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Quo Vadimus

UN Decade Challenge 6: navigating the waves of the future—enhancing community resilience to ocean-related hazards

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Abstract

The ocean, a dynamic and complex system, is crucial to Earth's environmental and human life balance, from regulating the climate to supporting biodiversity and livelihoods. Monitoring the ocean has always been essential, but the increasing climate change impacts have made it a critical necessity for safeguarding our future through timely predictions and mitigation measures. The Ocean Decade is an initiative to find transformative solutions to existing and future challenges facing the ocean and thus humankind. Among its 10 challenges, Challenge 6 focuses on enhancing coastal community resilience to ocean-related hazards by adapting advancements in science. This article explores how building community resilience through data integration, community outreach, and policy development can contribute to achieving the Ocean Decade's vision of 'A Safe Ocean'.

Keywords: ocean hazards; community resilience; multi-hazard early-warning system

Introduction

The Ocean Decade (2021–2030) is a 10-year framework to identify, generate, and use critical ocean knowledge for sustainable ocean management (United Nations, 2021). Within this framework, Challenge 6 focuses on increasing community resilience to ocean-related hazards. The strategic ambition for Challenge 6 is outlined in the Vision 2030 White Paper (Pinardi et al. 2024). This document highlights the growing vulnerability of coastal communities to geophysical/geological, ocean weather, hydrological, climatic, ecological, biological, anthropogenic, and infrastructural threats. The Challenge 6 White Paper advocates for developing and strengthening multi-hazard early-warning services and improving adaptation planning in coastal areas to enhance community resilience, and this short paper is intended to be a summary of it.

The strategic ambition: a people-centred approach

By 2030, the goal is to achieve substantial progress in enhancing community resilience to ocean-related hazards through 'people-centred' multi-hazard early-warning systems (MHEWSs) and designing adaptation strategies that target ocean-related risks and coastal management. People-centred MHEWSs aim to empower communities to act promptly and effectively during hazards, reducing risks to lives, and the environment, while addressing social and gender inequalities to ensure effective implementation.

These systems are crucial for coastal areas facing growing risks from ocean-related hazards, which are intensified by climate change, sea-level rise, and stronger wave action (IPCC 2021). Unlike other natural hazards, ocean-related hazards often have a rapid onset and can cover vast areas, making traditional response mechanisms inadequate, as seen in the 2004 Indian Ocean tsunami. MHEWSs should provide essential lead time for evacuation and protective measures. Moreover, ocean hazards create cascading effects that amplify their impact on infrastructure and communities. For example, the 2011 Japan tsunami caused widespread destruction and led to critical failure at the Fukushima–Daiichi Nuclear Power Plant, triggering long-lasting nuclear-related consequences (UNSCEAR 2020/2021). This complexity necessitates a sophisticated and integrated approach to monitoring and designing MHEWSs that consider the full spectrum of potential threats.

Ocean multi-hazard adaptation planning (OMHAP) strategies target risks associated with the ocean, including those linked to climate change, through proactive planning. These strategies prevent damage by promoting the transition from traditional 'grey' infrastructure to 'green' (nature-based solutions) while also raising population awareness. A people-centred ocean multi-hazard adaptation strategy demands advanced climate projections at the coasts, which are not yet available everywhere and the challenges include data fragmentation, technical barriers, and gaps in availability across the regions. Active participation from diverse stakeholders and close collaboration between research and management have been emphasized as important mechanisms to under-

