Cleaning our seas and oceans of plastic litter

Elise Blondel and Laura Klinkenberg
Allseas, Poortweg 12, The Netherlands

As a leading player in the global offshore market, Allseas is concerned about the future of our planet. Working every day at sea, we witness first-hand the devastating impact plastic pollution has on the world's oceans and marine life (see Figure 2). Plastic pollution is a global problem. We are committed to helping clean our oceans by developing systems to collect waste in rivers and waterways before it flows out to sea, where it spreads out, sinks, and breaks up into microplastics—affecting sea life and ultimately human health.

Figure 1: Allseas' sampler for riverine litter pushed by the workboat Baby Lady. The frame holding the three sampling nets is up.

Figure 2: Photo taken by an ROV (remotely operated vehicle) during the survey of a pipeline installed by Allseas at 2km water depth 250km ashore of the Brazilian coast in 2018. The picture was taken not one year after the installation of the pipeline and shows the accumulation of post-consumer plastic litter around the pipe.

The plastic problem and how to solve it

Due to an expanding world population and the demand for ever-improving standards of living, plastic production has increased since 1950 to over 7,800 million tons, with half of that plastic being produced between 2004 and 2017 (Schmaltz, 2020). Plastic has a lot of favourable properties that explain its prolific use; it is lightweight, strong, durable and resistant to corrosion. However, poor waste management has led to a build-up of plastic litter in the world's oceans. It is estimated that 150 million tons of plastic had already accumulated in the marine environment in 2016 (Schmaltz, 2020).

Most of the plastic pollution in the oceans has land-based sources and is transported through riverine systems. With the river plastics removal project launched in 2017, Allseas aims to tackle the problem close to the source. The strategy started with gaining more knowledge and understanding of the problem by researching the transportation of plastics in rivers via in-situ sampling and modelling, continuing with the successful installation and testing of two plastic collection system prototypes in 2019 and 2020.

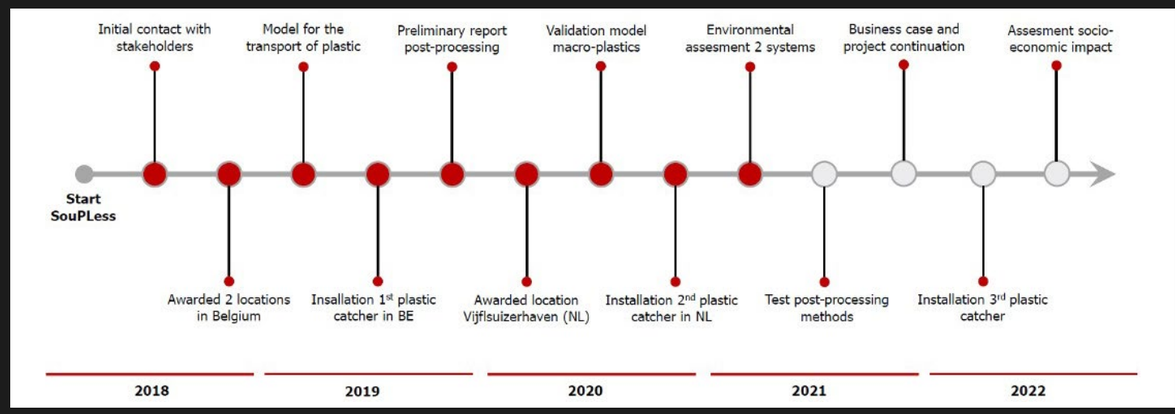
The plastic pollution problem also needs to be addressed on a larger scale. Therefore, raising awareness through media campaigns is also an essential part of Allseas plastic project. We also see changes in rules and regulations by the European Commission and other governing organisations to improve the way we handle plastics and decrease the inlet of plastic litter to the environment. One major issue is the ownership of the problem. Who takes ownership and responsibility? Creating ownership and responsibility among people and nations is one of the big challenges towards solving the plastic problem.

LIFE SouPLess

In 2018, Allseas' combined all its efforts to catch plastics in rivers into the LIFE SouPLess project, "Sustainable riverine PLastic removal and management." The driving goal of this project is a significant reduction of marine plastics, recovering them in rivers before they can spread to seas and oceans and thus protecting marine biodiversity, natural habitats and human health. The project aims to install three systems to collect plastic litter in various types of water environments (e.g. harbour, river, tidal zone), develop tools to predict hotspots of plastic accumulation in rivers, and provide advice on sustainable and cost-effective solutions for the post-processing of the collected (plastic) litter. The project started in July 2018 and will end in December 2022.

