

OSPAR RAP action 41

Inventory of knowledge and actions concerning riverine litter relevant for the OSPAR area



OSPAR RAP action 41

Inventory of knowledge and actions concerning riverine litter relevant for the OSPAR area

November, 2016

On behalf of Rijkswaterstaat Zee en Delta, The Netherlands

Index

| | <i>page</i> |
|---|-------------|
| Introduction | 4 |
| 1. Awareness of riverine litter | 5 |
| 2. State of knowledge regarding litter in rivers | 9 |
| 3. Data Collection | 13 |
| 4. Examples of inspirational projects and best practices to prevent litter entering the water systems | 25 |
| 5. Future connection between marine and riverine communities | 34 |
| 6. Conclusions and recommendations | 37 |
| Appendix 1: Further reading and references | 40 |
| Appendix 2. Overview of European monitoring studies on plastics in freshwater environments | 42 |

Introduction

The Netherlands, Germany and Belgium are task leads for action 41 of the Regional Action Plan for Prevention and Management of Marine Litter in the North-East Atlantic. Action 41 is part of Theme B: Actions to combat land-based sources.

Action 41: "Exchange experience on best practice to prevent litter entering into water systems and highlight these to River or River Basin Commissions."

For the implementation of action 41, OSPAR has sent out a questionnaire to river commissions to find out their (policy) approach to reduce riverine litter for the European rivers.

Response

Responding river commissions were:

- Administração da Região Hidrográfica do Tejo e Oeste / Agência Portuguesa do Ambiente (ARHTO/APA), with a separate answer from their subsidiary the Alentejo River Basin Commission
- International Meuse Commission (IMC)
- International Commission for the Protection of the Elbe River (ICPER)
- International Commission for the Protection of the Rhine (ICPR)
- International Commission for the Protection of the Mosel and Saar (ICPMS)
- International Scheldt Commission (ISC)
- River Basin district Ems (RBE)

Other respondents were:

- The United Kingdom supplied some information which is either national or river specific (UK)

Results

In this report you will find the results from this inventory. It tells you:

- how high the prevention of riverine litter is on the agenda of the river commissions;
- the national policy for the rivers concerned;
- the state of knowledge on the amount of litter concerned (available monitoring results);
- relevant reports and good practices that can be a source of inspiration;
- how European scientific and policy networks on salt and freshwater could cooperate more effectively on the issues of monitoring, quantitative results, reduction of litter.

The report presents the answers to the questionnaire. The information provided is not exhaustive.

1. Awareness of riverine litter

Questionnaire: 1a. Is riverine litter on the formal agenda of your organisation currently and/or do you have any related policy or plans in place?

General conclusion on question 1a

The extent to which riverine litter is on the agenda of river commissions varies from 'hardly/not important' to 'increasing attention'. External policy and networks give an incentive to include the subject in their activities. The subject is definitely upcoming due to growing research-based evidence.

Agenda setting

Riverine litter is not high on the agenda within the respective river commissions. Up till now waste policy is often regulated by national legislation, but this is not aimed at solving the waste problem in riverine systems.

- Riverine litter is no issue on the ICPER (Elbe) agenda so far and therefore there are no river basin wide policies or plans.
- Since a few years, riverine litter is part of the work of the IMC (Meuse), but it is not a major issue. A first brochure for the public was published in 2010. It put forward the problems and hazards associated with the presence of waste along rivers in the Meuse basin.
- Riverine litter is not yet part of the work of the International Scheldt Commission (ISC).
- RBE (Ems) notes that in transitional waters riverine litter is on the formal agenda of Lower Saxony (one of the 16 German federal states).
- ARHTO (Tagus) is aware that a lot of litter is accumulated on the river banks, and that during periods of high flows huge amounts of litter can be dragged to the coastal zone and sea. They are just starting the process of launching a pilot study for riverine litter monitoring in order to select the most effective sampling.
- UK: there is awareness that riverine litter is a source of marine litter. The attention has been accelerated by the 2015 study 'SFRA0025: Identification and Assessment of Riverine Input of (Marine) Litter', which showed that rivers play an important role in transporting litter and noted that 'management action is required if this input is to be decreased'. (see page 20)

Relevant policy and network developments

The exchange and cooperation with policy programmes and networks create an incentive to embed the subject in the river commissions' action programmes:

- The Marine Strategy Framework Directive (MSFD) has issued a call for action, the ICPER (Elbe) notes. Member States should develop a Programme of Measures (PoM) by 2015. In the process of the implementation of these MSFD-PoMs, riverine litter will be addressed, as some of these measures will help prevent litter entering marine water systems.
- The problems of riverine litter have recently been confirmed in the IMC (Meuse) working programme through the coordination between the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD).
- International Commissions for the Protection of the Mosel and the Saar (ICPMS) includes the connection between WFD and MSFD. This includes litter as a relevant topic.
- Recently, the problems of riverine litter along the Scheldt was briefly discussed in the working group coastal water as an item to coordinate between the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD). However the Parties of the ISC each worked on it through separate programmes which are not yet coordinated.
- Portugal (through FCT/UNL) has been a partner of MARLISCO FP7 project, aiming (amongst many other subjects) on marine litter. More than 11,000 people participated in its awareness activities (project ended 2015). Also ARHTO (Tagus) is a stakeholder of the Portuguese Association of Marine Litter, a non-profit organization for the defence, conservation, and preservation of the environment against the impacts of marine litter in the ecosystems, coastal, estuarine and inland waters.
- UK litter strategies recently covers riverine, aquatic and marine litter. England's National Litter Strategy, in draft; Northern Ireland Marine Litter Strategy, (https://www.daera-ni.gov.uk/sites/default/files/publications/doe/marine-policy-ni-marine-litter-strategy-2014_0.pdf); and the Marine Litter Strategy for Scotland, (<http://www.gov.scot/Resource/0045/00457889.pdf>) recognise the importance of riverine, aquatic and marine litter.

Information exchange and increasing evidence

Information is already being exchanged in several ways:

- To guarantee information exchange and enable a possible joint approach in the future there are many meetings and conferences dealing with riverine litter, especially microplastics.
- ICPR (Rhine) notes that regarding plastic litter there is a regular information exchange between contracting parties about national developments (e.g. ongoing studies) and new findings. This includes a living document summarizing this information, which is updated on a yearly basis.

- ICPMS (Mosel & Saar) comments that a regular information exchange is planned from the end of 2016.
- Germany and the Netherlands carry out several studies and actions, e.g. studies on macroplastics and microplastics in the Rhine river or monitoring activities in the estuaries of the rivers Elbe, Weser and Ems.
- Studies proving the effects of litter in fresh water lead to more pressure to take action. However, many questions remain on whether actions are proven to be effective.

Questionnaire: 1b. Is there a difference in your organisation's awareness or interest concerning microplastics (< 5 mm) versus larger sized litter?

General conclusion on question 1b:

Attention is paid to both macroplastics and microplastics, although there is a clear shift of focus towards microplastics, according to the river basin commissions.

The attention to the damage of microplastics to the environment, people and animals is growing enormously in recent years.

- Most river basin commissions note that the exchange of information includes all sizes of plastic, although the focus is more and more on microplastics.
- ARHTO (Tagus) is aware of the two dimensions of litter and this subject is included in their environmental education actions towards teachers and students.
- UK indicates that although the public awareness of macrolitter is high, public awareness of riverine litter may not be. Public awareness of microplastics as marine litter is currently high thanks to high profile campaigns that highlight the pollution caused by microbeads in cosmetics and personal care products.

External studies have been started to measure the amount of microplastics in rivers. See paragraph 2e and 3e.

2. State of knowledge regarding litter in rivers

Questionnaire: 2a. What is the state of knowledge regarding quantities (and/or types) of litter in your riverine system?

General conclusion on question 2a:

Knowledge regarding quantities in riverine litter is rare with most river commissions. But some studies have been conducted.

Studies mentioned by river commissions:

- ICPMS (Saar&Mosel) and ICPR (Rhine) mention the recent study of Mani et al. (2015). This research gives a first insight into the distribution of microplastics in the Rhine, showing the regional differences in microplastic pollution and giving insight into the mixture of different microplastic types.
- Deltares' study (2013), *'Plastic litter in the rivers Rhine, Meuse and Scheldt, contribution to plastic waste in the North Sea'* was mentioned by ICPMS (Saar&Mosel) and ICPR (Rhine), ICM (Meuse) and ISC (Scheldt). This study shows that the Rhine transports 5000 m³ of macroplastics per year. Deltares roughly estimates that the transport of plastic litter (fine fraction, 5-24 mm) by the river Meuse – upstream of the nature reserve Biesbosch – is about 100-1000 m³ per year in periods with average floods. The transport of plastic litter (fine fraction, 5-24 mm) by the river Scheldt is about 60-600 m³ per year in periods with average floods.
- ISC (Scheldt) mentions the study 'For the river' by the University of Gent on occurrence and distribution of microplastics. It concludes that "the Scheldt river is a highly polluted freshwater ecosystem in comparison with several marine and freshwater environments." Especially small microplastic fragments (< 100 µm) are abundantly present in the Scheldt river. This poses a potentially significant threat to the ecosystem functioning of the river. There's even a tendency of microplastics to become smaller towards the mouth of the river. Next to finding smaller particles whilst moving towards the river mouth, the abundance appears to increase as well. As the river has travelled a longer distance, the anthropogenic pressure on the ecosystem (e.g. input from land) has augmented.
- ISC (Scheldt) also reports that several study results are available on a regional or national scale, but these studies aren't coordinated or endorsed by the ISC. They are carried out by individual ISC members or universities.
- UK reports that riverine litter may come from direct littering or from sewage overflows but volumes are unknown.

- RBE (Ems) mentions that some German Federal States have already initiated a co-ordinated study by Laforsch on microplastics in the river Rhine and some relevant tributaries. Microplastic particles are ubiquitous also in freshwater environments. Contamination in river surface samples is higher than in water surface samples of lakes. Preliminary results and conclusions were presented at an international conference in Berlin 21-22 June, 2016, organized by Germany. (German Environment Agency, 2016. p73-74)
- For the Ems and Elbe two studies are noteworthy: KÜFOG (2013) and Schulz (2015) give preliminary results of monitoring activities of the total suspended litter (TSL) for the rivers Ems, Weser and Elbe. Composition of material categories and litter items were similar in these estuaries, with plastic/polystyrene amounting to more than 94%. Abundances of total suspended litter (TSL) range from 0 to 19.7 pieces of litter per 105 m³. Mean TSL amounted to 1.1 ±1.3 (EMS), 2.0 ±1.7 (Weser) and 2.5 ±3.8 (Elbe) pieces of litter per 105 m³.
- ARHTO (Tagus) notes that they record the presence (yes/no) of litter under the monitoring of bathing water quality. Therefore, they have some information related to the fluvial beaches in the Tagus and West River Basin District.

