

Enhancing Mediterranean coastal resilience with *Posidonia oceanica* and Nature-based Solutions



A coastline under threat

The Mediterranean basin is a biodiversity hotspot particularly vulnerable to the effects of global climate change. The region is warming 20% faster than the global average, and temperatures are expected to increase 2 to 3°C by 2050, and 3 to 5°C by the end of the century¹. Due to the near absence of tides throughout much of the Mediterranean, low-lying cities and coastal infrastructures are particularly vulnerable to the effects of increased storm surges and sea level rise, which in some areas of the Mediterranean, is expected to exceed one metre by 2100². Coastal areas face heightened disaster risks, including erosion and severe flooding, potentially threatening the livelihoods of

many Mediterranean coastal communities. Furthermore, population densities in Mediterranean coastal areas have continued to rise over the last decades, with approximately one-third of all Mediterranean populations (roughly 150 million people) living along the coastline³.

Coastal erosion generates a significant societal and economic to Mediterranean management bodies and to the tourism sector in particular, which expects over 500 million international arrivals by 2030⁴. Some Mediterranean beaches retreat up to several metres per year, while in areas such as Italy, France and Spain, the length of eroded beaches surpasses that of non-eroded ones⁵.

To combat the issue of erosion and sand loss, many Mediterranean government bodies implement beach nourishment or replenishment activities.

This involves the artificial placement of sand and/or pebbles onto an eroded shoreline with the aim of replacing the volume lost to erosion, often for tourism or recreational purposes. This process involves dredging material (primarily sand) from an offshore or inland source area and transporting it to the eroded beach. While beach nourishment may temporarily increase the surface area and sand volume of the beach, the replenished sand is often lost with time and the process is repeated on a regular basis.



¹ United Nations Environment Programme/Mediterranean Action Plan and Plan Bleu (2020). State of the Environment and Development in the Mediterranean. Nairobi.

² WWF Mediterranean Marine Initiative (2021). The climate change effect in the Mediterranean. Six stories from an overheating sea. Rome, Italy.

³ EEA-UNEP/MAP (2014). Horizon 2020 Mediterranean report. Toward shared environmental information systems. Technical Report N°6/2014.

⁴ Piante, C., Ody, D. (2015). Blue Growth in the Mediterranean Sea: The challenge of Good Environmental Status. MedTrends Project. WWF-France. 189 pp.

⁵ European Commission (2009). The Economics of Climate Change Adaptation in EU Coastal Areas; Final Report; Policy Research Corporation (in Association with MRAG); Brussels, Belgium.

Building coastal resilience through Nature-based Solutions

As the effects of climate change continue to put pressure on the Mediterranean region, *Posidonia oceanica*, a marine seagrass endemic to the basin, plays an increasingly significant role in building coastal resilience. This long-living and slow-growing marine plant forms extensive underwater meadows from shallow waters up to depths of 40-45 m. These meadows contribute to the spatial structure of the sea floor and, through friction within the water column, can reduce the speed and strength of waves arriving to the shoreline. This buffering action can protect the coastline for example during storm surges and act as a natural coastal defence mechanism that minimises beach erosion and increases the overall resilience of the coastline in the long term. Within the seafloor, *Posidonia* roots form horizontal networks known as rhizomes that consolidate the sediment and help to further stabilise coastal areas, and in particular sandy beaches.

