Final Report

Brilliant Marine Research Idea 2020

This report should be submitted **no later than 28 February 2021** via filantropie@vliz.be and consist of the following documents:

- A final report listing the work done and the problems encountered. This report will be made available online. If any of the tasks has not been completely finished, the report should clearly mention this, including a short explanation. **max. 5 pages**
- An overview of all expenditures including invoices.
- A set of five pictures (low resolution in this document). The five High Resolution pictures should be delivered to VLIZ by email to karen.rappe@vliz.be. Pictures should be free from use - to upload on the VLIZ website and to use in VLIZ communications.

Keep in mind that VLIZ should be mentioned in the acknowledgements of publications following the results of this Brilliant Marine Research Idea.

1. General information

Title of the idea	Tracking marked plastic items on their journey through the Scheldt estuary, using the Permanent Belgian Acoustic Receiver Network (PBARN).
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Name supervisor	Stefan Van Damme
Flemish University or Flemish University College	University Of Antwerp

2. Brilliant Marine Research Idea – Report about the activities

Abstract

To answer such questions as: “How long does it take for plastic waste in the Scheldt river to end up in the North Sea?” and “What factors determine why some types of plastic are found more on riverbanks than in the river itself?”, it was decided to follow a variety of marked plastic items on their journey through the estuary of the Scheldt river. In December 2019 and July 2020 marked plastic items, either fitted with GPS trackers or part of a Citizen Science project, were released at different location along the Maritime Scheldt. Thanks to the ‘Brilliant Marine Research Idea’ grant we were also able to equip a number of plastic items with acoustic telemetry tags, normally used to monitor the movement of fish or marine mammals. Using the Permanent Belgian Acoustic Receiver Network (PBARN) we were able to monitor the movement of submerged plastic items in a more detailed way than ever before.

Intro

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. 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. Therefore, the Ecosystem Management Research Group of the University of Antwerp, is studying the potential contribution of the Scheldt river to the worldwide “Plastic Soup”. In this project the focus is on macroplastics (≥2.5cm). For this fraction it is still realistic to design removal strategies in rivers, the ultimate goal of this study. For the last 2 years samples have been taken in the river using different techniques, like: fyke nets, a fishing technique called anchor netting and a specially designed “combination sampler”. The latter allows to study the vertical distribution. Additionally, clean up’s have been organized to study the composition of plastic waste that ends-up on riverbanks. The data collected to date has provided crucial insights. It shows that plastic collected in the river itself mainly consists of foil-like plastic, and that less than 5% is hard plastic. On the other hand, during clean-up actions on riverbanks, the amount of foil-like plastic is fairly low and the majority of plastic items found are hard plastics. Additionally, the data shows that the highest amounts of plastic are found near Steendorp and Antwerp. Further downstream the amount of plastic declines. This phenomenon cannot be explained by a dilution effect only because the river becomes deeper and wider, so further research is required. Key questions are: “What is the effect of the tides?”, “How long does it take for plastic to end up in the North Sea?” and “Which factors determines why some plastics are found more on riverbanks than in the river itself?” A key component is to understand how plastic items behave when entering a river. A main driver of this is its density. Plastic items, like PP and PE, have a low density and will float and therefore stay at the surface. Plastic items with a high density, like PET en PS , will sink towards de riverbed. Secondly the conditions in the river can have a large effect on the movement of plastic items. As the Scheldt river is a tidal river, plastic items will move downstream during ebb, but will move upstream again during flood. Furthermore, the discharge of the river can vary through the year. The Scheldt river has an average discharge rate of 107m^3/s (measured near Schelle). In winter this can increase to 253m^3/s and in summer it can be as low as 53m^3/s. A theoretical model[1] for the Scheldt river indicates that a floating item, released in Merelbeke (KM155) needs 3 days to reach Dendermonde (KM122), 8 days to reach Temse (KM98), 16 days to reach Antwerp (KM78) en 92 days to reach Vlissingen (KM2), taking into account an average discharge. With higher discharges (in winter) it takes 1 day to reach Dendermonde, 3 days to reach Temse, 7 days to reach Antwerp and 50 days to reach Vlissingen. With a low discharge (in summer) it takes 13 days to reach Dendermonde, 38 days to reach Temse, 63 days to reach Antwerp and 246 days to reach Vlissingen. Additionally ,variables like vegetation on riverbanks or sediments, which can trap items temporarily, can alter the retention time of the river even further. Reduced flowrates near the riverbed can affect the movement of submerged items. Furthermore, foil like plastic, due to their shape, have a so called large “Surface to Volume ratio”. This means their behavior can be altered more easily by the current. Therefore they tend to move in suspension, rather than simply float or sink. To get a better idea of the true retention time of the Scheldt river, it was decided to follow marked items on their journey through the estuary of the Scheldt river.