Questionnaire: 2b. What is the state of knowledge concerning sources and pathways of litter in the riverine system within your river basin?

General conclusion on question 2b:

The sources and pathways of litter in the riverine system are largely unknown. The level of knowledge is currently low, and might need to be improved in the future.

Some knowledge that is available on litter sources:

- In the study by Mani et al. (2015), different plastic types were analysed, which also gives an insight into their respective sources. The study showed that the sources of litter vary depending on the surrounding area and influences of industry and waste water treatment plants. Some data that is known:
 - Main sources for the Meuse: untreated wastewater, effluents of treatment plants, storm water of municipal areas, industry, recreation, shipping etc.
 - Main sources for the Mosel/Saar: water treatment plants, storm water discharges, municipal areas, industry, navigation etc.
 - Main sources for the Rhine: storm water discharges, municipal areas, industry, navigation, waste water treatment plants etc.
- The IMC (Meuse) follows the progress and the results of the studies in this field and notably their implications for the International Hydrographic District of the Meuse. Information about this subject is exchanged on a regular basis.
- ARHTO (Tagus) mentions that it is possible to make the link between some litter items and their sources, as it is already done concerning marine litter. The pathways must be very well understood as a means to control and minimize riverine litter.
- ICS (Scheldt): known and main sources of litter can be untreated wastewater, effluents of treatment plants, storm water of municipal areas, industry, recreation, shipping etc. The Deltares study made clear that there are not many data available for the Scheldt.

Questionnaire: 2c. Is there an identified need for additional data and research on riverine litter within your area?

General conclusion on question 2c:

There is a call for standards and additional data on the sources of litter.

There is a clear call for standards, coming from the IMC (Meuse), RBE (Ems), ICPR (Rhine) and ICPMS (Mosel & Saar). Once standard procedures are established, more studies are needed to get a better overview of plastic from different sources, but also their pathways to rivers and their occurrence and fate in rivers.

- To begin with, there is a need to determine standard procedures regarding monitoring of litter, especially for microplastics. But the IMC (Meuse) points out that this is also necessary for mesoplastics/macropastics, including sampling methods, sample preparation and analysis.
- Exception to the need for standard procedures for microplastics or for meso/macro-plastics is ISC (Scheldt).
- UK: Van der Wal, et al. (2015), contracted by the European Commission, concluded that: "From data that is available it is anticipated that in the absence of additional mitigation measures and improved performance of existing waste management legislation, any region with large rivers entering the sea will see inputs of large amounts of litter into the marine systems, stemming from land based sources. However, the scale of such input remains to be systematically quantified by long term monitoring."

Different internationally recognized organisations have worked on standard procedures for monitoring litter. These should be carefully studied, to enhance global harmonisation and to avoid overlapping work. The examples of such internationally recognized work include:

1. Guidance on Monitoring of Marine Litter in European Seas (2013) (<https://ec.europa.eu/jrc/>)
2. The development in the International Organisation for Standardization ISO (whose first working group was held in April 2016).

3. Data collection

Questionnaire: 3a. Is there monitoring data available for riverine litter within your river basin?

General conclusion on question 3a:

No regular monitoring of plastic is performed by the river commissions. The national research programmes for litter do not presently include riverine litter.

There are scattered data available on the monitoring of riverine litter:

- ICPER (Elbe) indicates that monitoring data are available on a national level. There are also some monitoring data available for the transitional waters of the Ems, Weser and Elbe. The availability of data is limited and the data are not harmonised. For example in the Bavarian monitoring project data are still being processed and quality assurance needs to be accomplished before public access can be granted.
- For macrolitter, there might be national monitoring programs and there might be data on the amount of litter based on litter collection on cleaning days and at hydropower plants/retaining dams, according to ICPMS (Mosel/Saar), IMC (Meuse), ISC (Scheldt) and ICPR (Rhine).
- ARHTO (Tagus) records only the presence of litter (yes/no) under the monitoring of bathing water quality.
- UK riverine litter is dealt with mostly by charities which concentrate on litter collection rather than monitoring. The techniques used are not consistent and the effort applied to each river basin varies widely. Most work seems to happen in the River Thames. The charity Thames21 runs citizen science programmes to conduct riverine litter monitoring (see box). Results of this monitoring are available at <http://www.thames21.org.uk/thames-river-watch-litter/>.
- The Meuse has also started a monitoring project with volunteers in The Netherlands.

There may be more voluntary monitoring projects running than are presently known.

Thames21's Thames River Watch programme shows that food packaging in the Thames is one of the biggest culprits contributing to the river's litter issue. Since its launch in 2014, Thames River Watch has conducted 36 litter surveys on the river foreshore with the aim of gaining a greater understanding of the types of litter present in the Thames and where they come from.

The study, conducted by a network of trained citizen scientists, has thrown up some interesting finds about the health of the river. Not least that the 36 litter surveys recorded approximately 35,000 pieces of plastic less than 2.5 cm in size, blighting the Thames foreshore.

Alice Hall, Thames River Watch Coordinator at Thames21, said: "What is worrying from our findings is that food wrappers are not only one of the most common items found littering the Thames, but also that they seem to be degrading into smaller and smaller pieces; adding to the global microplastics crisis."

<http://www.thames21.org.uk/2016/07/food-packaging-responsible-for-74of-litter-found-in-the-thames/>

MAIN ORIGINS OF LITTER

- Food related 74% - including packaging, bottles, cups
- Toiletries 15%
- Non-food related packaging 6%
- Smoking related 5%
- Clothing 0.5%

* Toiletries = predominantly cotton bud sticks, wet wipes & sanitary products; all likely to originate from sewers



Tabel 3.1 monitoring data available for riverine litter

| | Yes | No | Data may be available | Comments |
|-------------------------|-----|----|-----------------------|---|
| ICPER - Elbe | | | | |
| National level: Germany | | | | Not harmonized, Bavarian project |
| National level: Czech | | | | |
| RBE - Ems | | | | |
| ICPMS - Mosel & Saar | | | | National monitoringsprogrammes |
| IMC - Meuse | | | | Data of macro litter on cleaning days |
| ICPR - Rhine | | | | National monitoringsprogram's |
| ISC - Scheldt | | | | Data of macro litter on cleaning days |
| ARHTO - Tagus | | | | Only (yes/no) litter under monitoring bathing water |
| UK | | | | UK Government (beach), Chartity Thames21 |

Questionnaire: 3b. If there is monitoring data available, how is such data of riverine litter collected in/along the rivers?

General Conclusion:

The river commissions indicate that their data on riverine litter is collected by cleaning actions, some research in transitional waters and during the monitoring of bathing water quality.

- In many areas cleaning actions are organized, during which people collect macrolitter along and in the rivers. Based on the amount of collected litter, basic information can be gathered. This kind of information was for example used in the Deltares (2013) study, concerning the Mosel, Saar, Meuse and Rhine.
- The ICPER (Elbe) indicates that data is also collected within the implementation of the EU Water Framework Directive (WFD), which involves the assessment of the fish fauna to determine the ecological status of transitional waters. During this monitoring, which is based on the anchor net catch method, litter is collected from the nets in transitional waters and the tidally influenced part of the Elbe, Weser and Ems rivers. Sampling takes place in spring and autumn at 3 to 12 locations along each estuary. Per sampling occasion, the flood and ebb period are sampled separately during approximately three hours per tidal cycle. Litter is categorised according to the 'Guideline for monitoring marine litter on the beaches in the OSPAR Maritime Area'.
- UK notes that there is not a consistent monitoring technique used across the UK. However, there is a push to use OSPAR protocols in future. Some developments in this respect:
 - There is a preliminary methodology under development amongst collaborators on the marine plastics pollution monitoring that includes identifying sources on land, identifying pathways to the river, and quantifying shoreline, floating and pelagic litter.
 - Thames21 have recently started quantifying and categorising at their litter picks.
 - The PLA has passive debris collectors for floating litter and a means of quantifying what they collect is under development.
 - Trawls for litter in conjunction with other river monitoring are being pursued.
 - Thames Estuary Partnership is convening other academics to develop a litter monitoring method for the Thames Estuary that will be scaled up from the plastics monitoring methodology.

Tabel 3.2 Way of collecting riverine litter

| | Visual observations | Cleaning actions | Research | Comments |
|--------------------------------|---------------------|------------------|----------|---------------------------------------|
| ICPER - Elbe | | | | |
| National level: Germany | | | | Not by water -authorities |
| National level: Czech Republic | | | | |
| RBE - Ems | | | | |
| ICPMS - Mosel & Saar | | | | |
| IMC - Meuse | | | | |
| ICPR - Rhine | | | | |
| ISC - Scheldt | | | | |
| ARHTO - Tagus | | | | |
| ARTHO/APA | | | | |
| UK | | | | Not a consistent monitoring technique |

Questionnaire: 3c. Are microplastics and macrolitter being treated as the same or as different issues? Is there a link being made between litter and microplastics?

General Conclusion:

Microplastics and litter (macroplastics) are being treated as different issues. There is an awareness of the link between litter and (secondary) microplastics. Measures that address macrolitter contribute to addressing microlitter by reducing the amount of overall litter in the marine environment, all of which may eventually fragment to form microlitter.

However, concerning monitoring and measures, both are mainly being treated as different issues, because of different monitoring and analytical requirements and, at least concerning primary microplastics, different sources and pathways in comparison to litter.

- At Saar/Mosel, Meuse and Rhine the MSFD guidelines are followed (see box), although they all name 20 mm as the threshold for macroplastics, whereas the MSFD uses 25 mm.

Guidelines MSFD and OSPAR

In the Marine Strategy Framework Directive (MSFD) the descriptor 'marine litter' distinguishes between litter particles above or below 5 mm, referred to as macro-litter and micro-litter, respectively (EU (2008), (Galgani F. (2013)). In their guidance document on the monitoring of marine litter in the European Seas the MSFD Working Group on Good Environmental Status (WG-GES) specified size classes for plastic litter: > 25 mm = macroplastics, 5 - 25 mm = mesoplastics, 1 - 5 mm = large microplastics and 20 µm - 1 mm = small microplastics. Over time, the upper size boundary of 5 mm has become broadly accepted not only by marine but also by freshwater scientists.

<http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83985/lb-na-26113-en-n.pdf>

OSPAR (2010) has also issued a 'Guideline for monitoring marine litter on the beaches in the OSPAR Maritime Area'.

http://www.ospar.org/ospar-data/10-02e_beachlitter%20guideline_english%20only.pdf

- ICS (Scheldt) is aware of the various definitions and notes that Collin Janssens considers microplastics as plastic fragments < 1mm, Van Cauwenberghe (2015) uses 25 mm (instead of 20 mm) as distinction between mesoplastics and macroplastics. For microplastics a difference is made between primary and secondary microplastics, with secondary microplastics originating from macroplastics.
- The ICPER (Elbe) is presently in discussion at the German national level about the coordination of terms and definitions. At present in riverine litter only a distinction is made between two fractions: particles with diameter < 5 mm and > 5 mm (due to bioavailability).
- The ARHTO (Tagus) will adopt the categories defined in the MSFD-initiated RIMMEL-project (Riverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading), but plans to include categories related to specific anthropic activities at the river basin. (Note of editor: RIMMEL only covers floating macro litter of > 25 mm.)

