DeMARC:
Design of Marine and River Cleaner

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Every year: 8 billion kg of
plastics flow into sea


By 2050:
Mass plastics = mass fish

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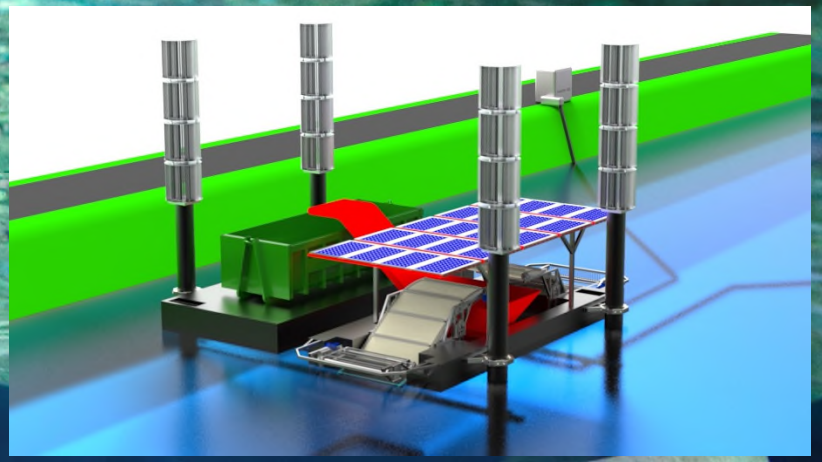
MArine & River Cleaner (MARC)



A fit-for-purpose marine plastic cleaner

DeMARC: Design of Marine and River Cleaner

Partners

4 pillars

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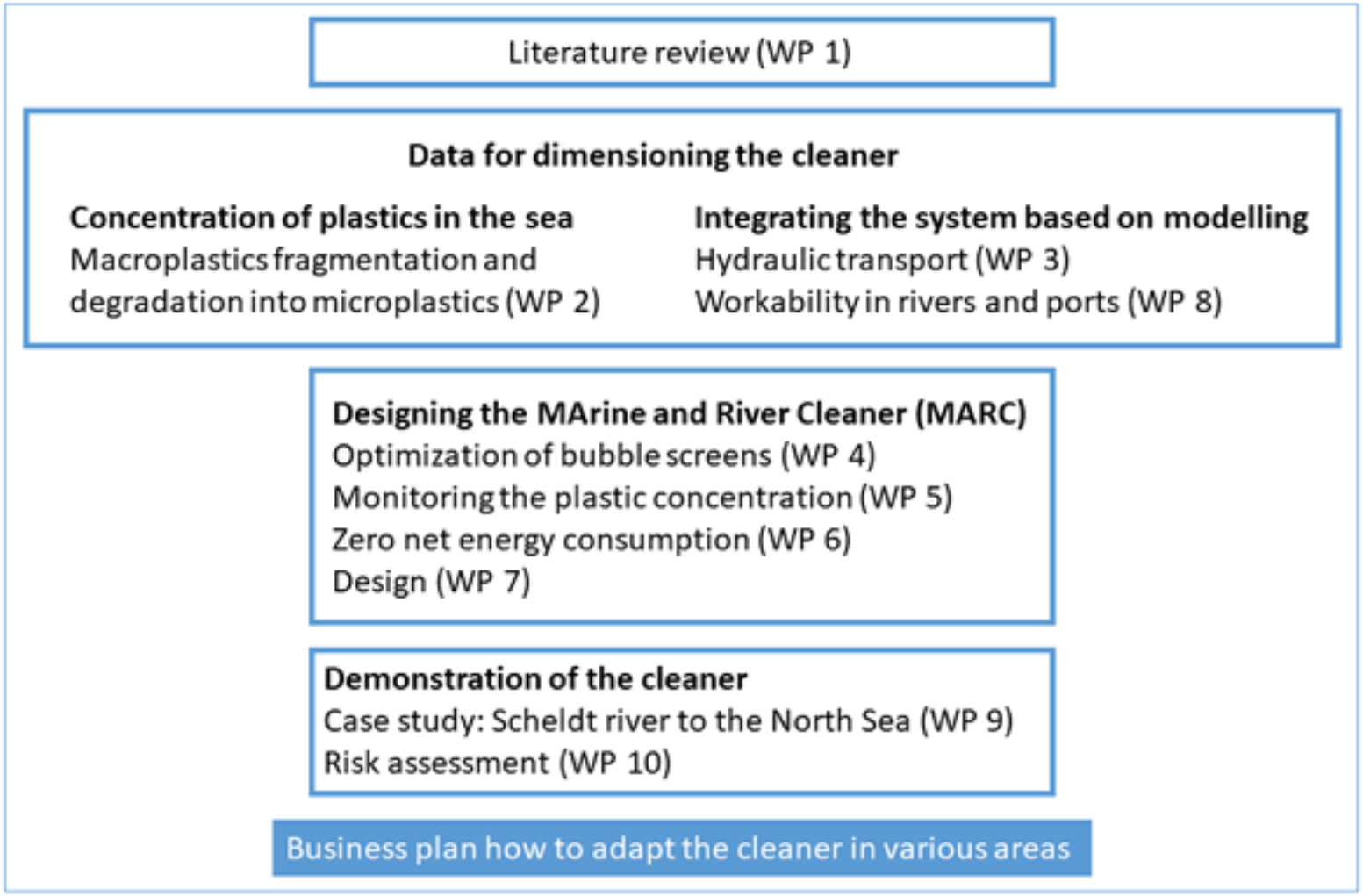
WPs


Literature review (WP 1)
Data for dimensioning the cleaner
Concentration of plastics in the sea
Macroplastics fragmentation and degradation into microplastics (WP 2)
Integrating the system based on modelling
Hydraulic transport (WP 3)
Workability in rivers and ports (WP 8)
Designing the MArine and River Cleaner (MARC)
Optimization of bubble screens (WP 4)
Monitoring the plastic concentration (WP 5)
Zero net energy consumption (WP 6)
Design (WP 7)
Demonstration of the cleaner
Case study: Scheldt river to the North Sea (WP 9)
Risk assessment (WP 10)
Business plan how to adapt the cleaner in various areas

