

Apulia region, Italy

Stakeholder-driven marine protection: implementing Nature-based Solutions in Apulia Region through Bayesian Network modelling

The MPA of Torre Guaceto



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The environmental degradation, the loss of biodiversity and fish stock in marine-coastal areas is among the main threats affecting socio-economic systems and ecosystem functioning. The MPA of Torre Guaceto, located along the Apulian coast (Southern Italy), is a successful story of NBS implementation (i.e., MPA creation) and environmental management through the active participation of stakeholders (especially fishermen), NGOs and civil society in defining protection actions.

The marine reserve of Torre Guaceto covers an area of 2200 hectares, surrounded by a terrestrial protected area of 1100 hectares.

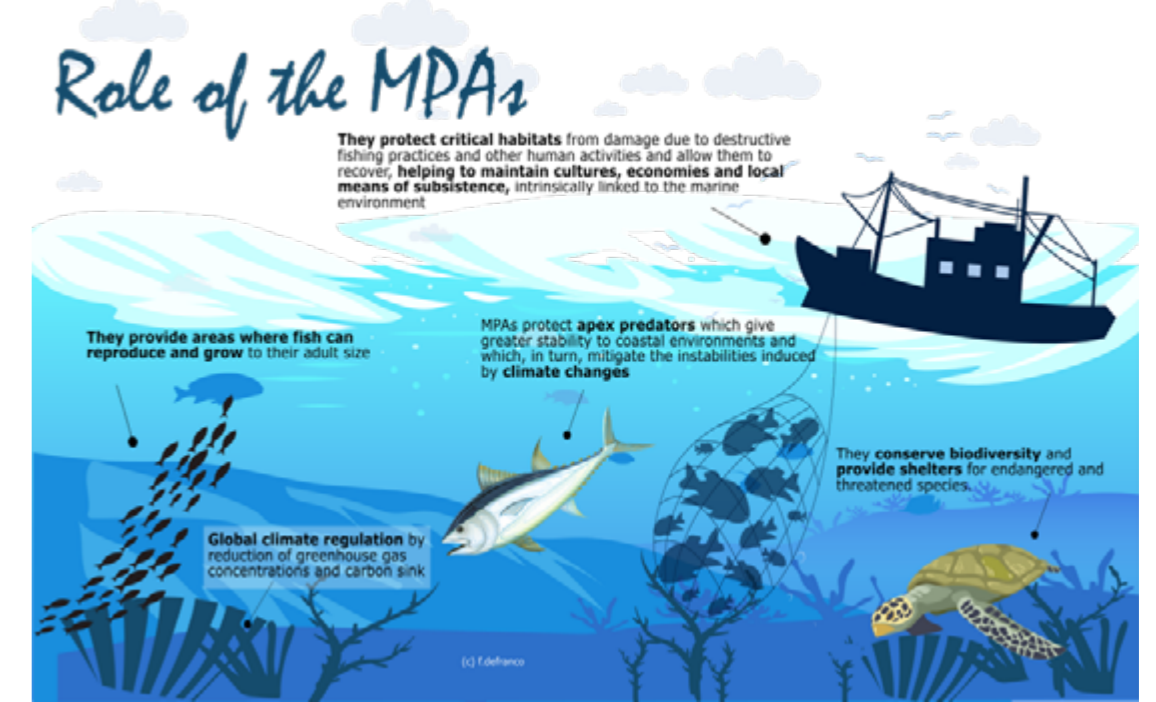
The marine reserve is divided into three zones, with a different level of protection:

Zone A: no take zone.

Zone B: general reserve in which fishing and harvesting, while entry, sailing and approaching of all kinds of craft are forbidden.

Zone C: partial reserve, in which fishing is allowed.