According to the issue paper 'Plastics in European Freshwater Environments' (2016), the lack of generally accepted definitions of microplastics, mesoplastics and macroplastics hamper a comprehensive monitoring of freshwater environments.

Questionnaire: 3d. Are there monitoring guidelines in place to collect data in a systematic/repeated manner or is data collection reliant on individual studies?

General Conclusion:

No river commission has issued official monitoring guidelines.

- The IMC (Meuse) and ICPR (Rhine) rely on individual studies for data collection. They note that there might be more systematic and clearly defined monitoring guidelines in the future.
- The RBE (Ems) does not use official monitoring guidelines, but data are collected during the standardised procedure for the WFD assessment of the fish fauna in transitional waters. To ensure that the data are comparable with the beach litter data, they use the survey form and litter categories of the 'Guideline for monitoring marine litter on the beaches in the OSPAR Maritime Area'.
- ARHTO/APA (Tagus) notes that until now the monitoring of water status is only carried out under the scope of WFD and other directives (nitrates and bathing waters). They are just starting the process of launching a pilot study for riverine litter monitoring in order to select the most effective sampling.
- UK notes that there is not a consistent monitoring technique used across the UK. However there is a push to use OSPAR protocols in future.
- UK has requested to add an extra criterium. Sewage related debris has a visual or aesthetic impact, which is one of the criteria used to define combined sewer overflows with unsatisfactory performance (and therefore needs to be addressed as part of water company water quality improvements).

Questionnaire: 3e. Please provide links to any available monitoring results or studies if these are available

General conclusion

For most of the river basins few data are available and known by the river basin commissions. The best-known studies are Mani et al (2015) and Deltares (2013).

The nature of the data varies enormously in the studies mentioned by the river commissions. In addition to the lack of monitoring data, the data are often not comparable because there is no standardisation. The quantity of microplastics, mesoplastics and macroplastics are given in particles per m² in one study, in grammes per m³ or percentages in other. The methods vary from photospectrometry to catching litter. This makes data virtually impossible to compare.

In the issue paper 'Plastics in European Freshwater Environments'(2016) the appendix "Overview of European monitoring studies on plastics in freshwater environments" provides an overview of the available data per river (see appendix 2). This survey confirms the findings of the river basin commissions:

- Monitoring studies cover only individual European rivers and lakes, and spatial data for European freshwater environments are not comprehensive.
- Sampling of plastics in freshwater environments, sample processing and analytical identification are not harmonised, including data reporting.
- Temporal data are missing. In general, measurements are based on individual time points.
- There are not enough data on the loads and patterns of plastics in rivers to characterise riverine inputs into the marine environments.
- The potential risk from uptake and accumulation of plastics in freshwater ecosystems has only been investigated in very few species so far.

Beyond the already conducted studies, several further monitoring programmes on plastics in freshwater environments are ongoing, currently scheduled or under discussion. Many new studies will focus on the smallest microplastics, also known as nanoplastics (smaller than 300 µm), because these particles are suspected to have an effect on organisms.

Studies mentioned by the river commissions:

Rhine

Mani et al., (2015) *Microplastics profile along the Rhine River*

Although as much as 80% of marine debris originates from land, little attention has been given to the role of rivers as debris pathways to the sea. Worldwide, not a single great river had yet been studied for the surface microplastics load over its length. Mani et al. report the abundance and composition of microplastics at the surface of the Rhine, one of the largest European rivers. Measurements were made at 11 locations over a stretch of 820 km. Microplastics were found in all samples, with 892,777 particles / km² on average. In the Rhine-Ruhr metropolitan area, a peak concentration of 3.9 million particles / km² was measured. Microplastics concentrations were diverse along and across the river, reflecting various sources and sinks such as waste water treatment plants, tributaries and weirs. Measures should be implemented to avoid and reduce the pollution with anthropogenic litter in aquatic ecosystems.

<http://www.nature.com/articles/srep17988>

Rhine, Meuse and Scheldt

Deltares, (2013) *Summary report. Plastic litter in Rhine, Meuse and Scheldt, contribution to plastic litter in the North Sea*

This study estimates the contribution of river litter to the total plastic litter in the North Sea. Based on this research it can be stated that the presence of (plastic) litter in the studied catchment areas is of high environmental and societal concern and is perceived as such by the general public. Regular clean-ups by volunteers have raised awareness about the pollution of the environment in the floodplains of the rivers Rhine, Meuse and Scheldt. The large annual effort to remove debris with plastic litter from the dykes and the floodplain by river management organizations requires considerable budgets. The amount of available quantitative data for litter in Dutch rivers is limited and can mainly be found from sources that have not been scientifically validated. This means that research in this area depends strongly on estimations based on expert judgement and a few available data sources. On basis of the available data it can be roughly estimated that rivers discharging into the North Sea cause the inflow of about 50% of all floating plastic litter in the North Sea and that the rivers Rhine, Meuse and Scheldt contribute about 15% of all floating plastic litter.

<http://www.kenniswijzerzwerfafval.nl/document/summary-report-plastic-litter-rhine-meuse-and-scheldt-contribution-plastic-litter-north-sea> (PDF download)

Scheldt

Van Cauwenberghe L. (2015) *Occurrence, effects and risks of marine microplastics*.

PhD Thesis, Ghent University. One of the chapters is 'Land-based Sources of Microplastics: rivers and sewage treatment plants'.

<http://www.vliz.be/imisdocs/publications/286292.pdf>

Scheldt

De Troyer N. (2015) *Occurrence and distribution of microplastics in the Scheldt river*. MSc Thesis, Ghent University. pp

http://lib.ugent.be/fulltxt/RUG01/002/217/189/RUG01-002217189_2015_0001_AC.pdf

Saar & Mosel

Presentation at European Conference on Plastics in Freshwater Environments (2016)

At the moment, there are only a few preliminary results about the concentrations of microplastics in the Mosel river available. In 2015 one water sample was taken near the inflow into the river Rhine (Koblenz), and another from sediments in a harbour in Koblenz. Results of both samples were presented at a conference in Berlin in June 2016.

<https://www.umweltbundesamt.de/en/service/dates/european-conference-on-plastics-in-freshwater>

Meuse

Tweehuysen, G. (2015) *Results Meuse sampling, IVM reports*

2013 Microplastics survey of the Dutch environment

2013 Microplastics in river suspended particulate matter and sewage treatment plants

2014 Microplastics in suspended particular matter (in Dutch)

2015 Microplastics in North Sea marine sediment and Dutch river suspended particle matter

Elbe/Ems/Weser

Schuchardt, B. & Beilfuß, S. (2013) *Müll in der Nordsee - Pilotprojekt zur Relevanz des Eintragspfades Ästuar am Beispiel der Unterweser. Studie vor dem Hintergrund der Meeresstrategie-Rahmenrichtlinie (MSRL)*, BioConsult Schuchardt & Scholle GbR – commissioned by: Freie Hansestadt Bremen, Der Senator für Umwelt, Bau, Verkehr und Europa.

Elbe/Ems/Weser

Schulz, M. (2015) *A comparative study of suspended litter in the Elbe, Weser and Ems Estuaries (southeastern North Sea)*, study commissioned by the Lower Saxony Agency for water management, coastal protection and nature conservation (NLWKN), 21 p.

Other studies known

Swiss lakes and rivers

Faure et al. (2015) 2014a/.2014b *Evaluation de la pollution par les plastiques dans les eaux de surface en Suisse. Rapport final. École polytechnique fédérale de Lausanne (EPFL), Laboratoire central environnemental GR-CEL, Lausanne.*

This study demonstrate that relevant amounts of mesoplastics (5 - 25 mm) are present in lakes and rivers. In seven Swiss lakes the average amounts of 44 g/m² (referring to water surface) of mesoplastics were measured. Contrary, the average of microplastics was 26 mg/m² (referring to water surface). Furthermore, the mean concentrations of four Swiss rivers were 0.43 mg/m³ for mesoplastics and 1.4 mg/m³ for microplastics.

<http://www.news.admin.ch/NSBSubscriber/message/attachments/37656.pdf>

Flanders

eCOAST Marine Research (2015) *Monitoring and interventions for riverine litter (case De Leie)*

In 2014 the Public Waste Agency of Flanders commissioned an assessment study on plastic debris in the river De Leie (Lys). The report contains quantitative and qualitative data of floating plastic debris, as well as plastic debris from the upper part of the watercolumn. The study focused on the touristic part of the Lys river and takes into account occurring currents, interfering hydrological influences and seasonal variations. It also includes microplastic analyses from samples taken along the watercolumn and sediment. Sampled microplastics are categorized in spherical beads, amorphous fragments and fibres as a preliminary indication of the source of the microplastics. Management measures are suggested.

Switzerland

ETH Lausanne, *Erste Bestandesaufnahme von Mikroplastik in Schweizer Gewässern, BAFU, Bern, 11.12.2014.* <https://www.news.admin.ch/message/index.html?lang=de&msg-id=55628>

Flanders

Lecomte M. (2015). *De verwijdering van microplastics in rioolwaterzuiveringsinstallaties: een case-study voor Vlaanderen.* MSc Thesis, Ghent University.

http://lib.ugent.be/fulltxt/RUG01/002/217/211/RUG01-002217211_2015_0001_AC.pdf

New available data and current studies

Van der Wal, M. et al. (2015) *Report: SFRA0025: Identification and Assessment of Riverine Input of (Marine) Litter*

This report summarises findings of the project 'SFRA0025: Identification and Assessment of Riverine Input of (Marine) Litter' for the DG Environment of the European Commission. The aim of the project is to investigate the level of pollution in EU rivers from plastic litter and to estimate the level of inputs of plastic litter from the rivers into four European regional seas. The study identified and compared the quantities of micro litter across four rivers with varying characteristics and different sea catchment areas in Europe. Plastic litter was found in all of the rivers sampled, even in rivers with low population pressure (i.e. the Dalälven).