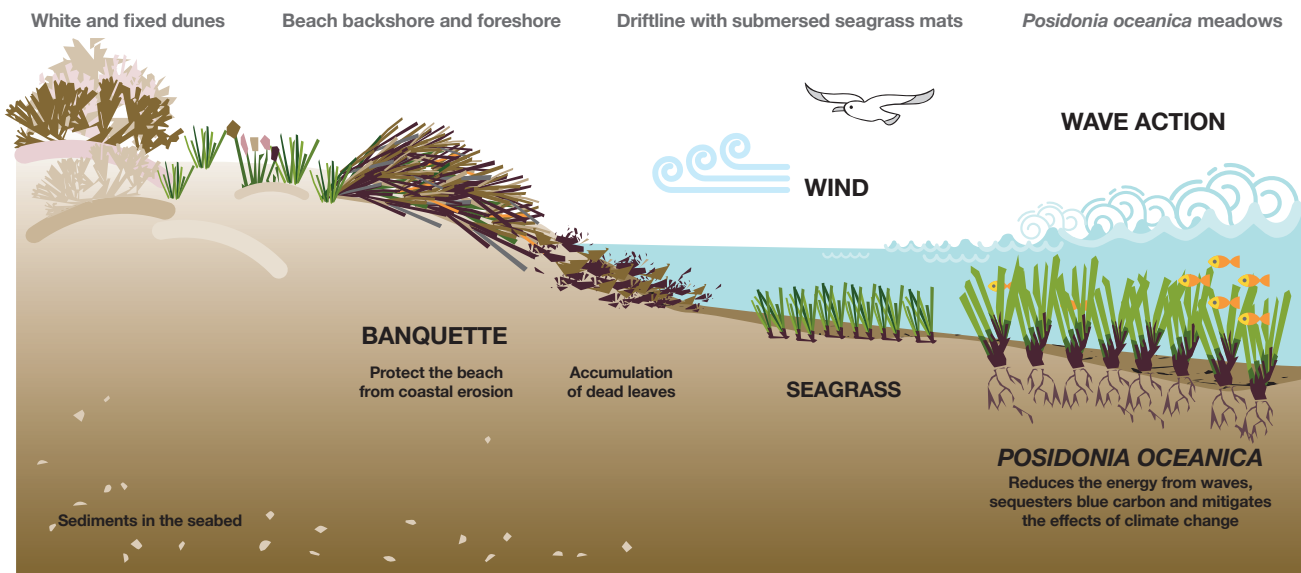


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Due to their nature as a marine plant, *Posidonia* plants lose their leaves seasonally.

The dead leaves, together with plant fibres, wash ashore where they can form extensive structures called banquettes that protect and nourish coastal environments such as

beaches and rocky shores. *Posidonia* banquettes can be up to 2.5 m thick and 20 m wide, constituting a solid and natural structure that protects the shoreline from erosion caused by prolonged wave action or swells, particularly during heavy storms. *Posidonia* banquettes may be temporary or permanent in nature, often inhabited by a rich macrofauna, including crustaceans, molluscs and insects. Banquettes also play an important role in the continuous formation of sand dunes and the creation of dune vegetation. *Posidonia* beachcast and banquettes represent an important input of nitrogen and calcium carbonate to the beach and its adjacent habitats. This is particularly important in some Mediterranean regions where the supply of sand on the shore comes mostly from biogenic origin (animal skeletons, corals, foraminifera, calcareous remains of benthic algae and shell fragments) or as the result of coastal erosion.





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The presence of healthy *Posidonia* seagrass meadows and well-developed banquettes that are left to accumulate along the shoreline can help significantly improve the overall resilience of coastal ecosystems. Indeed, there is an increasing demand among many Mediterranean coastal municipalities and stakeholders for more sustainable and economically viable solutions for the long-term management of *Posidonia* banquettes.

In addition to mitigating the physical impacts of climate change, *Posidonia* plays a significant ecological role in Mediterranean marine ecosystems.

Posidonia meadows are often home to a variety of life forms and constitute spawning grounds, nurseries or permanent habitats for hundreds of plant and thousands of animal species, including many of commercial

***Posidonia* beach-dune systems can increase the natural resilience of the coastline and contribute to climate change mitigation and adaptation.**

value⁶. The resulting ecosystems are very high in biodiversity and species richness.

Posidonia meadows are also important producers of oxygen and organic matter that contribute to water purification. They are considered excellent biological indicators of good water quality. *Posidonia oceanica* is the most abundant and widespread seagrass present in the Mediterranean, as well as the most efficient in

retrieving and storing CO₂ from the atmosphere, rendering its meadows essential coastal blue carbon sinks. Coastal blue carbon can remain stored in these ecosystems as biomass from months to decades, or for centuries or even millennia in the soils. The organic carbon stored by *Posidonia oceanica* alone has been estimated to be up to 4,100 t CO₂ ha⁻¹ in some locations, highlighting the importance of these seagrass meadows for climate change mitigation⁷.

Coastal resilience

is the capacity of the socioeconomic and natural systems in the coastal environment to cope with disturbances induced by factors such as sea level rise, extreme weather events and human impacts by adapting whilst maintaining their essential functions.

