EMB POLICY BRIEF

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Requirements for Coastal Resilience in Europe

European MARINE BOARD
Advancing Seas & Ocean Science

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This Policy Brief is based on Position Paper N°. 27[1] of the European Marine Board, drafted by an interdisciplinary Working Group on Coastal Resilience which ran from January 2021 – October 2023. The Working Group consisted of 14 experts, nominated by the European Marine Board Member organisations.

[1] Villasante, S., Richter, K., Bailey, J., Blenckner, T., Farrell, E., Mongruel, R., Timmermann, K., Bouma, T., Melaku Canu, D., Chen, M., Lachs, L., Payo, A., Sousa Pinto, I. (2023) Building Coastal Resilience in Europe. Alexander, B., Muñiz Piniella, A., Kellett, P., Rodriguez Perez, A., Van Elslander, J., Bayo Ruiz, F., Heymans, J. J. [Eds.] Position Paper N°. 27 of the European Marine Board, Ostend, Belgium. 128pp. ISSN: 0167-9309. ISBN: 9789464206197 DOI: 10.5281/zenodo.8224055

What is coastal resilience?

Coastal resilience is the capacity of coastal natural and socio-economic systems to persist, adapt or transform when faced with disturbances, whilst maintaining their essential functions. Coasts are complex social-ecological systems that host diverse economic activities, cultures, political arrangements and ecosystems with local, national, regional and global implications. However, they face an increasing number of interacting pressures due to climate change and various human activities. The resilience of coastal communities and their natural environments is essential to safeguard life, ecosystems and economies in the face of current and future challenges.