The study proved that rivers play an important role in transporting litter and noted that 'management action is required if this input is to be decreased:

- Urban areas are an important likely source in all sampled rivers, therefore waste management in urban areas and wastewater treatment practices should be investigated in order to identify actual causes of emissions of litter from urban areas.*
- In the Rhine and Po catchments further investigation should be done to identify industry, that could actually be emitting plastic to surface water.*
- Extensive public awareness raising is recommended to emphasise the importance of changing behaviour which contributes to the pollution of surface waters with litter.*
- Agriculture is also a likely important litter source identified mainly in the Po and Danube rivers. In these two catchments in depth analysis of litter pollution stemming from agriculture should be performed to identify problem areas.*
- In the Po and Rhine rivers fishing was identified as an important likely litter source. Awareness raising campaigns are recommended among fishermen in these two catchments.*

<http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/iasFinal%20Report.pdf>

Information on recent studies and data is available in Breuninger, et al (2015) *Plastics in European Freshwater Environments- ISSUE PAPER (Draft)*, and in German Environment Agency (2016), *European Conference on Plastics in Freshwater Environments (abstracts)*. Below are some examples.

Poster presentation '*Waste in German Rivers - input- and output-pathways, amount, key figures and avoidance measures*'-on the International conference in Berlin, 2016 by Marco Breitbarth, M.Sc. Research in German rivers: Saale river, Werra river.

Results

- For both, macro- and micro waste, plastic is the major part of all materials
- Littering is the major input pathway for macro waste
- The entry of primary micro waste takes place by discharges from Drain and Sewer Systems
- The removal of screenings of hydroelectric power plants is the major output pathway for macro waste and due to adhesions for micro waste as well
- Packaging materials are dominating the amount of macro waste by mass and units

- plastic pellets (mass-based) and plastic foil fragments (by units) are dominating the micro wastes
- On basis of the acquired knowledge, several avoidance measures are derived

To see the above poster Waste in German Rivers,

https://www.umweltbundesamt.de/sites/default/files/medien/377/dokumente/poster_marco_breitb_arth.pdf

German Federal Ministry of Education and Research, *MiWa project*

The German Federal Ministry of Education and Research has recently started a research project MiWa on microplastics in the water cycle. The German Federal Ministry of Education and Research (BMBF) aims to develop and establish scientific processes, methods, instruments, and concepts for examining plastic in the environment in order to:

- develop a consistent picture of the overall problem and lay a basis for international action;
- identify, develop, and implement possible solutions together with relevant stakeholders from the fields of politics, business, and civil society;
- found cooperative projects with international partners from important countries of production and consumption with the goal of reducing the amount of plastic that is released into the environment.

<https://www.fona.de/en/plastics-in-the-environment-20982.html>

A scientific poster presenting results can be found in

https://www.umweltbundesamt.de/sites/default/files/medien/377/dokumente/poster_marco_breitb_arth.pdf

RIMMEL, the Riverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading

The Marine Strategy Framework Directive (MSFD) (European Commission, 2008) is the key policy framework for the protection of the marine environment across Europe. It aims to achieve Good Environmental Status (GES) of the EU's marine waters by 2020. Marine litter has also been identified as a high priority at the G7 Science Ministers Meeting (Berlin, 2015). Literature refers to riverine and freshwater inputs as main sources of marine litter, but little research has been done on this subject so far. Therefore, an exploratory research project has been launched: RIMMEL.

The RIMMEL project aims to quantify floating macro-litter loads through rivers to marine waters, by collecting existing data and developing a European observation network for acquisition of new data. Additionally, the project will develop the RiverLitterCam methodology for continuous recording of floating litter in rivers, providing a new tool for observation and assessment of litter in freshwater/estuarine environments.

Join the RIMMEL network

RIMMEL launches a call for expression of interest to join the Floating Litter Observation Monitoring Network. The project will provide a monitoring protocol for observation of floating litter, allowing harmonization of the approach at international level. Our approach considers the following:

- Contribution from researchers, MS authorities, river commissions, ngo's;
- Visual observations of floating macro litter (>2.5 cm) on river water surface;
- Monitoring at river/sea boundary (e.g. estuaries) from an elevated position (e.g. bridges);

- Harmonized approach using the JRC Floating Litter Monitoring App;
- Regular monitoring based short individual surveys (e.g. 1/2 hour survey per week)

Interested parties are encouraged to contact RIMMEL for further info: Institute for Environment and Sustainability, European Commission, Joint Research Centre Ispra (Italy), rimmel@jrc.ec.europa.eu

Conferences and sources of data

- The European Conference on Plastics in Freshwater Environments, Berlin (June 2016)
Numerous publications, expert meetings and scientific conferences have discussed plastics in marine environments. This conference is the first to address the potential problems arising from plastic pollution in freshwater environments at a European scale, as much less is known about the occurrence and the ecological risks of plastics in rivers and lakes.
Abstracts can be found in: <https://www.umweltbundesamt.de/en/node/45086>
- The International Conference on Prevention and Management of Marine Litter in European Seas, Berlin (2013)
The International Marine Litter Conference, jointly organised by UBA and the German Federal Environment Ministry in cooperation with the European Commission, took place in April 2013 to define additional measures and prepare effective actions plans against marine litter.
Abstracts can be found in: <http://www.marine-litter-conference-berlin.info/> and <https://www.umweltbundesamt.de/en/topics/international-conference-on-marine-litter-results>

4. Examples of inspirational projects and best practices to prevent litter entering the water systems

Questionnaire: 4.1 Can you offer any examples of inspirational projects and/or best practices (cleaning technology, awareness raising campaigns for prevention, legal measures etc.) to prevent litter entering the water systems?

Questionnaire: 4.2 Who are the stakeholders applying these measures in practice?

General conclusion question 4.1 and 4.2

The best way of reducing litter in the rivers is to reduce litter at the sources. According to IMC (Meuse) and IPCR (Rhine) in general, measures to reduce the amount of litter entering the river should first consist of waste and resource management and secondly of water management. ICPER (Elbe) also notes that prevention is generally more effective and efficient than remedial action. Several best practices are mentioned.

River commissions mention several good examples of litter prevention or measures against macroplastics and microplastics. They lie in seven categories:

- a. prevention measures against river litter (government, policy, etc.)
- b. cleaning activities along rivers
- c. Blue Flag for fluvial beaches
- d. monitoring and research projects
- e. conventions to make international agreements
- f. an increasing number of meetings and think tanks with cross-overs between parties, resulting in a rapid knowledge exchange
- g. generic source prevention measures (microbeads, plastics bags)

a. Prevention: measures against river litter (policy, etc.)

Legislation on litter for landowners and sewerage infrastructure (UK)

The measures put in place by the UK Government to prevent litter entering the water systems are set out in the UK's Marine Strategy Part Three.

In particular, preventing the dropping of litter and requiring its removal are covered in legislation. This makes littering a criminal offence, sets out the standards that land managers (primarily local authorities) are expected to meet in keeping their land clear of litter, including beaches above mean high water



springs, and provides local authorities with powers to take enforcement action against littering.

Environmental Protection Act 1990 (as amended) (England, Wales and Scotland), Litter (Northern Ireland) Order 1994 (as amended), Clean Neighbourhoods and Environment Act 2005 (England and Wales), Code of Practice on Litter and Refuse (England) 2007, Clean Neighbourhoods and Environment Act (Northern Ireland) 2011, Code of Practice on Litter and Refuse (Scotland) 2006

Several Directives drive measures to reduce intermittent discharges from sewage treatment works and sewerage systems. The water industry has been working to improve coastal sewage treatment works and collecting systems, including adding screening to and/or reducing volumes from overflows to limit polluting events. In addition, campaigns by water companies educate the public and businesses on items and material that should not be disposed of in sewers, avoiding blockage and reducing items that might otherwise pass through sewers and treatment processes. Measures to address pollution from surface water runoff and drainage are also likely to reduce litter entering rivers and other water bodies.

EU Urban Waste Water Treatment Directive (UWWTD; 91/271/EEC), EU Bathing Waters Directive (BWD; 2006/7/EC) and EU Water Framework Directive (WFD; 2000/60/EEC; including river basin management plans)

In relation to sewage related debris sewage undertakers are required to remove litter known to be caused by their assets. This may constitute responses to single discharge events or more generally, and varies from river to river. For example Thames Water deploys skimmer vessels on the Tideway stretches to the River Thames to remove litter (obviously this is all litter rather than just SRD).

More information: <https://www.gov.uk/government/publications/marine-strategy-part-three-uk-programme-of-measures>

Other projects in this category:

- Descriptor 10 of the MSFD. Currently, the programme of measures related to the descriptor 10 of the MSFD is further developed and made operational. Some of these measures will contribute to the prevention of litter entering the water systems. It is too early to give detailed examples on projects at this stage. (RBE - Ems)
- Marine Strategy for the Dutch part of the North Sea 2012-2020, Part 3 MSFD programme of measures Appendix 5 to the National Water Plan 2016-2020
https://www.noordzeeloket.nl/images/NL%20Marine%20Strategy%20part%203%20English%20translation_5022.pdf (IMC- Meuse)
[https://www.noordzeeloket.nl/images/Mariene%20Strategie%20voor%20het%20Nederlands%20deel%20van%20de%20Noordzee%202012-2020%20\(deel%203\)_4885.PDF](https://www.noordzeeloket.nl/images/Mariene%20Strategie%20voor%20het%20Nederlands%20deel%20van%20de%20Noordzee%202012-2020%20(deel%203)_4885.PDF) (Dutch, Descriptor10) (IMC-Meuse)
- UK: Northern – Ireland, “Omega Project”, the Rural Wastewater Investment Programme and improvements to sewer networks are increasing compliance with environmental standards and reducing the risk of out-of-sewer flooding. This has resulted in cleaner rivers and beaches.
- A new project in Bavaria will start soon and will provide a standard for cleaning procedures to prevent illegal draining of wash water from nutrients and fertilisers. This project is planned to be implemented from summer 2016 to summer 2017. (ICPER - Elbe)

- At the institutional level APA/ARHTO intends to promote sensitization campaigns, collaborating specially with coastal municipalities, raising awareness among the community for the problem of the litter on coastal areas. (ARTH0/APA)
- Central Command for Maritime Emergencies (working on estuaries too). (ICPER - Elbe)
- Flanders: 'In de vuilbak' is a waste policy to reduce abandoned litter, also in rivers. This policy is based on five axes: infrastructure, communication and rising awareness, participation, environment and controls. www.indevuilbak.be (IMC - Meuse, ISC - Scheldt)
- Uk-wide: The Marine Conservation Society is running a campaign to prevent items being inappropriately flushed down the loo, in order to reduce blockages and untreated overflows leading to riverine and marine litter. <http://wetwipesturnnasty.com/>

b. Cleaning activities and awareness along rivers

Cleaning activities are carried out in many areas along the Rhine, Meuse ('Schone Maas Limburg' in The Netherlands and the regular 'Le chomage de la Meuse' in Wallonia), Elbe ('Uklid'me Česko'), Saar, Mosel and their tributaries. The activities not only prevent litter from entering the river, they also raise awareness. These initiatives are taken by local NGOs, local or regional governments, or national governments.

'Schone Maas Limburg' (The Netherlands)

One of the integral approaches in the Marine Strategy, for the Dutch part of the North Sea, 2012-2020 Part 3, is for example the 'Schone Maas Limburg' ('Clean Meuse Limburg').

