Impetus

Co-funded by the Erasmus+ Programme of the European Union

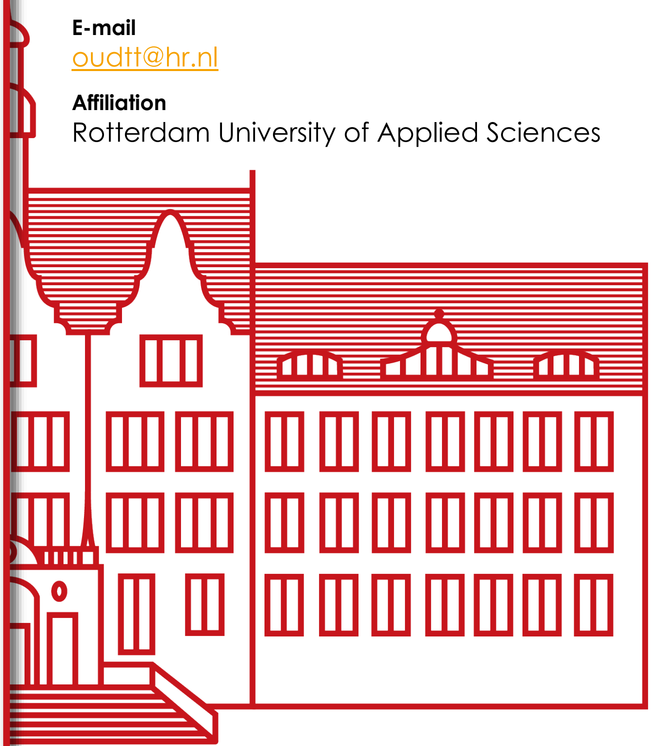
Innovative Measurement Tool towards Urban Environmental Awareness

RPWM
RIVERINE PLASTIC WASTE MESUREMENTS

Author
Tijmen den Oudendammer

E-mail
oudtt@hr.nl

Affiliation
Rotterdam University of Applied Sciences



This project has been funded with support from the European Commission.

This publication reflects the views only for the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Project Partners

POLITECHNIKA GDAŃSKA · Rotterdam University · Hanzehogeschool Groningen University of Applied Sciences · Universität Klagenfurt · Universidade de Coimbra · Fachhochschule Graubünden University of Applied Sciences

Table of contents

1 Assignment Urban Plastic Waste Pollution

1.1 Introduction

Plastic pollution in the world's oceans and seas is under growing attention and the environmental impact of plastics in the environment has only recently been studied. It is however known that much of this plastic pollution comes from urban areas, where disposed plastics are discharged through rivers and streams to finally end up in the oceans (Jambeck, et al., 2015; Lebreton, et al., 2017; Meijer et al., 2021).

To be able to tackle the influx of plastics into the marine environment data on plastic discharge by rivers is needed so appropriate measures can be taken. The discharge can be measured by surface measurements (visual camera registration of floating items), river body monitoring (actual sampling in the water column using nets and filtration systems) and riverbank monitoring (monitoring of plastic litter deposited on river banks) (Gonzáles & Hanke, 2017; Gonzáles, et al., 2017; UNEP, 2020; Vriend & van Emmerik, 2020). The latter seems the most practical method to get quick indicative results on types and numbers of litter transported by rivers, since it does not involve technical tools and logistics such as nets, boats and cameras.

Since there is a strong variation in river morphology and amount of plastic discharged as well between rivers as within a river basin, a standardized method is needed to be able to validate recorded data on plastic riverine litter. For marine litter the OSPAR beach monitoring method is long standing (Ospar Commission, 2010). Since 2017 this method has been adapted to suit river bank monitoring in the Netherlands within the Schone Rivieren (clean river) project (Schone Rivieren, sd; van Emmerik, et al., 2020). However this method focuses on natural riverbanks instead of urban systems where plastics can accumulate on hotspots on riverbank structures.

Therefore an adapted methodology for rivers in urban environments has been developed to be able to obtain comparable data on plastic waste in these systems. The method involves randomized subsampling in order to make quick assessments in different conditions possible.

