine litter amount and impact in marine environment including marine monitoring, information campaigns and measures regarding pollution from ships.

In **Estonia**, actions to reduce microplastics in storm water and wastewater are planned in the Estonia Marine Strategy Action Plan.

In Belgium, the Flemish Action Plan on Marine Litter aims at reducing the flux of litter to the marine environment with 75% by 2025, by implementing a diverse set of measures.[62]

NGOs

19 countries report efforts addressing the reduction of input of litter involving NGOs. Some examples include multiple public campaigns by NGOs in Finland to raise awareness of the littering problem, and the actions of some NGOs in Portugal which focus on the avoidance of litter that is common in waters (e.g., through the decrease in the use of plastic straws).

Industry

[60] https://www.umweltpakt.bayern.de/abfall/aktuelles/3423/einschraenkungen-massnahmen-einwegprodukte-einwegverpackungen

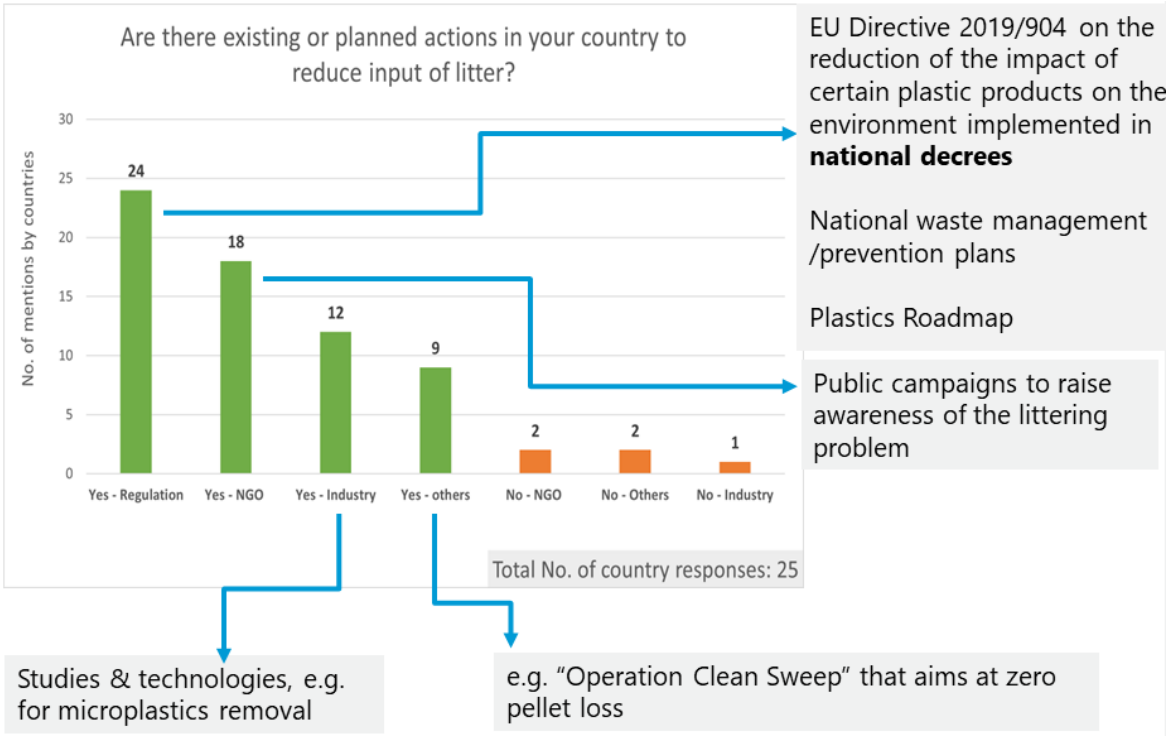
[61] References provided:

- https://www.abfallratgeber.bayern.de/haushalte/vermuellung_der_landschaft/index.htm
- https://www.altmuehlfranken.de/natur/fruehjahrsputz-in-altmuehlfranken/
- https://ingolstadt.bund-naturschutz.de/mitmachen/ramadama

[62] https://ovam-english.vlaanderen.be/documents/177280/797580/2019+-+Flemish+Action+Plan+Marine+Litter.pdf/192dc76d-90ce-45da-8321-a1776b3277e0?version=1.1

12 countries (of 28) indicated efforts addressing the reduction of input of litter within the industrial sector. Specific information was reported only by few countries. In Finland, the Finnish Plastic Association has adopted the "Operation Clean Sweep" that aims at zero pellet loss. There is a similar zero pellet loss agreement in place in Austria. In Belgium, companies can sign up to the Operation Clean Sweep (OCS) pledge to implement zero pellet loss measures.[63]

Figure 19 Actions to reduce litter input (Question 21)



5.2 Actions to remove existing litter from surface water environments

Question 22 Are there existing or planned actions in your country to remove existing litter from surface water environments?