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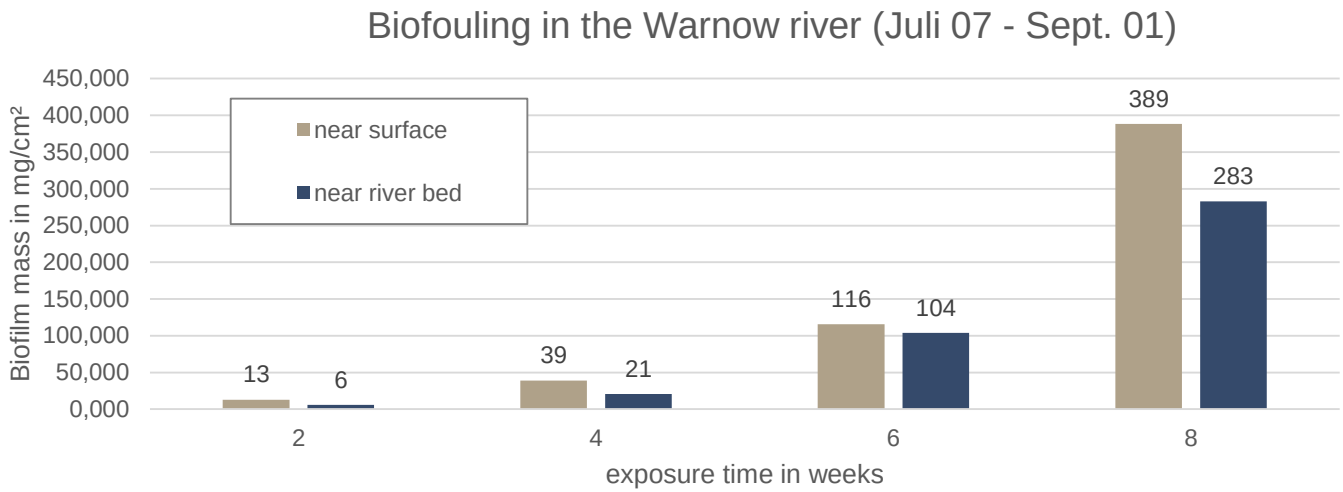
WP 2 – Concentration of plastics - Status

- Based on the literature review, experimental data should be evaluated:
  - Fragmentation and degradation of plastics at the estuary?
  - Change of density due to biofouling ?

  → measurements in winter and summer in river Warnow: **biofouling on PET samples**

  - Winter results:



  - **Task** : Classification of plastics litter in dependence on size and density → input for modelling

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WP3: Hydraulic transport of plastics

- Objective
  - Determine optimal location for plastic catcher using large scale model
- Method
  - Implement transport processes of plastics in TELEMAC-3D
  - Tests in schematic estuaries
  - Apply in IMDC's Scheldt model
    - Sensitivity analysis
    - Validation (using data University of Antwerp)
  - Use model to determine optimal location plastic catcher (WP9)

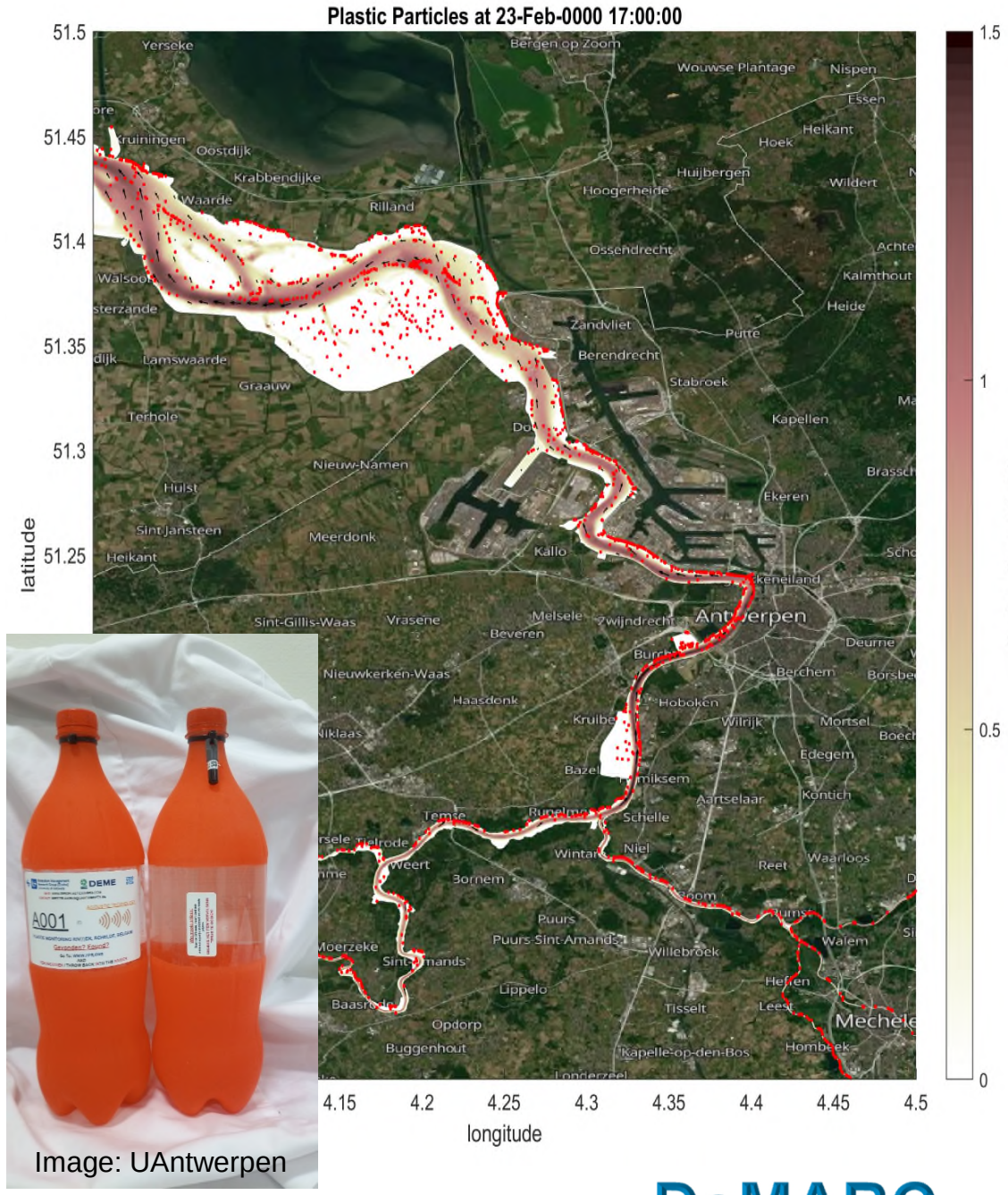
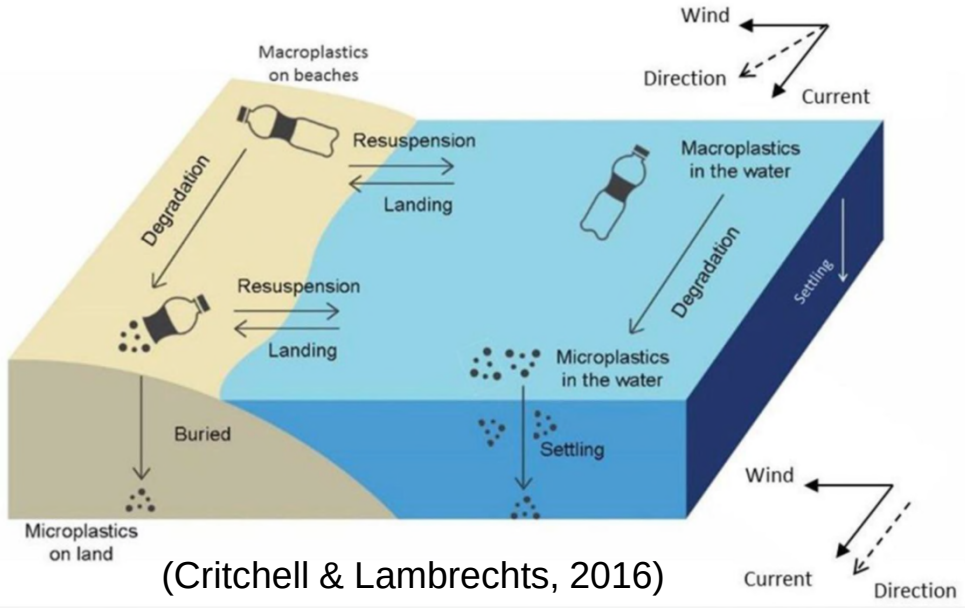