1.2 Field measurement description *Randomized OSPAR riverbank monitoring*

In this method you will determine the amount and composition of riverine plastic litter on a riverbank using a random subsample. For a riverbank length of 100 m 10 subsamples of 1 m2 will be collected. The measurements consist of marking down the observed river litter on the adapted OSPAR form, per square. On each square a detailed photo is taken (with clear boundaries of quadrant).

Tools needed:

- **Riverine Plastic Waste Measurements Riverbank form.xls**,
- Measure tape,
- Camera (smartphone),
- Quadrat 1x1m or string/cord of 4m, with each m marked,
- Bin Bags,
- Gloves,
- Ruler (optional).

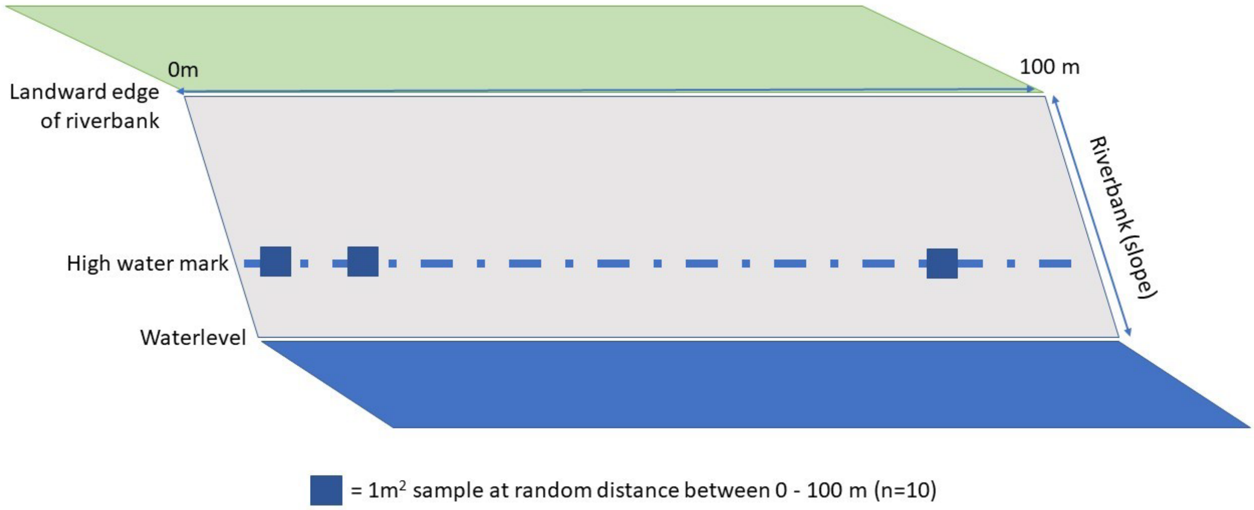


Figure 1.1. Schematic display of the sampling grid for OSPAR monitoring along urban riverbank.

Data collection protocol & methodology

The following steps are taken for data collection:

1. Select a stretch of riverbank of 100m length, that is safely accessible. Mark the beginning and end of the stretch.
2. Describe the type of waterway, for example river / canal / stream and indicative characteristics such as width, flow velocity etc. (Please note that this method focusses on natural river systems. The selected river should preferably have a relatively natural flow regime (e.g. periodical fluctuation of discharge. Canals or highly controlled discharges are less suitable for riverbank monitoring). Take pictures for future reference!
3. Generate 10 random numbers between 0-100, for example by using www.randomizer.org. These numbers relate to the distance at which a m^2 sample will be collected.
4. For your stretch of riverbank. See if you can recognize an average highwater mark. Usually visible by a higher level of debris (branches, sticks and other organic material) and litter (plastic waste etc.) or by color difference on soil or rocks.
5. Roughly following this high water mark. Place the square meter quadrant at the selected 10 different distances.
6. A photograph is taken of each square prior to the measurement, using the quadrant (see example in Figure 1.2).
7. All items are counted and registered according to the different categories and types given in the OSPAR monitoring form.
8. Did you count and record all items? All forms complete? Great! Now, while you're here: let's do a riverbank Clean Up by collecting all trash in binbags and dispose of them in the right way!
9. **OSPAR forms should be filled in per square clearly stating the square ID (Location and distance recorded), and handed in per form in excel**.
10. Photographs should be saved as .jpg, with square ID in name (LocationXdistanceX.jpg)

Figure 1.2. Example photograph of square m^2 measured.

