

DUNEFront PROJECT: DEMONSTRATION OF DUNE-DIKE HYBRID NATURE-BASED SOLUTIONS

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OBJECTIVES OF THE DUNEFront PROJECT

The European coasts are among the most densely populated of the world, with natural sand dune barriers urbanised and replaced by traditional hard coastal protection structures. Without the needed measures to adapt, the number of people exposed to floods is anticipated to increase 187 million worldwide by the end of the 21st century. In Europe, the coasts of The North Sea, the Baltic Sea, and the Atlantic are anticipated to experience substantial flood risks from sea-level rise, and climate extremes are also expected to impact southern Europe Mediterranean coasts (Voudoukas et al., 2017). Future coastal management surpasses the current fixed and non-adaptive flood coastal protection setup: Hybrid Nature-based-Solutions (abbreviated as NbS) that can efficiently integrate static hard infrastructure with dynamic aeolian, and vegetated sediments are currently developed along urbanized areas of most of the European sandy coasts, yet still at small scales (Fig. 1).



Figure 1 - Marram grass Dune-Dike at Westende, Belgian Coast (photo courtesy: Herman Troch).

The integration of dikes and dunes for coastal protection is a key example of such infrastructure and is typically referred to as dune-dike hybrid Nature-based Solutions (DD-hybrid NbS). Such infrastructure can provide advantages for coastal safety and protection that cannot be reached by hard (dikes, seawalls) or soft (beach nourishments, existing dunes) infrastructure alone. Key to their adaptability to sea-level rise is the integration of hard safety lines (dikes) and resilient biodiverse dune systems that only function when both physical and biological boundary conditions are met. This type of infrastructure will deliver an integrated, multidisciplinary coastal management system (Fig. 2). The applications of DD-hybrid NbS even reach out towards marine environments as the future design and installation of emerging concepts of energy/barrier islands largely relies on so far not developed roadmaps from replicated coastal solutions.

In line with the European Green Deal and New European Bauhaus initiative, the overall objective of the new DuneFront Horizon Europe project is to optimize dune-dike hybrid NbS as a new generation of sustainable, inclusive and aesthetic blue-grey coastal management infrastructure, that further mainstreams biodiversity into one of the most important socio-economic challenges along European coasts.

APPROACH

Dune-dike coastal protection is one of the few examples where hybrid soft-hard coastal protection applications have been implemented at targeted locations along European coasts, but the integration between the hard, soft and ecological engineering components as well as the connected socio-economic impacts, are still to be understood and implemented towards a market-ready Decision Support System (DSS). Hard and soft marine and

coastal protection infrastructures have been studied in isolation. We have profound insights into the design and safety assessment of hard coastal protections (EurOtop, 2018). We understand the basic principles of sediment transport, vegetation, dune development, and the dune's role in coastal protection, and have good insights in the globally expected shoreline trends, and their potential drivers under different climate change scenarios (Vousdoukas et al., 2020). We equally start to qualitatively understand the socio-economic advantages with respect to eco-system services and multi-use (Van der Biest et al., 2020).

Nevertheless, the key-target of DuneFront is to identify the biological, physical and socio-economic boundary conditions and their interactions to tailor specific marine and coastal DD-hybrid NbS to jointly safeguard the protection of human assets, blue economy activities, biodiversity gain and restoration. DuneFront will translate evidence on biodiversity, morphodynamics and safety from 12 Demonstrators along the vulnerable coasts from Europe into new roadmaps for DD-hybrid NbS design and installation, within an enriched coastal biodiversity, surpassing traditional single coastal flood protection.

DuneFront is designed as a multidisciplinary project uniting ten academic, three non-academic research institutes, two partners from industry and one governmental agency, with an innovation programme aligned along the scientific disciplines of biology, sediment dynamics, socio-economics and coastal processes/safety engineering.

Importantly, international collaboration and co-creation between key stakeholders is the basis of DuneFront, i.e. co-creation between private companies, public institutions (state and local governments, and municipalities), international organisations, local communities and citizens, universities and researchers.

PROJECT RESULTS

The DuneFront approach will move R&I from discipline-specific validated concepts and theory towards an integrated multidisciplinary development of a Decision-Support-System (DSS). The DuneFront DSS will be based on the Predictive Digital Twin, applied in the development of market-ready coastal and marine infrastructure Blueprints, and demonstrated through new operational dune-dike prototypes within a so far untested relevant context of high recreational pressure.

DuneFront will provide a wide range of stakeholders with design, installation and market-ripe business plans for DD-hybrid NbS. Translation of new research and innovations into the DuneFront targeted actions will occur within a full co-creation-procedure.



Figure 2 - Example of Dune-Dike hybrid Nature-based-Solutions at Westende, Belgian Coast.

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