Achievements to date

- A full-scale plastic collection system has been designed, fabricated and installed in a non-tidal harbour—the Doeldok in the Port of Antwerp (Belgium). The system captures micro and macroplastics at the water surface and up to 1.5m under the surface.
- A full-scale plastic collection system has been designed, fabricated and installed in a tidal harbour—the Vijfsluizerhaven, which is along the river Nieuwe Maas (an effluent of the Rhine river). The Nieuwe Maas flows through the city of Rotterdam and the harbour of Rotterdam (the Netherlands).
- A numerical model has been developed to calculate the transport of micro and macroplastics in rivers and identify hotspots where plastic litter accumulates. The model is applied to the river Nieuwe Maas, and trends have been validated with in-situ data from a sampling campaign in the river.
- The basis of a methodological guide on riverine (plastic) waste management has been set up, containing the current technological options for post-processing.
- Engagement has taken place with national and international stakeholders such as authorities, post-processing companies, research institutes and NGOs.



Currently, a third plastic catcher is in its design phase. That system will be a full-scale collection system in a flowing river. Furthermore, mechanical recycling and chemical recycling processes will be investigated using the litter collected by the plastic collection systems.

A simulation model with Deltares

In the early stages of the project, Allseas collaborated with Deltares to develop a numerical model to simulate the transport of macro and microplastics in rivers (see Figure 3). The model's objective was to predict plastic hotspots, improve the efficiency of collection systems, find trends and gain general knowledge on the transport of plastic in rivers.

The model gave insight as to the best location for a plastic collection system, such as tidal zones and zones of high flux. It also showed that the whole water column should be targeted by a collection system, not only the water surface. Besides the tides, wind also has a significant effect on the transport of plastics in surface water.

These trends were also found in data collected by in-situ measurements with the Allseas' sampler (see Figure 1 and Figure 4). Data from more than 100 hours of sampling litter at various water depths in the Nieuwe Maas were used to validate the model. It was concluded that some effects were reproduced well by the model while others were not. For example, the model could not take into account the effect of passing ships. Besides, the model could not be easily transferred to every other river, as each river is different and needs its own hydrodynamic model.

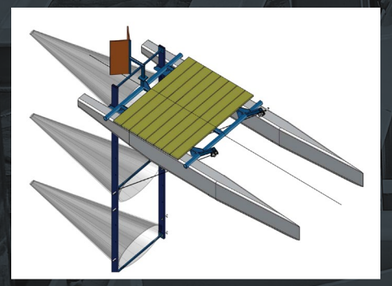


Figure 4: Rendering of Allseas' sampler; three nets enable litter sampling at various water depths up to 5 m under the water surface.

Plastic collection system for a non-tidal harbour

Allseas' first plastic catcher named "Patje Plastic" was installed in 2019 in the Doeldok in the Port of Antwerp in Belgium. It is a passive system, i.e. it does not require energy to function. A 100m floating boom guides the litter towards the collection system under the action of wind and wind-driven current (see Figure 5 and Figure 6). The boom is equipped with an underwater skirt to convey both surface and underwater litter to the collection system.

The collection system is composed of a floating frame supporting two collection cages, one for large litter and one for smaller litter (see Figure 7). A system of filters enables the segregation of the litter by size and prevents the litter from escaping when the wind direction changes. An anti-retour flap closes when the wind drops or changes direction.

The cages have sidewalls made out of plastic mesh and can catch microplastics up to a size of 1 mm. The Doeldok is a non-tidal harbour, which allows the system to be moored at the quayside without moving. The system is emptied every three months by hoisting the cages out of the floating frame with a truck-mounted crane. This first prototype has been sold to the Port of Antwerp.

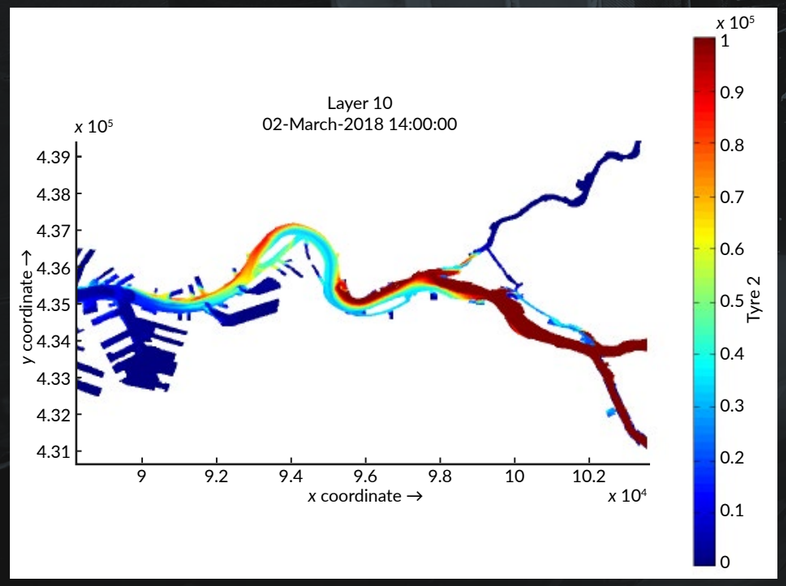


Figure 3: Example of the results obtained with the transport model for microplastics in the river Nieuwe Maas. This figure shows the concentration of plastics under water in layer 10 of the simulation, which means 10m under water. Blue to red represents low to high concentration.

