# Workshop Riverine Litter

Paris - June 4th-5th, 2019

This document gathers information on projects developed by participants of the workshop on Riverine Litter.

## Projects on microplastics

| **Project's name** | **Plastic and Microplastic in the Environment** |
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| **Contact** | Marcel Liedermann |
| **Organization** | BOKU - University of Natural Resources and Life Sciences, Vienna |
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| **Project's description** | Although freshwater systems are known to be the transport paths of plastic debris to the ocean, almost no freshwater studies existed. Over the recent years, such studies are advancing, but they rarely address the spatial distribution of plastic debris in the water column. Hence a methodology for measuring microplastic transport at various depths that is applicable to medium and large rivers was needed, offering the possibility of measuring microplastic transport at different depths of verticals distributed within a profile. A robust, net-based device was developed which can be applied at high flow velocities and discharges. The device consists of a strong and stable equipment carrier enabling a stable positioning within a river. Three frames can be equipped with 1-2 nets each, having different mesh sizes. The methodology was tested in the Austrian Danube River, showing a high heterogeneity of microplastic concentrations within one cross-section. As plastic transport cannot be limited to the surface layer (turbulence, different densities, growth of biofilms) of a river, it must be examined within the whole water column like suspended sediments. Hence multi-point measurements are necessary for obtaining the spatial distribution of plastic concentration and are a prerequisite for calculating the transport that is occurring. |
| **Please, describe here shortly the method you use** | Numerous tests were conducted to develop a sampling strategy and optimise the device. The first tests within the free-flowing section of the Austrian Danube clearly showed the necessity of a strong and stable equipment carrier, therefore the modified BfG basket sampler was used to form the basis of the device. The aim was to use the largest possible net dimensions in order to get the highest possible discharge through the nets. Hence, the net openings were fixed to 600x600 mm, with two nets attached at each depth. The nets are positioned at the surface, in the middle of the water column and at the bottom of the river. As mesh sizes varied throughout the previous studies, different sizes were used to also address the differences between larger and smaller mesh |

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| | types. On one side, a 250 µm net was used, and on the other, a 500 µm net was used at each depth. A 41µm net was also tested and successfully gathered data at lower discharges, but failed at higher discharges, as high suspended sediment and organic loads stressed the net-material. At flow velocities of around 2-3 m/s for the mean flow condition, the application of meshes that are too fine is not feasible. However, as an option, a small version can be attached to the centre frame. Furthermore, fibres and microbeads were not the intended focus of this study, but primary and secondary microplastics.<br>The nets have an actual porosity of 38%, hence a length of about 2.5 m was necessary for reaching the required "open area ratio" of three (Tranter & Smith, 1968). The uppermost net assemblage was equipped with a buoyant body to ensure that these nets are skimming the water surface. The net frame was equipped with a fin on each side to assure streamwise alignment, but when tests showed that this was not sufficient, another 1.6 m-long fin was added in the middle of the frame. The center nets can be adjusted in height according to the prevailing water depth by using a displaceable stopper. The lowermost net assemblage was destroyed due to material fatigue at a Danube discharge of 3000 $m^3/s$, hence the system was changed by mounting a single centred net to the sampler near the bed instead of the basket. In the first attempts, the frames were fixed to the steel cable with shackles, but to accommodate the inclination of the cable, the upper shackle of each net was replaced by an inclination rack, which allowed the nets to have an upright position when deployed. A sampling container was constructed at the end of the nets to reduce the emptying time. After sweeping the content to the container by using a high-pressure sprayer, the catch can easily be emptied within comparatively short operational times (30 – 40 minutes for all nets). A mechanical flow meter was attached to measure the discharge through the nets, which is required for calculating plastic concentration. |
| **References** | Liedermann, M; Gmeiner, P; Pessenlehner, S; Haimann, M; Hohenblum, P; Habersack, H.<br>(2018): A Methodology for Measuring Microplastic Transport in Large or Medium Rivers<br>WATER-SUI. 2018; 10(4) |
| **Final indicator used** | plastic concentration (mg/1000$m^3$) and transport rate (mg m-2 h-1) |
| **Can this method be applied to any watercourse?** | The method works for medium and large rivers and can be easily adapted for smaller rivers |
| **How much time per year this monitoring would take for a river of about 100 km?** | 1 day for a cross-section wise measurement at medium and large sized rivers - to get insights on transport conditions, I would recommend 3-5 measurements per year (depending on discharge conditions) over a time span of 3 years. For longer river sections (as asked) I would recommend to sample more cross-sections depending on what changes (confluences, big cities, industry, other sources) |

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| **How much this monitoring would cost per year for a river of about 100 km?** | approx. 15.000€ for four measurements at one river cross-section (excl. travel expenses, and except data analysis, etc.) |
| **What are the gaps / issues on the method that need to be solved?** | For high flow velocities (at large rivers) microbeads cannot be sampled (at least bigger net sizes of a 50 µm did not work). Research gaps in process understanding e.g. what are the factors influencing transport quantities (flow discharge, season, sources, ...) |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | Yes - if the method is applied over a longer time series - trends and process understanding could be analysed properly |
| **Abstract of the talk** | Methods for measuring plastic transport in large and medium rivers |

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| **Project's name** | **1) EMFF project aiming to develop a standardized monitoring strategy;**<br>**2) Towards guidelines for effective plastic removal from rivers;**<br>**3) Plastic-free rivers**<br>**4) Limnoplast**<br>**5) Paper submitted about monitoring riverine litter from Jakarta area** |
| **Contact** | Frans Buschman |
| **Organization** | Deltares |
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| **Project's description** | 1) Project for Rijkswaterstaat (Dutch water ministry), where we model the transport of different microplastics. We prepared a roadmap and are currently working on the project.<br>2) Project for Allseas on modelling of both macro- and microplastics fluxes in rivers. I can share results only roughly.<br>3) Plastic-free rivers is a larger research program submitted by the TU Delft (Wim Uijttewaal) and Deltares has a role. The beginning of June it should be clear whether this will be granted.<br>4) Granted research proposal (VU Amsterdam) aiming to increase understanding of freshwater microplastics that results in innovative solutions.<br>5) Paper is based on monitoring for two weeks and extrapolating this result to a year using a hydrodynamic model |
| **Please, describe here shortly the method you use** | On 1) To determine which processes are leading in transport of plastic items, an effect chain was developed. It shows the dominant processes, which are expected to be leading in the transport of microplastics. We did this also for macroplastic items. This gives us an idea what to monitor specifically (e.g. plastic transport near the bed) to further understand how plastic items are transported.<br>On 5) 2 weeks the plastic concentration is monitored by visual counting and by trawls. From this the concentration of plastic is determined in the cross section. A model was used to calculate flow velocity, such that the transport of plastic litter could be determined. The model was also used to extrapolate the transport over the whole year, such that an annual estimate can be given. |
| **References** | Emmerik, Tim van, Frans Buschman, Michelle Loozen, Kees van Oeveren and Geert Prinsen (subm.) Riverine plastic emission from Jakarta into the ocean, ERL-107031.<br>Buschman, F.A., M. van der Meulen, A. Markus, M. Weeber and F. Kleissen, 2018, Roadmap voor de modellering van verspreiding microplastics in Rijkswateren, i.o.v. Rijkswaterstaat, Deltares kenmerk 11202218-003-ZKS-0002. |
| **Final indicator used** | kg/m3, since we are interested in mass balance. |
| **Can this method be applied to any watercourse?** | The method described in Emmerik et al. (subm) can be applied to any river. Especially in developing countries where the transport is high, the rough estimate of the plastic transport obtained with this method is useful. |
| **How much time per year this monitoring would take for a river of about 100 km?** | 2 persons 2 weeks per cross section (Emmerik et al. (subm)). A two-week monitoring period can be enough to cover several branches flowing out in sea. |