[1] **Plancke, Y.; Vandenbruwaene, W.; Vereecken, H.; Verwaest, T. ; Mostaert, F.** (2017). Plasticvervuiling en verhogen efficiëntie bij het ruimen van drijfvuil in het Schelde-estuarium: Deelrapport 1 – Advies voor het optimaliseren voor het ruimen van drijfvuil. Versie 4.0. WL Rapporten, 16_092_1. Waterbouwkundig Laboratorium: Antwerpen.

Material & Methods

Based on the results of a prior release in December 2019 using GPS trackers and a Citizen Science project, 15 different types of plastic items were selected. As each of these different types was released in duplicate, a total of 30 items was equipped with acoustic tags. In order to make them recognizable if found on a riverbank, the items were painted bright orange and equipped with a label. Additionally, the items carry a unique number (A001-A030). If they are found on a riverbank they can also be registered through the website www.zpr.one, as would it be a bright yellow item which is part of our Citizen Science project.

Of the 15 different types of plastic items used in this experiment: 6 are made of PP, 6 are made of PET, 1 is made of HD-PE, 1 is made of LD-PE and 1 is made of PS. As PP and HD-PE have a lower density, they are assumed to float and stay at the surface. Items made from PET and PS are assumed to move as bed-load as they are made from high density polymers. Items made from LD-PE (Foils) are assumed to move in suspension due to their high surface to volume ratio.

The acoustic tags that were used in this project are made by VEMCO (V7-4x) and equipped with a special end-cap to attach them to the items. They are programmed with a random delay between 120 and 180s and last ± 358 days. In order to track the items we rely on a network of underwater receivers. The "Permanent Belgian Acoustic Receiver Network" (PBARN), is established by the Ghent University, the Flanders Marine Institute and the Research Institute for Nature and Forest, within the LifeWatch project. The PBARN currently consists of 160 permanently installed acoustic receivers in the Belgian part of the North Sea, the Schelde Estuary, ... To retrieve data from the receivers, scientist from either INBO or VLIZ, manually read out all receivers twice a year. The release took place on July 7th, 2020 at 11h00 (UTC+2), during ebb.

Results/Conclusion

The dataset available to me at present, contains only data between July 7th, 2020 and September 30th, 2020. The dataset therefor only contains data for the first 3 months of tracking. In order to make a full analyses, knowing that the batteries of the tags will last around 1 year, additional read-outs are required. These are scheduled in March and September 2021.

A simple analysis shows that, out of the 13 items which reached Wetteren (the first receiver downstream from the release site at KM145), only 4 items got as far as Dendermonde (KM122). Out of these 4 items, only 1 item reached the City of Antwerp (KM78). In contrast, all items were detected at least once upstream from the release site. 29 out of 30 items were detected at least once in the stretch of the river between the sluices in Merelbeke (KM155) and the release site. 6 out of 30 items were detected at least once in the cut-off tidal arm towards Gentbrugge *(Figure 2)*. The item reaching Dendermonde first, needed 12 days to get there. The item reaching Antwerp needed 53 days to get there. Plotting the last known location for each item, at the moment the data from the receivers was downloaded, shows that the majority of items (24) were residing upstream from the initial release site. Because the Scheldt river is a tidal river, items which have moved downstream at a certain point in time can easily move upstream again, even beyond the initial release site. By the 30th of September, only 6 items were residing downstream from the release site (1 item near Wetteren, 2 items near Wichelen, 1 item near Branst, 1 item near Bornem and 1 item near Antwerp), 3 items were residing in the cut-off tidal arm towards Gentbrugge and 21 items were residing in the part of the river between the sluice in Merelbeke and Melle. Only once an item was spotted on a riverbank and registered via de website www.zpr.one.