27 out of 28 countries answered to this question, while 25 countries reported measures to reduce existing litter from surface water environments, with most frequently reported actions related to NGO activities and regulations.

5.2.1 Regulations and other activities of national governments

11 countries indicated efforts related to regulations and other activities of national governments.

In **Poland**, litter removing is one of the river maintenance measures defined by the Polish Water Act. The realization of these measures is planned in the 6-years Water Maintenance Plans at the level of the water bodies.

[63] https://www.opcleansweep.eu

In **Denmark,** in 2018, the government launched the National Plastic Action Plan with 27 initiatives for reduction, reuse and recycling of plastics to reduce the littering and pollution of plastic. Subsequently, the Danish government and parliament agreed on 11 additional initiatives for reduction, reuse and recycling of plastics to reduce the littering and pollution of plastic. Further, the Danish EPA continuously launches campaigns to raise awareness on littering. The most recent have been developed in cooperation with other authorities, including the Danish Road Directorate and the Royal Danish Navy under the title „Thank you for nothing… in nature" as well as the clean-up campaign Garbage Safari for school kids.

In **Sweden**, the programme of measures for good environmental status (MSFD) supports an effective and sustainable retrieval and collection of derelict fishing gear and cleaning up beaches in particularly affected areas. The Swedish Agency for Marine and Water Management is also supporting the collection and recycling of end of life boats.

In **Germany**, there are actions included in the national MSFD programme of measures[64] and several other actions such as clean-ups, beach litter boxes[65] and specific projects in ports[66].

In **Iceland**, the Plastic strategy includes efforts to clean up the shores of Iceland.

In **Estonia**, in addition to actions to reduce microplastics in storm water and waste water, the construction of artificial wetlands is planned as action to remove existing litter.

5.2.2 NGOs

18 countries indicated efforts addressing the removal of existing litter related to NGOs and several countries refer to relevant examples.

In **Malta**, NGOs are mainly involved in coastal and marine clean-ups. In Romania, the NGO Mare Nostrum is involved in clean-ups of beaches. In **Germany**, NGOs of national scope carry out litter removal activities such as the NABU Fishing for Litter and the ghost net project of WWF funded by the Federal State of Mecklenburg-Vorpommern. In **Finland**, the Association Keep the Archipelago Tidy has a Clean Beach program. Also in **Portugal**, the promotion of litter removal campaigns by NGOs and civil society is quite common, mainly in coastal waters and sometimes also associated with actions to remove invasive species.

In **Czechia**, there is an annual volunteer cleaning event "Let's Clean Up the Czech Republic" held every year on April 2. Its goal is to clean up illegally generated black dumps and garbage in the wild, including the environment near water bodies and watercourses. Also in **Luxembourg**, the "Aktioun Grouss Botz" is organised every year in spring by municipalities, NGOs or fishing clubs.

In **Poland**, NGOs or administrations organize regularly actions related to litter removing, e.g. the 2021 "Clean River Operation" has gathered over 4,600 volunteers, and 2,000 volunteers (workers from administrations) took part to the 2021 operation "Water is not a garbage can!".

In the **Netherlands**, there are NGOs and local government that have litter-catching facilities installed (mainly pilot based). The Dutch government will currently no longer invest in these initiatives since they prove to be not very effective (from a cost perspective).

