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Within the framework of the project SeaArt: *Long-term establishment of Seagrass ecosystems through Artificial biodegradable meadows*, the restoration of seagrass, specifically *Zostera Marina*, is set as an objective through the use of artificial elements. A good understanding of the interactions between hydrodynamics and vegetation is needed in order to achieve this objective. This challenge brings forth several questions, which are suitable for parallel studies. These include*:

- **Physical Experiments:**
  - Investigation of possible experimental set-ups for investigation of vegetation against waves and currents (e.g. Fig. 1) **(PA)**
  - Experiments with waves and currents using actual or artificial Vegetation (Fig.2) **(BA,SA)**, as well as the effect of the former on soil dynamics. Sedimentation is increased due to the presence of vegetation, hence morphodynamics change proportionally. **(SA, MA)**
  - Analysis of forces present on the structure-fluid interaction level (e.g. Turbulence, shear stress) and the phenomena that drives these (e.g. vortices, monami, canopy layers) for physical process parameterization. What are reliable measurement techniques for these parameters? **(BA,SA,MA)**
  - Experiments with PIV systems **(MA)**

Fig. 1 Circular-track flume experiments in Marienwerder

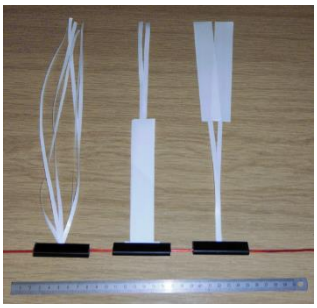

Fig. 2 Example of artificial vegetation using polyethylene at "different biomass distributions"

- **Field measurements:**
  - Field measurements in coastal engineering regarding hydrodynamics and vegetation interactions **(SA)**
  - Literature research on state of the art of hydrodynamic conditions with regard to vegetation extent along coastlines around the world (i.e. Tropical, sub-tropical and temperate areas) **(PA,SA)**
  - Measurement and evaluation of data taken from field campaigns (Fig 3-4) within the framework of the project **(SA)** including validation in numerical models **(MA)**

- **Drone deployment for mapping**
  - Investigation on the use of different photogrammetry software for the mapping of vegetation in tidal and subsurface conditions (Fig. 5-6) **(PA,SA)**
  - Coupling of regional numerical models with aerial mapping utilizing drone recordings **(BA,MA)**

Fig. 3 Seagrass meadow

Fig. 4 Boat field deployment

Fig. 5 Drone deployment

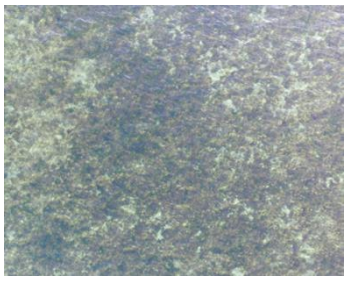

Fig. 6 Drone orthophoto

- **Numerical modeling†:**
  - Investigating deeply the vegetation modules included in models such as Delft3D, SWASH and Xbeach, among others in comparison to physical experiments elaborated on the framework of the project. What are the important parameters to be found and what differences can be set when using artificial vegetation? **(MA)**
  - Use of more powerful computational programs, such as REEF3D and OpenFOAM for the evaluation of fluid-structure Interaction, turbulence development and velocity field development in a small scale. **(MA)**
  - Seagrass meadows, and vegetation in general, play an important role on sediment transport. They inhibit erosion and hence cause sedimentation to take place. Shoreline changes are thus less noticeable over time and morphodynamics change drastically due to the presence of vegetation. Knowing the role of different species and types of vegetation on morphodynamics using numerical models could help explain more quantitatively what the role of vegetation is. **(MA)**

This project shows how vegetation and seagrass are an important part of the coastal ecosystem, an important driver of hydro and morphodynamics, and a key player on coastal protection in terms of soft-measures of coastal protection. This falls within the framework of ecosystem-based disaster risk reduction solutions (Eco-DRR), now an important focus point of environmental organizations and governments. Social questions arise; and they are a subject of discussion and study **(PA)**:

- What is the role of vegetation on development and sustainability of aquatic ecosystems?
- How do governments and organizations tackle the ever declining seagrass population?
- How do we, as engineers, bring vegetation into the ecosystem-engineering framework and how do we bring this in context with policy and governance (see for example the Sendai Framework on Disaster Risk Reduction)?

... but also technical questions arise **(PA,SA)**:

- What is the role of vegetation on global hydrodynamics?
- What about tidal dynamics and coastal protection?

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* These are the general topics that spawn from the development of the SeaArt project (click on the logo to see its webpage and general information). Since this is just a general list of topics, please keep in mind that some of them could have already been given away and developed by other students. Contact me in order to know about further availability. It is also better if you get to me via Email already stating what your specific topic of interest would be.

† In the framework of the project, I do not work with numerical models. However, this is indeed an interesting topic in which seagrass, as other ecosystems, makes for an important source of research questions. The development of such a research topic would have to be accompanied by the supervision of a colleague from the institute who works more regularly with numerical models.