To conclude we can state that using acoustic tags yields more detailed information than a Citizen Science project ever can, where items first need to be found. Furthermore it can supplement the use

of GPS trackers without altering the behavior of the specific plastic items.

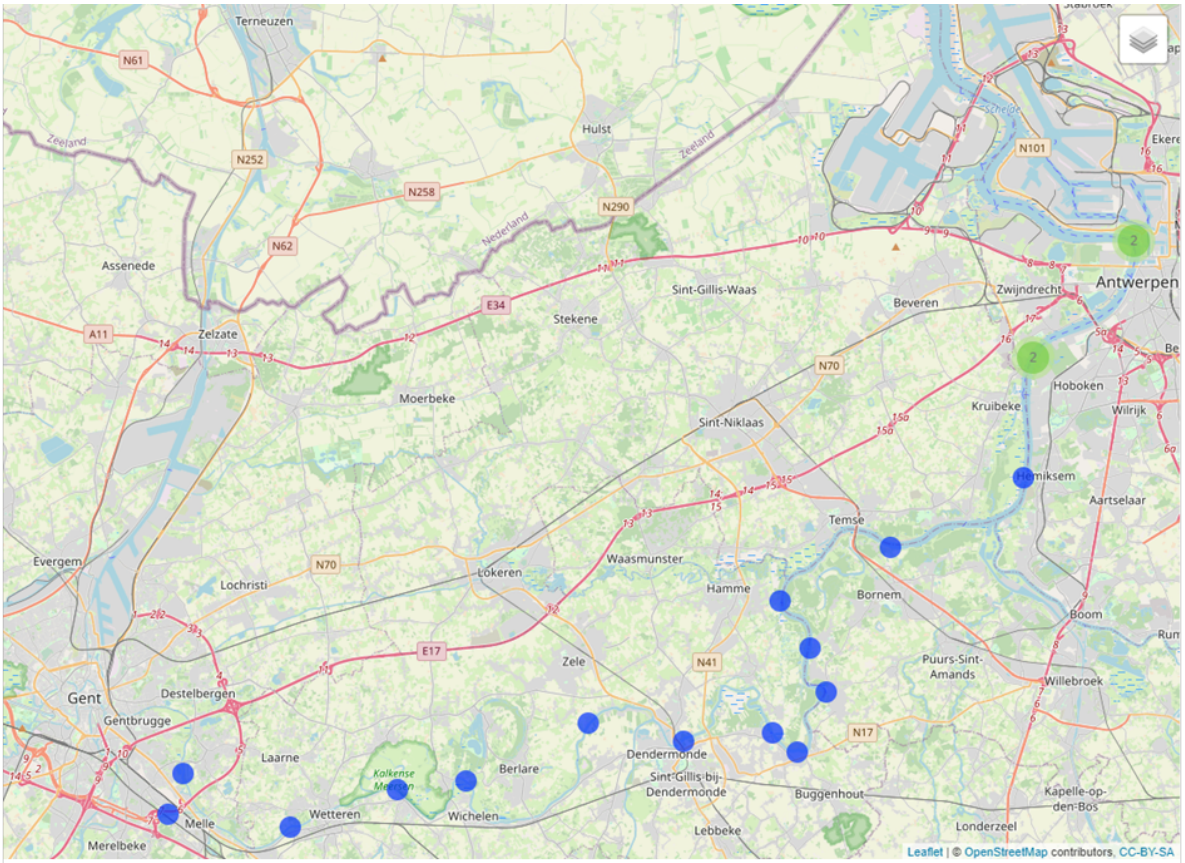

Figure 1: Network of receivers where items were registered. Items were released in Melle. Upstream → Downstream: Merelbeke and Gent-Brugge (upstream), Wetteren, Wichelen, Berlare, Zele, Dendermonde, Vlassenbroek, Buggenhout, Sint-Amands, Branst, Hamme, Bornem, Bazel (=Hemiksem), Kruibeke and Burcht (Clustered), Royersluis and Sint-Anna (Clustered).