Data analysis

The following steps in data analysis should be executed:

1. Make sure a separate form for each measured m^2 **sample is recorded in excel**. Thus resulting in 10 completed forms.
2. Determine the total amount of litter found on 100m riverbank by extrapolating the number of items found in the 10 samples (sum of sample 1-10 x 10).
3. Determine the composition of the litter found, for example by visualizing in a circle diagram (see example in Figure 1.3).

Can you determine the mean density of litter found on the river bank (mean number of items / m^2) by measuring the total riverbank surface (total area m^2 of riverbank: length x width of riverbank slope)?

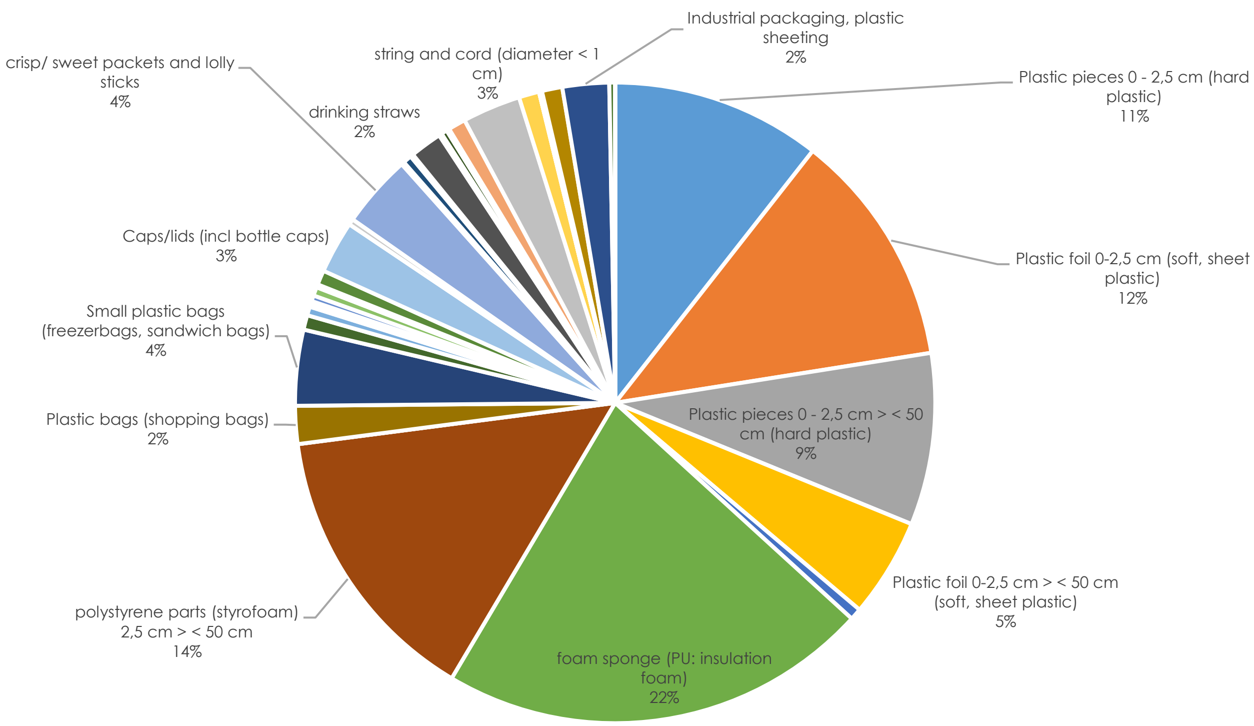


Figure 1.3. Example of riverine litter composition along the river Meuse (The Netherlands).

1.3 Field measurement description *Randomized OSPAR floating plastic waste*

Since several water systems consist of very slow velocity waters with stable water levels it is not always possible to measure riverbanks to get an insight on plastic waste in the water system.

Therefore an additional method has been developed to measure floating plastic waste.

During these measurements you will focus on potential litter hotspots. These hotspots are presumably in canal corners (corners in harbors, dead ends, sluice etc.). The measurements will be taken by observation from the quay, because of this it will be difficult to exactly measure the normally used 1 m².

Tools needed:

- **Riverine Plastic Waste Measurements Floating Form.xls**,
- Camera (smartphone),
- Optional: measure tape or ruler.