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| **How much this monitoring would cost per year for a river of about 100 km?** | Maybe 20 kE, including the modelling (Emmerik et al. (subm)). |
| **What are the gaps / issues on the method that need to be solved?** | It is rough. An idea how the concentration varies with river discharge would be valuable. |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | For comparing rivers, yes. For longterm trends it is too rough. |
| **Abstract of the talk** | An aim is to develop a standardized monitoring strategy that can be applied to monitor the microplastic concentration in freshwater. A promising method is presented by Liedermann et al. (2018), who reported a robust method to monitor microplastic concentration at three levels within the water column simultaneously in the Danube river. Where in the river monitoring of plastics should take place can be based on depth and width averaged 1D numerical hydrodynamic model results: e.g. what branch is representative. Using 3D hydrodynamic models, the temporal variation of plastic concentration for locations within the cross section can be investigated. The model results indicate how often at what locations should be monitored in order to get a good estimate of plastic concentration and transport. This method to obtain an optimal monitoring strategy is presented along with some first results. It can be applied for both microplastic particles and macroplastic items.<br><br>In conclusion a selection of research questions are given to be answered in the coming period from both dedicated monitoring and possibly modelling:<br>•How is plastic transport affected by vegetation?<br>•When does a plastic particle aggregate to a sediment particle?<br>•What is the role of biofouling?<br>•After deposition to the bed, at what critical shear stress does a plastic particle resuspend? |

| Project's name | **Creation of a protocol for sampling microplastics in rivers of Spain: LIBERA project** |
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| **Contact** | David Léon |
| **Organization** | Hombre y Territorio Association, HyT |
| **Email** | davidleon@hombreyterritorio.org |
| **Project's description** | As part of LIBERA project (Ecoembes, SEO/BirlLife) Hombre y Territorio-HyT- is developing a methodology for sampling, detection and identification of microplastics in rivers. We have planned to sample at least 50 rivers all over Spain thanks to the collaboration with the Spanish National Research Council (CSIC). We aim at editing a protocol by the end of 2019 with the support of several experts, networking and field tests. This will include a series of steps suitable for different stakeholders depending on the objective, scope and budget of each one. |
| **Please, describe here shortly the method you use** | We sample the water volume from the river (by different methods) and filter it through a mesh with a pore-size below 100 µm. Several replicas of water volume are taken depending of the channel width in order to account for a similar sampling-effort: all samples are softly oxidized and then transported to the laboratory, where a primary treatment of filtering is carried out: then we discard organic elements and inorganic pieces, and count and pre-select plastic fragments under the microscope, which are then evaluated under a FTIR microscope with ATR. |
| **References** | https://proyectolibera.org/noticias/libera-arranca-un-estudio-piloto-de-caracterizacion-de-microplasticos-en-rios/<br>https://hombreyterritorio.org/docs/Memoria_HyT_2018.pdf<br>https://hombreyterritorio.org/index.html |
| **Final indicator used** | Work in progress. |
| **Can this method be applied to any watercourse?** | This methodology seems to be suitable for all kind of watercourses and riverine areas once the number of necessary replicas and sampling sites are taken into account. In each case the sampling can be adapted to environmental conditions. Anyway, this methodology is more suitable for medium and small rivers, typical of Spain. |
| **How much time per year this monitoring would take for a river of about 100 km?** | We estimate that a good monitoring of a 100 km river depends of several factors (geography, location, rainfall, seasonality, potential flow alterations...). In each of the seasonal samplings (if convenient depending of the case), a team of two people is needed for field work. Laboratory primary and secondary treatments would be achieved by one or two people.<br><br>Our estimate of days for the field monitoring of a river of 100 km (in average) could be about 2 days. |
| **How much this monitoring would cost per year for a river of about 100 km?** | Having into account the different factors mentioned above, we estimate an average of 3.500 € by river: obviously the costs decrease with the increasing of rivers under sampling. |
| **What are the gaps / issues on the method that need to be solved?** | We are very interested in contrasting our results with other projects, in particular regarding the volume to be filtered in each location to obtain a reliable, easy and sustainable (time and budget) methodology; also, we are interested in other sampling aspects as the location of sampling sites |

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| | in each case, field experience of other methods, and their results to be complemented all together. |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | Because of the extraordinary variability of rivers in Spain (and Europe), a methodology needs to be easy, effective and time-cost efficient. Although there are several aspects to be discussed, we think this methodology could contribute to a general approach when sampling the great diversity of European rivers. |
| **Abstract of the talk** | Integration of limnological aspects to microplastics sampling in rivers of Spain.<br><br>As part of a LIBERA project (Ecoembes, SEO/BirlLife, Hombre y Territorio), HyT is developing a methodology for sampling, detection and identification of microplastics in rivers. We have planned to sample at least 50 rivers all over Spain thanks to the collaboration with the Spanish National Research Council (CSIC). We aim at editing a protocol by the end of 2019 with the support of several experts, networking and field tests. This will include a series of steps suitable for different stakeholders depending on the objective, scope and budget of each one.<br><br>We sample the water volume from the river (by different methods) and filter it through a mesh with a pore-size below 100 µm. Several replicas of water volume are taken depending of the channel width in order to account for a similar sampling-effort: all samples are softly oxidized and then transported to the laboratory, where a primary treatment of filtering is carried out: then we discard organic elements and inorganic pieces, and count and pre-select plastic fragments under the microscope, which are then evaluated under a FTIR microscope with ATR<br><br>This methodology is also participated by the Spanish Ministry for the Ecological Transition Strategies for microplastics in rivers, in collaboration with the Centre for Harbor and Coastal Studies of Spain. |
| **Remarks** | Regarding the study of sources of the riverine litter, this study is complemented in the field with the e-Litter sampling, developed by Paisaje Limpio and Vertidos Cero, with Ecoembes support. We are really interested in learning about other similar experiences in Europe. |

| Project's name | **Micro- and macroplastics in German rivers - description of state, transport mechanisms, ecological risks and management options** |
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| **Contact** | Friederike Stock |
| **Organization** | German Federal Institute of Hydrology |
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| **Project's description** | We work in our project mainly on methods for sampling, sample preparation, ecotoxicological analyses and monitoring activities in German rivers. Until now, the focus was mainly on microplastics, but we will focus from this year on also on macroplastics.<br>https://www.plastic-network.org/ |
| **Please, describe here shortly the method you use** | sampling: water: minimum of 1 $m^3$, other depending on water flow in 15 minutes, until 2018: plankton net with 150 µm mesh size and manual flowmeter; from 2019 on: several nets with mesh sizes down to 10 µm; another possibility: continuous-flow centrifuge with 10µm net,<br>sediment: van-veen grabber<br>preparation of samples: freeze-drying, larger sediment samples: electroseparation (mass reduction of ca. 80%); then organic digestion with KOH and H2O2, neutralisation with formic acid, density separation with potassium formate, pressure filtration on aloxfilters or glass fibres<br>analyses: Pyrolisis GCMS and µFTIR<br>also for direct analyses in the field for plastics larger than 1 mm: µPHAZIR |
| **References** | Felsing, S., Kochleus, C., Buchinger, S., Brennholt, N., Stock, F., Reifferscheid, G., 2018. A new approach in separating microplastics from environmental samples based on their electrostatic behavior. Environmental Pollution 234: 20-28.<br>Stock, F., Kochleus, C., Bänsch-Baltruschat, B., Brennholt, B., Reifferscheid, G., 2019. Sampling techniques and preparation methods for microplastic analyses in the aquatic environment - A review. Trends in Analytical Chemistry 113: 84-92. |
| **Final indicator used** | microplastics per $m^3$ for water, particles/kg for sediment or g/kg when results with pyrolysis GCMS |
| **Can this method be applied to any watercourse?** | yes, either the nets are fixed on a boat, if the water flow is not high enough, sampling of the river surface of a certain distance |
| **How much time per year this monitoring would take for a river of about 100 km?** | It clearly depends on how many sites are sampled. We would need ca. 2-3 people per sampling campaign. I think that several weeks per year are necessary, especially when water and sediment samples should be taken, and a boat is needed. |
| **How much this monitoring would cost per year for a river of about 100 km?** | |
| **What are the gaps / issues on the method that need to be solved?** | sampling of different depths of the water phase are not yet possible. With the nets, we can only sample the surface waters (ca. the upper 30 cm).<br>Centrifuge works well but is very time consumptive. |
| **Could this methodology be used to assess long term** | Especially water and sediment samples taken with nets and van veen grabbers can be easily compared, especially when the same methods are used (same nets, as small as possible). |