⁶ Boudouresque C. F., Bernard G., Bonhomme P., Charbonnel E., Diviacco G., Meinesz A., Pergent G., Pergent-Martini C., Ruitton S., Tunesi L. (2012). Protection and conservation of *Posidonia oceanica* meadows. RAMOGE and RAC/SPA publisher, Tunis: 1-202. https://www.rac-spa.org/sites/default/files/doc_vegetation/ramoge_en.pdf

⁷ IUCN (2021). Manual for the creation of Blue Carbon projects in Europe and the Mediterranean. Otero, M. (Ed.), 144 pages.

Banquettes are wedge deposit structures made up of *Posidonia oceanica* leaves and rhizomes mixed with sediments, and can be between a few centimetres and several metres thick.



Nature-based Solutions are actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits (IUCN, 2020).

Nature-based Solutions (NbS), as defined by the IUCN Global Standard, involve the implementation of interventions centred around well-managed or restored ecosystems that use nature and the natural functions of healthy ecosystems to positively contribute to the environment and the communities who benefit from them⁸.

The nature-based management of *Posidonia* beach-dune systems is rooted in an ecosystem-centred approach, which focuses on the restoration and enhancement of the entire ecosystem and its services.

It involves the implementation of actions addressing key societal challenges through the protection, sustainable management and restoration of both natural and modified ecosystems. These approaches aim to benefit both biodiversity as well as human well-

being, and are often more efficient than traditional technical measures. Indeed, NbS in *Posidonia* management have significant although currently underutilized potential to help address challenges, such as biodiversity loss and coastal erosion.



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⁸ IUCN (2020). *Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS*. First edition. Gland, Switzerland: IUCN.

Soft approaches for managing Posidonia banquettes

This integrated coastal management approach promotes soft interventions that support the natural processes of the Posidonia beach-dune system, increase the resilience of the coastline and contribute to climate change mitigation and adaptation. This holistic vision recommends avoiding the removal of banquettes and allowing their natural cycles of formation and destruction from season to season. In cases where the removal of banquettes is deemed truly necessary, the least invasive removal methods available should always be used. This includes avoiding the use of heavy machinery, limiting the pressure asserted on the beach and shoreline, as well as assuring the sufficient know-how of the entities responsible for carrying out the removal operations.

Management approaches should take into account the factors that influence the natural dynamics of the entire Posidonia system, including dunes, as well as the presence of potentially sensitive areas nearby. Furthermore, it is important to consider the pressures caused by beach goers and leverage the opportunities to build capacities and raise awareness on the significance of this endemic species among the tourism sector.

Unfortunately, despite their key role as unique Mediterranean marine environments, Posidonia meadows continue to face many threats including the impacts of boat anchoring, sewage dumping, sand extraction and an overall decrease in their health and well-being. Posidonia plants

have low genetic variability and are very slow-growing. In some cases, it can take several hundreds of years for a damaged or lost ecosystem to recover, which makes it extremely difficult for them to combat the threats they face.

Posidonia banquettes unfortunately also face a series of challenges as they are often perceived as a nuisance to beach goers, particularly in popular touristic areas. As a result, banquettes are often regularly removed, even from protected areas where fragile sandy beaches and vulnerable coastal dune environments can be found. Many times, this is done using tractors and other heavy machinery, which can result in significant sand loss, consequently leading to



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increased coastal erosion and a decrease of the overall quality and resilience of the coastline.

Fortunately, management approaches in Mediterranean coastal areas are evolving to focus on the conservation of Posidonia beach-dune ecosystems as a whole and to take into account the effects different management practices can have on the health and well-being of the coastline. Management solutions to enhance coastal resilience can also play a critical role in ensuring the stability, sustainability and longevity of Mediterranean coastal livelihoods. With half of Mediterranean tourist arrivals

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occurring in coastal areas, the degradation and loss of beaches and shorelines endangers not only the health and image of the sea, but also plays a critical role in the region's economy.

The Mediterranean coastal environment is particularly vulnerable to balancing the trade-offs between managing its biodiversity and natural resources, and ensuring the socio-economic well-being of its communities. Nonetheless, there is great potential to enhance the significant benefits of this key Mediterranean natural asset and the advantages of implementing management strategies based on nature.



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