COASTAL ZONE MANAGEMENT

DUNE RESTORATION AND COASTAL VEGETATION

CZM2

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ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Reduna Project view of the fences installed for the dunes formation.
Image Credit: [Municipality of Almada], [2015]. Used with permission.

What is it?

Dunes and coastal vegetation protect coastlines by absorbing wave energy, reducing storm surge impacts, and preventing erosion (Fernández-Montblanc et al., 2020). Vegetation stabilises dunes by trapping sand with roots, maintaining their structure. Together, they act as natural buffers, safeguarding coastal infrastructure, habitats, and communities from extreme weather events and sea-level rise.
(Sedrati et al., 2025)

Challenges this NbS addresses

- **Floods -** reduction
- **Erosion -** prevention
- **Storms -** reduction

Ecosystem services

- **Biodiversity support:** dune and coastal vegetation provides habitat for various species, fostering ecological resilience and supporting ecosystem services.
- **Carbon sequestration:** coastal vegetation, including shrubs and grasses, captures a fair amount of CO_2 and stores carbon in biomass
- **Water Filtration:** dune ecosystems help filter and purify water by trapping pollutants and sediments in groundwater recharge areas.
- **Recreation and Tourism:** dunes, especially those with vegetation, offer recreational opportunities such as hiking, birdwatching, and eco-tourism (Sedrati et al., 2025)

Site suitability, scale and coverage

Implemented in low-lying sand beaches, especially relevant for the case of landscapes with previous sand dune ecosystems, exposed to common coastal climate-hazards, exacerbated by Climate Change.
(Fernández-Montblanc et al., 2020; Sedrati et al., 2025)

Primary functions and key services

- **Flood risk reduction:** sand dunes and vegetation act as natural buffers, dissipating wave energy and reducing the impact of storm surges and coastal flooding. This helps to protect critical seafront infrastructure, including **roads, promenades, housing, drainage systems, among others**.
- **Erosion control:** stabilisation of sand dunes through vegetation prevents soil and sand loss, protecting shorelines from degradation. The erosion control service attenuates damages to natural sea front landscape, **housing** and other construction elements located in proximity.
- **Wind protection:** dunes reduce the impact of strong winds on inland areas by acting as physical barriers, particularly relevant to protect **electrical lines** and other aerial infrastructure.

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Cost-benefit profile

Dune restoration and coastal vegetation projects are cost-intensive but highly effective solutions for coastal erosion control, storm protection, and biodiversity conservation. **Establishment costs** include sand nourishment, native vegetation planting, and dune stabilisation structures, while **annual maintenance** expenses for activities like sand replenishment, invasive species control, and infrastructure reinforcement can sometimes exceed initial investment costs (Coastal Management, 2022). **Opportunity costs** arise in tourism-dependent or high-value coastal areas, where alternative land uses may offer higher economic returns (Research Utwente, 2021). Additionally, **long-term conservation costs** can emerge when maintaining protected dune habitats and ensuring ecological connectivity (NOAA, 2022). Despite these costs, dune restoration enhances coastal resilience, mitigates storm damage, and supports local economies through tourism and ecosystem services, making it a strategic long-term investment in sustainable coastal management. A comprehensive cost-benefit analysis is crucial to balance implementation costs with long-term environmental and economic benefits.

Environmental impacts
(EU taxonomy)

- ☑ **Climate change mitigation**
- ☐ **Climate change adaptation**
- ☑ **Sustainable use and protection of water and marine resources**
- ☐ **Transition to a circular economy**
- ☐ **Pollution prevention and control**
- ☑ **Protection and restoration of biodiversity and ecosystems.**

Main components

- **Sand:** is the main component of dunes, usually deposited by wind or waves.
- **Vegetation:** helps stabilising dunes and preventing erosion by trapping the sand with roots.
- **Foredune:** closest to the shore, acting as the first defence against waves.
- **Backdune:** located inland, offering additional protection and biodiversity.

Reduna Project
Image Credit: [Municipality of Almada], [2015]. Used with permission;

Example of installation

- **ReDuna - Restoration of S. João da Caparica Sand Dunes | Oppla.**
- **Implemented by:** collaboration of the local community, NGOs and schools, supported by the Municipality's Environmental Education and Awareness Division. Financed by the EU Structural and Investment Funds & the EU Cohesion Fund.
- **Description and results:** manifested contribution to the recovery of the dune ecosystem, protection against storm surges that produced pushing or lifting water inland. Some extreme events pushed the surge kilometres inland. The protection offered by this restoration action provides valuable information for replication in other vulnerable low-lying coastal beaches.

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