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| **trends and compare levels of pollution between rivers?** | |
| **Abstract of the talk** | Distribution of microplastics in sediment and water samples of the river Elbe, Germany<br>Plastic pollution in the aquatic environment has gained worldwide attention in the last years. Meanwhile, intensive research activities have been initiated in these environments; however, the effects and consequences of the plastic pollution are not fully known and have to be better understood. In the frame of the project about macro- and microplastics in German rivers, samples from 11 sites from the German part of the river Elbe were taken in order to study the plastic pollution in water and sediment, detect the sinks of microplastics and better understand the transport mechanisms.<br>The sediment samples were taken with a Van-Veen-grabber, the water samples from the Elbe with an Apstein plankton net (mesh size 150 µm). The sediment samples were presorted with wet sieving, organic digestion and density separation, filtered on aluminium oxide filters and visually analysed. For the water samples, the organic matter was digested using a reagent composed of equal volumes of 10 M KOH and 30 % $H_2O_2$, then, the (micro)plastic particles were isolated from remaining matrix by density floatation using 1.6 g/mL potassium formate solution and pressure filtration. Analysis was done by visual inspection, selected particles measured with pyrolysis GCMS and Fourier-transform infrared spectroscopy.<br>The results of the sediments of the Elbe point to a microplastic concentration depending on the sampling site (esp. polystyrene and polypropylene particles) and to a decrease in the flow direction whereas the water samples only show a site specific microplastic concentration. |
| **Remarks** | |

| Project's name | The Riverine Input Project |
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| **Contact** | Antoine Bruge |
| **Organization** | Surfrider Foundation Europe |
| **Email** | abruge@surfrider.eu |
| **Project's description** | Numerous studies have been conducted to quantify microplastic contamination, but only few of them deal with the sampling methodology and associated uncertainties. This study examines the influence of sampling strategy on the confidence interval of river microplastic estimates. 16 samples are collected in the Gave de Pau River, southwestern France, during a three-hour window with a 330 µm mesh size net. Three different exposure times (3, 5 and 7 minutes) allow the filtration by the net of: 35.6 $m^3$ (3 samples), 59.4 $m^3$ (10 samples) and 83.2 $m^3$ (3 samples) of water. Microplastic concentrations are not statistically different for the three exposure times. The microplastic concentrations vary between 2.64 and 4.24 mp/$m^3$, with a median value of 3.26 mp/$m^3$. Analyses showed that the higher the number of samples, the lower the confidence interval is. For triplicates, the maximum confidence interval reaches 40% of the median value. Thus, collecting triplicates seems to be reasonable time wise (for sampling and sample processing) and allows for acceptable error percentage. This study also recommends the filtration of around 35 m3 per sampling. This study reports, for the first-time, uncertainties related to microplastics sampling in river. Those findings will help to highlight spatial differences between sites and improve the accuracy of annual microplastics fluxes in rivers. |
| **Please, describe here shortly the method you use** | 16 samples are collected in the Gave de Pau River, southwestern France, during a three-hour window with a 330 µm mesh size net. Three different exposure times (3, 5 and 7 minutes) allow the filtration by the net of: 35.6 m3 (3 samples), 59.4 m3 (10 samples) and 83.2 m3 (3 samples) of water. Microplastic concentrations are not statistically different for the three exposure times. |
| **References** | https://surfrider.eu/riverine-input/ |
| **Final indicator used** | mp/m3 |
| **Can this method be applied to any watercourse?** | There is too many gaps of knowledge so far |
| **How much time per year this monitoring would take for a river of about 100 km?** | |
| **How much this monitoring would cost per year for a river of about 100 km?** | |
| **What are the gaps / issues on the method that need to be solved?** | |

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| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | |
| **Abstract of the talk** | A first estimation of uncertainties related to microplastic sampling in rivers. |

# Projects on macroplastics

| **Project's name** | **MacroPLAST Seine** |
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| **Contact** | Romain Tramoy |
| **Organization** | LEESU |
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| **Project's description** | Monitoring macroplastic flux in the Seine River using statistical and field approach. We also developed a new methodology based on collected litter from the riverbanks to estimate plastic flux entering into the ocean. Finally, GPS tracking shade new lights on the transfer dynamic of riverine litter in an estuarine environment.<br>Facebook page:<br>https://www.facebook.com/Projet.MacroPLAST/?ref=bookmarks |
| **Please, describe here shortly the method you use** | - Statistical models : plastic waste generation + rate of leakage<br>- Floating booms : plastic rate in captured debris + extrapolation with the water flow<br>- Visual counting : Counting floating litter + conversion numb to mass + extrapolation with time<br>- Nets in situ with a boat : concentration of plastic in the water column + extrapolation to the water flow<br>- GPS tracking : transfer dynamic<br>- Riverbanks clean up and data collection : using transfer dynamic + probabilities of collection + extrapolation to the mass collected |
| **References** | R. Tramoy, J. Gasperi, R. Dris, L. Colasse, C. Fisson, S. Sananes, V. Rocher and B. Tassin, 2019. Assessment of the Plastic Inputs From the Seine Basin to the Sea Using Statistical and Field Approaches. Fontiers, XX, XXX https://doi.org/10.3389/fmars.2019.00151<br><br>R. Tramoy, J. Gasperi, R. Dris, L. Colasse, C. Fisson, S. Sananes, V. Rocher et B. Tassin, 2019. Estimation des flux de plastiques transitant en Seine : quelles méthodes pour quels résultats ? TSM, 1-2, 15-26. https://doi.org/10.1051/tsm/201901015<br><br>R. Tramoy, L Colasse, Gasperi, B. Tassin, 2019. Plastic debris dataset on the Seine river banks: plastic pellets, unidentified plastic fragments and plastic sticks are the Top 3 items in a historical accumulation of plastics. Data in Brief, 23, 103697. https://doi.org/10.1016/j.dib.2019.01.045<br><br>J. Gasperi, B. Tassin, D. Blot, R. Tramoy, 2018. Pollution Plastique : retour sur une prise de conscience. The Conversation, https://theconversation.com/pollution-plastique-retour-sur-une-prise-de-conscience-101541 |
| **Final indicator used** | - Statistical models: t/yr<br>- Floating booms: t/yr<br>- Visual counting: #/minute<br>- Nets in situ with a boat: #/m3 and g/m3<br>- GPS tracking: net km/jour and total km/jour<br>- Riverbanks clean up and data collection: % and metric tons collected, #/km and kg/km |

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| **Can this method be applied to any watercourse?** | - Statistical models: yes<br>- Floating booms: yes<br>- Visual counting: yes<br>- Nets in situ with a boat: yes<br>- GPS tracking: yes<br>- Riverbanks clean up and data collection: yes, but need a team for dayly clean ups |
| **How much time per year this monitoring would take for a river of about 100 km?** | - Statistical models: 1 person during an internship<br>- Floating booms: N/A<br>- Visual counting: 3 persons during 3 days per month<br>- Nets in situ with a boat: 2 persons during 1-2 days per month<br>- GPS tracking: 1 person during 2 days per month<br>- Riverbanks clean up and data collection: 4 persons during 5 days per week! |
| **How much this monitoring would cost per year for a river of about 100 km?** | - Statistical models: One computer...<br>- Floating booms: For SIAAP, 1.5 million euros per year...<br>- Visual counting: Almost nothing<br>- Nets in situ with a boat: 1500 euros per day + 1500 euro for one net (2.5 * 1.2 m with mesh size of 10 mm)<br>- GPS tracking: 100 to 350 euros per GPS<br>- Riverbanks clean up and data collection: Clean up in Seine Maritime costs 300 000 euros per year with the equipment needed. |
| **What are the gaps / issues on the method that need to be solved?** | - Statistical models: Not connected to the field, weaknesses with several statistical parameters. Can give a wide order of magnitude.<br>- Floating booms: Huge investments. Rough extrapolations needed. Not effective to account for flood events.<br>- Visual counting: the easiest and cheapest to do, but do not account for litter into the water column. Strongly observator-dependent.<br>- Nets in situ with a boat: Can be expansive, because must be done a lot of time to be representative of the water column. Issues about the vertical distribution of plastic in function of the hydrological conditions ==> can miss litter depending on the depth sampled.<br>- GPS tracking: N/A do not quantify plastic litter<br>- Riverbanks clean up and data collection: Can miss a part of the submerged plastics that do not strand. However, in the case of the Seine River, all type of plastic items was found on riverbanks meaning that all types of plastic can strand for a while... |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | - Statistical models: No, only dependent on waste generation per capita, not on the behaviors leading to leakage into the environment through loss or littering.<br>- Floating booms : Yes, not recommended because too much uncertainties<br>- Visual counting : Yes, coupled with citizen sciences, it could be a useful tool but missing a large part of the plastic pollution<br>- Nets in situ with a boat : Yes, but not recommended (too expansive, to much issues regarding sampling conditions)<br>- GPS tracking : N/A do not quantify plastic litter<br>- Riverbanks clean up and data collection : Yes, coupled with clean up programs financed by national agencies or collectivities it could be a very powerful tool using units such as #,g/100 m. |