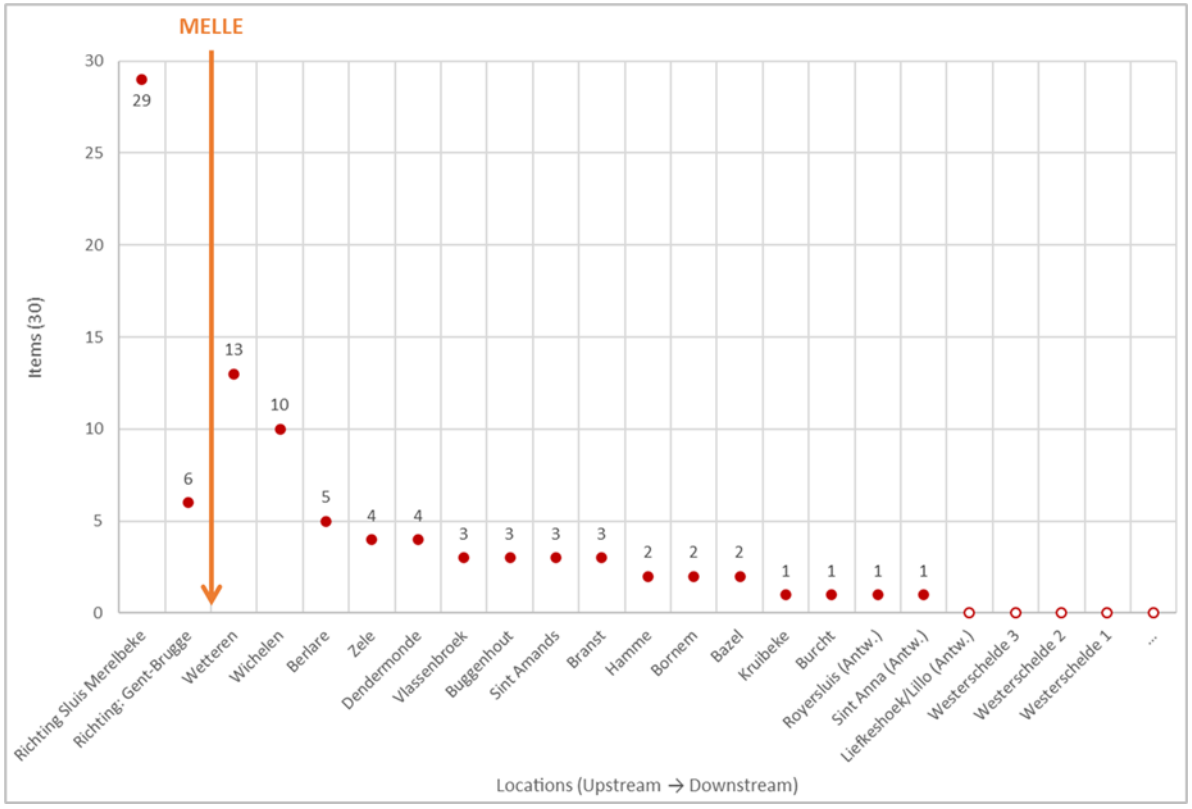

Figure 2: Number of items passing each of the receivers.

3. Overview of the expenditures

Describe in detail how the requested fund was spent within the implementation period (1 March 2020 and 28 February 2021). Be as specific as possible.
In total 30 acoustic tags were purchased for an amount of €7922.10, spread over 2 invoices (2x15tags). The full €5000 from this grant was used for this purchase. The remainder was paid from our own funds, including additional cost like: paint, labels, printing, labour, … .

4. Pictures

A set of five pictures (low resolution in this document). The five High Resolution pictures should be delivered to VLIZ by email to karen.rappe@vliz.be.