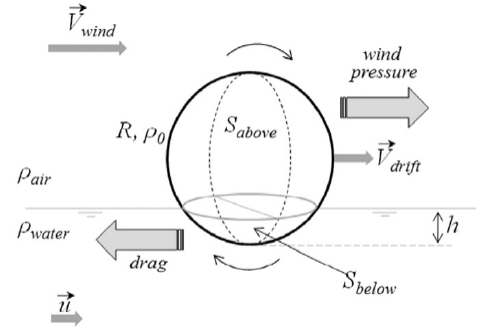
Image: UAntwerpen

WP3: Hydraulic transport of plastics - Implementation of plastic transport

- Implemented processes
  - Motion of the plastic objects based on a Lagrangian (particle tracking) algorithm
  - Influence of settling and rising due to density difference between the plastics (including possible biofouling) and the surrounding water (which may vary based on temperature and salinity)
  - Effect of the wind on the motion of floating plastics
  - Effect of interaction with the bed on sinking plastics
  - Parametrization of beaching effects



(Critchell & Lambrechts, 2016)



Wind effect - Chubarenko et al (2016)

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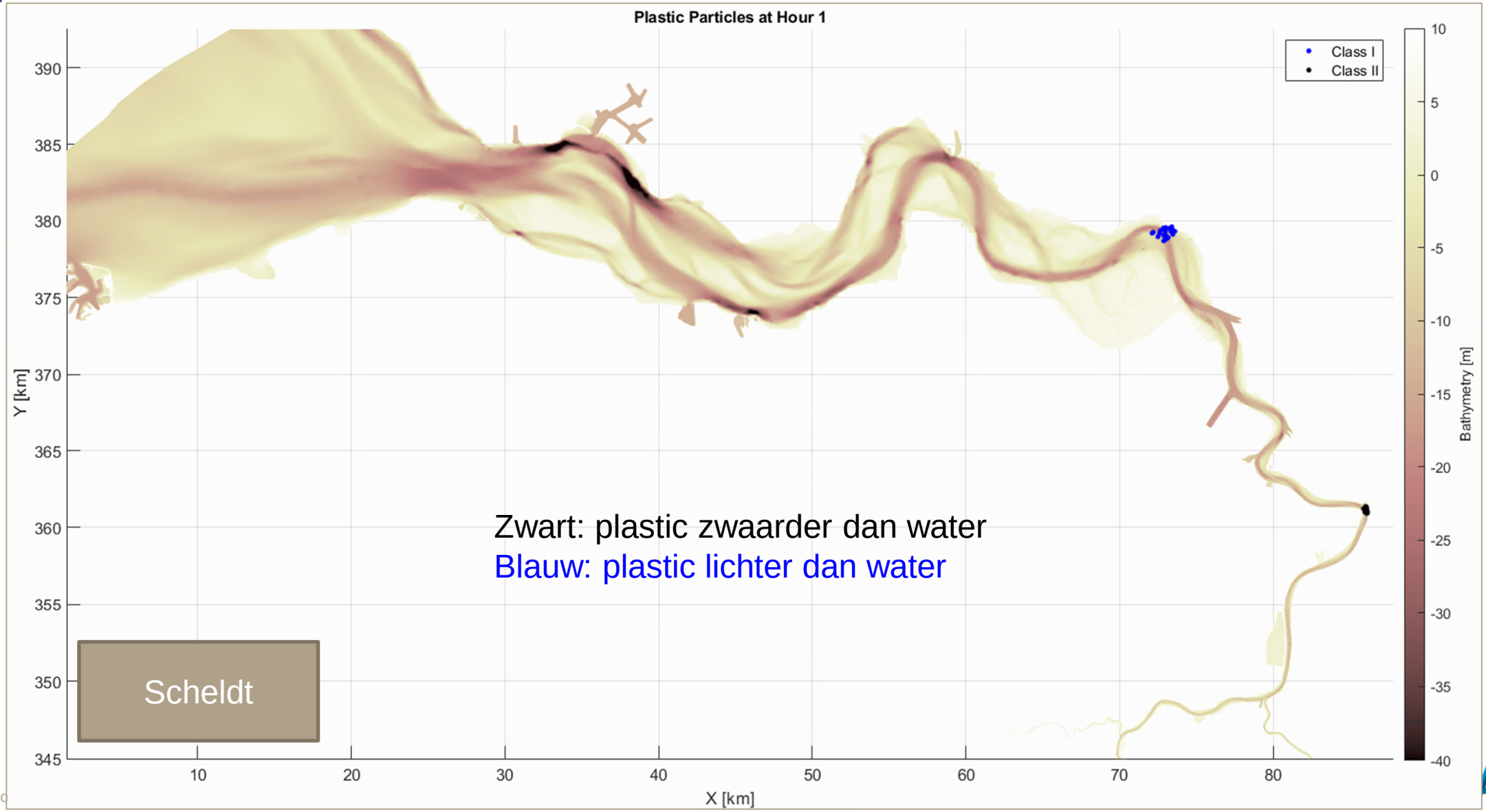
WP3: Hydraulic transport of plastics - TELEMAC



WP-9: Large scale plastic Modelling – Test case Scheldt

- Selection possible location of MARC in Scheldt
- Criteria:
  - High average plastic flux
  - Medium water depth (<5m)
  - Low velocity (and high velocity nearby for tidal energy)