Pressures and impacts on the coast

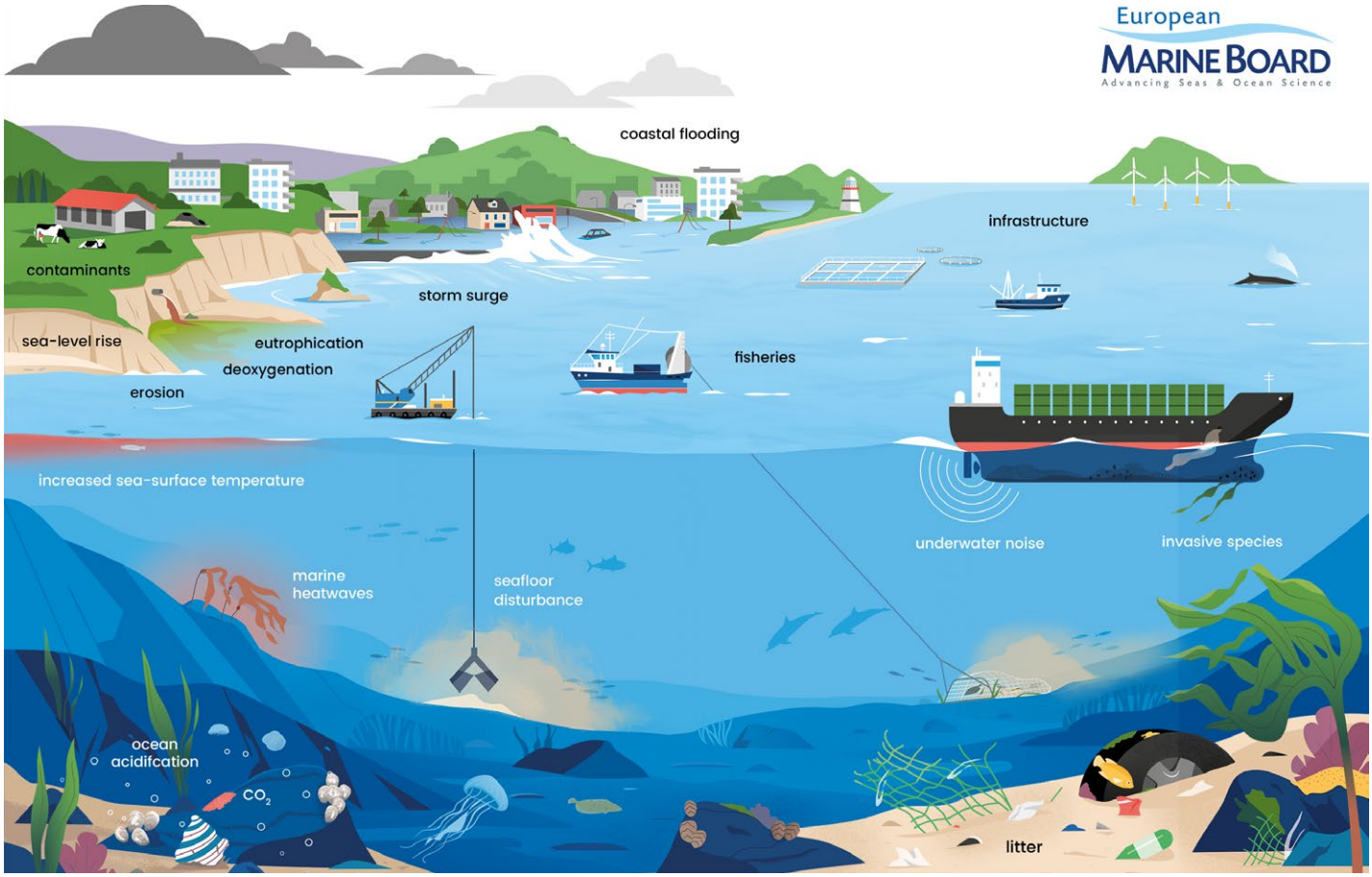

Figure 1. Overview of the multiple pressures affecting European coasts.

Coasts face multiple interacting pressures (Figure 1) that cause negative ecological and social impacts, which can erode coastal resilience. Sea-level rise, sea temperature increase, Ocean acidification and deoxygenation, and increased frequency and magnitude of extreme events such as marine heatwaves, floods and storminess which often originate further offshore, are the main pressures caused by climate change. Fishing, aquaculture, waste disposal, maritime transport, coastal urbanisation, agriculture, and marine coastal infrastructure including renewable energy structures, create pressures such as eutrophication, invasive species, contaminants, marine litter, seafloor disturbance and underwater noise. Population and economic growth, and tourism also contribute to increasing pressures. As a result, many coastal habitats in Europe have low resilience and are degraded, meaning that they cannot deliver valuable ecosystem services, and show no, or only small signs of recovery even when pressures are reduced.

When ecosystems have low resilience, small changes in one or more pressures can lead to disproportionately large responses or abrupt changes causing them to cross tipping points[2]. Local ecosystem tipping points often occur within the broader context of large-scale Ocean and climate system changes. After a tipping point is crossed, a regime shift occurs in which an ecosystem is reorganised, with different ecological functions and dominating. A better understanding of the impacts of single and cumulative pressures is needed to guide more effective management and policies to avoid crossing tipping points. This includes further understanding of resilience properties, such as integrated ecological and social processes that lead to tipping points, so that effective management interventions can be taken before shifts are triggered. Further research is needed on the extent to which Blue Economy activities can be expanded while maintaining coastal resilience.

[2] A tipping point is a critical point at which a transition to a new state is triggered. A return to the previous state is difficult or impossible.

Concepts and frameworks to assess coastal resilience

Managing social-ecological systems towards resilience is not widely practiced due to a lack of knowledge about how to implement resilience-based management. EMB Position Paper N°. 27 "Building coastal resilience in Europe" showcases a range of concepts and frameworks[3] that can be used to assess coastal resilience. However, there is no one-size-fits-all approach, since the use of coastal zones and the scales at which action is needed (i.e. local, national, regional, European, global) vary. Therefore, the use of a combination of different frameworks is recommended. The choice of which framework to use depends on the issue to be addressed, the stakeholders involved and available knowledge. We recommend that coastal managers, experts and researchers follow a strategic six-step approach (see Figure 2) to select and use these frameworks.