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| | To compare between rivers, results must converted into comprehensive units: e.g. # or g/capita or km2 or density |
| **Abstract of the talk** | Flux and transfer dynamic of macroplastics into the ocean: the Seine River as a case study (MacroPLAST Project). |
| **Remarks** | To reduce plastic pollution, we must reduce its production, its accessibility and its consumption, in particular for packagings related to nomadic consumption. Thus, solutions are political and not technological. Problems related to waste generation, but also to the loss of biodiversity, to energy demand or to climate change all face the same "reality" : our economical model and to name it the Capitalism regime. Thus, techonological solutions represent a leap forwards to perpetuate this model, which is at its ending life. The only serious question to address as scientists studying facts is then "will we be able to go beyond this model and to invent a new one?" Other discussions would be like to brush the dog :) |

| Project's name | PlasticFreeDanube |
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| **Contact** | Sebastian Pessenlehner |
| **Organization** | BOKU - University of Natural Resources and Life Sciences, Vienna |
| **Email** | sebastian.pessenlehner@boku.ac.at |
| **Project's description** | Waste collecting activities in the National park Donau-Auen – a part of the Austrian Danube River in the East of Vienna – indicate that increasing quantities of plastic waste can also be found near the banks and within the inundation areas of our rivers.<br>To face this challenging pollution problem the EU financed project "PlasticFreeDanube" was launched. The goal of the project is to investigate macro plastic waste (plastic particles > 5 mm) in and along the Danube, in particular its sources, environmental impacts, transported amounts and paths, compositions and possible plastic accumulation zones. New methods have been developed to hydraulically characterize accumulation zones and possibly use them as plastic traps in future.<br>The results of this study could lead to a reduction of future collection efforts for macro plastics in riverine environments. Information about potential accumulation zones can be provided and by drawing a reverse conclusion recommendation for creating “artificial” accumulation zones can be given. |
| **Please, describe here shortly the method you use** | Three-dimensional numerical simulations were performed to calculate hydrodynamics for different flow conditions and river sections using the software RSim-3D (Tritthart, 2005). The main objective of these high-resolution models is to characterize flow fields near river engineering structures such as groynes and guiding walls in areas known as plastic accumulation zones. In addition, a particle tracing tool was implemented in RSim-3D. This tool was adapted and further developed, accounting for the floating properties of macro plastic and to describe the flow paths especially in bank near regions. To gain experience on a larger scale a 2D model was set up, predicting potential accumulation zones in the Danubian inundation areas. |
| **References** | |
| **Final indicator used** | |
| **Can this method be applied to any watercourse?** | The methodology can be applied to any river or stream where the necessary input data (bathymetry and terrain data, hydrological boundary conditions, flow field data) is available and accumulation zones can be found. |
| **How much time per year this monitoring would take for a river of about 100 km?** | This totally depends on the exact research question, the extent of the modelling reaches and the dimension of the used model (2D or 3D). |
| **How much this monitoring would cost per year for a river of about 100 km?** | see question 11 |
| **What are the gaps / issues on the method that need to be solved?** | The influence and effect of the different parameters besides hydraulic boundary conditions (we focus on that) such as wind, vegetation and source related issues are not quantified until now. |

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| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | The model is a powerful tool in terms of process understanding about why and how plastic accumulates in complex rivers reaches (groyne fields, inundation areas, siede arms). By applying different scenarios - e.g. engineering measures or different hydrological boundary conditions - trends of change in the accumulations behavior can be derived. |
| **Abstract of the talk** | Numerical modelling of plastic transport and accumulation at the Austrian Danube River |
| **Remarks** | https://plasticfreeconnected.com/ |

| Project's name | Freswater pathways and litter |
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| **Contact** | María Cabrera |
| **Organization** | Paisaje Limpio |
| **Email** | maricabrera@paisajelimpio.com |
| **Project's description** | We work on a methodology to know how much, what and where is the litter that you can find in the river.<br><br>We apply an affordable methodology and we focus on macro litter but we have discovered that we can intercept micro plastics too.<br><br>We are monitoring the macro litter in the surface, riverbank, riverbed and the column of water. |
| **Please, describe here shortly the method you use** | We are monitoring four important parts of river:<br><br>1. Surface: We used a RIMMEL app (European Commission) to measurement macro floating litter, and a barrier to intercept macro and micro plastics.<br><br>2. Riverbank: We use a eLitter app to measurement the litter in the riverbank. eLitter app has been created by Paisaje Limpio, Vertidos Cero and Libera project in Spain. It is an specific to measurement litter form the land, everywhere you go, it is possible to use in Europe as well.<br>If we know that 80% of litter comes from the land, this tool is harmonized with marine litter tools like (Marine litter watch, MARNOBA in Spain). The classify of litter of this app is based on OSPAR.<br><br>Riverbed: We use a dredge. This method has been applied in marine litter projects to research the seabed.<br><br>Colum of water: In this case we use nets. |
| **References** | https://proyectolibera.org/wp-content/uploads/2019/03/PAISAJE-LIMPIO.-CLEAN-EUROPE-NETWORK-RÍOS-INFORME-FINAL-METODOLOGÍA-MUESTREO-RIOS.pdf<br><br>eLitter.org<br>https://paisajelimpio.com/elitter-una-nueva-forma-de-ver-el-vertido-incontrolado/ |
| **Final indicator used** | Number of macro plastics per 100 x 6 m of the riverbank (eLitter app)<br>Number of floating macro plastics intercepted by the barrier<br>Number of floating macro plastics that you are monitoring per hour (RIMMEL app) |
| **Can this method be applied to any watercourse?** | This method is possible to apply in different rivers.<br>We use a kayak to introduce us in the middle of the river and it is useful to place the barrier in a big and deep river, where is not possible to take the other shore on foot, because of the vegetation.<br>It is environmentally friendly. |

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| | I have designed a specific barrier, that is possible to move "easily" everywhere you go. |
| **How much time per year this monitoring would take for a river of about 100 km?** | At least three years |
| **How much this monitoring would cost per year for a river of about 100 km?** | 50.000 € per year |
| **What are the gaps / issues on the method that need to be solved?** | We would like to apply in a river where is possible to sail, in this case the barrier doesn´t work.<br>It depends on the river and season of the year, the exposition of the barrier is different. We haven´t got a specific time for different rivers and different seasons. |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | Yes, it does. It is only to compare the litter pollution |
| **Abstract of the talk** | Freshwater Pathways and litter<br><br>We work on a methodology to know how much, what and where is the litter that you can find in the river. The objective is to find the source of litter.<br><br>We apply an affordable and measurable methodology and we focus on macro litter.<br>We believe that the river´s course is important, not only the estuary. We would like to know what happen is with the litter both in the upper river, as the lower river.<br><br>We are monitoring four important parts of river:<br><br>1. Surface: We used a RIMMEL app (European Commission) to measurement macro floating litter, and a barrier to intercept macro and micro plastics.<br><br>2. Riverbank: We use a eLitter app to measurement the litter in the riverbank. eLitter app has been created by Paisaje Limpio, Vertidos Cero and Libera project in Spain. It is a specific to measurement litter form the land, everywhere you go, it is possible to use in europe as well.<br>If we know that 80% of litter comes from the land, This tool is harmonized with marine litter tools like (Marine litter watch, MARNOBA in Spain) The clasiffy of litter of this app is based in OSPAR.<br><br>3.Riverbed: We use a dredge. This method has been applied in marine litter projects to research the sea bed.<br><br>4. Column of water: In this case we use nets. |