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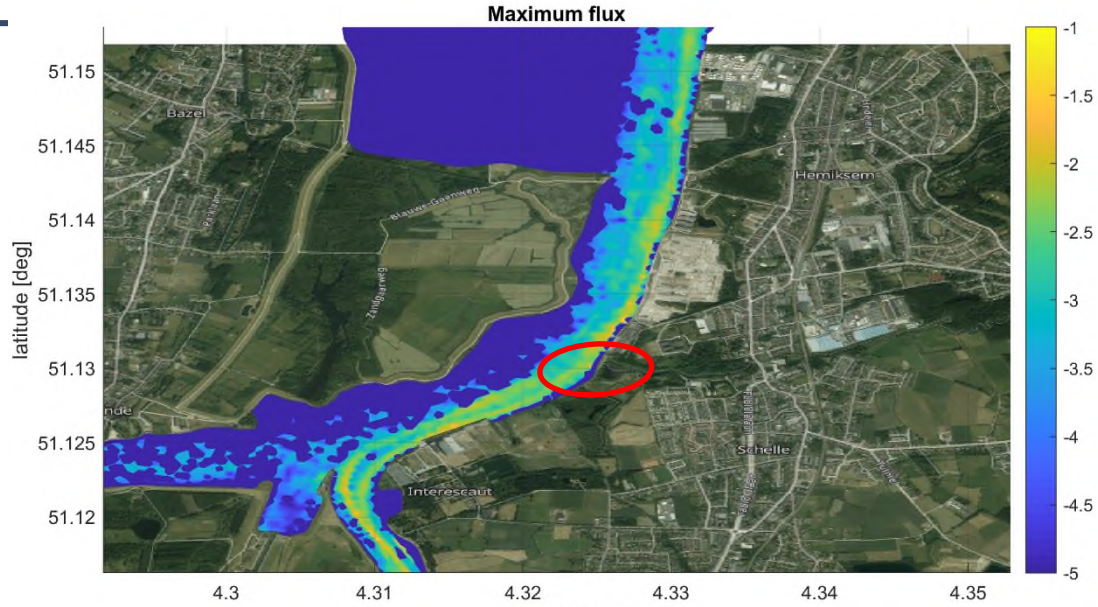
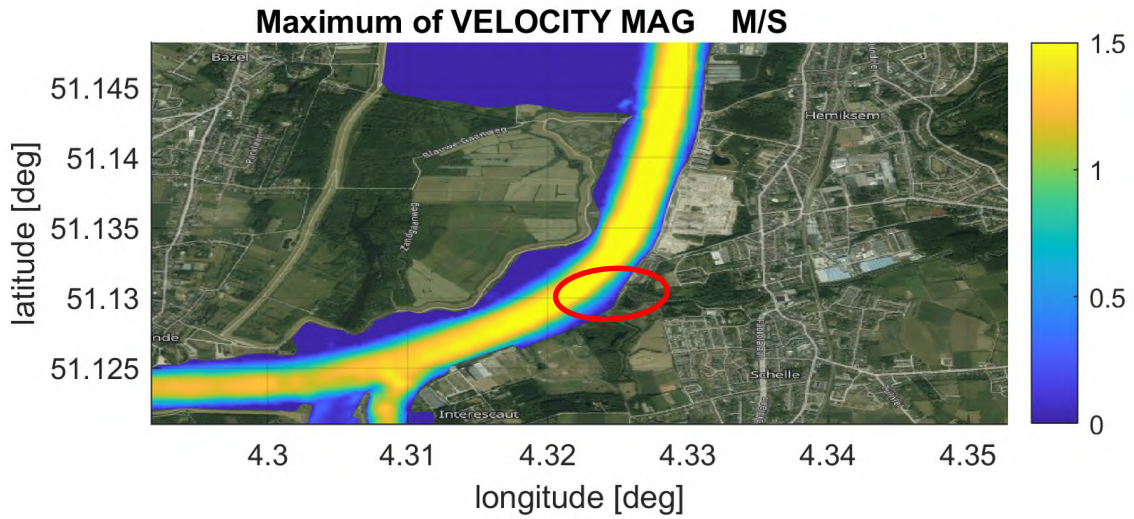
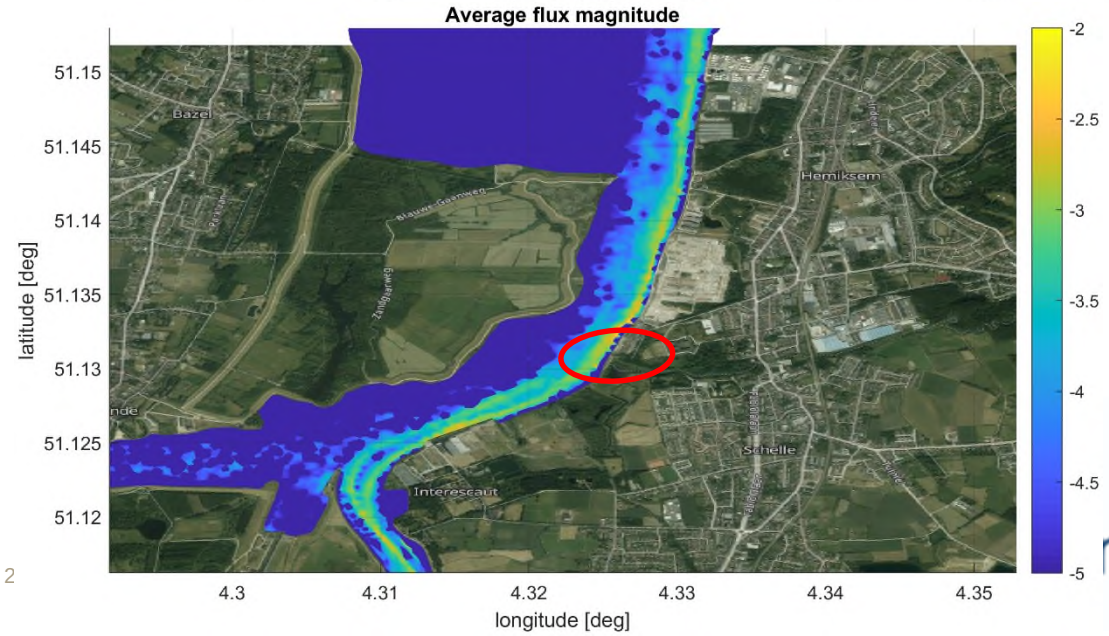
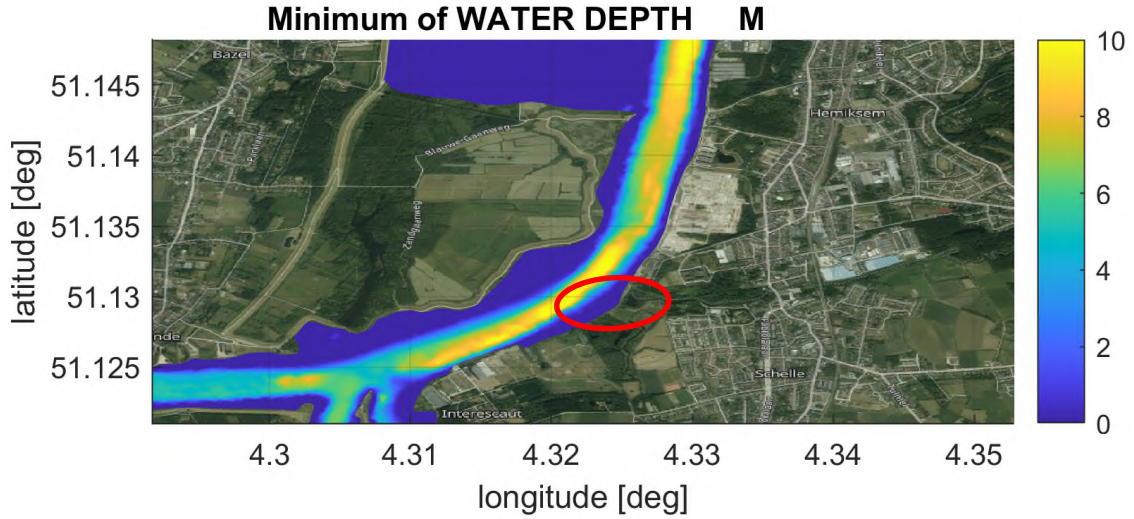
Location2 : Schelle (Lower Sea Scheldt)









