Same but Different:
A Framework to Design and Compare Riverbank Plastic Monitoring Strategies

Paul Vriend[1], Caspar Roebroek[1] & Tim van Emmerik[1]

[1]Hydrology and Quantitative Water Management Group, Wageningen University, Wageningen, Netherlands

Paul Vriend
Paul.vriend@wur.nl

1. Introduction

- Data on presence of macroplastic on riverbanks is essential for design of mitigation and removal strategies
- Current methods to quantify riverbank plastic vary greatly, complicating comparison of data between programs
- Goal of this paper is to create a framework that can be used to compare or aid design of monitoring methods, as a first step towards standardization

2. Methods

- Analyze current monitoring efforts for common elements
- Determine the range of possibilities for each of these elements
- Determine effort required for each end of this range
- Convert to framework

3.1 The Framework

- Four main elements: **Space**, **Time**, **Observers**, and **Categorization**
- Each main elements can be further divided in sub-elements
- Range of possibilities shows what options can be chosen for each element, with left and right showing the extremes currently used in literature

Element	Sub-element	Range		
Space	Domain	Sub-basin		Multi-basin
	Sampling area	Subsampling		Sampling larger area
	Structure	Structured		Unstructured
Time	Period	4 Weeks		Single day
	Frequency	Yearly		Daily
	Structure	Structured		Unstructured
	Duration	Singular		Multi-year
Observers		Citizen Scientists		Trained Professionals
Categorization	Category	Material Based		Identity Based
	Size Range	Macro		Macro and Micro

Fig. 1 – A schematic representation of the proposed framework for riverbank plastic pollution quantification protocols. The range of possibilities is given for each element within the framework. The colored dots represent where the Plastic Pirates[1] (blue), Schone Rivieren[2] (green), Battulga[3] (yellow), and CrowdWater[4] (red) are on this scale of possibilities.

3.2 Space

- **Domain**: scale at which sampling is performed
- **Sampling area**: the space in which samples are taken
- **Structure**: method in which sampling locations are chosen

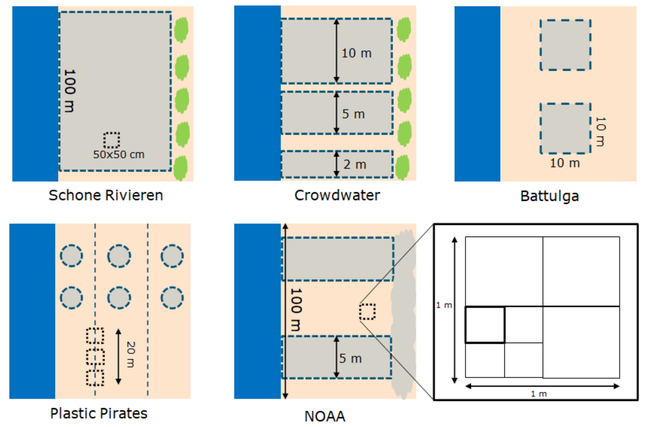

Fig. 2 - An overview of sampling areas (shaded areas, black dashed lines for microlitter analysis) for multiple riverbank plastic quantification protocols, and the NOAA beach litter protocol[5] to exemplify random sampling.

3.3 Time

- **Period**: the timeframe in which measurements for a measurement round are taken
- **Frequency**: number of sampling rounds in a year
- **Structure**: whether to use a structured protocol (using rounds and frequency) or randomly sample throughout the year
- **Duration**: range of time in which plastic is sampled

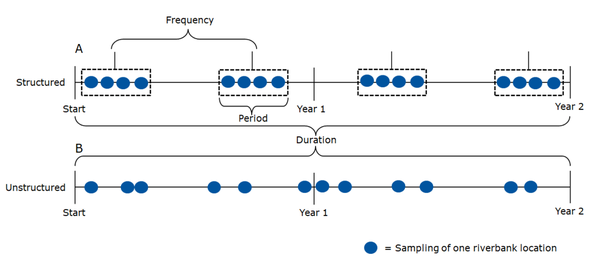

Fig. 3 - The four elements of time depicted on two timelines, where timeline **(A)** represents structured temporal sampling, and timeline **(B)** depicts unstructured temporal sampling. The duration is the total time that samples are taken, the frequency is the number of samples that are taken annually, and the period the time that samples are considered as one measuring round.

References

[1]Kiessling et al. (2019)
[2]van Emmerik et al. (2020a)
[3]Battulga et al. (2019)
[4]van Emmerik et al. (2020b)
[5]Lippiatt et al. (2013)

WAGENINGEN UNIVERSITY & RESEARCH

Interested? Read the full paper here:
https://doi.org/10.3389/frwa.2020.563791

3.3 Observers

- Group of people that sample riverbank macroplastic
- Growing interest for citizen scientists due to possibility to sample a large domain, though can affect data quality

3.5 Categorization

- **Category**: level of detail in characterization of items
- Categorization can be aggregated to higher levels to compare between monitoring strategies (see figure below)
- **Size range**: Macro-, microplastic, or both

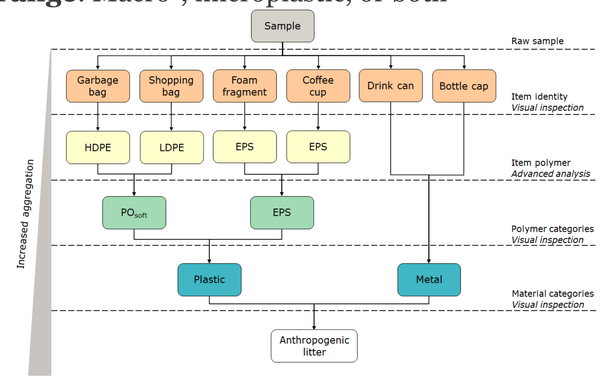

Fig. 4 - An example of riverbank plastic classification, where the upper layer represents the most detailed categorization (identity based, based on OSPAR categorization, not an exhaustive list), and each layer below represents a higher level of aggregation. The type of categorization and how this categorization is achieved is listed on the right side.

4. Trade-off analysis

- Limited amount of resources, so trade-offs are made
- Score each range from least effort to most effort
- Plot monitoring strategy to see trade-offs that were made

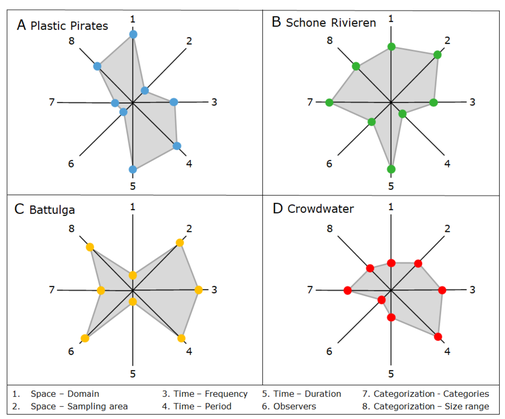

Fig. 5 - Graphical representation of the choices made for each element for the Plastic Pirates protocol[1] **(A)**, Schone Rivieren protocol[2] **(B)**, the Battulga protocol[3] **(C)**, and the CrowdWater protocol[4] **(D)**. Where each axis represents the following elements: (1) Sampling scale, (2) Space—Sampling area, (3) Time—Frequency, (4) Time—Period, (5) Time—Duration, 6. Observers, 7. Categorization, and (8) Size range. For each axis, the inner part represents low priority, and the outer part represents high priority. The sub-element of structure for time and space were excluded since these factors do not influence total cost.