[64] https://www.meeresschutz.info/berichte-art13.html

[65] E.g. https://www.nationalpark-wattenmeer.de/news/strandmuell-sammeln-und-sinnvoll-entsorgen/

[66] E.g. in Niedersachsen, https://www.nports.de/nachhaltigkeit/projekte/seabin/

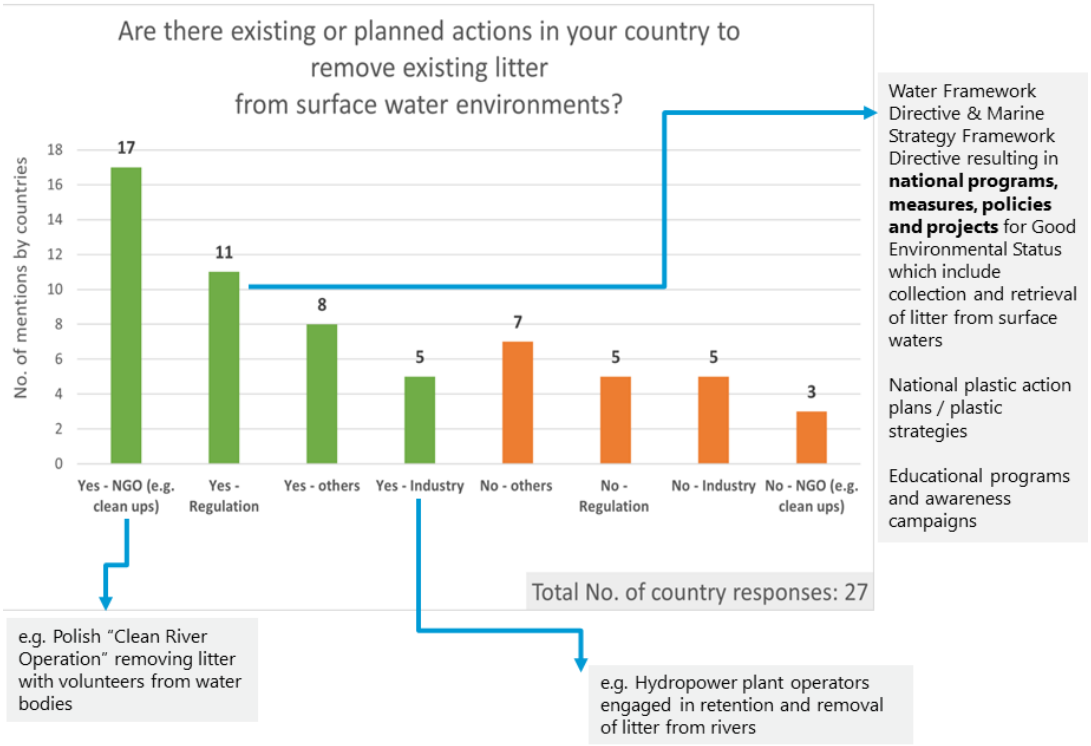
In Belgium, the Zero Plastic Rivers is an initiative aiming at reducing plastic pollution in rivers, by organising cleanups and promoting research and collaboration between stakeholders.[67]

5.2.3 Industry

Only 5 countries indicated efforts addressing the removal of existing litter within the industrial sector.

Both **Poland** and **Germany** report the role of hydropower plant operators in the retention and the removal of litter from rivers.

Figure 20 Actions to remove litter (Question 22)



[67] https://zeroplasticrivers.com

6 Key conclusions on the European picture of activities/methods in relation to research and monitoring of litter in water and soil