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WP4: Optimisation of bubble screen

Work done in this work package

- Set-up and validation of mathematical (CFD) model
  - based on 2 small scale laboratory experiments
- Scale-up of the bubble screen model and introduction of plastic particles
- Execution of test matrix → define optimum air flow rate and angle of the bubble curtain at different conditions.

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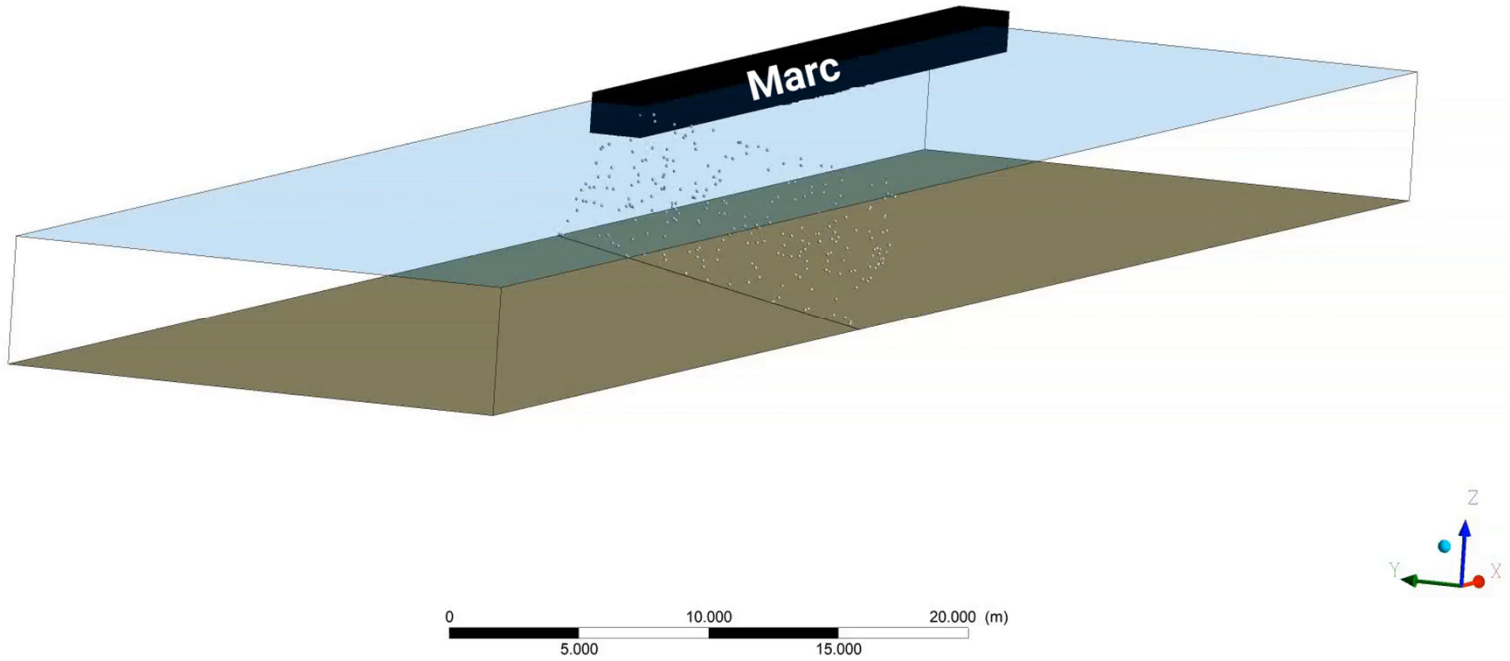
WP4/WP11: Optimisation of bubble screen: Next steps/Dissemination

- CFD model for interactions of water flow, air bubbles and plastic items



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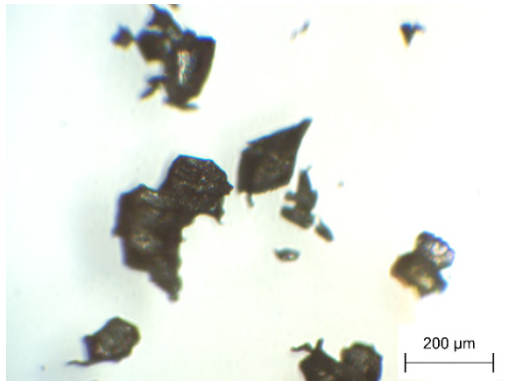
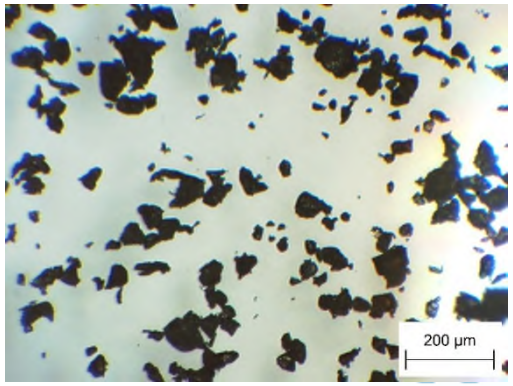
WP5 – Monitoring of plastic concentration

