Model-Based Assessment of Carbon Sequestration by Macroalgae Farming near Offshore Wind Farms in the Belgian Coastal Zone: Preliminary Results.

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In the past decade, macroalgae farming has gained popularity due to its wide range of applications—including food production, packaging, cosmetics, and biofuels. Beyond its economic value, macroalgae cultivation supports local biodiversity by attracting marine fauna and contributes to blue carbon sequestration through organic carbon storage in its biomass.

In 2024, Amazon announced the construction of one of the first commercial macroalgae farms in the North Sea, covering an area of 0.05 km² with an anticipated harvest of over 6 tons in its first year. This farm is co-located with the Hollandse Kust Zuid offshore wind farm (OWF), where submerged foundations are colonized by blue mussels—filter feeders that consume phytoplankton and produce carbon-rich fecal pellets, further contributing to carbon sequestration.

The strategic integration of a macroalgae farm near an OWF leverages an expected surplus of nutrients in the water column—resulting from reduced phytoplankton concentrations due to mussel predation. In this study, we employ a coupled hydrodynamic–sediment–wave–biogeochemical–diagenetic model, enhanced with blue mussel and macroalgae modules and calibrated using stationary data, to assess the potential of such a farm in Belgian coastal waters.

Preliminary results highlight the synergistic effects of OWFs and macroalgae cultivation on carbon sequestration and regional primary production. We demonstrate how farm positioning relative to OWFs, combined with local hydromorphological conditions, significantly influences biomass yield and ecological performance.