Data collection protocol and methodology

The following steps are taken for data collection:

1. Select a litter hotspot. Make an assumption of 1 m².
2. Describe the type of waterway, for example river / canal / stream and indicative characteristics such as width, flow velocity etc. (Please note that this method focusses on natural river systems). Take pictures for future reference!
3. A photograph is taken of each square prior to the measurement, make an estimation of 1 m².

4. All items are counted and registered according to the different categories and types given in the OSPAR monitoring form.
5. After filling in the form you will categorize the location of measurement according to the table below (Table 1.1).
6. OSPAR forms should be filled in per square clearly stating the square ID (Location and distance recorded), **and handed in per form in excel**.
7. Photographs to illustrate the amount of pollution can be included in the file.

Data analysis

The following steps in data analysis should be executed:

1. Make sure a separate form for each measured m^2 sample is **recorded in excel**.
2. Determine the composition of the litter found, for example by visualizing in a circle diagram (see example in Figure 1.3)

Extra:

3. Can you determine the mean density of litter found in the river / canal (mean number of items / m^2) by measuring the total water surface (total area m^2 of river: length x width of river)?

1.4 Conclusion on plastic waste

On the basis of the data analysis of riverbank and floating plastics conclusions can be drawn on the extent of plastic pollution using the following index.

Table 1.1. Riverine Plastic Waste pollution index.

Riverine Plastic Waste						
Category	**A**	**B**	**C**	**D**	**E**	**F**
Pieces per 1m^2 floating	0 - 1	2-5	6 - 25	26-50	51-100	100>
Pieces per 100 m riverbank	<10	10 - 50	51 - 250	251-500	501-1000	1000>
	(Almost) clean	Slightly polluted	Polluted	Severely Polluted	Heavily polluted	Extremely polluted

1.5 Online inventory on local plastic waste pollution

Several resources are available to execute an online plastic pollution scan. By analysis of several datasets, scientific resources and open source data an overview of plastic pollution in a local river system can be generated.

The following sources should be assessed:

1. **Online scientific data:** To get an overview of the amount of mismanaged waste and the potential input into river systems the interactive maps created by The Ocean Clean Up can be used:

   - River Plastic Pollution Sources | The Ocean Cleanup
   - Mismanaged Plastic Waste | Mapbox

   Questions you could answer are:

   - How much waste is mismanaged in my research area (kg / km^2 /yr)?
   - Are hotspots of mismanaged waste located around my river system?
   - What is the local discharge of the river? Is this fed primarily by rainfall? How could this affect the amount of waste being transported by the river?
   - What are the estimated outputs of the river into the sea/ocean?
   - How much of this waste could be generated in your reasearch area?

   Answering these questions should give an impression of the local plastic waste input in the local river system. The outcome should be a risk assessment: is plastic waste an environmental threat in our research area?

2. **Open source data:** Of course this data only gives a very rough overview and estimate of the amount of plastic waste in your area. Citizen science data collection tools however can give insight in local conditions. The following data collection apps are very useful: to gather data yourself or to make a quick inventory of local pollution hotspots:

   - 🌎💛Litterati - The Global Team Cleaning The Earth | Litterati
   - CrowdWater App Manual EN – CrowdWater

   Questions you could answer are:

   - Where is data available in your research area?
   - What does the data say in terms of the amount and composition of plastics waste?
   - What do you think are the sources for the plastic waste collected in the apps? (consumer, industrial, shipping, fisheries etc.)
   - Is the data in the vicinity of a local river or stream?

3. **Scientific articles and reports:** there is an ever growing library of scientific articles on plastic riverine pollution. These articles can give either an generic overview of plastic problems that can be transferred to your research area. It can also give very detailed insights in a specific river system, maybe yours. Use search engines such as:

   - Google Scholar
   - Home Feed | ResearchGate

   You can use keywords such as: plastic, river litter, macro litter, riverine plastic waste etc.

1.6 Final results description

During measurements, the results will be collected manually using Riverine Plastic Waste Measurements Riverbank form.xlsx or Riverine Plastic Waste Measurements Floating Form.xlsx depending on the type of measurements and send the results to the Climate Scan database. Students should prepare a full report of data collection and data analysis, including photo documentation of sampling and measurements conduction. Report should include analysis of are and reservoir description and the results of the survey. For the knowledge income verification use the RPWM pre-post test to print.doc.