- Analysis using microscopy and Raman spectroscopy together with **Soliton** for validation of results
- Contribution to Deliverable 5.1

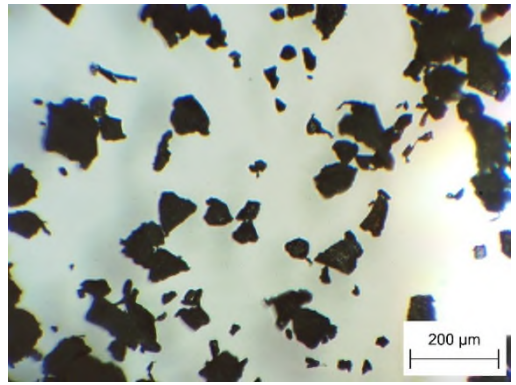
LDPE



PET



LDPE + PET



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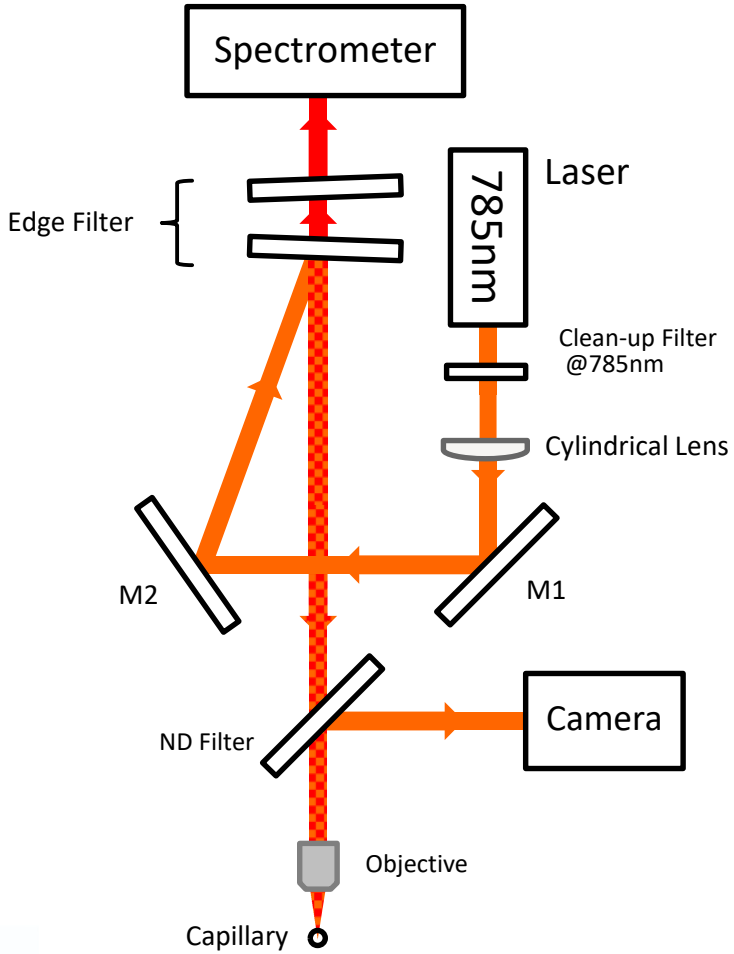
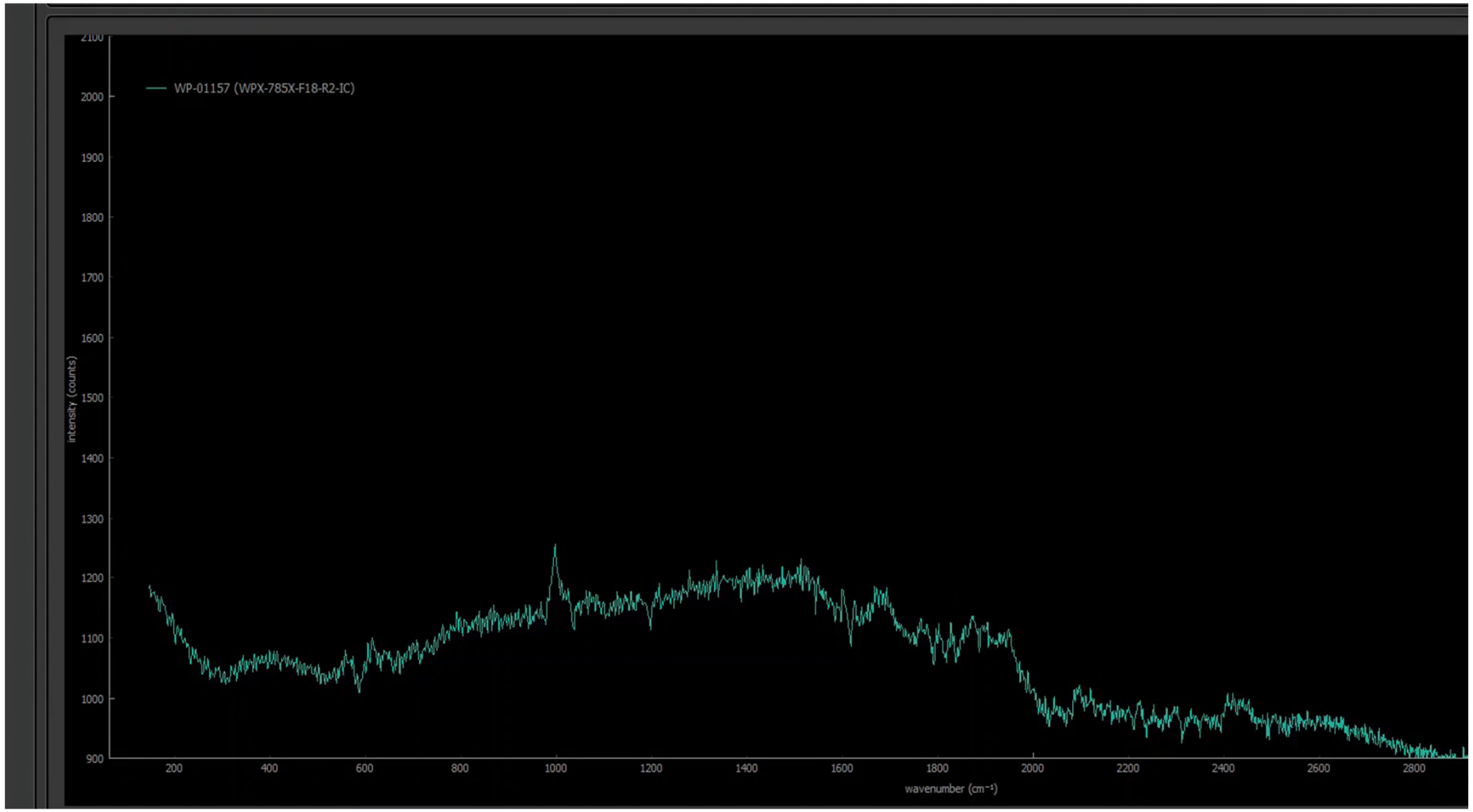
WP5: Monitoring of plastic concentration - Optical setup with flow cell