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| **Remarks** | |

| Project's name | 1) MedSealitter; 2)Rimmel |
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| **Contact** | Roberto Crosti |
| **Organization** | ISPRA |
| **Email** | Roberto.crosti@isprambiente.it |
| **Project's description** | 1) MedSeaLitter is a Interreg MED project implemented on the Mediterranean basin, both from the large and local scale (such as MPAs) aiming at developing specific marine litter monitoring protocols. https://medsealitter.interreg-med.eu;<br>2) RIMMEL (RIverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading) quantify floating macro litter loads through rivers to marine waters, by collecting existing data, developing an European observation network. |
| **Please, describe here shortly the method you use** | 1) https://medsealitter.interreg-med.eu/fileadmin/user_upload/Sites/Biodiversity_Protection/Projects/MEDSEALITTER/last_MEDSEALITTER_Final_shared_monitoring_protocol_03.05.2019.pdf<br>2) https://mcc.jrc.ec.europa.eu/main/dev.py?N=simple&O=380&titre_page=RIMMEL |
| **References** | 1. Crosti R., Arcangeli A., Campana I.2, Paraboschi M., González-Fernández D. (2018). 'Down to the river': amount, composition, and economic sector of litter entering the marine compartment, through the Tiber river, in the Western Mediterranean Sea. RENDICONTI LINCEI 11/2018; DOI:10.1007/s12210-018-0747-y<br>2. Campana I., Angeletti D., Crosti R., Di Miccoli V., Arcangeli A.(2018). Seasonal patterns of floating macro-litter across the Western Mediterranean Sea: a potential threat for cetacean species. Rendiconti Lincei. Scienze Fisiche e Naturali (2018) 29:453–467 //doi.org/10.1007/s12210-018-0680-0<br>3. Arcangeli A., Campana I, Angeletti D, Atzori F., Azzolin M., Carosso L., Di Miccoli V., Giacoletti A., Gregorietti M., Luperini Cristina, Paraboschi M., Pellegrino G., Ramazio M., Sarà G., Crosti R. (2017) Amount, composition, and spatial distribution of floating macro litter along fixed trans-border transects in the Mediterranean basin. Marine Pollution Bulletin 10/2017, DOI:10.1016/j.marpolbul.2017.10.028<br>4. Daniel González Fernández, Georg Hanke, …., Roberto Crosti, …: (2019) Floating Macro Litter in European Rivers-Top Items. Report number: EUR 29383 EN, Affiliation: 10338, DOI:10.2760/316058 |
| **Final indicator used** | Density |
| **Can this method be applied to any watercourse?** | Half of the river width can be monitored. |
| **How much time per year this monitoring would take for a river of about 100 km?** | 200 hours |
| **How much this monitoring would cost per year for a** | 10.000 |

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| **river of about 100 km?** | |
| **What are the gaps / issues on the method that need to be solved?** | |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | |
| **Abstract of the talk** | Triumph and Laments of a riverine litter monitoring experience at the mouth of a river<br><br>Monitoring macrolitter at the mouth of rivers: What do we really know? Can numbers of items, or number of fragments recorded give us indication of riverine litter abundance or trends? Do we need numbers or information?<br>What we really monitor can be an indicator of legislative measures aiming to reduce litter in the environment? Size matters? Waste, Habitats, Water, Marine Strategy EU Directives how can we fulfill their requirements with one monitoring protocol? Items, indicators, indexes?<br>A tale of questioning after a three-year study monitoring riverine litter at the mouth of the Tiber river in Roma (Italy). |
| **Remarks** | |

| Project's name | RIMMEL (finished in 2017); LitRivus (Marie Curie Grant 2020-2022) |
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| **Contact** | Daniel González Fernández |
| **Organization** | University of Cádiz |
| **Email** | daniel.gonzalez@uca.es |
| **Project's description** | RIMMEL (RIverine and Marine floating macro litter Monitoring and Modelling of Environmental Loading, 2015-2017, Joint Research Centre - European Commission). Collection of data across Europe using visual observations to estimate floating macro litter input to the sea.<br><br>https://mcc.jrc.ec.europa.eu/main/dev.py?N=simple&O=380&titre_page=RIMMEL&titre_chap=JRC%2520Projects<br><br>LitRivus (Marie Curie Grant 2020-2022, University of Cádiz): Assessing riverine litter input variability to the marine environment at large scale through field data collection: progress in marine litter pollution science beyond the state-of-the-art. |
| **Please, describe here shortly the method you use** | RIMMEL: visual observations from elevated sites (e.g. bridges), close to the mouth of the river to account for inputs to the sea. Harmonized data collection and reporting using the JRC<br><br>LitRivus: combination of different sampling methodologies, visual observations, stationary nets, floating booms, bottom nets. |
| **References** | RIMMEL:<br>http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/MSFD_riverine_litter_monitoring.pdf<br><br>https://www.frontiersin.org/articles/10.3389/fmars.2017.00086/full<br><br>http://publications.jrc.ec.europa.eu/repository/bitstream/JRC108172/floating_macro_litter_in_european_rivers_-_top_items_eur_29383_en_28_11_2018.pdf |
| **Final indicator used** | Top items list.<br><br>Macro litter flux: items/hour.<br><br>Macro litter concentration: items/volume, weight/volume.<br><br>Estimation of litter load into the marine environment: items/year, weight/year |
| **Can this method be applied to any watercourse?** | Visual observations will work best for small and medium rivers with appropriate monitoring sites, e.g. bridges with maximum height 10-12 meters (recommended to allow identification of items down to 2.5 cm), reasonable Observation Track Width, reasonable coverage of the total river width (multiple observers can be used simultaneusly). In large rivers, bridges are usually too high, not accessible or not existing, which imply large uncertainties in the identification of items and estimation of litter flux.<br><br>Nets can be used in any river, but it may require a long period |

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| | deployment to get a representative sample. Deployment of nets may be complex and require permits. |
| **How much time per year this monitoring would take for a river of about 100 km?** | Visual Observations: once per week - 3 hours per week (1 hour observation) - 162 hours per year per observer (for monitoring of litter input to the sea, considering one single monitoring site close to the mouth of the river).<br><br>Depending on the river size, you may need more than one observer to cover a good portion of the total river width. |
| **How much this monitoring would cost per year for a river of about 100 km?** | Visual observation: apart from human resources, you need a tablet computer per observer, transportation to monitoring site, training observers. |
| **What are the gaps / issues on the method that need to be solved?** | frequency of monitoring sessions to catch temporal variability<br><br>Compare visual observation with other methods, e.g. nets |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | Visual monitoring - it can be used to assess trends in floating macro litter items flux, e.g. to assess impact of mitigation measures such as the banning of certain Single Use Plastic (SUP) items.<br><br>The use of different methodologies is complementary, you cannot study micro and macro litter using the same methodology as the need for collection of representative samples requires different monitoring set up. |
| **Abstract of the talk** | The RIMMEL experience: designing monitoring programs for assessment of floating macro litter input to the sea.<br><br>The RIMMEL database provides information that can help in designing monitoring programs for floating macro litter in rivers. Estimated litter flux can be useful in the selection of monitoring set up parameters, number of observations, length of observations, etc. These details are also relevant when using other methodologies such as nets to collect representative samples for different size fractions. |
| **Remarks** | |