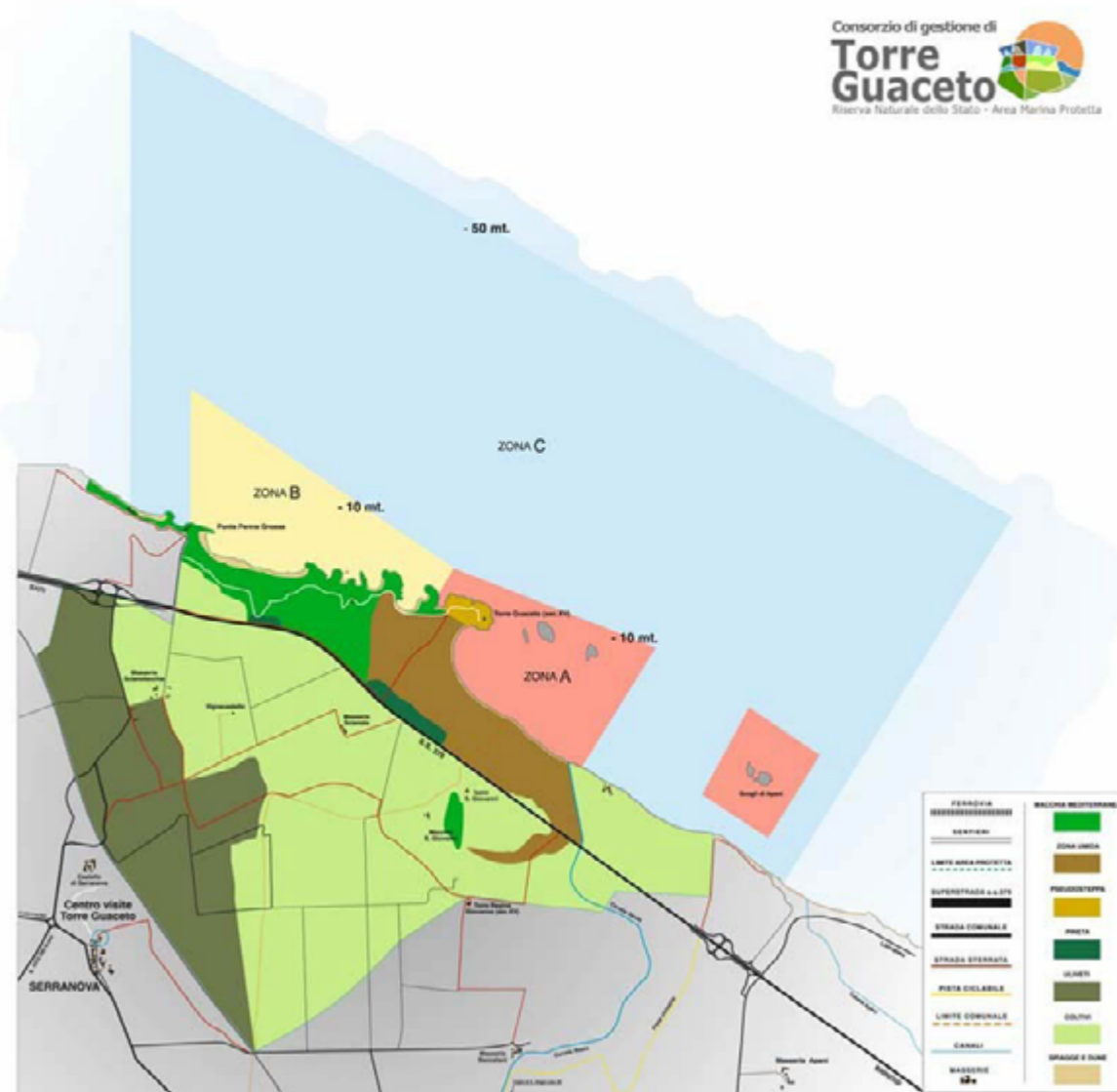
The Adriatic Sea is considered the most productive area of the Med Sea, due to a high variety of ecosystems with a crucial role in providing services. The intense economic activities make the Adriatic Sea one of the most intensely and severely degraded regions. Along the Apulian coast, multiple ports, cities and touristic activities take place, affecting and modifying coastal ecosystems and the natural equilibrium. Additionally, climate change constitutes a concern due to the vulnerability of ecosystems and the presence of economic and cultural values, impacting the marine benthic communities and reducing their functional activities.



