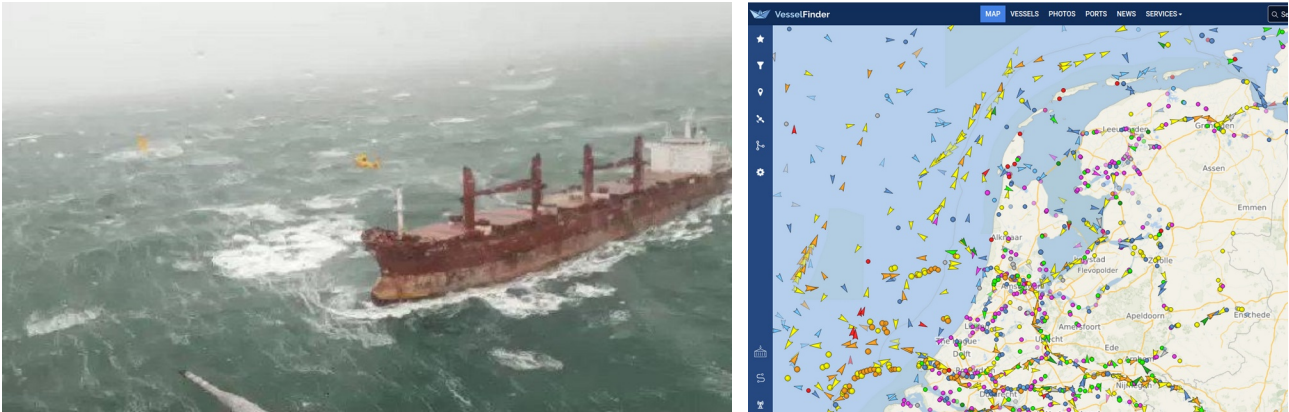# Interactive, Visual Track-and-Trace of Particles on Dutch Coastlines

The Dutch coastl is part of the high-traffic *English Channel* economic area, with an excessive amount of container ships throughput each day (see https://www.vesselfinder.com/). At the same time, the coastline (and specifically the *Waddenzee*) is a unique ecological, biodiverse marine area, serving as nesting place for a massive bird population. Both economic- and ecological interest are often at odds and get into conflict when container ships wreck at sea near the coast (see '*Het Geheugen'*). The cargo drop of plastics, containers and fuel endangers the local ecosystem, as happened with the *MSC Zoe* in 2019 and the *Fremantle Highway* in July 2023.

In order to raise awareness of the impact such accidents have, and to educate the general public and public authorities, this project aims to develop an interactive visualisation to track-and-trace polluting objects along the Dutch coastline. The visualisation is intended to engage the audience through interaction. Furthermore, visually-animated background elements aim to capture the interest of passing-by observers. A clever focus-and-context design in space- and time allows interacting users the control the visualized elements with respect to their interest and attention-span.

This BSc project is conceptually split in two periods: In the initial phase, the student(s) develop a simple fluid-flow particle simulation (under tutorage). The simulation utilizes 2D hydrodynamic velocity fields from CMEMS or NEMO, together with the wind-induced stokes drift data from WaveWatch-III (similar to [1]). The simulation is embedded in an interactive user interface for a desktop (e.g. C^{++}, Java, Python)- or web (e.g. Node.js, Three.js) environment. Through the GUI, the user can spawn new particles. In the second phase, the student(s) can choose for one of three focus objectives:
- simulation: physics: give the particles mass, volume, and simulate drag
- interactions: halt & probe particles; select & compare particles; space-time focus & context
- visualisation → facilitate multiple visual metaphors (particle trails; particle blobs, trajectories, bundled trajectories)

Goals for this BSc project are as follows:
- Survey interactive- and gamified visualisation approaches for coastal fluid-flow
- Design and develop an (electronic) user survey to measure audience engagement
- Design and develop an engaging visual-interactive interface for fluid particle tracing
- Implement a rudimentary Lagrangian particle simulation with available, open-access data
- Design, plan and develop extensions of the interactive particle tracker for either (a) the simulation, (b) the interaction or (c) the visualisation
- Conduct, review and conclude on a user study according to the developed survey

[1] Kaandorp, M. L. A., Ypma, S. L., Boonstra, M., Dijkstra, H. A., and van Sebille, E. "Using machine learning and beach cleanup data to explain litter quantities along the Dutch North Sea coast", *Ocean Science*, 18, 269–293, https://doi.org/10.5194/os-18-269-2022 , *2022*