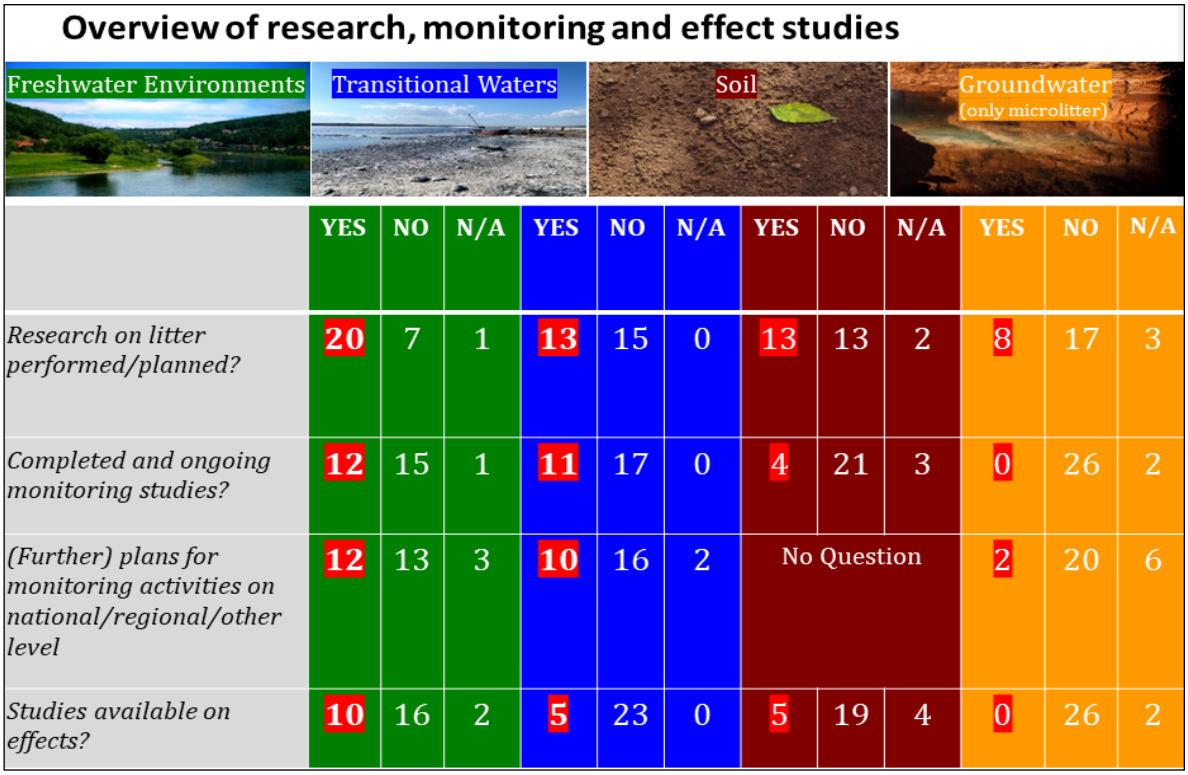
6.1.1 Good practices

- Although most monitoring activities of litter in the freshwater environment concentrate so far on selected water bodies, there are some examples of monitoring litter at larger scale, i.e. national and transnational river monitoring programmes, e.g. the Joint Danube Survey and the forthcoming Dutch river monitoring programme based on a proposed national macrolitter monitoring strategy/roadmap for Dutch rivers.
- There are also some examples of national monitoring programmes for transitional waters, e.g. the German Monitoring of litter in the water column of German North Sea estuaries.
- Most European countries have taken or are planning actions to reduce the input of litter as well to remove existing litter from surface water environments. Several countries have developed national strategies, action plans or roadmaps on plastics e.g. as part of broader strategies on waste prevention and reduction or as particular actions focusing on microplastics. Further, there are NGOs in several countries that are very active on removal of existing litter from surface water environments and initiate clean-ups of beaches and of rivers and other litter removal campaigns.

6.1.2 Key gaps, challenges and needs for further action in research and monitoring

- In many countries, the sources and pathways for litter into the water environment and soil are still unknown. The gap reported (unknown sources of litter) is larger for groundwater compared to freshwater, transitional, coastal and marine waters and soil.
- Research studies on litter are more common for the freshwater environments than for transitional waters (see Figure 21 below).
- Also more countries have monitoring studies or further plans for monitoring for freshwater and transitional water environments than for groundwater and soil.
- In particular, for the freshwater environments, research studies are more common than monitoring and effect studies, which indicates that in several countries, the subject of litter is still at pilot stage. The situation is similar for transitional waters.
- Monitoring studies on litter in freshwater environments still seem to cover only selected European rivers and lakes, and relevant monitoring studies on national level are missing. Also several country responses indicate that overall, there are only very few studies about the impact of plastic on freshwater biota.
- Similarly, monitoring studies on litter in transitional waters still seem to cover only selected European transitional waters (these can be estuaries and bays, coastal inlets or fjords, and intermittently closed and open lagoons and lakes, etc.) and relevant monitoring studies at national level are mostly missing.