'Schone Maas Limburg' organizes cleaning events of riverine litter. Every year, after the high water has lowered, many volunteers clean up all the litter along the Meuse river. The larger aim is much broader: a clean river without litter (microplastics and macroplastics). Activities range from awareness to monitoring and from making provisions to management and enforcement.

A characteristic feature is the comprehensive approach to litter in the water. Each party contributes its own expertise. Stakeholders such as the government, province, district water boards, municipalities, land managers, NGOs, (leisure) businesses, volunteers, and others are involved in this area-based approach. Giving each party the room to choose what they want to take on, creates energy and a snowball effect.

The project is now shifting from cleanup towards agenda setting, monitoring with volunteers and measures at the source. Also businesses such as Plastic Europe are participating. Through INTERREG neighbouring countries are now approached.

Other rivers

'Schone Maas Limburg' started in 2012 as the first river network. Now other Dutch rivers are also starting an integral approach. Accents vary between rivers: at the Waal River the focus lies on experiencing the river and creating commitment, and at the IJssel river pilot projects are started like sifting litter from the river.

The Litter Collection Scheme operated by Rijkswaterstaat (National Water Board) is an important success factor in terms of approach of 'Schone Maas Limburg'. As part of this scheme, Rijkswaterstaat removes and processes all the collected waste. In 2017 this Litter Collection Scheme will be scaled up to all Dutch rivers.

Results of Dutch river networks spring 2016:

- 4250 volunteers (cleaning actions)
- 225 stretches of river
- 125 organisations (municipalities, district water boards, NGOs, provinces, companies etc.)

More information: <http://schonemaas.nl/>, <https://www.facebook.com/schonemaas/> (in Dutch)

Rivercare (UK)

Keep Britain Tidy runs the programme RiverCare, which encourages local communities to take pride in their environment and come together to maintain and enhance this for future generations.

Located within East Anglia this long term project is managed by Keep Britain Tidy and funded by Anglian Water. The groups do much more than just clear litter, they remove non-native species, survey and monitor flora and fauna and carry out habitat management and restoration. These groups work with Keep Britain Tidy, and receive support and advice from Wildlife Trusts, RSPB, Environment Agency, Natural England, National Parks Authority, district and county councils to manage vital wildlife corridors and maintain national nature reserves, rare bird colonies and priority habitats within the UK.

More information: <http://www.keepbritaintidy.org/rivercare/551>

Trashbusters H2O – Crash the Trash! A youth Project for Clean Waters (Germany)

Since the 'International Coastal Clean Up Day' takes place once a year in September, this day has been picked to be the start of the Trashbusters H2O Action Weeks that are carried out by youngsters dedicated to the project. All over Germany, young people team up to clean up beaches and inland water during two weeks. To have their work included in the international statistics, participants are being asked to weigh the collected trash and report their results to the project coordinators.

During the Action Weeks, an online map on trashbusters.de, and the Trashbusters H2O app for mobile phones helps to raise interest in people to identify their own local clean-up area. Activities are not only restricted to water bodies. It is also useful to clean up other areas to prevent trash finding its way into waters.

'Trashbusters H2O' is supported by the German Environment Agency (UBA) on behalf of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), NAJU and others.

More information: www.trashbusters.de

Other projects in this category:

- UK - Thames: Port of London Authority run the Cleaner Thames Campaign which is all about stopping the tide of rubbish that is ending up in the Thames. Up to 300 tonnes of rubbish is recovered from the Thames every year, with the amount of plastics, especially plastic bottles growing year on year. <http://www.pla.co.uk/cleaner-thames/>
- England- Thames: Thames21 is an environmental charity that mobilises thousands of volunteers every year to clean up the foreshore of the Thames. Its work includes clearing up waterside grot-spots, removing graffiti and creating new habitats for wildlife. It runs up to 150 events every year throughout London's 400 mile network of waterways. The Canal and River Trust run cleaning programmes using volunteers to do much of the work and dedicated maintenance teams for big bits of litter eg washing machines.
<https://canalrivertrust.org.uk/about-us/our-work/maintaining-our-waterways/vegetation-management/clearing-litter>
- Czech Republic: 'Uklidíme Česko' ('Clean up the Czech Republic') is a volunteer cleaning activity. It is part of the annual event 'Clean Up The World' that is held in September. In this event millions of volunteers in more than 100 countries clear litter from nature. Within the programme riverine litter attracts increasing attention. For example, in 2016 the Czech river Vltava was cleaned. Stakeholders: The cleaning days are organised by many different stakeholders, including NGOs and municipalities. 'Uklidíme Česko' is an initiative of the Ministry of Environment, but sponsored by many companies like Veolia, E-On, CANON.
<http://www.uklidmecesko.cz/> (different languages)
- IMC – Meuse: Annual Operations 'clean municipalities and rivers'.
- ICPER – Elbe: Beach cleaning in heavily frequented public areas on the river banks.
- ICPER - Elbe: Springtime cleaning of larger litter in tributaries by divers.
- ICPMS – Saar & Mosel: Awareness raising by the 'cleanriverproject' in which a canoeist on the river Mosel publishes photo artwork of collected plastic litter. Project attracted a lot of media attention, with a general call to make sure plastic doesn't become litter
www.cleanriverproject.de.
- France and Wallonie: in different places, natural parks, contrat de rivières, NGOs, youth organizations pick up regularly riverine litter for example:
 - http://pnr-scarpe-escaut.fr/upload/Outil/f6_1.pdf;
 - http://www.crescautlys.be/wp-content/uploads/2016/04/Bilan_2015_CREL.pdf
 - <http://www.notele.be/list13-le-jt-a-la-carte-media1250-ramassage-de-dechets-sur-les-berges-de-l-escaut-a-pecq-06-03-08.html>;
 - http://www.rtb.be/info/regions/detail_antoing-operation-berges-propres-le-long-des-rives-de-l-escaut?id=8224979;
- ICPR - Rhine: Cleaning days in the countries/regions

c. The Blue Flag

The Blue Flag for fluvial beaches (Portugal)

In Portugal The Blue Flag award is also attributed to fluvial beaches. The environmental education activities that are developed by the municipalities in order to apply to the Blue Flag award may include the issue of litter in rivers and its link to the contamination of the oceans. Also the criteria for attribution of the award could pass for including such a measure: cleaning up actions and collection of litter on the river.

Stakeholders: Associação Bandeira Azul da Europa-FEE Portugal

More information: www.ABAE.pt20

d. Monitoring projects

'Projecto Rios' (Portugal)

In Portugal 'Projecto Rios', developed by an NGO, is based on the principle of 'citizen science' in practice. People adopt a river and implement a simple monitoring programme, including biological and physical-chemical quality elements. Some rehabilitation actions are taken by the community and these could be extended to riverine litter, as well.

Stakeholders: APLM- Portuguese Association of Mariner Litter (www.aplixomarinho.pt), and the municipalities, for example Cascais Ambiente

More information: www.cascaisambiente.pt

e. Conventions

Controlling an integral approach can be done through a convention. An older project, but still running and relevant is 'The convention on the collection, deposit and reception of waste produced during navigation on the Rhine and Inland Waterways' of 9 September 1996 (CDNI). The most important stakeholders are the operators of passenger ships and the operators of ports and handling plants.

'Convention on the collection, deposit and reception of waste produced during navigation on the Rhine and Inland Waterways' of 9 September 1996 (Rhine)

This convention was ratified on November 1, 2009 by six countries (Luxembourg, Switzerland, the Netherlands, Belgium, Germany and France) and is applicable over the entire length of the river Rhine and on all inland waterways in Germany, the Netherlands and Belgium, and the Mosel in Luxembourg and France.

The implementing regulations make a distinction in the origin of the waste occurring on board: oily and greasy waste, cargo waste, and household waste.

The CDNI celebrated its 20th anniversary with an [animated film](http://www.cdni-iwt.org/wp-content/themes/cdni/videos/la-cdni-fete-ses-20-ansen-image-decouvrez-son-film-animation_en.webm). (http://www.cdni-iwt.org/wp-content/themes/cdni/videos/la-cdni-fete-ses-20-ansen-image-decouvrez-son-film-animation_en.webm)

Stakeholders: the most important stakeholders are the operators of passenger ships and the operators of ports and handling plants.

More information: <http://www.cdni-iwt.org/>

Ship-generated waste management plan (Germany)

In line with the convention recently a new management plan for ship-generated waste has been implemented at Hamburg Port. Ships can deliver large amounts of waste in the port (6m³/ship) free of charge, regardless of the size of ship. At inland waterways, ships can deliver garbage free and separated at the port, at locks and anchorages.

The port of Hamburg processes around 2,800 disposals of 50,000m³ of oily waste and 3,000 disposals of 8,000m³ of household or similar waste generated by ships, which is possible only because of the outstanding waste disposal infrastructure at the port of Hamburg.

Stakeholders: Hamburg Ministry of Environment and Energy, Water Police, Hamburg Port Authority, District Authorities, NGOs.

f. Cross-over – think tanks

Innovative solutions for removing plastic from our rivers were collected during a Makathon, a cross between a think tank and a design competition for new ideas and existing concepts already in the market. Together with experts on waste prevention ideas were tested and improved. Prize was 'a river' to test the idea on and a starting budget. The bonus of this integral approach is the quick exchange of ideas on a subject for which everybody is still inventing the wheel.

Plastic Free Rivers Makathon (Netherlands)

Using proven Design Thinking methods, participants analyzed the problem of plastic waste in rivers. Together they generated ideas and the best solutions were selected. After the Design Thinking day, teams received assistance in preparing for the Makathon. The winners were encouraged to further develop their concept and prepare a pitch for the Plastic Free Rivers Innovation Board, consisting of potential customers and investors.

The winner of the Makaton was 'The Great Bubble Barrier'. Oxygen is brought into the water column in the shape of bubbles, moving the waste towards the surface where it can be removed. The idea is shown in a video: <https://www.youtube.com/watch?v=vUXh0Wg-FJQ>

More information: www.plasticfreerivers.com

g. Generic prevention measures

Generic litter and microplastic prevention (not aimed at rivers) helps awareness and agenda setting, and indirectly lessens the flow of litter from land to water.

Microbeads

Public awareness of microplastics as marine litter is currently high in the UK thanks to high-profile campaigns by Greenpeace, the Marine Conservation Society and national newspapers to highlight the pollution caused by microbeads in cosmetics and personal care products, the recent Environmental Audit Committee's inquiry into the Environmental Impact of Microplastics and the UK government's recent announcement (3rd Sept '16) that it plans to ban microbeads in cosmetics and personal care products.

In other European countries there is also a positive development in which many companies voluntarily abandon microplastics from their cosmetic products. This is a good example of tackling a problem at its source, and hopefully followed by other parties in the industry.

