

Seaward nature-based solutions in sandy coastlines: Applying the DAPSI(W)R(M) Framework to the Coastbusters concept

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Coastal resilience is critical for soft-sediment ecosystems vulnerable to climate change and human-induced pressures (O'Leary *et al.*, 2023). Current engineering approaches fall short, prompting a shift toward Nature-based Solutions (NbS), which mimic natural ecosystem features and processes (Faivre *et al.*, 2017; Seddon *et al.*, 2020). NbS, defined by the United Nations Environment Program, offers a holistic approach by simultaneously addressing social, economic, and environmental challenges (UNEP, 2022). The European Commission aligns NbS with EU policies, emphasizing the need for legislative frameworks and international standards for effective implementation. EU Legislative frameworks, such as the EU Biodiversity Strategy, the Habitat and Birds Directives, and the Marine Strategy Framework Directive, as well as the Marine Spatial Planning Directive, play crucial roles in guiding NbS implementation. The DAPSI(W)R(M) framework (Drivers- Activities-Pressures-State change-Impacts (on human Welfare)-Responses (using Measures)) (Patrício *et al.*, 2016) can be employed to assess NbS in the context of the EU legislative landscapes, as explored by this study (Semeraro *et al.*, submitted). The framework connects human pressures (referring to the drivers e.g. coastal defence and the activities e.g. aquaculture coastal infrastructure, which enhances pressures on the environment), state changes in marine ecosystems (through criteria and indicators), impacts on human welfare (through ecosystem service indicators), and responses or measures to prevent or mitigate impacts for deploying a NbS. The application of this framework is illustrated for NbS on sandy coastlines, with the Coastbusters project as a pioneering example (Goedefroo *et al.*, 2022; Coastbusters (2020); Coastbusters 2.0 (2023)). The Coastbusters concept exemplifies NbS application in the Belgian Part of the North Sea (BPNS), focusing on mussel beds and tube-worm aggregations. This public-private partnership induced mussel biogenic bed formation through innovative reef-facilitating systems. The DAPSI(W)R(M) framework allows us to illustrate the multifaceted challenges related to the integration of seaward NbS in sandy coastlines, as the Coastbusters concepts. The novelty here is that it also emphasizes the importance of integrating social concerns into environmental assessments, highlighting the scarcity of recent information on public perceptions of NbS.

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Keywords

DAPSI(W)R(M); Nature-based Solutions; Biogenic Reef; Subtidal; Coastal Resilience