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Vertical biomass distribution drives flow through vegetation: An experiment under unidirectional currents

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Seagrass meadows are one of many soft measures of coastal protection nowadays not in focus of modern soft coastal protection attempts, despite their steady decline during the last decades. Accurate quantitative prediction of the effectiveness of seagrass meadows as a measure of coastal protection has not yet been achieved. Additionally, restoration attempts have proven difficult due to the bolstered hydrodynamic conditions found on non-vegetated areas, which do not allow resettlement of seeds; consequently no growth can take place. The industry has applied artificial vegetation as a measure of scour-protection for pipelines; such applications, however, rely on high-density meadows to achieve maximized sediment capture, thus leaving no place for regrowth of actual vegetation. Nevertheless, this suggests a solution through the deployment of artificial meadows which emulate the effect of vegetation on hydrodynamic conditions, thus supporting sedimentation, seed resettlement and a resultant sprouting of vegetation. This study aims to assess the interaction between currents and artificial seagrass resembling the characteristics of Zostera marina, one of the most common species of seagrass found in the European North Atlantic, as well as the Baltic Sea, in order to evaluate the possibility of optimizing and utilizing artificial meadows as means of restoration of actual seagrass.
The effect of artificial elements emulating vegetation on flow is measured in a circular track flume of maximum 1 m depth and 1 m width. Sedimentation is measured within the flume with the help pf a mobile sand bed. An Acoustic Doppler Velocimeter (ADV) is then utilized to measure velocity profiles in front, within and behind the meadows in different submergence depths to capture the characteristic flow profiles induced by vegetation. The tests include velocities ranging from 0.1 – 0.9 m/s, which are tested individually, allowing to provide an insight into the changes in the velocity profile affected throughout the meadow. Additionally, pressure sensors on the base of individual shoots are used to obtain the drag force induced by the current. Ultrasonic sensors are also deployed in order to measure any height fluctuations within the flume as an effect of vegetation. An efficient artificial plant setup for energy dissipation is assessed by using a constant biomass, but varying vertical distributions.
The experiment shows the sheltering and filtering capacities of the artificial seagrass at a density similar to that found in nature. It allows assessment of the protection of settling seeds and sprouts, but also the availability of space for them to grow – thus fulfilling the restoration objectives. Drag measurements prove that the chosen material can hold the tested hydrodynamic conditions, which in turn proves the feasibility of the chosen base layer and anchoring systems. Artificial seagrass meadows prove to be a means of sedimentation good enough for restoration purposes. Results will be further used to inform a study on wave effects comparable to real conditions on northern European coasts.