Beat the Microbead (international campaign)

The 'Beat the Microbead' campaign runs since 2012. The objective is to prevent plastic microbeads in personal care products ending up in the sea. Consumers are asked to stop using products containing microbeads. The Beat the Microbead app makes it easy to check whether a product contains plastic.

A new campaign started recently. Instead of consumers having to check and choose, producers be asked to declare their products free of microplastics. Plastic free products will be included in the new 'Zero' category of the Beat the Microbead website and app. The brands that do not use microplastics can carry the 'Zero plastic inside' logo. In one glance, this logo makes it clear for consumers that a product is guaranteed 100% free of microplastics. In the European context The Netherlands are searching for support to ban microbeads in cosmetic products, because there are alternatives.

More information (different languages): <https://www.beatthemicrobead.org/en/look-for-the-zero>

A self-test method of microplastics for companies (Belgium)

The Belgian Federal Public Service of Health, Food Chain Safety and Environment presents a manual for a self-test with the goal to help to evaluate and reduce the emission of microplastics in the aquatic environment. This manual has been developed in cooperation with TAUW consultancy.

This manual allows companies to inventory their use of microplastics and to take preventive measures, either by using alternative materials or by preventing the emission of microplastics in the environment. <http://www.health.belgium.be/en/microplastics-manual#sthash.8jiTbKcG.dpuf>

Plastic bags

A good practical example with regard to litter prevention, as well as awareness raising, is the limited availability of plastic bags in supermarkets. Plastic bags are an important source of litter on land and in water. There are many initiatives in various countries over the last two years to tackle the free plastic bags in supermarkets.

Limited availability of plastic bags in supermarkets

The ban or charge on plastic bags already implemented or planned in several ISC contracting parties. This will reduce the amount of bags used and contribute directly to the reduction of this specific source.

France is forbidding the issue of free plastic bags in shops and supermarkets from July 2016.

In April 2016 the German government concludes a voluntary agreement with the retailing industry on a significant reduction of plastic bags by charging them.

In Luxembourg the Ministry for the Environment together with the Luxembourgish Trade Confederation and Valorlux asbl have set up in 2004 the 'Eco-bag' project as part of the national waste prevention plan. In 2012, the 'Eco-bag' project was awarded the European Commission's best practice award for waste prevention. In cooperation with 85 retailing companies, including the five major supermarket chains in Luxembourg, the 'Eco-Bag' project has been a resounding success. Since the project's start, some 300 million disposable shopping bags were prevented. More information: <http://ec.europa.eu/environment/waste/prevention/pdf/eco-sac.pdf>

Other projects in this category:

- ISC – Scheldt, IMC - Meuse (Flanders): 'In de vuilbak' is a waste policy to reduce abandoned litter, also in rivers. This policy is based on 5 axes: infrastructure, communication and rising awareness, participation, environment and controls www.indevuilbak.be
- ISC – Scheldt: Several apps for smartphones indicate the content of microplastics (microbeads) in cosmetic products.
- ICS –Scheldt: Escaut sans frontière: microplastics awareness, http://www.gs-esf.be/mailer/mailer-ESF-INFO-73/FR/ESFinfo73_T4.htm

5. Future connection between marine and riverine communities

Questionnaire: 5 How do you think marine and riverine science and policy communities can be linked in order to facilitate an exchange concerning monitoring, assessment and mitigation of litter?

General conclusion question 5:

The information exchange between marine and riverine communities would preferably happen on an international, national and regional level. Most urgent is the need for harmonisation and cooperation. Several opportunities have been mentioned:

International level

- Practically all river commissions feel a need for international monitoring standards. Only then, ICPMS (Mosel & Saar) notes, river commissions can link their data between marine and riverine science and policy communities.
- ICPR (Rhine) notes that at an international level attention is brought to the connection between marine and riverine communities in a letter to EU commissioner Vella. In this, one of the proposed next steps was a stronger cooperation and synergies between actors, in particular between Regional Sea Conventions and River Conventions as well as between the EU Commission, member states and stakeholders in general.
- ICPR (Elbe) comments that at an international level there is a need for stronger cooperation and information exchange among the river basin commissions, OSPAR and the European Commission.
- There is also a need for collaboration between neighbouring states along the coast, as litter is transferred depending on the sea currents.
- According to ICM (Meuse) the riverine countries along the coasts can cooperate to exchange information:
 - within the river commissions;
 - between the river commissions and the marine community;
 - between the neighbouring coastal states;
 - with possible emitters, e.g. industry and fishery.
- ICPR (Rhine) notes that the 'Trilateral Cooperation on the Protection of the Wadden Sea' provides a good basis for collaboration between neighbouring states along the coast.

National level:

- The need for standardisation of monitoring is also felt on a national level. Comparable measurement makes sure that the link between marine and riverine science and policy communities can be made on a national basis.

- At a national level there are more opportunities to exchange data between marine and freshwater, for example through the Water Framework Directive and other national water policy, working groups or educational programmes.
- ICPER (Elbe) notes that the exchange and harmonisation of riverine science and policy communities is secured by the authorities responsible for implementing the Water Framework Directive and the Marine Strategy Framework Directive.
- At RBE (Ems), at a national level in Germany the exchange between marine and freshwater takes place at the 'Round Table Marine Litter': working groups on land and sea-based sources as well as on awareness/education will make measures on the mitigation of litter operational. Members of the working groups are all relevant stakeholders from e.g. science, industry, shipping, NGOs, politics, and local authorities.
- ARHTO (Tagus) also mentions that they want to strengthen the relation between marine and freshwater, by using environmental education activities in the coastal beaches, with the issue of riverine litter and its contribution to the contamination of the oceans

Regional level:

- RBE (Ems) would like more workshops organised by OSPAR, or OSPAR expert groups (similar to the expert groups under ICG-COBAM).

Tabel 5.1 Future connection between marine and riverine communities

Dark blue denotes intentions; in light blue regular or future plans are given.

| | Regional level | National level | International level |
|---|----------------|---|---|
| ICPER - Elbe, ISC-Scheldt, IMC-Meuse | | | The cooperation and information exchange among the river basin commissions, OSPAR and the European Commission should be strengthened. |
| ICPR - Rhine | | | The connection between marine and riverine communities was included in a letter to the EU commissioner Vella, in which one of the proposed next steps was: a stronger cooperation and synergies between actors, in particular between Regional Sea Conventions and River Conventions as well as between the EU Commission, Member States and Stakeholders in general. |
| ICPR - Rhine, ICPMS - Mosel & Saar, IMC - Meuse | | | The methods and process of monitoring, assessment and mitigation of marine and riverine litter need to be standardized, harmonized and connected. |
| IMC - Meuse | | The methods and process of monitoring, assessment and mitigation of marine and riverine litter need to be standardized, harmonized and connected | |
| ICPMS - Mosel & Saar | | Based on comparable measurement results the link between marine and riverine science and policy communities can be made in river commissions and on national basis. | |
| ICPER - Elbe National level: Germany | | Authorities responsible for implementing the Water Framework Directive and the Marine Strategy Framework Directive are in regular contact. | |
| ICPER - Elbe National level: Czech Republic | | Authorities responsible for implementing the Water Framework Directive and the Marine Strategy Framework Directive are in regular contact. | |

| | Regional level | National level | International level |
|---------------------------------|--|---|---|
| IMC - Meuse, ISC - Scheldt | | | <p>The riverine countries along the coasts can build bridges for an information exchange:</p> <ul style="list-style-type: none"> * Within the river commissions; * Between the river commissions and the marine community; * Between the neighbouring coastal states. <p>Possible emitters need to be included, e.g. industry and fishery.</p> |
| ICPR - Rhine | | | <p>Need for collaboration between neighbouring states along the coast, as litter is transferred depending on the currents. This is implemented for example in the Trilateral Cooperation on the Protection of the Wadden Sea. Additionally, possible emitters need to be included, e.g. industry and fishery.</p> |
| RBE - Ems | Workshops organised by OSPAR, or OSPAR experts groups (similar to the experts groups under ICG-COBAM). | "Round Table Marine Litter". Working groups on land- and sea-based sources | |
| RBE - Ems | | "Round Table Marine Litter" Projects awareness/education will make measures on the mitigation of litter operational. | |
| ARHTO - Tagus | | ARHTO will strengthen environmental education activities in the coastal beaches, with the issue of riverine litter and its contribution to the contamination of the oceans. | |
| Alentejo River Basin Commission | | | On first hand, marine and fresh communities should be aware about this problem and get information about best practices to tackle it and after, exchange experience on practices to prevent litter entering into water systems (fresh and marine). |

6. Conclusions and recommendations

General conclusion:

Despite the lack of (comparable) data, steps are taken to reduce the litter in rivers. The issue of riverine litter gains momentum on local, national and European levels.

Awareness of riverine litter

- The extent to which riverine litter is on the agenda of river commissions varies from 'hardly/not important' to 'increasing attention on their own agenda.'
- External policy and networks give an incentive to include the subject in their activities.
- The subject is definitely upcoming due to growing research-based evidence.
- Attention is paid to both macroplastics and microplastics, although there is a clear shift of focus towards microplastics, according to the river commissions.

State of knowledge regarding litter in rivers

- Knowledge regarding quantities in riverine litter is rare with most river commissions. The best-known studies are Mani et al. (2015) and Deltares (2013).
- The sources and pathways of litter in the riverine system are largely unknown. The level of knowledge is currently very low, and needs to be improved also concerning effects.
- No regular monitoring of plastic is performed by the river commissions.

Data collection

- Some monitoring data are available on a national level and for transitional waters. However, the availability of data is limited and the data are not standardised.
- The river commissions indicate that their data on riverine litter is collected by cleaning actions, some research in transitional waters and during monitoring of bathing water quality.
- Microplastics and litter (macroplastics) are being treated as different issues. There is an awareness of the link between litter and (secondary) microplastics. Measures that address litter contribute to addressing microplastics by reducing the amount of overall litter in the marine environment, all of which may eventually fragment to form microplastics.
- There is a clear call for standards. To begin with, there is a need to determine standard procedures regarding monitoring of litter, especially for microplastics. But the IMC (Meuse) points out that this is also necessary for meso/macroplastics, including sampling methods, sample preparation and analysis.
- Several river commissions lack a good overview of plastic from different sources, their pathways to rivers and their occurrence and fate in rivers. Once standard procedures are established, more studies are needed to get a better overview.
- None of the river commissions have official monitoring guidelines.
- UK notes that there is not a consistent monitoring technique used across the UK. However, there is a push to use OSPAR protocols in future.



- At Saar/Mosel, Meuse and Rhine the MSFD guidelines are followed, although they all name 20 mm as the threshold for macroplastics, whereas the MSFD uses 25 mm.
- For most of the river basins few data are available and known by the river basin commissions. The best-known studies are Mani et al (2015) and Deltares (2013). The nature of the data varies enormously in the studies mentioned by the river commissions. In addition to the lack of monitoring data, the data are often not comparable because there is no standardisation. The quantity of microplastics, mesoplastics and macroplastics are given in particles per m² in one study, in grammes per m³ or percentages in other. The methods vary from photospectrometry to catching litter. This makes data virtually impossible to compare.

