Cultivating mussels in the Belgian North Sea

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A research project to examine the feasibility of growing mussels off the coast was initiated within the project named Edulis. Two experimental test setups were proposed to be installed in the Belgian North Sea within the wind power park areas of C-Power and Belwind. The partners of Edulis project are: ILVO, UGent, OD Nature, C-Power, Belwind, DEME, Sioen Industries, Colruyt Group, Brevisco and Lobster Fish. In this collaboration, Maritime Technology Division of Ghent University takes part in the numerical modelling of the mussel line system.

Two lines were installed in 2017: the bio-line (focussing on mussel growth) in the C-Power park and force line at the Belwind site. Mussel seeds attached in the bio-line and have grown into mussels. As for the force line, it was put into the water in November 2017 with grown mussels, and is equipped with measuring devices installed for the purpose of almost real time data gathering. These data will be used to calibrate parameters in the numerical predictions.

The longline system is considered for the study in which the floating system consists of a long backbone line, collector lines and several buoys. Mussels will grow on the V-shaped collectors. Due to the specific restrictions in the wind power offshore park, movement of mussel line system is restricted to some limited extent in order not to interfere with the activities of the power companies within the wind power park. Hence, a mathematical model is needed to predict the behaviour of a mussel line based on its configuration and the environmental conditions. External parameters to be taken into account are waves, current, tide and growth of mussels (size and weight variations).
An open source software written by Matthew Hall, namely MoorDyn, was used as a starting point to develop a code that is able to perform numerical predictions of mussel lines dynamics. The Fortran implementation of MoorDyn is meant to be coupled with an external code (FAST v8) to drive the motion [1]. MoorDyn is a complementary code specifically to calculate mooring dynamics of a floating system.
In order to deal with modelling of mussel line system, many modifications have been implemented to the Fortran version of MoorDyn, which now can be used as a standalone software. These modifications include: implementation of current, regular and irregular waves as environmental loads, modelling of three degree of freedom buoys, capability to model an anchor as a clump weight and sea bed friction. The code itself is based on lumped mass model in which each line is divided into a discrete number of segments, whose physical properties are concentrated in points called *nodes*. Each node is subject to half of the forces and weight transferred from the two segments on each side. At each time step, acceleration of each node is computed by summing up all the calculated forces. The nodes velocity and position are computed by employing second order Runge-Kutta integration scheme [2]. At the end of a time step, each node has a new position, representing the new position of each of the contiguous segments. This translates into a new position of the whole mussel line system. The current version of the code is capable of predicting mussel line system dynamics due to environmental loads with the inclusion of a 3D visualization tool. Furthermore, modelling of several mussel line systems will be performed to find the most effective configuration to make use of the area provided.

References

[1] Hall, M., 2015. MoorDyn User's Guide. Department of Mechanical Engineering, University of Maine.
[2] Hall, M., Goupee, A., 2015. Validation of a lumped-mass mooring line model with DeepCwind semisub-mersible model test data. In: Ocean Engineering Volume 101, Pages 590-603.

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