Figure 5: 3D rendering of Patje Plastic in the Doeldok. A 100 m boom guides the litter towards the collection system.

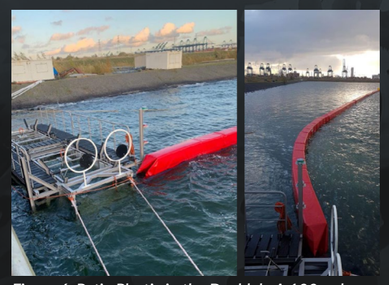


Figure 6: Patje Plastic in the Doeldok. A 100 m boom guides the litter towards the collection system.

Figure 7: Litter in the two collection cages of Patje Plastic. Larger litter is in the front cage, and smaller litter is in the back cage. The microplastics are clearly visible in the back cage (top).

A plastic collection system for a tidal harbour

In 2020, Allseas installed its second plastic collection system named "Catchy" as part of a pilot project with Rijkswaterstaat, the Dutch authority for public works and water management. This system is a passive system that catches litter flowing into the Vijfsluizerhaven, a creek along the river Nieuwe Maas in South Holland. The river Nieuwe Maas is an effluent of the Rhine that flows through the city of Rotterdam and the port of Rotterdam.

Two floating booms of 200m and 12m equipped with an underwater skirt guide the floating and underwater litter towards a collection system under the action of wind and current. The collection system is composed of a floating frame supporting a collection cage. It is moored to spud piles to move vertically with tidal variations of the water level. An anti-retour flap and a system of filters prevent litter from flowing out of the system with unfavourable wind and/or current.

The system captures macro and microplastics up to 3mm. It is emptied once a month with a mobile crane. The litter is further sorted and analysed into different size categories and material categories. This analysis is an important part of the project with Rijkswaterstaat to get insight into the types and amounts of litter, the possible sources of the litter, and how it can be post-processed with existing technologies. The Dutch government can further use this information to take new measures in tackling plastic pollution in rivers.

Figure 8: 3D rendering of Catchy, the plastic collection system installed in the Vijfsluizerhaven, along the river Nieuwe Maas in the Netherlands. The litter is guided by two floating booms under the action of wind and current towards the collection system.

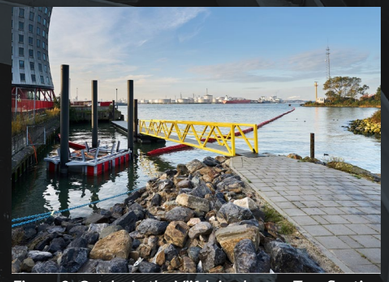


Figure 9: Catchy in the Vijfsluizerhaven. Two floating booms guide the litter toward the collection system. The system is moored to spud piles to accommodate the variations of the water level with the tide.

A plastic collection system for a flowing river

Allseas is currently designing a third plastic collection system, this time for use in flowing tidal and non-tidal rivers. It will, therefore, need to withstand the strong forces present in flowing water. This system is due to be installed and tested in a Dutch river in 2021/2022.

At a later stage, the aim is to install the system in highly polluted rivers in developing countries like India and Thailand. A new method that allows continuous emptying will therefore be tested. As with the previous systems, it will be a passive system collecting micro and macroplastics.

PROJECT NAME

LIFE SOUPLESS

PROJECT SUMMARY

Increased global production and poor waste management have led to a build-up of plastic litter in the world's oceans. This has devastating effects on ecosystems and marine life. The flow of plastics into the oceans occurs through a variety of pathways, but rivers are one of the largest contributors. The LIFE SouPLess project aims to develop technology to catch plastics from rivers before they spread to the seas and oceans. It is a 4.5 years project (July 2018 – December 2022). Three main links of the chain of riverine plastic recovery will be tackled: from locating plastic hotspots with a dedicated numerical model to effectively collecting the plastics with systems and finding sustainable and cost-effective solutions for post-processing the collected litter.

PROJECT LEAD

Elise Blondel holds a PhD in Hydromechanics from the Ecole Centrale Nantes (ECN) in France. She worked as an assistant professor at the ECN before she moved to The Netherlands in 2011 to pursue her research on sea wave forecast at the Delft University of Technology (TU Delft). In 2013 she joined the Dutch offshore company Allseas where she was involved in several projects around Pioneering Spirit, the largest construction vessel in the world. Since 2017 she has been involved in the company's river plastics removal project.

CONTACT DETAILS

Elise Blondel
Poortweg 12, 2612 PA Delft,
The Netherlands
+31 15 268 1813
EBL@allseas.com
https://allseas.com/allseas-river-plastics-removal-project

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