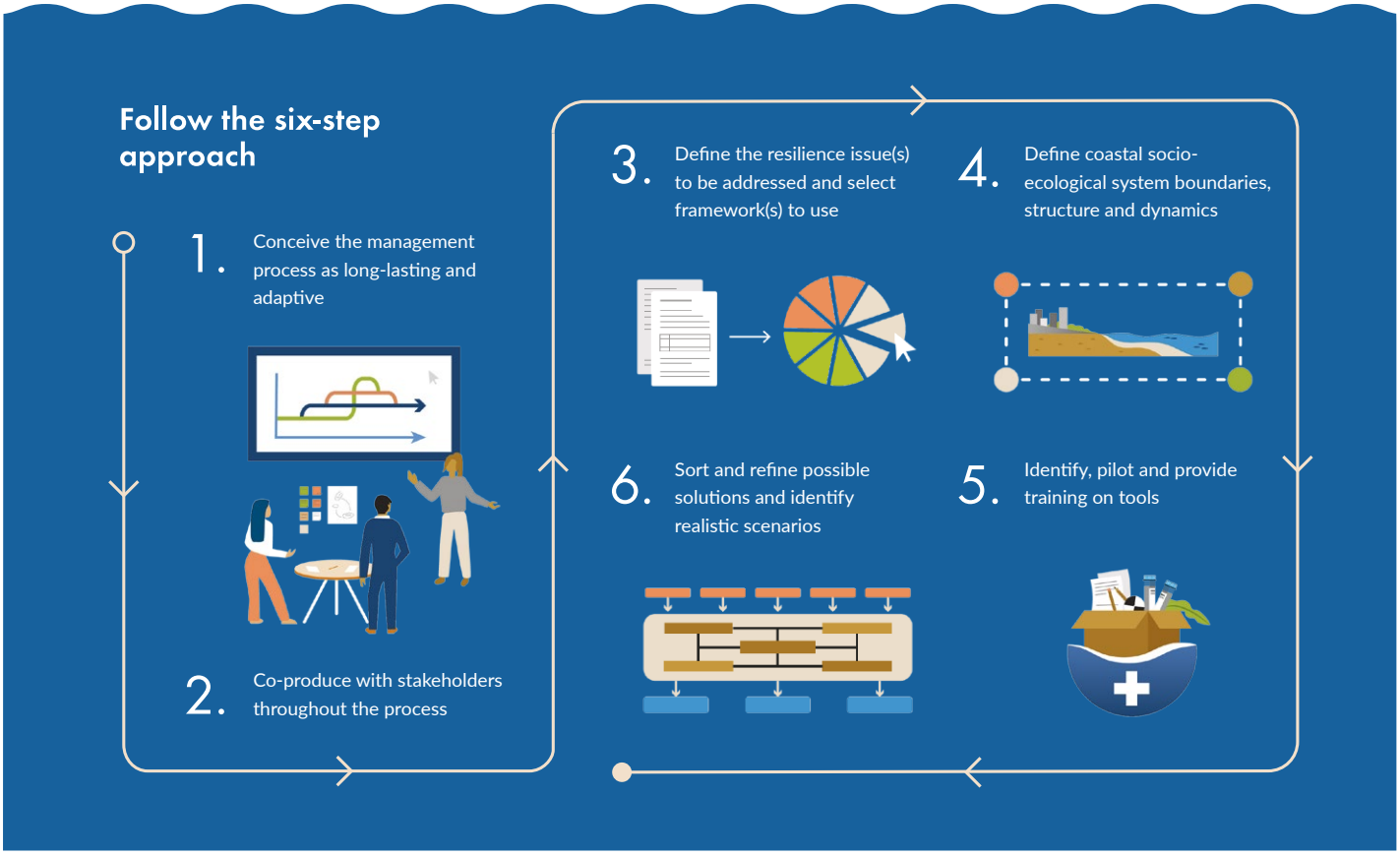

Figure 2. Six-step approach for building coastal resilience. The first two steps are transversal and steps three to six should be carried out in sequence.

Governing and managing the coast

Coastal pressures create a unique set of context-specific issues that need to be addressed holistically using a systems approach that considers the dynamics between coastal societies and ecosystems as part of interconnected social-ecological systems, and links to global processes. Coastal resilience requires scaling up sustainable practices, effective responses to minimise pressures, and strategies to reduce the impact of pressures that cannot be minimised, while maintaining the social, political and economic integrity and welfare of human coastal communities.

In Europe, a wide range of legislation is used to manage coastal pressures (see Position Paper N°. 27). However, these are insufficient to protect, rebuild and future-proof coasts towards resilience, and they need to better address impacts of climate change and cumulative pressures. For example, the Marine Strategy Framework Directive's Good Environmental Status Descriptors should consider the impact that future climate change will have, and the impact of climate change should be considered in the marine spatial plans proposed by Member States. The impacts of cumulative pressures need to be managed holistically through coordinated marine and maritime policies. This requires the use of ecosystem-based management, which is currently not widely implemented for coastal areas. It is also important to reflect the multiple social and economic values of natural capital[4] in public policies and decision-making processes.