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| **Project's name** | **Quantification and characterization of the plastic flux in the Scheldt basin, with the ultimate goal of setting-up efficient remediation.** |
| **Contact** | Bert Teunkens |
| **Organization** | University of Antwerp |
| **Email** | bert.teunkens@uantwerpen.be |
| **Project's description** | For my PhD I'm studying macroplastic pollution in the Maritime Scheldt, which is the part of the Scheldt river in Belgium that is subjected to the tides. The aim is to quantify the plastic flux for the entire Scheldt basin. In this project we will only focus on macroplastics (≥2.5cm). For this fraction it is still realistic to design removal strategies, which eventually is the ultimate goal of this project. Because a certain fraction of microplastics originates from disintegration of macroplastics, it is assumed that this project also has a beneficial impact in microplastic pollution as well. This project can be separated into 3 different aspects. The 1st aspect is studying plastic in the water column by taking point measurements, the 2nd aspect is to study plastic that can be found on riverbanks and the 3th aspect is to study the behaviour of marked plastic items in the river. |
| **Please, describe here shortly the method you use** | To collect plastic from the water column 3 different techniques are used. The 1ste technique being used are fyke nets. 4 times per year at 6 locations along the Maritime Scheldt, 2 double fyke nets are set at the low water line. They are left for 2 tidal cycles after which they are emptied a first time, and then set back for a second time. This technique allows plastic to be collected which moves close to the riverbanks. The 2nd technique, called anchor-netting, is done with a fishing vessel. This fishing vessel has 2 large nets and each of these nets is 8m wide. With this technique plastic can be collected over the entire depth (from surface to riverbed) of the river. This is done 3 times per year at 4 locations. These 4 locations are identical to the 4 most downstream locations used during fyke netting. In contrast to fyke nets, which are set close to the riverbanks, this technique allows samples to be taken in the centre of the river. Thirdly, we have developed our own sampler, which consists of a number of smaller nets placed below each other. This sampler allows several samples to be taken simultaneously at different depths, this in order to study vertical distribution. Furthermore, the eb and flood tide are sampled separately and for each of these samples it is also possible to measure the volume of water that went through the nets. To study plastic that washes up on riverbanks 8 locations are selected. At each of these locations a 100m long area is marked, which are cleaned 4 times per year. To clean up these locations we work together with a social workplace. To study the movement of plastic through the estuary of the Scheldt basin, a study is set up based on a project currently being conducted on the Seine river in France (MacroPLAST by LEESU). The methodology consists of 2 different parts. The first part is to monitor floating bottles fitted with GPS trackers. The second part is by tracking marked items that wash up on riverbanks. These items are fitted with unique numbers which we can trace back. For this we work together with a social workplace and local organizations (like youth movements and local nature organizations) which already |

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| | organize clean ups from time to time. Also the general public can participate. |
| **References** | |
| **Final indicator used** | The final indicator is the concentration of plastic in the river (in items/$m^3$ and g/$m^3$). This is supplemented with information on: the size distribution of plastic found in the water column and whether or not the composition of plastic found on riverbanks is identical to what is taken from the river itself. Furthermore, we want to gain insight on the effects of tidal movement on the behaviour of plastic in the water column and the presence of hotspot locations. |
| **Can this method be applied to any watercourse?** | The Maritime Scheldt is a tidal river with a depth which varies between 6m and 12m due to tidal action. Fyke nets require riverbanks which should be accessible to reach the low waterline. Anchor netting requires a certain minimum depth and width of the river. Especially the width of the river is of great importance to prevent obstruction in shipping lanes (2 nets of 8m each + width of the fishing vessel itself). The "combination sampler" uses smaller (1m x 0,5m), detachable nets and therefore it is more versatile. |
| **How much time per year this monitoring would take for a river of about 100 km?** | The Maritime Scheldt also has a length of about 100km. In this study plastic collected with fyke nets requires 72 field days and results in 96 samples, ranging from 40l to 120l in volume (including organic matter). The time required to sample with fykes can be cut in half by not setting the nets back for a second time. To further analyse the samples the plastic has to be separated from the organic matter, which has to be dried in advance. After this, all plastic has to be sorted and counted. To collect plastic with anchor netting 3 times per year at 4 locations, 12 days in the field are required. Collecting plastic with the “combination” sampler is done 4 times per year at the same locations as anchor netting, which means 16 field days. For all techniques 2 people are required.<br>To get de plastic separated from the organic matter and to get everything counted we rely on a social workplace. For the cleaning up of riverbanks (8 locations x 4 times per year) we also rely on a social work place (conducted in teams of 6 to 8 people).<br>The plastic collected in 2018 with both fyke nets and through anchor netting yielded around 80.000 individual items, mostly foils. As the real clean-up of riverbanks only starts in June 2019 it is impossible to state what the time investment will be to get everything sorted. |
| **How much this monitoring would cost per year for a river of about 100 km?** | |
| **What are the gaps / issues on the method that need to be solved?** | |
| **Could this methodology be used to assess long term trends and compare** | The methodology we have implemented to study plastic pollution in the Scheldt river is very detailed, but therefore comes with a high financial cost. Nevertheless, this type of data collection can be copied to other rivers. As the sampling campaigns with fyke nets and through anchor |

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| **levels of pollution between rivers?** | netting are already part of a long term monitoring campaign by INBO to study fish populations in the maritime Scheldt, these samplings will continue to be conducted in the future. This also allows long term monitoring to be set up to study trends in plastic pollution over longer periods of time as well.<br>Furthermore, we have our doubts about projects which only look at floating items like RIMMEL and projects using camera technology. Samplings conducted in the Maritime Scheldt, so far, indicates that the fraction that is visible from the surface is very marginal and that the bulk is below surface and therefore not visible. As long as there is no clear link between items visible from the surface on the one hand and items which are moving in suspension or as bed-load on the other hand, we doubt the feasibility of these methodologies to simplify monitoring and collect good datasets.<br>Although the real clean-up actions on riverbanks still have to start, first insights on what can be found on these riverbanks is the opposite to what is found in the river itself. As mentioned before, plastic collected in the river mainly consist of foils and only a very small fraction are harder plastics. In contrast, what we see on the riverbanks are mainly hard plastics. |
| **Abstract of the talk** | Title: Quantification and characterization of the plastic flux in the Scheldt basin, with the ultimate goal of setting-up efficient remediation.<br><br>Plastic waste in coastal areas and the expanding “Plastic Soup” in our oceans are a growing threat for the marine environment. In recent years the role of rivers as a potential main contributor to marine plastic pollution has been suggested. Yet, the scale of such input remains to be systematically quantified. Also, the understanding of seasonality remains poorly studied. If high contributions can be determined, considering the vastness of oceans and seas and the great depth of some, the feasibility of projects removing plastic in rivers might be better than those in which plastic is removed from the open oceans.<br>Therefore, the University of Antwerp (ECOBE & SPHERE) will study the potential contribution of the Scheldt river to the worldwide “Plastic Soup”. The aim is to quantify the plastic flux for the entire Scheldt basin. In this project we will only focus on macroplastics (≥2.5cm). For this fraction it is still realistic to design removal strategies, which eventually is the ultimate goal of this project. Because a certain fraction of microplastics originates from the disintegration of macroplastics, it is assumed that this project also has a beneficial impact in microplastic pollution as well.<br>To determine the plastic flux different monitoring techniques will be used, like: fyke nets, a fishing technique called anchor netting and a specially designed “combination sampler”. The latter allows us to study the vertical distribution. Additionally, a study is set-up to analyse plastic waste that ends-up on riverbanks, which might yield vital information on its sink function. Furthermore, marked items will be monitored on their journey through the estuary. |
| **Remarks** | |