To conceptualize and model the interactions between variables (e.g., pressures on the system) and the assessment endpoint, as well as the probabilistic evaluation of (inter)dependence relations among diverse natural and anthropogenic components underpinning the system at stake, a spatio-temporal Bayesian Network (BN) model has been developed. The BN model estimates the adverse effects of human-induced and climate pressures on seagrass meadows (*Posidonia oceanica*) along the Apulian coast. Both anthropogenic (e.g., land use, MPAs) and environmental data (e.g., nutrients, temperature, transparency, depth, etc.) were integrated in the BN model, and jointly combined at the coastal water bodies scale, as framed within the WFD, and elicited by expert knowledge. Baseline environmental conditions were compared against multiple 'what-if' scenarios, representing different climate conditions, under RCP4.5 and 8.5, and nature-based management schemes.

The MPA of Torre Guaceto safeguards one of the most biodiverse areas in the Mediterranean, encompassing habitats such as seagrass meadows, sandy beaches and deep-sea coral formations. The seagrass meadows are populated by endemic species and provide habitats to a variety of fish, crustaceans, sponges and mollusks.

NBS in depth

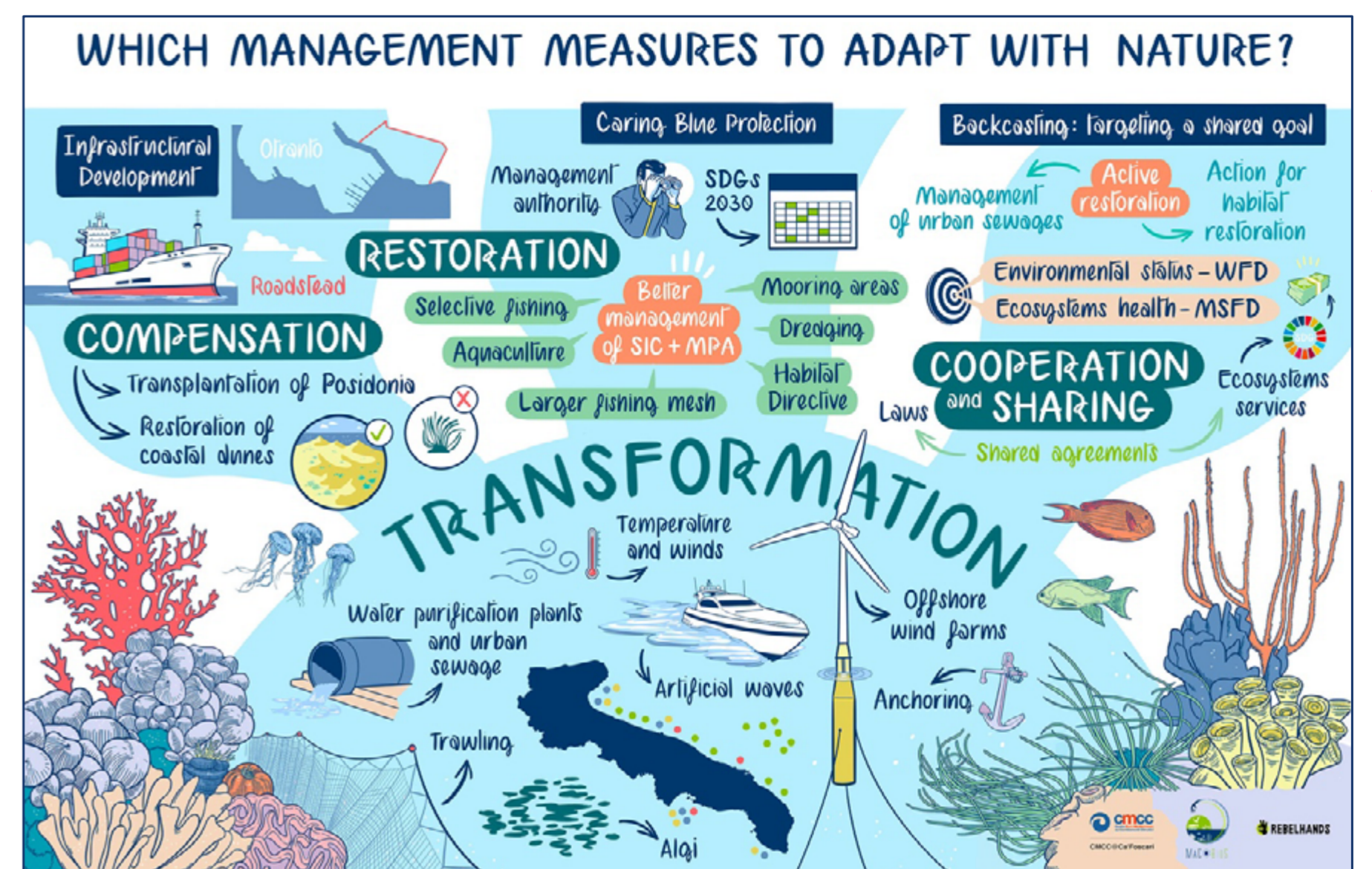


Social benefits

The co-creation of fully protected areas, up to include the Special Conservation Zone, through a bottom-up approach is a successful achievement of a participatory approach that engaged all local and regional stakeholders, including both commercial and recreational fishers. The participatory process followed a scientific approach, considering key habitats and the area's economic activities. The co-development of nature-based management measures has led to more ecologically and economically sustainable fishing practices.

The identified measures, which align with EU directives and objectives of environmental protection, have been tested in the BN model to assess the effect of different protection actions on the seagrass meadows habitat.

Furthermore, the integration of management actions, primarily linked to land-use changes and widening of MPAs, benefit WQ conditions for *Posidonia oceanica* health status, while contributing to achieve the Sustainable Development Goals (as part of Agenda 2030), and the Good Environmental and Ecological Status as required by relevant EU acquis.