A holistic approach to coastal management requires that policies are coherent across economic sectors and levels of governance, and that the land and sea are considered as a single, dynamic system. The links between marine- and land-based policies should be improved, and all aspects of the land-sea interface need to be included in the Integrated Maritime Policy. Although there are good examples of regional implementation of Integrated Coastal Zone Management (ICZM), such as the Protocol on ICZM in the Mediterranean Sea[5], the lack of a European ICZM Directive means

[3] A framework is a structured set of concepts, principles, guidelines or tools that provide a systematic approach to understanding, analysing or addressing a problem. Frameworks range from purely conceptual to varying degrees of operationalisation in support of policymaking.

[4] Natural capital is the stock of natural resources.

[5] https://wedocs.unep.org/bitstream/handle/20.500.11822/35671/08IG18_Final_Act_iczm_eng.pdf

that there is no European-wide legal obligation for Member States to design and apply sustainable land-sea interactions.

Conflict mitigation and resolution should also be integrated into policy, for example on decisions to allocate space for offshore renewable energy installations as part of the European Green Deal, and the protection of 30% of land and sea areas as called for in its 2030 Biodiversity Strategy. Policies need to be adaptive (i.e. have built-in flexibility with frequent reviews), well monitored and enforced. They also need to take advantage of co-benefits such as the creation of space for recreation and nature, and be co-designed with diverse stakeholders, as negotiations, trade-offs and compromises will be needed within and between stakeholder groups. To address the transformative change needed, all policies must have mechanisms to identify and overcome practices that are resistant to change and that lead to the persistence of business as usual. Polycentric governance[6] is critical, and local governments and coastal communities play an important role in responding to climate change and managing the coasts towards resilience. Capacity building, financial and human resources, and tools are needed for local governments to develop and implement effective national plans for coastal management.

Resilient human communities

To build resilient coasts, we need resilient and adaptive human communities, which requires: *Assets* that people can draw on in times of need, including finance, expertise, technology, information, knowledge, and natural and other resources; *Flexibility* to change strategies; *Social organisation* influencing the ability to act as a collective, cooperate and to share knowledge; *Learning* to recognise and adapt to change, while managing uncertainty; and *Agency*, i.e. the ability of individuals or groups to choose how to respond to change. To increase the participation of local communities in building coastal resilience we recommend to obtain systemic natural and social scientific knowledge that is relevant to communities, develop and adhere to coherent national coastal plans, and co-design citizen science initiatives.

Improved knowledge for building coastal resilience

Improved knowledge of the complex dynamics of coastal areas, links to the open Ocean, and interactions between multiple pressures requires co-designed transdisciplinary research, coherence between diverse research communities at the land-sea interface, and the integration and prioritisation of local and indigenous knowledge. Multi-platform (i.e. satellite, airborne and *in situ*), multi-scale and multidisciplinary observations are needed to monitor, understand and predict changes in coastal systems, and for early-warning systems for coastal hazards.

All observations need to feed into open data services such as the European Marine Observation and Data Network (EMODnet[7]) and Copernicus Marine Environmental Monitoring Services (CMEMS[8]) in order to monitor the success of implemented coastal resilience solutions and fulfil governmental monitoring requirements. A key challenge is the integration of socio-economic data with physical, biological and chemical data, especially given the significant data gaps that exist for social datasets. Moreover, all existing long-term physical, biological and chemical datasets should be integrated into these data services to gain a historical perspective. This will require new methods to overcome the challenges of managing and extracting information from large, diverse datasets spanning multiple disciplines.

Modelling local and regional coastal change is critical for understanding how different pressures manifest and interact. Models need to be validated through continuous observations and monitoring of key indicators to ensure accuracy. Global and Ocean-basin climate change models need to be downscaled to a regional level to help inform the development of protection and adaptation measures and help decision-makers to mitigate the compound impacts of interconnected pressures. The European Digital Twin Ocean[9], supported by short- and longer-term models and open data, should advance the prediction of the impact of climate change and human activities on coastal systems and the effectiveness of interventions. Advances are needed in the development of multi-hazard early-warning systems that consider multiple, interacting coastal pressures. Research infrastructures should contribute to environmental monitoring for the development of such systems.