- Laser source
- Optical setup
- Flow capillary
- Detection



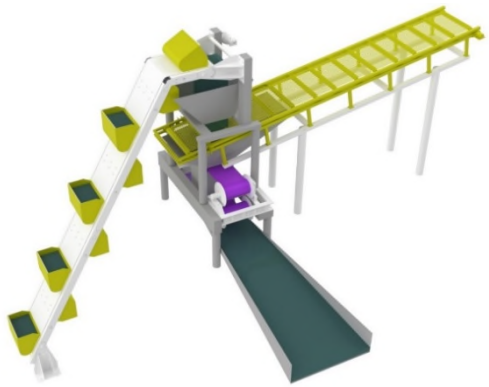
WP5: Monitoring of plastic concentration - Raman spectra of POLYSTYROL Particles in water flow

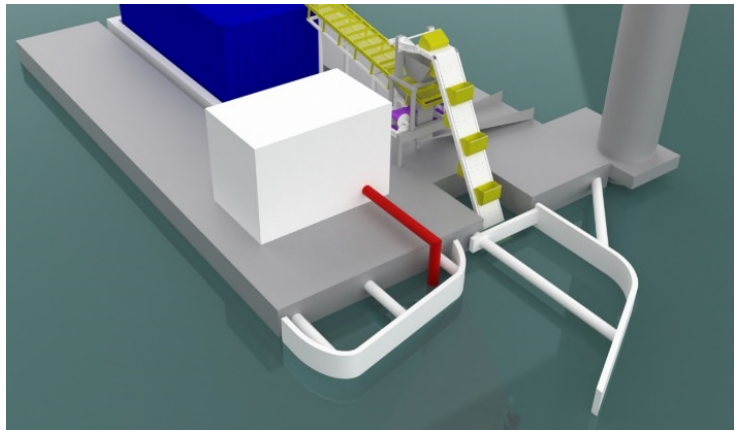
- Laser excitation at 785 nm
- Laser power 500 mW
- 50x Objective
- Measurement time 41 ms
- Flow Rate 1ml/min
- 100µm Particles
- Point focus



WP7: Design

- First concept of the MARC by integrating all the essential components and assuring its operation
- The inline monitoring system integrated in the waste collecting system.
- The collector combined with conveyor belt systems to evacuate the waste.
- The complete system installed on a floating platform.
- The structure with spud piles designed in order to carry all the mechanical systems, the power generation and distribution systems and to allow for easy access for maintenance activities.



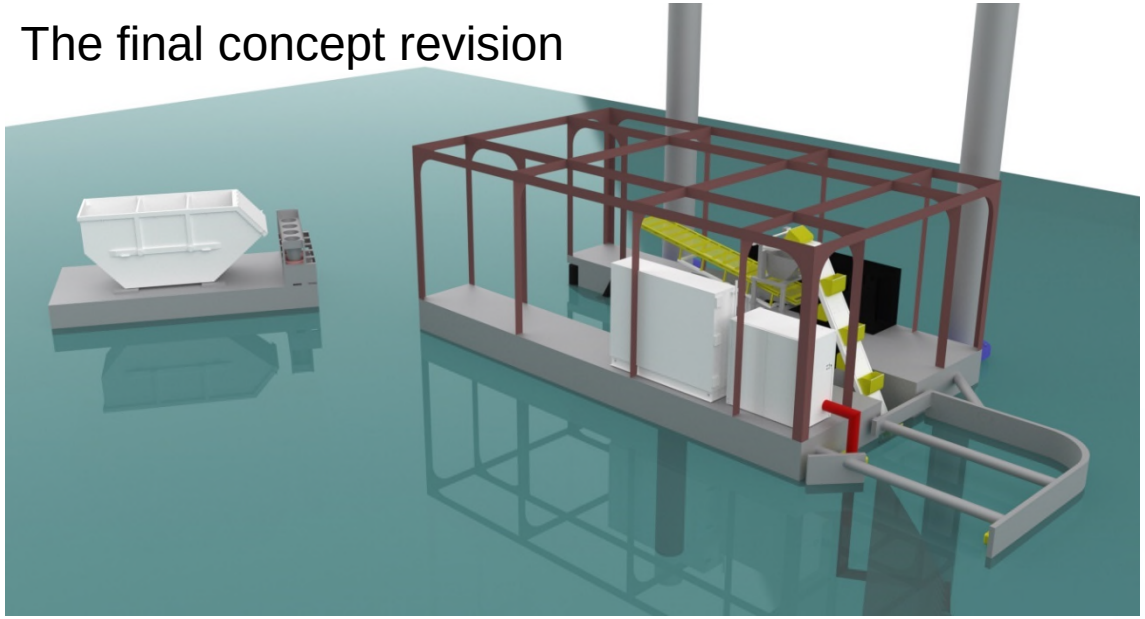


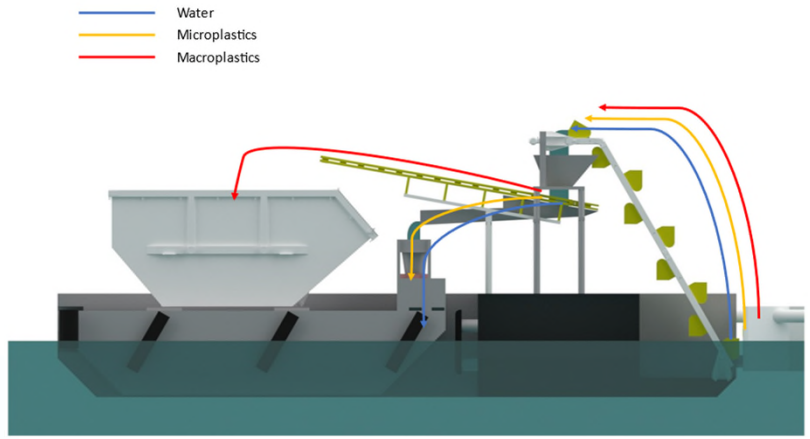
Total Cost of Ownership for future commercialization: M€ 5

WP8: Workability in rivers and ports

- Accessibility, operability and maintainability of the MARC installation
- Assessment of any limitations of the system with respect to wave heigh, current velocity and tidal ranges by using and evaluating the developed models.
- A marine contractor provided complemented practical and operational expertise and review the research outcome as a subcontractor.