| Project's name | BLASTIC |
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| **Contact** | Eva Blidberg |
| **Organization** | Keep Sweeden Tidy |
| **Email** | eva.blidberg@hsr.se |
| **Project's description** | BLASTIC was an EU-project (2016-2018) with the aim to facilitate for municipalities to work on measures to stop the inflow of marine litter to the sea from urban areas. Within this project, one workpackage included to develop a method how to monitor marine (plastic) litter in riverine water. The method has been tested in three municipalities in the Central Baltic area and a manual for the method has been published. |
| **Please, describe here shortly the method you use** | We used oilbooms with nets of about 50 cm under. They were out for a week and then all the litter was picked up and categorised according to the protocol. |
| **References** | The manual is available here: https://www.blastic.eu/wp-content/uploads/2019/02/blastic-guidelines-riverine-litter-monitoring.pdf. On www.blastic.eu you can also find other information about the project and marine litter as well as other results from the project. |
| **Final indicator used** | During the test of this method, they have used different units however it is concluded the unit should be (kg/m3). However, it is still important to categorise the litter in order to derive sources. And maybe total number of litter items can be of interest as well. |
| **Can this method be applied to any watercourse?** | No, what was found in the tests were that the method is only applicable on smaller rivers and preferable that where it is possible to block the river during the monitoring period |
| **How much time per year this monitoring would take for a river of about 100 km?** | I'm not sure if I can but you need to be two persons for the work to handle in the equipment. Sampling is relatively easy however counting and categorisation depends on how much litter you find. |
| **How much this monitoring would cost per year for a river of about 100 km?** | Not at the moment but I can try to find out to the presentation. However, I'm sure that with Swedish salaries, it will be expensive compared to many other countries. |
| **What are the gaps / issues on the method that need to be solved?** | • Cost effective and simple monitoring option for floating litter;<br>• Simple and direct method that can be used for several different purposes such as scientific measurements, measuring the result of implemented litter actions and used in awareness projects;<br>• Collects litter so that it can be counted, weighed and categorized;<br>• Submerged litter items can be captured by net curtains.<br>Disadvantages<br>• Frequent observations are recommended for representative monitoring;<br>• The monitoring is easily influenced by external circumstances such as weather conditions (wind and precipitation) and flowrate/direction;<br>• Not suitable in wider rivers or in rivers with boat traffic as it is recommended to block the entire width of the river;<br>• Monitoring can be affected by the discharge of organic material. Monitoring during spring and autumn floods is not recommended |

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| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | To my experience, the municipalities are mostly interested of how much their cities contribute to the inflow of plastic in the sea. And they are interested in sources, as a basis to implement effective measures against marine littering, With the right prerequisites, I think this method could fulfil these expectations also in the long run. However, other authorities may have other requests of results. |
| **Abstract of the talk** | BLASTIC – a plastic litter riverine monitoring methodology<br>The overall aim is, by mapping and monitoring marine plastic litter, to facilitate the reduction of the inflows of plastic litter and of hazardous substances into the Baltic Sea. The monitoring of marine plastic litter is important not only in order to acquire knowledge about know how much plastic is already in the marine environment, but it is also important in order to know how much plastic is being discharged into the oceans. The idea within BLASTIC was to develop a cost efficient, flexible and scalable method for monitoring of riverine plastic discharge. The method of floating litter booms was chosen as litter booms are flexible in both size and positioning and that they collect the floating litter which then can be quantified, categorised and analysed, which is considered to be a major strength of this method. It was designed with the intention of producing high quality, robust data sets while being flexible in regard to the purpose of the monitoring. The methodology for riverine litter monitoring was developed and tested at four different pilot areas within the BLASTIC project. The three project partners that reported results had different experiences and the floating litter booms worked better in some sites than others. The physical conditions of the monitoring site are of great importance when monitoring with floating litter booms. All monitoring was in some way affected by either the width of the river, weather conditions such as wind and/or water flow rate/direction. Based on the experiences from the monitoring in the pilot areas the conclusion by the project members is that the floating litter boom methodology is suitable in narrow rivers with a continuous water flow and a high frequent sampling rate is recommended to obtain high quality data sets. |
| **Remarks** | |

| Project's name | Macro riverine litter |
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| **Contact** | Wilma Middel |
| **Organization** | Rijkswaterstaat (Ministry of Infrastructure and Watermanagement) |
| **Email** | wilma.middel@rws.nl |
| **Project's description** | Two major governmental projects should be mentioned with respect to macro litter in rivers. The program Microplastic 2019 -2021 (in progress) and the project monitoring strategy for riverine litter (proposal).<br><br>Program microplastics (Ministry of Infrastructure and Water Management) 2019-2021<br>The program contains different project lines. One-part focusses directly on microplastics (developing a monitoring strategy for micro plastics (see also the project information sheet produced by Bert Bellert/Henk Zemmelink), researching the relationship between micro's and health and reducing microplastics originating from tires, clothing and paint). The other part of the program focusses on macro litter in rivers as macro's seem to be one of the main sources for micro plastics in water.<br><br>Rijkswaterstaat, the implementation agency of the Ministry of Infrastructure and Water Management, is responsible for the implementation of the program. Coordinator is Wilma Middel. wilma.middel@rws.nl<br><br>Macro (plastic) litter:<br><br>1 Identifying hotspots (quick scan) & developing smart solutions for removing litter in rivers<br>Pilots floatersystems to collect/catch litter will be placed in several rivers. Questions to be answered are:<br>• What are the best systems and under which conditions?<br>• What are the costs and can it be upgraded to a circular economy businesscase?<br>• Is it possible and usefull to install riverfloating systems on a larger scale?<br>Collected litter from the rivers will be sorted out and identified. This will provide information on the type and estimated amount of litter in rivers. These data could also be compared with data collected in the "Schone rivieren" projects (Ospar riverine Litter) and data from Ospar Beach Litter.<br>2 Identifying main sources/responsible parties & developing a broad approach to prevent these sources/parties to cause riverine litter. After identifying the hotspots (e.g: rivierbeaches, sewage treatment plants, ships en harbors) measures to prevent litter entering into the rivers will be tested. Behavioral insights play a major role in the so called broad approach as well as making sure that the basics are optimized (optimized bins, public space design, optimized management and maintenance etc). Other aspects that will be investigated are the possibilities of citizen science to create public awareness and public participation.<br>Furthermore we will evaluate the Ospar riverine litter method that is currently used, aiming at bringing the method to a higher level and produce reliable data. |

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| | Developing a monitoring strategy for riverine litter (proposal, estimated start of the project: early 2020)<br>This project is financed mainly by the European Maritime and Fisheries Fund. The project aims at starting implementation of structural monitoring riverine litter in the main Dutch rivers.<br>Questions to be answered are:<br>1. What type of riverine litter is present in our main watersystem (rivers) based on OSPAR BEACH categorization<br>2. What is the source of this riverine litter? Where does litter enter the watersystem and what are the pathways from (sources to) regional rivers?<br>3. What is the amount of riverine litter (particles and kg/year/..)<br>4. Where is the riverine litter found in the riverine system?<br>a. From point of view of the width of the river bed (in the middle, at the sides, in fast fluent parts, outside turn, inside turn)?<br>b. From a point of view of depth of the river profile (surface, water column, sediment)?<br>5. How does macroplastics behave, spread and transport through the river, where do hotspots arise, and why)<br><br>First implementation of monitoring will start in de Meuse at different locations above the river, locations on shore, locations in the water of the river with different depths/widths and locations at the riverbed. |
| **Please, describe here shortly the method you use** | Currently we are researching/will start to research different methods:<br>1) ospar riverine litter (tracks of 100m using a slightly modified ospar beach litter categorization) together with the project "Schone rivieren"<br>2) camera systems on bridges/locks/weirs etc (not yet operational)<br>3) Floatersystems in combination with sorting out and identifying litter (not yet operational)<br>4) Sorting out litter collected during keep it clean days or collected at hotspots at more regular base |
| **References** | |
| **Final indicator used** | Depends on the method.<br>Ospar: number /100 m river banks<br>Camerasystems: under research, probably number/time unit/<br>Floatersystems: under research, probably kg/xx and % (composition)<br>Sorting out actions: kg and % (composition) |
| **Can this method be applied to any watercourse?** | Under research |
| **How much time per year this monitoring would take for a river of about 100 km?** | Not yet, our evaluation of the ospar river litter method will hopefully provide this information |
| **How much this monitoring would cost per year for a river of about 100 km?** | Not yet, our evaluation of the ospar river litter method will hopefully provide this information |