Figure 21 Overview of research, monitoring and effect studies



	YES	NO	N/A	YES	NO	N/A	YES	NO	N/A	YES	NO	N/A
Research on litter performed/planned?	**20**	7	1	**13**	15	0	**13**	13	2	**8**	17	3
Completed and ongoing monitoring studies?	**12**	15	1	**11**	17	0	**4**	21	3	**0**	26	2
(Further) plans for monitoring activities on national/regional/other level	**12**	13	3	**10**	16	2	No Question			**2**	20	6
Studies available on effects?	**10**	16	2	**5**	23	0	**5**	19	4	**0**	26	2

- For groundwater, only few countries have past or ongoing research studies on microlitter, but no countries have monitoring studies or studies on effects. Further, only two countries report to have (further) plans for monitoring activities for microlitter in groundwater, indicating that this gap will persist.
- For soil, although a number of countries have research studies on (micro)litter, very few report monitoring studies or further plans for monitoring in the future.
- Overall, there is lack of systematic litter monitoring programmes for freshwater environments, transitional waters and soil. Information collected and results are still scarce and often dispersed among different institutions within countries.
- In specific for the freshwater environments, challenges reported by countries include lack of financial support for microlitter monitoring, lack of extensive research covering longer timelines, and lack of clear legal background to establish regular monitoring activities.
- For transitional waters, country responses indicate a general absence of structural/systematic monitoring programmes, while there is some non-specific or ad hoc monitoring, especially in the context of student projects, visual monitoring to solely allow for the removal of litter without being attached to a research project, etc.
- With regard to soil, monitoring studies still seem to cover only very few European soil systems and, with few exceptions, relevant monitoring studies at national level are missing.

6.1.3 Possible follow-up at ECOSTAT and EU level

This report was presented to the working group ECOSTAT as a draft version in October 2022 (44th ECOSTAT meeting). The report was revised to take account of ECOSTAT comments and presented to ECOSTAT in its final version in March 2023 (45th ECOSTAT meeting).

Discussions in the ECOSTAT working group confirmed the complexity of the topic as the litter problem is not only relevant to different compartments of surface waters but also to groundwater and soils. Further, litter management is intrinsically linked to waste management and to the principles of a circular economy. Therefore, the topic of litter in rivers, lakes, transitional waters, groundwater and soil should also be embedded in European exchange fora that deal with these issues. The ECOSTAT working group may continue to play a role in the litter topic in the future, following ongoing policy developments on microplastics in the water environment.

In the responses received the following proposals for possible follow-up activities have been made:

- Set up a specific technical working group on European level for litter monitoring in rivers (and/or having such a technical working group per main European rivers, like Rhine and Meuse). The objective would be to exchange knowledge, methods, results and standards (suggestion Netherlands)
- The EU could provide the development of a method of microplastics sampling from compartments of interest as well as development and publication of an analytical method on analysis of microplastics. Clear answers to these questions are crucial for Member States to start monitoring of microplastics and generating data suitable for comparison and future water/waste management steps. (suggestion Slovakia)

From the German co-lead side it is under consideration to hold a workshop or participate in a workshop inter alia together with Regional Sea Conventions to discuss the report and elaborate further on the way forward. One issue to be covered could be:

- Are the proposals received (see above) appropriate to achieve a common understanding on litter monitoring/research in rivers and further exchange knowledge, methods, results and standards for sampling and analysis?

Prerequisite for further activities is the set-up of an ad hoc steering group within ECOSTAT to support this activity and support by a consultant for preparation of the workshop, its execution and drafting of a final report. In any case, the MSFD (Marine Strategy Framework Directive) CIS Working Group on Good Environmental Status (WG GES) and the Technical Group on Marine Litter (TG ML) will be informed.

All Regional Sea Conventions undertake relevant work on marine litter and will be addressed as well. The relevant EU Working Groups on Chemicals, Groundwater & Soil will be informed about this report.

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A Appendix I Empty questionnaire

ECOSTAT-Questionnaire On Research and Monitoring Activities on Litter in Groundwater, Rivers, Lakes, Transitional, Coastal, Marine Waters and Soil

Name:

Organisation:

Country:

Contact information:

SECTION 1

Question 1

What agency/agencies/institution/institutions is/are in charge of litter and ...

- **Freshwater (rivers, lakes) monitoring**
- **Freshwater (rivers, lakes) research**
- **Transitional waters monitoring**
- **Transitional waters research**
- **Groundwater monitoring**
- **Groundwater research**

Question 2

Is research on litter in freshwater environments performed/planned in your country?

Yes ☐ No ☐

If yes, which methods are/were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 3

Is research on litter in transitional waters performed/planned in your country?[68]

Yes ☐ No ☐

[68] Coastal and marine waters covered by TG ML

If yes, which methods are/were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 4

Is research on microlitter in groundwater performed/planned in your country?