1.7 External materials

See: https://impetus.aau.at/outputs/

Folder: Riverine plastic waste measurements

- RPWM instruction.pdf
- Riverine Plastic Waste Measurements Riverbank form.xlsx
- Riverine Plastic Waste Measurements Floating Form.xlsx
- RPWM pre-post test to print.doc
- RPWM pre-post test key.doc

1.8 Additional materials

- A scientific poster has been made and presented at the Water Summit in Delft, The Netherlands, illustrating the applicability of the method and showing results on plastic pollution in Rotterdam – Poster Water Summit Randomized OSPAR Sampling.pdf.
- Data has been collected in Rotterdam, Groningen and Gdansk during IMPETUS City Scan weeks. They are presented in the file Measurement results from Gdańsk, Rotterdam, Groningen.xls and can be used for the various analysis.
- The instructional video was developed to help understand the idea of collecting data on plastic pollution - https://youtu.be/YoMJYXej0wI.

1.9 Literature

Jambeck, J. R., Geyer, R., Wilcox, Siegler, T.R., Perryman, M., Andrady, A., Narayan, R. & Law, K.L. 2015. Plastic waste inputs from land into the ocean. Science, 13 february 2015; vol 347 Issue 6223.

Lebreton, L.C.M., van der Zwet, J., Damsteeg, J.W., Slat, B, Andrady, A. & Reisser, J. 2017. River plastic emissions tot the world's oceans. Nature Communications 8, 15611 doi:10.1038/ncomms15611.

Meijer, L.J.J., van Emmerik, T., van der Ent, R., Schmidt, C. & Lebreton, L.C.M. More than 1000 rivers account for 80% of global riverine plastic emissions into the ocean. 2021. Science advances 7, eaaz5803

González – Fernández, D. & Hanke, G. 2017. Toward a Harmonized Approach for Monitoring of Riverine Floating Macro Litter Inputs to the Marine Environment. Frontiers in Marine Science. 4. 10.3389/fmars.2017.00086.

González, D., Hanke,G., Tweehuysen, G., Bellert, B., Holzhauer, M., Palatinus, A., Hohenblum, P., and Oosterbaan, L. 2016. Riverine Litter Monitoring - Options and Recommendations. MSFD GES TG Marine Litter Thematic Report; JRC Technical Report; EUR 28307; doi:10.2788/461233

United Nations Environment Programme (UNEP). 2020. Monitoring Plastics in Rivers and Lakes: Guidelines for the Harmonization of Methodologies. Nairobi.

Vriend P, Roebroek, C.T.J. & van Emmerik, T. 2020. Same but Different: A Framework to Design and Compare Riverbank Plastic Monitoring Strategies. Front. Water 2:563791. doi: 10.3389/frwa.2020.563791

van Emmerik, T.; Seibert, J., Strobl, B., Etter, S., den Oudendammer, T., Rutten, M. bin Ab Razak, M.S. & van Meerveld, I. Crowd-based observations of riverine macroplastic pollution. Front. Earth Sci. 2020, 8, 298.

Schone Rivieren. n.d. Accessed on 14-12-2021 via www.schonerivieren.org

van Emmerik, T.H.M., Vriend, P. and Roebroek, C.T.J., 2020. An evaluation of the River-OSPAR method for quantifying macrolitter on Dutch riverbanks. Wageningen, Wageningen University, Report. 86 pp.

van Emmerik, T.H.M. and Vriend, P., 2021. Roadmap Litter Monitoring in Dutch Rivers. Wageningen, Wageningen University, Report. 44 pp., https:// doi.org/10.18174/537439/

OSPAR commission. 2010. Guideline for monitoring marine litter on the beaches in the OSPAR maritime area. London. Agreement number 2010-02, ISBN 90 3631 973 9

IMPETUS (Innovative Measurement Tool Towards Urban Environmental Awareness). n.d. Accessed on 14-12-2021 via https://impetus.aau.at/

Schone Rivieren. 2021. Factsheet voorjaarsmeting 2021. Retrieved on 14-12-2021 from https://www.schonerivieren.org/wp-content/uploads/2021/06/Schone-Rivieren-factsheet-juni-2021.pdf