Best practices

- The best way of reducing litter in the rivers is to reduce litter at the sources, according to the river commissions.
- According to IMC (Meuse) and IPCR (Rhine) in general, measures to reduce the amount of litter entering the river should first consist of waste and resource management and secondly of water management. ICPER (Elbe) also notes that prevention is generally more effective and efficient than remedial action.
- The programme of measures related to the descriptor 10 of the MSFD is further developed and made operational according to UK, (RBE-Ems) and (IMC-Meuse). Some of these measures will contribute to the prevention of litter entering the water systems.
- An example of taking on the problem at the source is the long standing convention on waste from inland navigation: 'The convention on the collection, deposit and reception of waste produced during navigation on the Rhine and Inland Waterways' (9 September 1996, CDNI).
- Several campaigns focused on land litter are extended to litter in and along water. There is also a growing number of cleaning campaigns specifically aimed at rivers. Apart from remedial cleaning, the campaigns get a larger impact, creating awareness.
- As preventive measures there are for example national and international campaigns like 'Beat the microbead'. Also there are campaigns in several countries to limit the availability of plastic bags in supermarkets.

Future connection between marine and riverine communities

- The information exchange between marine and riverine communities would preferably take place on an international, national and regional level.
- Many river commissions find it important that the cooperation and information exchange between the River commissions and OSPAR is strengthened. Besides, the information exchange should not only focus on monitoring but also on possible effects, e.g. on human health, ecosystems and organisms.
- As mentioned above, the focus in respect to measures should be on reducing the sources and the amount of litter. Therefore, it is also important to mention that waste and resource management is an important part in the story and responsible actors need to be included in the discussion about litter in rivers.
- ICPSM (Saar&Mosel) also find it important that in the context of litter and especially microplastics there are many unknowns and further information and studies are needed. Therefore, all interested groups and actors should be included in the process. This should include all responsible parties (producers, consumers, policy etc.).

Questions for further discussion

Awareness: Riverine litter receives limited attention in the river commissions. What are the reasons that it is not higher on the agenda, also considering the difference between macroplastics and microplastics?

State of Knowledge: The sources and pathways of litter in the riverine system are largely unknown. How can river commissions learn from OSPAR experiences concerning this topic?

Data collection: Almost all questionnaire participants called for monitoring and analysis standards. How could we achieve harmonization? What role do the river commissions see for themselves? What should harmonized monitoring focus on? How could results be used and by whom? How can the river commissions benefit from the experience of monitoring litter in OSPAR?

Best practices: There are several best practices for cleaning activities and prevention. Are there projects that could be implemented on a larger scale?

Future connection: How can a regular exchange of information be organized between the riverine and marine policy communities? What role does the river commissions see for themselves in the future concerning this topic?

Appendix 1: Further reading and references

Further reading

- Breuninger, E., Bänsch-Baltruschat, B., Brennholt, N., Hatzky S., Reifferscheid, G. (2016). *"Plastics in European Freshwater Environments"- ISSUE PAPER (Draft)*, German Federal Institute of Hydrology Department Bio-Chemistry and Ecotoxicology, Koblenz. pp.1-57 (*attachement*)
- German Environment Agency., (2016). *Abstracts of the proceedings: European Conference on Plastics in Freshwater Environments*, 21-22 June 2016 in Berlin. Project number: 3715 22 20 20 pp.118 (*attachment*)
- MSFD, (2013). *Guidance on Monitoring of Marine Litter in European Seas*
<http://publications.jrc.ec.europa.eu/repository/bitstream/JRC83985/lb-na-26113-en-n.pdf>
- OSPAR, (2010). *Guideline for monitoring marine litter on the beaches in the OSPAR Maritime Area*
http://www.ospar.org/ospar-data/10-02e_beachlitter%20guideline_english%20only.pdf

References

- Bayerisches Landesamt für Umwelt. (2014). Dokumentation des Statuskolloquiums "Mikroplastik in der Umwelt" vom 03.07.2014 des Bayer. Landesamtes für Umwelt, p26.
http://www.lfu.bayern.de/analytik_stoffe/mikroplastik/index.htm
- Deltares, (2013). *Summary report. Plastic litter in Rhine, Meuse and Scheldt, contribution to plastic litter in the North Sea*
<http://www.kenniswijzerzwerfafval.nl/document/summary-report-plastic-litter-rhine-meuse-and-scheldt-contribution-plastic-litter-north-sea> (PDF download)
- De Troyer N., (2015). *Occurrence and distribution of microplastics in the Scheldt river*. MSc Thesis, Ghent University.
http://lib.ugent.be/fulltxt/RUG01/002/217/189/RUG01-002217189_2015_0001_AC.pdf
- eCOAST Marine Research, (2015). *Monitoring and interventions for riverine litter (case De Leie)*
- ETH Lausanne, *Erste Bestandesaufnahme von Mikroplastik in Schweizer Gewässern*, BAFU, Bern, 11.12.2014.
<https://www.news.admin.ch/message/index.html?lang=de&msg-id=55628>
- European Conference on Plastics in Freshwater Environments (2016) *Presentation*

<https://www.umweltbundesamt.de/en/service/dates/european-conference-on-plastics-in-freshwater>

- Faure, F., & De Alencastro, F. (2014). *Evaluation de la pollution par les plastiques dans les eaux de surface en Suisse. Rapport final. École polytechnique fédérale de Lausanne (EPFL), Laboratoire central environnemental GR-CEL, Lausanne.*
<http://www.news.admin.ch/NSBSubscriber/message/attachments/37656.pdf>
- Lecomte, M. (2015). *De verwijdering van microplastics in rioolwaterzuiveringsinstallaties: een case-study voor Vlaanderen.* MSc Thesis, Ghent University.
http://lib.ugent.be/fulltxt/RUG01/002/217/211/RUG01-002217211_2015_0001_AC.pdf
- Mani, T., Hauk, A., Walter, U., & Burhardt-Holm, P. (2015). *Microplastics profile along the Rhine River* <http://www.nature.com/articles/srep17988>
- McGoran, A. R., Clark, P.F. and D. Morrit (2017). *Presence of microplastics in the digestive tracts of European flounder, Platichthys flesus, and European smelt, Osmerus eperlanus, from the River Thames.* Environmental Pollution 220 Part A, 744 – 751.
- Schuchardt, B. & Beilfuß, S. (2013). *Müll in der Nordsee - Pilotprojekt zur Relevanz des Eintragspfades Ästuar am Beispiel der Unterweser. Studie vor dem Hintergrund der Meeresstrategie-Rahmenrichtlinie (MSRL), BioConsult Schuchardt & Scholle GbR*
- Schulz, M. (2015). *A comparative study of suspended litter in the Elbe, Weser and Ems Estuaries (southeastern North Sea), study commissioned by the Lower Saxony Agency for water management, coastal protection and nature conservation (NLWKN), 21p.*
- Tweehuysen G. (2015) *Results Meuse sampling, IVM reports*
2013 Microplastics survey of the Dutch environment
2013 Microplastics in river suspended particulate matter and sewage treatment plants
2014 Microplastics in suspended particulate matter (in Dutch)
2015 Microplastics in North Sea marine sediment and Dutch river suspended particulate matter
- Van Cauwenberghe L. (2015). *Occurrence, effects and risks of marine microplastics.* PhD Thesis, Ghent University. pp215.
<http://www.vliz.be/imisdocs/publications/286292.pdf>
- Van der Wal, M. et al. (2015). Report: *SFRA0025: Identification and Assessment of Riverine Input of (Marine) Litter.* <http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/iasFinal%20Report.pdf>

Appendix 2. Overview of European monitoring studies on plastics in freshwater environments

Breuninger et al. (2016), "Plastics in European Freshwater Environments"- ISSUE PAPER, German Federal Institute of Hydrology Department Bio-Chemistry and Ecotoxicology, Koblenz, Appendix, 49-57p

Overview of European monitoring studies on plastics in freshwater environments

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|---|--------------------|---|--|---------------------------------|---|---|---|
| Studies in individual countries | | | | | | | |
| Austria: Danube River | river water column | driftnets (500-, 250-, 41 µm) positioned along water column | visual sorting and inspection, ATR-IR analysis of subsamples | < 5 mm, total amount of plastic | | <u>Aschach:</u> 0.039-0.205 mg/m³ <u>Hainburg:</u> 0.029 -0.516 mg/m³ microplastics: 7-17 t/a total plastic: 14-41 t/a | Hohenblum et al. (2015)▲ |
| Austria: Danube River | river biota | electro fishing (30 fish individuals), autopsy | visual inspection (stereo microscope) | < 5 mm, total amount of plastic | no evidence | | Hohenblum et al. (2015)▲ |
| Austria: Danube River | river biota | electro fishing (840 fish individuals), autopsy | visual inspection (binocular) | > 5 mm | one particle (each) in 2 fish individuals identified | | Lumesberger-Loisl and Gumpinger (2015)▲ |
| France: Rivers Auvézère, Bedat, Braméril, Chée, Dore, | river biota | electro fishing (186 wild gudgeons), autopsy | visual inspection of digestive tract content (dissecting microscope) | < 5 mm | 12 % contaminated fish Fish from 7 of 11 sampled streams contained microplastics | | Sanchez et al. (2013) |

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|---|----------------------|--|--|---------------------------------------|---|---|-----------------------|
| Hers-mort, Jouanne, Loire (2 sites), Risle and Yerres | | | | | | | |
| France: Rivers Marne and Seine | river surface | floating booms | ATR -FT-IR | > 5 mm | | mean: 27 t/year (2008-2013) | Gasperi et al. (2014) |
| France: Rivers Marne and Seine | river surface | plankton net (80 µm) manta trawl (330 µm) | visual inspection (stereo microscope) | 100 µm- 5 mm | mean (plankton net): 30 p/m³ mean (manta trawl): 0.35 p/m³ | | Dris et al. (2015) |
| Germany: Rivers Elbe, Moselle, Neckar and Rhine | river sediment | | visual inspection | < 5 mm | 34-64 p/kg dw | | Wagner et al. (2014) |
| Germany: Rivers Main and Rhine | rivershore sediments | bulk sampling with steel spoon (3-4 kg/sample) | visual inspection (> 630 µm: naked eye, 63-630 µm: binocular microscope), FT-IR analysis of subsamples | 63- 200 µm, 200- 630 µm, 630 µm- 5 mm | all fractions: <u>Main:</u> 786-1368 p/kg dw <u>Rhine:</u> 228-3763 p/kg dw | all fractions: <u>Main:</u> 43.5-459 mg/kg dw <u>Rhine:</u> 21.8-932 mg/kg dw | Klein et al. (2015) |
| Germany: | river surface | mini manta trawl | visual inspection and sorting (ste- | 0.5 - 1 | total: | | Laforsch |