Yes ☐ No ☐

If yes, which methods are/were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 5

Is research on (micro)litter in soils performed/planned in your country?

Yes ☐ No ☐

If yes, which methods are/were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 6
Are there details available on completed and ongoing monitoring studies on litter in freshwater environments?

Yes ☐ No ☐

If yes, which methods are/were used for sampling, sample preparation, detection?

If yes, is/was the quality of the results quality assured? How? If not, are there plans to introduce QA procedures? If so, are any descriptions on QA procedures available?

If available, please specify and add references/weblinks, copies of the reports or short summaries, QA procedures etc.

Explanation

Question 7

Are there details available on completed and ongoing monitoring studies on litter in transitional waters?[69]

Yes ☐ No ☐

If yes, which methods are/were used for sampling, sample preparation, detection?

If yes, is/was the quality of the results quality assured? How? If not, are there plans to introduce QA procedures? If so, are any descriptions on QA procedures available?

If available, please specify and add references/weblinks, copies of the reports or short summaries, QA procedures etc.

Explanation

Question 8

Are there details available on completed and ongoing monitoring studies on microlitter in groundwater?

Yes ☐ No ☐

If yes, which methods were used for sampling, sample preparation, detection?

If yes, is/was the quality of the results quality assured? How? If not, are there plans to introduce QA procedures? If so, are any descriptions on QA procedures available?

If available, please specify and add references/weblinks, copies of the reports or short summaries, QA procedures etc.

Explanation

[69] Coastal and marine waters covered by TG ML

Question 9

Are there details available on completed and ongoing monitoring studies on (micro)litter in soil?

Yes ☐ No ☐

If yes, which methods are/were used for sampling, sample preparation, detection?

If yes, is/was the quality of the results quality assured? How? If not, are there plans to introduce QA procedures? If so, are any descriptions on QA procedures available?

If available, please specify and add references/weblinks, copies of the reports or short summaries, QA procedures etc.

Explanation

Question 10

Are there studies available on effects of litter in freshwater environments?

Yes ☐ No ☐

If yes, which methods were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 11

Are there studies available on effects of litter in transitional waters?[70]

Yes ☐ No ☐

If yes, which methods were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

[70] Coastal and marine waters covered by TG ML

Explanation

Question 12

Are there studies available on effects of microlitter in groundwater?

Yes ☐ No ☐

If yes, which methods were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 13

Are there studies available on effects of (micro)litter in soil?

Yes ☐ No ☐

If yes, which methods were used?

If available, please specify and add references/weblinks, copies of the reports or short summaries

Explanation

SECTION 2

Question 14

Are there data on riverine loads (mass, particle numbers) of litter available?

Qualitative data (what kinds of litter)

Yes ☐ No ☐

Quantitative information (Weight of litter – kg/tons per year)

Yes ☐ No ☐

If available, please specify and add references/weblinks, copies of the reports or short summaries. Please provide information on sampling, sample preparation and analytical methods and QA procedures if in place. Please indicate if not or if they are planned.

Explanation

Question 15

Are there data on riverine inputs into transitional, coastal and marine waters available?[71]

Qualitative data (what kind of litter)

Yes ☐ No ☐

Quantitative information (Amounts of litter per (milli)liter)

Yes ☐ No ☐

If available, please specify and add references/weblinks, copies of the reports or short summaries. Please provide information on sampling, sample preparation and analytical methods and QA procedures if in place. Please indicate if not or if they are planned.

Explanation

Question 16

What are the main sources and pathways for litter into groundwater, surface waters and soil in your country (multiple crosses are possible)?

Please differentiate into micro-/meso-/macrolitter where appropriate (< 5 mm, 5 - 200 mm, > 200 - 500 mm).

Groundwater

- Landscape littering ☐
- Waste water ☐
- Storm water ☐
- Industrial emissions
- (e.g. pellet loss) ☐
- Tire abrasion ☐
- Other ☐ please specify:
- Unknown ☐

If you ticked more than one box, please try to provide a ranking (preferably in percentages). If available, please specify and add references/weblinks, copies of the reports or short summaries.