Standardised resilience indicators are needed to identify where pressures and threats to resilience exist, and where the resilience of the system might be impacted. These will help to coordinate transnational, national, regional, local, and community level efforts towards coastal resilience. A pan-European framework to clarify and standardise the definitions and practice of coastal resilience is also needed.

Coastal protection and Nature-based Solutions

Coastal protection is a tool to minimise the impacts of sea-level rise, storm surges, flooding and erosion, and includes a spectrum of grey and blue-green infrastructure. Grey infrastructure includes concrete seawalls, breakwaters[10], groynes[11], rock armour[12] and storm surge barriers. Blue-green infrastructure includes ecologically enhanced grey infrastructure (e.g. bioblocks that create artificial pits and rock pools for native species), hybrid infrastructure that combines natural and grey-engineering features (e.g. a shellfish reef in front of a seawall), and landward and seaward Nature-based Solutions[13].

[6] Polycentric governance is the engagement of multiple governing bodies, policy communities and stakeholders at various scales in governance processes.

[7] https://emodnet.ec.europa.eu/en

[8] https://marine.copernicus.eu/

[9] https://www.edito.eu/

[10] A breakwater is a barrier built offshore to protect a coast or harbour from the force of waves.

[11] A groyne is a low wall or sturdy barrier built into the sea from a beach to control erosion and drifting.

[12] Rock armour is large boulders used to reduce wave energy reaching the shoreline.

[13] Nature-based Solutions are "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human wellbeing, ecosystem services, resilience and biodiversity benefits" (UNEA. 2022. Nature-based Solutions for supporting sustainable development [UNEP/EA.5/Res.5].). CD6

Credit: Ray Buckley

Community-led marram grass planting on the Maharees Peninsula, Ireland.

Nature-based Solutions for coastal protection typically require more space and time to develop than grey infrastructure, but are more likely to enable ecosystems to persist or recover from disturbances such as storms and sea-level rise. Nature-based Solutions also provide a wide range of co-benefits including biodiversity conservation, nutrient retention, carbon sequestration, water quality regulation, eco-tourism, human health benefits and recreation. These co-benefits need to be identified, better promoted and, where feasible and appropriate, monetised, so they can be taken into consideration within management. Critical knowledge gaps must be filled on the feasibility and potential benefits of large-scale Nature-based Solutions for coastal protection, including site-specific research on which coastal habitats and species provide coastal protection and under which conditions.

Holistic coastal management includes allowing coastlines to adapt and transform for the benefit of both nature and people. For example, in expansive gently sloping areas, removing defences and allowing the area to flood, sea-levels to rise, and moving towns and cities to higher ground may be more sustainable than attempting to "save" coasts from erosion or make them flood-proof. In addition, buffer areas may be designated where developments are not allowed thereby minimising economic damage from future flooding and sea-level rise.

The choice of which strategy to implement is context- and place-specific and deciding which to implement requires an inventory of options. This should include information on their ability to build and enhance long-term resilience, impacts on coastal ecosystems, socio-economic impacts, and long-term value in preparing for sea-level rise, extreme weather events and changing socio-economic conditions.

Nature-based Solutions also include approaches such as low- and integrated multi-trophic aquaculture, multi-use of Ocean space, and sustainable fisheries management that build resilience to pressures such as overfishing and eutrophication. New Nature-based Solutions need to be tested and existing solutions scaled-up. We also need further understanding of their physical, ecological and socio-economic impacts, and of the barriers to- and enablers for their implementation. Nature must be included from the start of the design of coastal protection strategies and national governments must integrate and prioritise Nature-based Solutions in their policies.

Overarching recommendations to build coastal resilience

In order to build the resilience of European coastal social-ecological systems to multiple interacting pressures, we recommend the following overarching policy and scientific actions.

Policy recommendations:

- Adopt a systems approach to coastal management;
- Include nature and people from the beginning of the design of coastal management strategies;
- Build adaptive capacity at multiple scales;
- Reflect the multiple values of natural capital; and
- Follow the six-step approach described in Figure 2.

Scientific recommendations:

- Establish integrated transdisciplinary research on coastal social-ecological systems;
- Develop sufficient observational, monitoring and data capacity and coverage;
- Develop and operationalise standardised coastal resilience indicators for Europe;
- Improve model prediction capacity; and
- Invest in research on Nature-based and hybrid solutions.

Credit: Chaosheng Zhang

To improve resilience, nature and people should be included from the beginning of the design of coastal management strategies.

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