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| **What are the gaps / issues on the method that need to be solved?** | Relationship between the amount and composition of litter on the river banks and amount and composition in different parts of the water column/sediment are not yet known. If this relationship can be established, monitoring could become easier. |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | If it appears to be possible to develop a model for litter behavior in rivers, including the pathways etc., probably monitoring f.e. litter on river banks could be used to assess long term trends and to compare levels of pollution between rivers. To be studied. |
| **Abstract of the talk** | |
| **Remarks** | |

| Project's name | RiverSe; INDICIT-II; MedSeaLitter |
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| **Contact** | Gaëlle Darmon |
| **Organization** | CEFE-EPHE ; HISA |
| **Email** | gaelle.darmon@cefe.cnrs.fr |
| **Project's description** | Riverse project aims at assessing litter abundance, impacts on fauna and inputs from rivers to seas as well as to develop litter impacts indicators specifically on rivers. It should include a feasibility study on the Rhone river (literature review, networking, defining available approaches in rivers and in seas and providing standard protocol). Participative approaches will be especially analysed. The approach is expected to be inspired from experiences in oceans and seas from currently work in the Mediterranean and Atlantic: INDICIT-II (https://indicit-europa.eu/) aim at supporting the implementation of litter impacts indicators (INDICIT-II). The main activities consist in i) providing standard approaches to monitor ingestion of Macro/Micro Litter and entanglement in sea turtles, fish, birds and mammals, ii) networking and training stakeholders, iii) collecting and analysing standard data, and iv) proposing threshold above which litter is consider to impact individuals' health. MedSeaLitter project (https://medsealitter.interreg-med.eu/) aims at testing and providing protocols for assessing litter abundance and impacts. Several protocols have been tested and compared to simulation approaches, from e.g., aerial surveys, drones, boats with different platform heights and with observers (ferries, fishing boat, sailboat). |
| **Please, describe here shortly the method you use** | For Litter ingestion: https://indicit-europa.eu/protocols/<br>For observation of macro-litter distribution: aerial surveys, drones, boats with different platform heights and with observers (ferries, fishing boat, sailboat). |
| **References** | MedSeaLitter and INDICIT final reports will be published soon. |
| **Final indicator used** | We have not tested it for rivers for now |
| **Can this method be applied to any watercourse?** | Drones/boat approaches can be adjusted for Rivers. Observations from fixed points (observers or cameras) should be exportable to almost any kind of water course. |
| **How much time per year this monitoring would take for a river of about 100 km?** | One of RiverSe project objectives (feasibility study). |
| **How much this monitoring would cost per year for a river of about 100 km?** | One of RiverSe project objectives (feasibility study). |
| **What are the gaps / issues on the method that need to be solved?** | Consider litter detectability according to colour and shape categories; intra-annual variability; meanderings. Define areas for standard monitoring. |
| **Could this methodology be used to assess long term trends and compare** | Transects from drones and boats with on-board observers (fishing boats / barges) should be repeated in the same zones, as well as observation on fixed points. The temporal window at which standard data should be analysed, has to be tested. |

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| **levels of pollution between rivers?** | |
| **Abstract of the talk** | I can present 1) my work on macro-litter at sea, especially our simulations of floating litter distribution and input from the Rhone river in the Gulf of Lion, 2) the RiverSe project. Unfortunately, I can't propose results for the rivers since we have no empirical data, for the moment! I can send technical sheets for boat and aerial approaches used at sea. |

| Project's name | Riverine Litter Monitoring Projects |
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| **Contact** | Sophie Rogers |
| **Organization** | Department for Environment, Food and Rural Affairs (UK Government) |
| **Email** | sophie.rogers@defra.gov.uk |
| **Project's description** | Upstream Battle: Citizen Science/ Community Engagement project<br><br>Objectives<br>•Better understanding of litter across the Clyde valley<br>•To trial a new methodology<br>•To raise awareness about the path of litter from source to sea<br>•Use of data to reduce litter locally and across the Clyde valley |
| **Please, describe here shortly the method you use** | Using community volunteers to measure plastics in and around river. Counting number of items of litter passing through 100m transect of river in 1 minute, assessing amount of litter accumulated on riverside and measuring number and types of litter items on area next to river. |
| **References** | https://www.keepscotlandbeautiful.org/upstreambattle/ |
| **Final indicator used** | Macroplastics per 100m in one minute flowing in river, accumulated on side and on land next to river. |
| **Can this method be applied to any watercourse?** | Is a citizen science project, so volunteers advised to avoid potentially dangerous areas |
| **How much time per year this monitoring would take for a river of about 100 km?** | Asks volunteers to measure same site 4 times per year (once per season). No further info on number of volunteers expected |
| **How much this monitoring would cost per year for a river of about 100 km?** | n/a |
| **What are the gaps / issues on the method that need to be solved?** | n/a |
| **Could this methodology be used to assess long term trends and compare levels of pollution between rivers?** | yes - methods could apply to multiple rivers and as measuring 4 times per year could be used to create records of particular places |
| **Abstract of the talk** | Riverine Litter Monitoring Projects<br><br>This presentation will cover the ongoing projects in Scotland to monitor macroplastics. The project 'Upstream Battle' uses citizen science to measure pollution in the Clyde river. This presentation will also briefly cover the Zero Waste Towns initiative. |

| Project's name | The Riverine Input Project |
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| **Contact** | Antoine Bruge |
| **Organization** | Surfrider Foundation Europe |
| **Email** | abruge@surfrider.eu |
| **Project's description** | Plastic waste has become a threat to all the world's oceans. Solutions exist but we need to localize our efforts on the most polluted areas. Rivers are a major pathway for litter entering the ocean, but a harmonized method is still needed to monitor this pollution. The present project contributes to the development of such a method by developing a new litter monitoring technique. This project will allow the computation of a plastic pollution indicator for rivers. This indicator will help us to compare the plastic pollution of different rivers, localize plastic inputs into the environment and track improvements.<br>Our vision is that long-term monitoring of litter in rivers will allow for the assessment of effectiveness of measures taken and contribute to the global reduction of marine litter pollution. |
| **Please, describe here shortly the method you use** | We go down rivers with kayaks or by foot<br>We use an app called OSM Tracker to geotag the litter items we observed on river banks<br>We then compute a plastic pollution indicator corresponding to the number of observed litter item per km of river bank and we use it to map the plastic pollution. |
| **References** | https://surfrider.eu/riverine-input/<br>https://www.mdpi.com/2077-1312/6/1/24 |
| **Final indicator used** | Number of observed litter item per km of river bank |
| **Can this method be applied to any watercourse?** | Yes, you do not need to ask for authorization to set up this monitoring<br>When the river depth is too low to do the monitoring on kayaks, it can be down by foot (further development are needed to be able to compare data collected by foot and data collected from kayaks). |
| **How much time per year this monitoring would take for a river of about 100 km?** | I believe that we should cover about 10% of the river to get a good overview of the pollution. For a river of about 100km, we have to do the monitoring on about 10 km but on several transect. Two persons would be needed for about 2 days. |
| **How much this monitoring would cost per year for a river of about 100 km?** | - Need to rent a kayak and perhaps a kayak guide<br>- Transportation to the different zone to be monitored<br>- Waterproof phones (800€)<br>- Data analysis can be fast if automatized |
| **What are the gaps / issues on the method that need to be solved?** | - What is the relation between riverine litter fluxes to the sea and what is stranded on river banks?<br>- This methodology assumes that the amount of stranded litter on river banks is unchanged if no measures against plastic pollution are taken upstream. Is that true?<br>- What is the relation between the monitoring done by foot and the monitoring done in kayak? We believe that we will see more litter items when doing the monitoring by foot. |
| **Could this methodology be used to assess long term trends and compare** | Yes, but we need to agree on the timing allowed to make a global state of play of the plastic pollution in rivers. The state of play could be done in 2 years for instance (the time needed to cover most of the rivers). |

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| **levels of pollution between rivers?** | |
| **Abstract of the talk** | A new approach to monitor riverine litter based on visual counting of litter on river banks. |