The final concept revision





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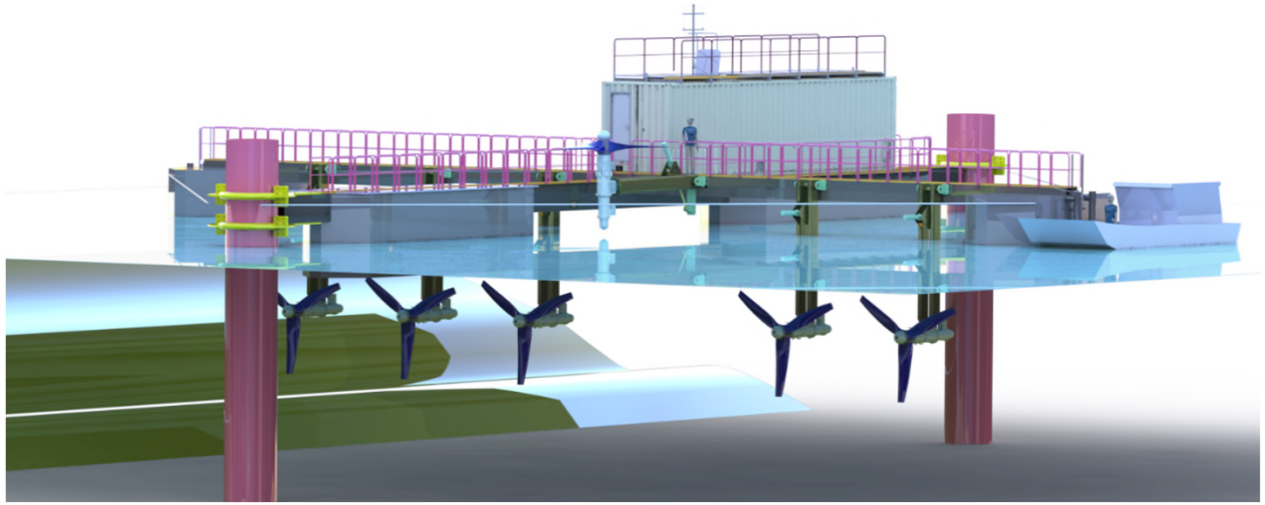
WP9: Case study

- Test location in the river Scheldt: learn from experience in virtual application
- Optimal location based on the simulations from IMDC.
- Plastic load → size, capacity, and mesh-size of the collection system → filling rate of the container
- A concept for a hydrokinetic energy system was developed given the local site conditions



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WP 11: Dissemination

- creation of a dedicated website: https://demarc-plastic-cleaner.com/
- posts on social media
- scientific publications and presentations on conferences:
  - Alexander Breugem; Kai Chu; Theofano Koutrouveli; Li Wang; Boudewijn Decrop, (2022) *Numerical Modelling of Plastic Dispersion: A Case Study of the River Scheldt*, Proceedings of the 39th IAHR World Congress (Granada, 2022), https://www.iahr.org/library/infor?pid=21438
  - W.A. Breugem B. Teunkens, K. Chu, T.I. Koutrouveli, S. Van Damme and B. Decrop, (2023). *Macro Plastic Modelling in the Scheldt Estuary*, accepted for publication in Proceedings of the 40th IAHR World Congress (Vienna, 2023)
  - Kyrousi, F., Koutrouveli, T and Decrop , B. (2024). 3D SIMULATIONS OF BUBBLE CURTAIN'S INTERACTION WITH FLOATING PLASTICS AND LITTER IN PORTS AND WATERWAYS. PIANC World conference (submitted)

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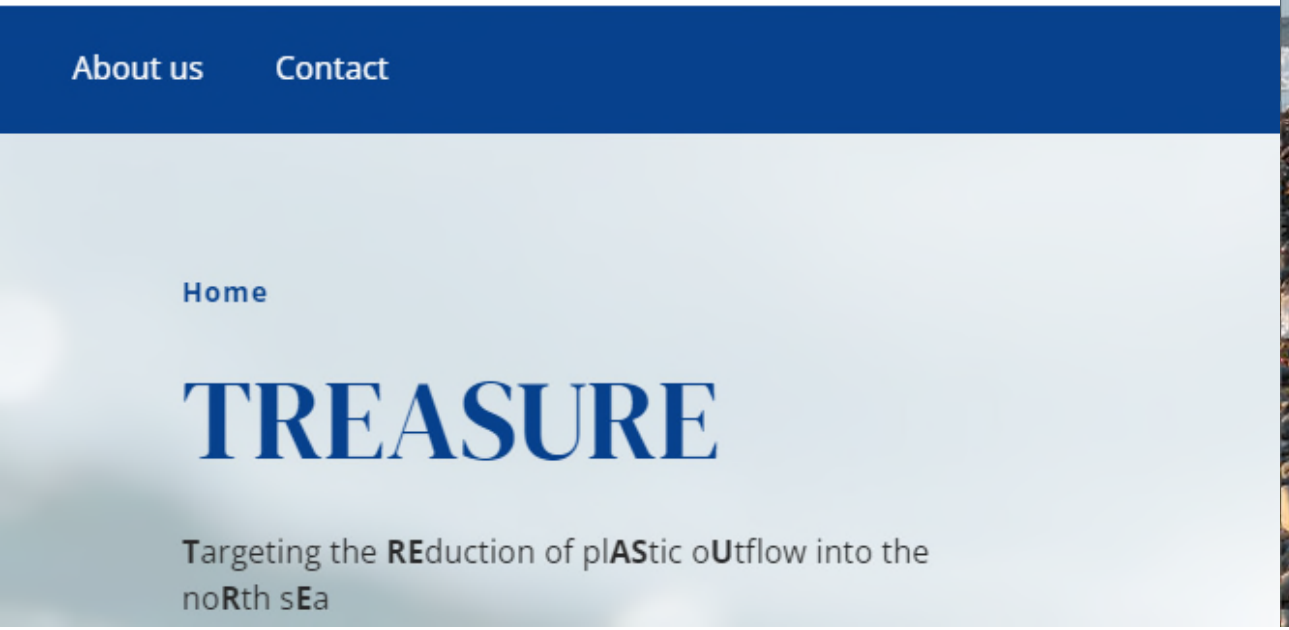
Next steps

TREASURE | Interreg North Sea | Co-funded by the European Union



→ Prototype tests in Living Lab Nieuwpoort, Belgium

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