Coastbusters, innovative nature-based solutions for sustainable coastal management

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The use of Nature-based Solutions (NbS) [1] are currently seen as a more sustainable and cost-effective alternative to conventional coastal engineering protection. Additional ecosystems such as dunes, mangroves, seagrass meadows, tidal marshes, coral reefs and shellfish reefs generates a natural resilience to the impact of storms and are able to keep up with sea-level rise through long-term sediment trapping and organic matter accretion [2]. There is thus a growing trend to include regional NbS in estuarine and coastal project development as a way to protect certain areas against natural forces [3]. The implementation of the NbS-concept in the marine environment necessitates in-depth knowledge of the driving parameters and local natural processes. This expertise is needed to integrate the stochastic nature of ecosystem development with the traditional technical engineering of coastal management tools (i.e. design, installation, operational management and maintenance). The result is a ground-breaking new coastal management approach: a Nature-based engineering project which identifies coastal habitats and determines their viability, function and possible contribution to coastal protection [4].

The public-private Coastbusters consortium aims to study and translate desired coastal protection functionality into designs that make use of the capability of ecosystem engineering species. In other words, does ecosystem creation and Nature-based Solutions' technical design provide a more sustainable and cost-effective management approach to conventional coastal engineering? To answer this question, two Coastbusters research projects are executed [5], funded by the Flemish agency for Innovation and entrepreneurship (VLAIO) and co-funded by the industry (Dredging International part of the DEME-group, Jan de Nul group and Sioen industries).

In the first – proof-of-concept – Coastbusters project (2017-2020) three ecosystem engineering species were tested: (1) subtidal seaweeds (*Saccharina latissima*), (2) intertidal tube building sand mason worms (*Lanice conchilega*), and (3) subtidal blue mussels bivalves (*Mytilus edulis*). An initial assessment of the biogenic reef potential of each of the selected species revealed some basic insights on (tidal) boundary conditions, and into the efficiency of their facilitating structures.

The three Coastbusters Nature-based Solutions have been installed successfully in North Sea coastal waters using modified aquaculture techniques. (1) The flora reef deployment shows that not all coastal locations are suitable for every type of ecosystem engineer. Therefore, the consortium will deploy similar setups in a more suitable location. (2) There's a potential for Lanice aggregations at the low tide intertidal fringe, as was demonstrated both in the lab and during small scale field experiments. The next step is a scaled-up field pilot, including new types of materials to ensure a sustainable no- impact NbS. (3) The bivalve reef proved the most promising and became the Coastbusters NbS flagship. The sequel Coastbusters 2.0 project (2020-2023), concentrates on further in-depth investigation and optimization of the setup for one of ecosystem engineering species: the bivalve reef. The project focusses on developing new tunable marine biodegradable & sustainable (bio)materials and optimizing the reef setup design to facilitate the reef development in a more efficient, sustainable and resilient way. Two identical setups have been installed: a sheltered area and one more exposed. These are followed-up with advanced environmental monitoring techniques, researching the effects and boundary conditions of the reef, while developing the optimal sampling techniques and strategy.

Based on diving footage, Van Veen grabs and SPI camera photos, sea floor characterization was performed (figure 1). The video analyses revealed that mussel beds did not develop during the first summer, although some remaining small patches were detected at the sheltered reef site. Moreover, it was clearly observed that the sheltered reef site was dominated by large *L. conchilega* aggregations, along with other organisms such as mud anemones (*Sagartia* spp.), brittle stars (*Ophiura* spp.) and razor clam pits (*E. leyi*). This serves as a baseline for comparisons in the future years of the Coastbusters project.

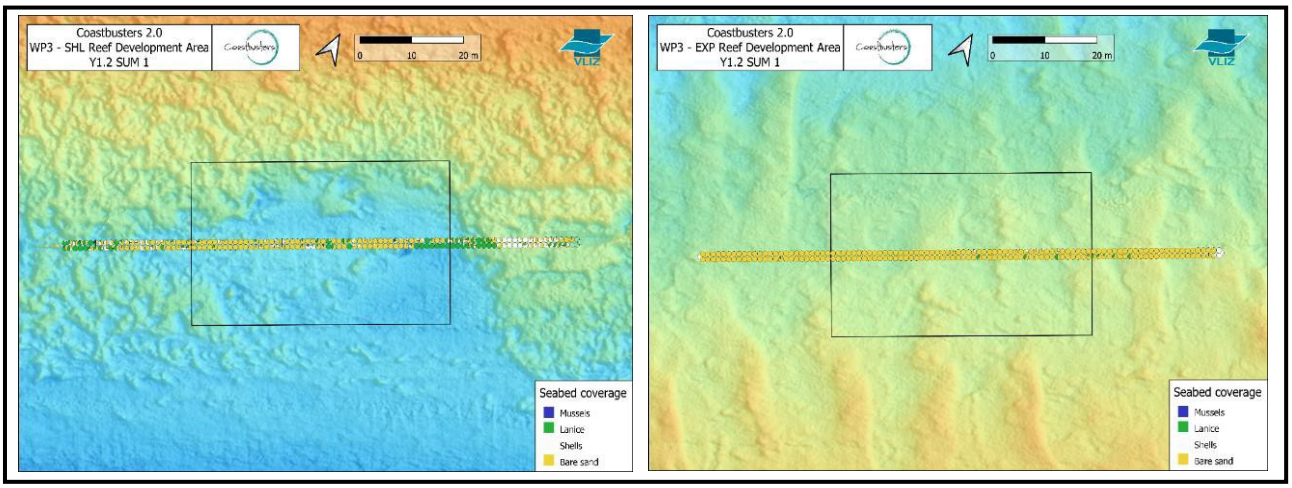

Figure 1: Sea floor characterisation of the Coastbusters site (sheltered (left) and exposed (right) reef development area) in Summer 2020, by video snapshots analysis with QGIS software, based on diving transects.

Furthermore, dynamic resilience and storm survivability are just a few topics to be managed and engineered in the forthcoming years during a further upscaling of the test setup. As a basis for this, innovative monitoring techniques are being developed and deployed (loggers, mooring system with ADCP and sonar, robotics, …) to get more insight in the highly dynamic behaviour of the installed setups, to reveal the complex natural processes of growing mussels and biogenic reef development and to evaluate the survivability of the mussel reefs under changing conditions.

The pioneering work of Coastbusters clearly demonstrated that each chosen ecosystem engineer and the boundary conditions at deployment location are crucial to the success of NbS projects. Hence, Coastbusters advocates for an Ecosystem-Based Coastal Management solution, with a longer lifetime, higher resilience to changing environmental conditions and reduced maintenance cost compared to conventional coastal protection systems - heading for a more sustainable coastal management.

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