

Nature-based Solutions (NBS) for Coastal Protection: why do we need nature to protect us from nature?



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INTRODUCTION

Coastal areas are complex and dynamic environments that exhibit high productivity, biodiversity, and ecological value [1]. Consequently, they are extremely attractive:

- 600 million people worldwide reside in low-lying coastal areas [2];
- In the European Union (EU), approximately 40% of the Gross Domestic Product is generated in coastal areas [1], [3].

This acute attractiveness, in a context of climate change, can enhance the exposure of coastal areas to extreme flooding, erosion, sea level rise episodes, and respective consequences [1], [3-4].

To address the growing coastal challenges, there are three main categories of response: **relocation** of coastal communities; **accommodation** to cope with flooding; and **protection** of assets and people [5]. Although effective in reducing the exposure to coastal hazards, relocation of populations further inland is not a popular alternative, due to place attachment and high costs [5-6]. Alongside accommodation, it assumes a great loss of coastal functions and benefits [6]. Protection strategies therefore rise as effective alternatives, the most common being conventional grey infrastructures, although in recent years innovative and greener alternatives have been gaining popularity – NBS being one major example [7].

COASTAL PROTECTION EVOLUTION

Extreme coastal events have always occurred, with the concept of coastal protection going as far back as the 13th century [8-9]. Historical data, however, only dates to the second half of the 19th century, when the first protection strategies started being implemented – stockade barriers, wooden walls with rock foundations, and experimental groins [8-10].

19th – 20th Century

- Physical demarcation of land-sea boundary + coastal squeeze
- Expansion of human territory
- Artificialization of shoreline and decrease in ecosystem services
- Hard protection strategies (groynes, seawalls, breakwaters [11-12])

Late 20th Century & 21st Century –

- Environmentalism movements
- Publication of Coastal Zone Management Act (1972)
- Integrated Coastal Zone Management Concept (1992)
- Proliferation of “building with nature” concepts [13-14].

The paradigm of coastal protection has started shifting to a more sustainable ground [9]:

Hard Forms
Grey Infrastructure
Engineered Strategies



Growing Sustainability Axis

Soft Forms
Green Infrastructure
Nature-based Strategies

WHAT EXACTLY ARE NBS FOR COASTAL PROTECTION?

Nature-based solutions are ecosystem-based approaches, which are designed to **adapt and mitigate climate change impacts and natural disasters**, by protecting, managing, and restoring ecosystems. NBS build resilience and improve human health, meaning they provide additional co-benefits to coastal protection – in the form of ecosystem services [15-17]. There are three types of NBS, according to a growing degree of intervention on the coastal ecosystem [15], [18]:

- TYPE 1:** Minimal interventions performed on the ecosystems (direct use or conservation of the coastal system)
- TYPE 2:** Restoration and/or rehabilitation of degraded coastal ecosystems, to improve delivery of ecosystem services
- TYPE 3:** Intensive management or even design of new ecosystems (ecosystem imitation approach of habitats who have previously existed in the area, but have since disappeared)



Dunes, coral reefs, marshes, and mangrove forests are common examples of NBS for coastal protection. These increase the adaptive capacity, resilience, and coastal protection efficiency of coastal ecosystems. Biogenic reefs and mangrove forests also create a physical barrier between sea and shoreline – therefore protecting the coast and dissipating wave energy.

CO-BENEFITS PROVIDED [16]

- Habitat
- Nursery for threatened species
- Carbon sequestration
- Water quality regulation
- Food production
- Blue-green spaces
- Nature-based tourism

CONCLUSIONS

Nature-based solutions are sustainable and adaptive: they adapt to changing environments, unlike conventional protection strategies, and can be used in combination with other strategies (either NBS or hard approaches). Despite this, they are still an emergent topic [15], [18]:

Require deep knowledge of ecosystems	Few guides for implementation and monitoring	Lack of cost-benefit and long-term efficiency analysis	Site-specific and not one-size-fits-all solution	Lack of political and population support

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