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|--|---|---|--|---|---|-----------|-------------------------|
| Rivers Emscher, Lippe, Rhine, Ruhr, Sieg, Weser and Wupper | | (300 µm) | reomicroscope), ATR-FT-IR spectroscopy analysis of > 500 µm | mm, 1-5 mm, > 5 mm, total number of plastic particles | <u>Emscher</u> : 15.7 p/m ³ , <u>Lippe</u> : 0.155 p/m ³ , <u>Rhine</u> : 0.928 - 4.45 p/m ³ , <u>Ruhr (including WWTP effluent sampling)</u> : 0-166 p/m ³ , <u>Sieg</u> : 0 p/m ³ , <u>Weser</u> : 0.487 p/m ³ , <u>Wupper</u> : 0.594 p/m ³ | | (2015)▲ |
| Italy: Lake Garda | lake beach sediment | random grid sampling | Raman Microspectrometry, Scanning Electron Microscopy (SEM) analysis of subsamples | micro-plastic: < 5 mm, macro-plastic | <u>northern shore</u> : microplastic: 1108 p/m ² ; macroplastic: 483 p/m ² <u>southern shore</u> : microplastic: 108 p/m ² ; macroplastic: 8.3 p/m ² (1 sample) | | Imhof et al. (2013) |
| Netherlands: Rhine River Estuaries | river surface sediment | 5 individual grab samples for each sample | visual inspection (light microscopy) | 1-300 µm, 300-5000 µm | mean: 3300 p/kg dw (2 samples) | | Lestlie et al. (2013)▲ |
| Netherlands: Rivers Meuse and Rhine | river water column: suspended particular mat- | flow-through centrifugation | visual inspection (light microscopy) | 1-300 µm, 300-5000 µm | <u>Meuse</u> : 1800-6880 p/kg dw (3 sampling points), | | Brandsma et al. (2015)▲ |

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|---|---|--|--|---|---|---|-------------------------|
| | ter | | | | <u>Rhine</u> : 990 p/kg dw (1 sample) | | |
| Netherlands: Lake IJssel | river water column: suspended particular matter | flow-through centrifugation | visual inspection (light microscopy) | 1-300 µm, 300-5000 µm | 2000 p/kg dw (1 sample) | | Brandsma et al. (2015)▲ |
| Switzerland: Lake Geneva | lake surface | manta trawl (300 µm), | visual inspection (stereo microscope) | micro-plastic (< 5 mm) macro-plastic (> 5 mm) | microplastic: 0.048 p/m ² (1 sample) macroplastic: 0.008 p/m ² (1 sample) | | Faure et al. (2012) |
| Switzerland: Lake Geneva | lake biota | manual collection of 41 fish individuals and 1 black-necked Grebe (bird) | visual inspection (stereo microscope) | micro-plastic (< 5 mm), macro-plastic (> 5 mm) | no evidence | | Faure et al. (2012) |
| Switzerland: Rivers Aubonne, Rhône, Venoge and Vuachère | river surface | manta trawl (300 µm) | visual inspection (naked eye, stereo microscope), FT-IR-ATR analysis of subsamples | micro-plastic: 300 µm-5 mm macro-plastic: | Microplastic (mean): 6.92 * 10 ⁶ p/a, 7 p/m ³ ; median: 1.24 * 10 ⁶ p/a, 0.36 p/m ³ Macroplastic (mean): | microplastics: mean: 0.001 t/a, 1.4 mg/m ³ ; median: 0.0004 t/a, 0.2 mg/m ³ | Faure et al. (2015) |

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|--|---------------------|---|---|---|--|--|---------------------|
| Switzerland: Lakes Geneva, Constance, Neuchâtel, Maggiore, Zurich, Brienz | lake surface | manta trawl (300 µm) | visual inspection (naked eye, stereo microscope), FT-IR-ATR analysis of subsamples | microplastic: 300 µm-5 mm macroplastic: > 5 mm | 1.66 * 10 ⁶ p/a, 0.012 p/m ³ microplastic: mean: 0.091 p/m ² ; median: 0.048 p/m ² macroplastics: mean: 0.002 p/m ² , median: 0.001 p/m ² | macroplastics: mean: 0.001 t/a, 0.43 mg/m ³ microplastics: mean: 0.026 mg/m ² ; median: 0.009 mg/m ² macroplastics: mean: 0.044 mg/m ² ; median: 0.012 mg/m ² | Faure et al. (2015) |
| Switzerland: Lakes Geneva, Constance, Neuchâtel, Maggiore, Zurich, Brienz | lake beach sediment | bulk sampling (each 4.5 L) | visual inspection (naked eye, stereo microscope), FT-IR-ATR analysis of subsamples | microplastic: 300 µm-5 mm macroplastic: > 5 mm | microplastics: mean: 1300 p/m ² median: 270 p/m ² macroplastics: mean: 90 p/m ² median: 11 p/m ² | microplastics: mean: 920 mg/m ² median: 110 mg/m ² macroplastics: mean: 14000 mg/m ² median: 480 mg/m ² | Faure et al. (2015) |
| Switzerland: Lakes Geneva | Lake biota | Sampling of 40 fish individuals with multi-mesh gillnets, vertical benthic and pelagic nets manuel collection of 9 birds | visual inspection (stereo microscope) | microplastic: 300 µm-5 mm macroplastic: > 5 mm | 3 fish contaminated: 1 – 31 p/organism 8 birds contaminated: mean: 4.3 /organism | 3 fish contaminated: 0.1 – 0.3 mg/organism 8 birds contaminated: mean: 4.8 mg/organism | Faure et al. (2015) |

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|--|--|--------------------|----------------------------------|---------------------------------|---|---|---------------------------|
| United Kingdom: Thames River (C,D) and tributary (Duke of Northumberland River: A, B) | river surface | | IR-spectroscopy | | <u>A</u> : < 0.05 p/L <u>B</u> : < 0.05 p/L <u>C</u> : 9.9 p/L <u>D</u> : 3.3 p/L | <u>C</u> : 0.35 mg/L, <u>D</u> : 0.04 mg/L | Sofra et al. ^a |
| United Kingdom: Thames River | river water column: water layer near river bed | eel nets | visual inspection | | 8490 submerged plastic particles (7 sampling sites September-December) | | Morritt et al. (2014) |
| United Kingdom: Tamar Estuary | river surface | manta net (300 µm) | FT-IR spectroscopy of subsamples | < 1 mm, 1-3 mm, 3-5 mm, > 5 mm, | mean: 0.028 p/m ³ 204 pieces of suspected plastic found microplastics (82 %) | | Sadri and Thompson (2014) |

Transboundary studies

| | | | | | | | |
|--|--------------|---------------------|-------------------|-----------|--|---|-----------------------|
| Austria, Slovak Republic Danube River | river column | driftnets (500 µm), | visual inspection | 0.5–20 mm | mean (2010): 0.938 p/m ³ mean (2012): 0.055 p/m ³ | mean (2010): 11 mg/m ³ mean (2012): 2 mg/m ³ mean input into the <u>Black Sea</u> : 1,533 t/a | Lechner et al. (2014) |
|--|--------------|---------------------|-------------------|-----------|--|---|-----------------------|

55

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|---|---|---|--|-------------------------|--|---|-------------------------|
| France, Germany, Switzerland: Rhine River | river surface | manta net (300 µm), | visual sorting (stereo microscope), FT-IR Spectroscopy | 300 µm- 5 mm | mean: 0.9 p/m ³ mean discharge into <u>North Sea (Rees)</u> : 6.99 * 10 ¹⁰ p/a | | Mani et al. (2015) |
| France, Switzerland: Lake Geneva | lake surface | manta trawl (300 µm) | visual inspection | micro- and meso-plastic | <u>St Sulpice</u> : 0.048 p/m ² <u>Petit Lac</u> : 0.024 p/m ² <u>Vidy</u> : > 0.083 p/m ² | <u>St Sulpice</u> : 0.011 mg/m ² <u>Petit Lac</u> : 0.003 mg/m ² <u>Vidy</u> : 0.293 mg /m ² | Faure et al. (2013)▲ |
| France, Switzerland: Lake Geneva | lakeshore sediments | manual collection | visual inspection | | below high water line: 5018.75 p/m ² above the water surface: 2656.25 p/m ² in between: 3733.33 p/m ² | below high water line: 2.2 p-mass/m ² above the water surface: 5.91 p-mass/m ² in between: 0.57 p-mass/m ² | Faure et al. (2013)▲ |
| Germany, Netherlands: Rivers Meuse and Rhine | river water column: suspended particular matter | | visual inspection (light microscopy) | 1-300 µm, 300 µm- 5 mm | <u>Rhine (Bimmen)</u> mean: 1700 p/kg dw, <u>Meuse (Eijsden)</u> mean: 1400 p/kg dw, <u>Rhine (Lobith)</u> mean: 4900 p/kg dw | | Brandsma et al. (2013)▲ |
| Germany, Netherlands: | river water column | electric centrifugal pump draws river water | visual inspection and Raman-/FT-IR | 0.125- 0.25 mm, | <u>Meuse</u> : mean: 9.7 p/m ³ | <u>Meuse</u> : mean: 0.14 mg/m ³ | Urgert (2015)▲ |

| Country - freshwater environment | Compartment | Sampling method | Identification method | Size range | Numerical unit | Mass unit | Reference |
|---|--------------------------------|---|--|-----------------------|---|--|------------|
| Rivers Meuse and Rhine | | in cascade oil sieves (1 mm, 250 µm, 125 µm) | spectroscopy analysis | 0.250- 5 mm | <u>Rhine</u> : mean: 56 p/m ³ | <u>Rhine</u> : mean: 0.56 mg/m ³ | |
| Italy, Netherlands, Romania, Sweden: Rivers Dalälven, Po and Rhine | River surface and water column | mantra net (330 µm), Waste Free Water Sampler (3.2 mm), pump-manta net method | visual inspection (naked eye, stereo microscope), NIR-/FT-IR-ATR spectroscopy analysis | 333 µm- 5 mm, 5-25 mm | Manta net sampling*: <u>Dalälven</u> : 5 *10 ¹⁰ p/a <u>Rhine I</u> : 30 *10 ¹⁰ p/a <u>Rhine II</u> : 10 *10 ¹⁰ p/a <u>Po</u> : 70 *10 ¹⁰ p/a, <u>Danube</u> : 200 *10 ¹⁰ p/a | | EC (2015)▲ |

▲Not peer-reviewed; the numerical and mass units were unified by solely applying prefixes. Sampling locations are underlined; # all data resulting from use of different sampling methods reported by EC (2015) is listed in Table 4 (see chapter 5.1.) Unit p: particles.