[71] We are interested in data/information beyond the article https://www.nature.com/articles/s41893-021-00722-6?proof=t

Explanation

Freshwater

microlitter	***mesolitter***	***macrolitter***
- Landscape littering ☐	Landscape littering ☐	Landscape littering ☐
- Waste water ☐	Waste water ☐	Waste water ☐
- Storm water ☐	Storm water ☐	Storm water ☐
- Industrial emissions	Industrial emissions	Industrial emissions
- (e.g. pellet loss) ☐	(e.g. pellet loss) ☐	(e.g. pellet loss) ☐
- Tire abrasion ☐	Tire abrasion ☐	Tire abrasion ☐
- Other ☐	Other ☐	Other ☐
- Please specify:	Please specify:	Please specify:
- Unknown ☐	Unknown ☐	Unknown ☐

If you ticked more than one box, please try to provide a ranking (preferably in percentages). If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Saline waters (i.e. transitional, coastal, marine waters)

microlitter	***mesolitter***	***macrolitter***
- Landscape littering ☐	Landscape littering ☐	Landscape littering ☐
- Waste water ☐	Waste water ☐	Waste water ☐
- Storm water ☐	Storm water ☐	Storm water ☐
- Industrial emissions	Industrial emissions	Industrial emissions
- (e.g. pellet loss) ☐	(e.g. pellet loss) ☐	(e.g. pellet loss) ☐
- Tire abrasion ☐	Tire abrasion ☐	Tire abrasion ☐
- Other ☐	Other ☐	Other ☐
- Please specify:	Please specify:	Please specify:
- Unknown ☐	Unknown ☐	Unknown ☐

If you ticked more than one box, please try to provide a ranking (preferably in percentages). If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Soil

microlitter	***mesolitter***	***macrolitter***

- Landscape littering	◻	Landscape littering	◻	Landscape littering	◻
- Waste water	◻	Waste water	◻	Waste water	◻
- Storm water	◻	Storm water	◻	Storm water	◻
- Industrial emissions		Industrial emissions		Industrial emissions	
- (e.g. pellet loss)	◻	(e.g. pellet loss)	◻	(e.g. pellet loss)	◻
- Tire abrasion	◻	Tire abrasion	◻	Tire abrasion	◻
- Other	◻	Other	◻	Other	◻
- Please specify:		Please specify:		Please specify:	
- Unknown	◻	Unknown	◻	Unknown	◻

If you ticked more than one box, please try to provide a ranking (preferably in percentages)

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

SECTION 3

Question 17

Are there (further) plans for monitoring activities on national/regional/other level for litter in freshwater environments?

Yes ☐ No ☐

If yes, which methods will be used?

If yes, how will the quality of the results be assured (QA in place or planned)?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 18

Are there (further) plans for monitoring activities on national/regional/other level for microlitter in groundwater?

Yes ☐ No ☐

If yes, which methods will be used?

If yes, how will the quality of the results be assured (QA in place or planned)?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 19

Are there (further) plans for monitoring activities on national/regional/other level for litter in transitional waters[72]?

Yes ☐ No ☐

If yes, which methods will be used?

If yes, how will the quality of the results be assured (QA in place or planned)?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

Explanation

Question 20

Are there (further) plans for monitoring activities on national/regional/other level on inputs of litter from freshwater systems into saline (transitional, coastal and marine) environments?

Yes ☐ No ☐

If yes, which methods will be used?

If yes, how will the quality of the results be assured (QA in place or planned)?

If available, please specify and add references/weblinks, copies of the reports or short summaries.

[72] Coastal and marine waters covered by TG ML

Explanation

Question 21
Are there existing or planned actions in your country to reduce input of litter?

	Regulation	NGO	Industry	Others (please indicate)
yes	☐	☐	☐	☐
no	☐	☐	☐	☐

Question 22

Are there existing or planned actions in your country to remove existing litter

from surface water environments?

	Regulation	NGO (e.g. clean ups)	Industry	Others (please indicate)
yes	☐	☐	☐	☐
no	☐	☐	☐	☐

Please add an overview or examples.

Explanation

Issue 23

If you want to provide further information on research or monitoring surveys on litter in groundwater, surface waters (freshwater and saline waters) and soil, please feel free to provide here free text and/or links/references.

Explanation

Issue 24

If you have any questions to ECOSTAT members on research or monitoring surveys on (micro)litter in groundwater and surface waters (freshwater and saline waters) and soil, please feel free to ask them here. We will collect all questions and find a procedure to respond.

Explanation