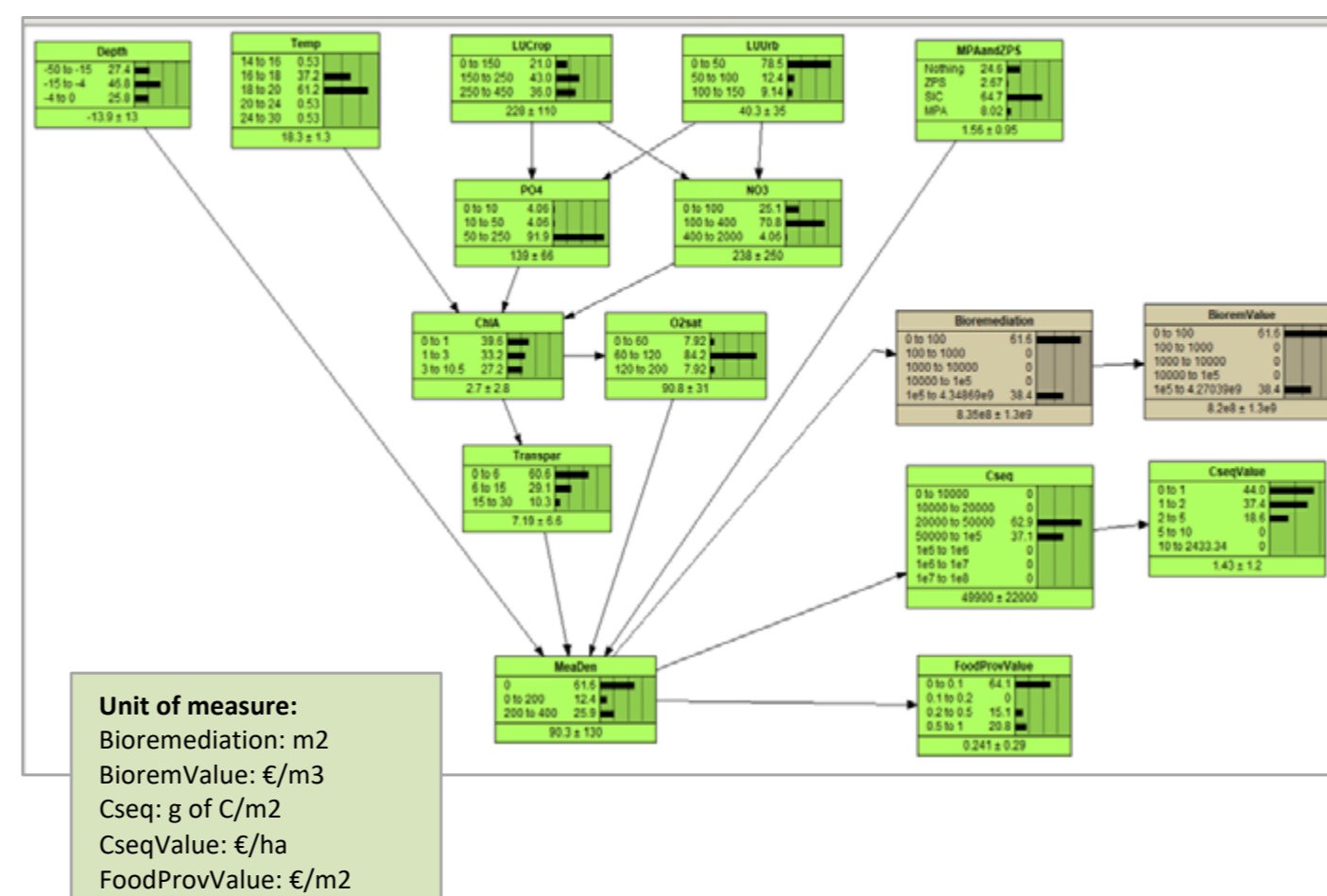


Environmental benefits



The results of the BN model emphasize the main variables (and the spatial extent) affecting the status of seagrass meadows, primarily depth, water transparency, and the presence/absence of protection actions along marine coastal areas, both on land and sea. On the other hand, results from scenario analysis highlight that under RCP4.5 the environmental conditions remain more suitable for seagrass habitat survival and growth, compared to RCP8.5 in both short (2050) and long (2100) term. Indeed, no evident changes are expected for seagrass habitats in the short term (2050), showing a resilience of seagrass meadows to a deterioration of water quality and environmental conditions. Furthermore, the implementation of nature-based management solutions, as the enlargement of the MPA, is beneficial to preserve the marine habitat, the existing seagrass meadows and improve the quality of fishing species.

Economic benefits



The implementation of NBS, i.e., the creation and enlargement of the MPA, has had so far positive economic effects on local communities. Specifically, the different degrees of protection have improved and enriched in biodiversity and species abundance, resulting in higher quality fishing with a consequent increasing of their commercial value.

Furthermore, through the BN model developed, the ecosystem services evaluation allowed to estimate and quantify the economic value that the communities benefit from a healthy ecosystem, as from seagrass meadows habitat. Specifically, the model quantified the ecosystem services and the related economic value in terms of carbon sequestration, bioremediation (i.e., the capability to perform pollutant degradation and remediation through metabolic processes), and food production. The results highlight that higher density of seagrass meadows leads to higher bioremediation activities, carbon sequestration and food provision. In the MPA of Torre Guaceto, the good environmental status achieved through the protection zones have significantly improved the marine environment, contributing to reaching EU environmental target.



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Selected case studies

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