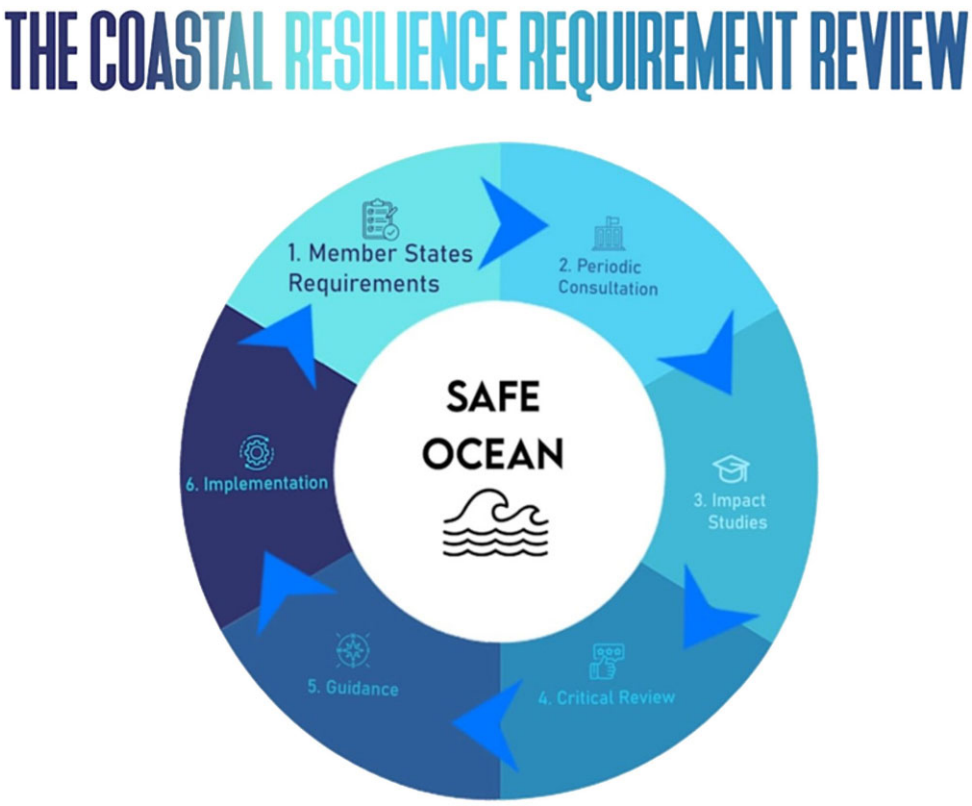

Figure 1. Coastal resilience requirement review process.

take and inform adaptation planning and implementation (Mimura et al. 2014). The Modulo Sperimentale Elettromeccanico (MoSE) barrier in Venice exemplifies a successful adaptation to protect the lagoon from rising sea levels by 2080–2100. Despite taking over 50 years to complete, it highlights the importance of making decisions amidst uncertainties in future scenarios.

Challenge 6's ambition includes two key elements: (1) **establishing comprehensive 'people-centred'** MHEWSs and (2) **devising OMHAP strategies**, and key actions include the following:

(1) **Develop an open and accessible information system:**
- **The data and technology:** Real-time, accurate data essential for predicting hazards must be coupled with cutting-edge technology, such as artificial intelligence (AI)/machine learning (ML), focusing on digital twin (DT) frameworks, through promoting interdisciplinary and international research. This requires robust infrastructure, which include global observing networks, computational facilities, and data-sharing frameworks. The Ocean Decade envisions making such standards globally, including small island developing states (SIDSs) and least developing countries (LDCs) through standardization initiatives, enhanced coordination, and support for innovative practices.
- **Building resilience beyond the science:** While science and technology are the backbone of MHEWSs and OMHAP strategies, integrating these advancements into daily life is equally important. Capacity building and community awareness programmes are key to ensure that the solutions are effective. Especially, indigenous and local knowledge, passed down through generations, offers valuable insights into ecosystems and adaptive strategies, with the potential to enhance coastal resilience. 'People-centred' MHEWSs and OMHAP strategies put communities at the heart of the system, engaging them in the design, implementation, and evaluation of the plans. Coastal resilience supported by this approach must be sustainable and inclusive, addressing the needs of vulnerable populations, by incorporating nature-based solutions such as mangrove restoration and coral reef preservation, to protect communities and enhance ecosystem health. Coastal resilience is closely linked to social–ecological systems, e.g. mangrove restoration enhances biodiversity and acts as a natural barrier against tsunamis and storm surges.

(2) **Integrate coastal resilience targets more extensively into sustainable development goals (SDGs):** The Challenge 6 paper aligns closely with the United Nations' Sustainable Development Goals (UNISDR 2015), particularly those related to climate action (SDG 13), life below water (SDG 14), sustainable cities and communities (SDG 11), and partnerships for the goals (SDG 17). Enhancing coastal resilience directly supports these goals, ensuring that our efforts to protect the ocean also contribute to secure our future.

(3) **Establish a coastal resilience requirement review process:** This process would involve identifying stakeholder needs and implementing a periodic consulta-

tion mechanism to assess progress in coastal resilience worldwide. Indicators need to be formulated to measure progress in areas such as awareness, stakeholder engagement, data quality, capacity building, community involvement, budget management, and policy alignment. The primary task involves fine-tuning these indicators according to the goals and objectives during each review cycle as in Fig. 1.

The way forward: a call to action

As we move forward, it is crucial to remember that the ocean does not recognize borders and ocean-related hazards can have ripple effects across the globe. Challenge 6 calls for collaboration among governments, industries, and communities to safeguard our collective future.

So, what can we do? We can start by critically assessing the role of tools and strategies. Are we using the best tools available to prepare for ocean-related hazards? How can we more effectively engage communities in the process? And most importantly, how do we ensure that the today's solutions remain viable against tomorrow's challenges respecting ecosystem capacities and biodiversity?

The journey to enhancing community resilience to ocean-related hazards is a marathon, not a sprint. It requires continuous commitment, innovation, and collaboration involving governments, international organizations, industries, and communities. The Ocean Decade provides a roadmap, so let's follow it to create a future where coastal communities thrive in harmony with the ocean.

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Author contributions

S.M. coordinated the overall efforts of preparing the manuscript, ensuring alignment with the Ocean Decade Challenge 6. S.K.T. contributed specifically with inputs on the MHEWS framework, integrating geophysical, meteorological, and oceanographic components to enhance tsunami and other ocean-related hazard warning services. N.P. led the OMHAP strategy design, focusing on coastal resilience, nature-based solutions, and long-term risk reduction strategies. Additionally, all three authors were co-authors of the Ocean Decade Vision 2030 White Paper (Pinardi et al. 2024), which served as the foundation for this work and benefitted from the valuable inputs provided by WG 6 members, as listed in the acknowledgement section of this manuscript.

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Data availability

The data underlying this article are available in the Vision 2030 White Paper (Pinardi et al. 2024) and in its online supplementary material.

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