cogitatio

OCEAN AND SOCIETY

Transforming Coastal Governance: Challenges, Experiences, and Ways Forward

Edited by Raoul Beunen and Gianluca Ferraro

Volume 2

2025

Open Access Journal

ISSN: 2976-0925

Ocean and Society, 2025, Volume 2
Transforming Coastal Governance: Challenges, Experiences, and Ways Forward

Published by Cogitatio Press
Rua Fialho de Almeida 14, 2º Esq.,
1070–129 Lisbon
Portugal

Design by Typografia®
http://www.typografia.pt/en/

Cover image: © UNDP (United Nations Development Programme) from Flickr

Academic Editors
Raoul Beunen (Open University of the Netherlands)
Gianluca Ferraro (University of Portsmouth)

Available online at: www.cogitatiopress.com/oceanandsociety

Table of Contents

Table of Contents

Ocean and Society
2025 • Volume 2 • Article 11139
https://doi.org/10.17645/oas.11139

cogitatio

EDITORIAL

Open Access Journal

Transforming Coastal Governance: Challenges, Experiences, and Ways Forward

Raoul Beunen [1] and Gianluca Ferraro [2]

[1] Department of Science, Open Universiteit, The Netherlands
[2] Centre for Blue Governance, University of Portsmouth, UK

Correspondence: Raoul Beunen (raoul.beunen@ou.nl)

Submitted: 13 August 2025 **Published:** 17 September 2025

Issue: This editorial is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Transforming coastal governance is essential to ensure the sustainable development and use of coastal areas. Such transformation processes may involve changes in different governance dimensions. This thematic issue focusses on five of these dimensions and the way in which changes in these dimensions are interrelated: (1) the integration of planning and management of land and sea, (2) the use of scientific knowledge, (3) the involvement of stakeholders in planning and policy processes, (4) the development and use of strategic foresights, and (5) digitalization and the use of e-governance tools. Drawing on the experiences from the BlueGreen Governance project that covers different coastal regions in Europe as well as Reunion Island, the different contributions explore various attempts to transform coastal governance, the obstacles that actors face, and the solutions that are developed along the way.

Keywords

coastal governance; e-governance; land–sea management; participation; policy integration; science-policy interface; strategic foresight

1. Introduction

Coastal areas face various social and environmental issues, such as habitat loss, pollution, vulnerability to storm surges and extreme weather events, decline of natural resources, and poorly planned developments. Some of these issues have been on the agenda for decades, indicating that finding and realizing solutions is anything but easy. Addressing these challenges has become even more urgent due to climate change. Coastal areas are particularly vulnerable to the various impacts of climate change, such as sea level rise and

increased frequency and intensity of extreme weather events, that threaten livelihoods, natural resources, and protected ecosystems.

Various studies have shown that current governance systems are ill-equipped for dealing with these coastal conditions (e.g., Brown et al., 2017; Tocco et al., 2024; Van Assche et al., 2020) and that the functioning of coastal governance is hampered by territorial, administrative, and sectoral fragmentation. Integrated forms of planning and management have been called for, but these are difficult to realize and implement. This thematic issue explores the challenges of transforming coastal governance in more detail, focusing on the different efforts to integrate the planning and management of land and sea. It presents reflections on and insights from coastal governance in different regions throughout Europe, namely the Oslofjord in Norway (Trubbach et al., 2025), the Scheldt basis on the border between Belgium and the Netherlands (Vitale et al., 2025), Valencia (Luján Climent et al., 2025; Grassi et al., 2025a) and the Canary Islands (González et al., 2025) in Spain, and Slovenia (Marušić & Gulič, 2025), as well as from Réunion Island (Losen et al., 2025), a French overseas department. Furthermore, it includes contributions that put forward more general reflections on the challenges of transforming coastal governance (Evans et al., 2025; Kotta et al., 2025; Nijamdeen et al., 2025). The contributions are based on research conducted within the framework of the BlueGreen Governance project, funded by Horizon Europe and UK Research and Innovation. BlueGreen Governance is dedicated to advancing innovative approaches to land–sea governance, with the overarching goal of developing novel strategies that better integrate terrestrial and marine management. It aims to address complex challenges at the land–sea interface, enhance ecological and social outcomes, and inform policy at both national and international levels.

The thematic issue explores the complex challenges associated with integrating the management and governance of land and sea and transforming coastal governance. The different contributions specifically focus on five key dimensions of coastal governance:

1. Integrated land–sea management and planning;
2. The use of scientific knowledge;
3. Participatory practices and stakeholder involvement;
4. The development and use of strategic foresight;
5. The use of e-governance tools.

2. Integrated Land–Sea Management and Planning

Integrated land–sea management is the key challenge that is addressed in the BlueGreen Governance project. Coastal governance requires policies and practices that take into account the social and ecological connectivity between terrestrial and marine ecosystems and address the direct and indirect impacts of land-based activities on marine environments. Integration requires the alignment of goals, policy instruments, and strategies across various governance levels and policy sectors in order to balance competing interests and promote the sustainable development of coastal areas. Although such integrated practices are regularly called for, they prove to be challenging to change current governance systems, even with deliberate attempts. Trubbach et al. (2025), for example, explore how the development of coastal plans can facilitate policy integration. Their study of the Oslofjord shows that the development of an integrated

plan can indeed complement existing institutions and therewith trigger some changes in coastal governance. Their study also shows that the implementation of the plan proves to be difficult because sectoral interests still prevail over environmental objectives, local self-government limits the authoritative force of the plans, and the issue of financing has not been solved (Trubbach et al., 2025). Also, the contribution by Vitale et al. (2025) illustrates how current forms of governance can present barriers for change. Their study examines the adoption of nature-based solutions in the Scheldt basin, located at the border between the Netherlands and Flanders. It illustrates how longstanding traditions of engineering-oriented water management continue to shape flood-risk governance, resulting in a gradual and incremental transition towards more integrated approaches. The study demonstrates that forms of governance are influenced not only by institutional legacies but also by prevailing forms of knowledge and material conditions. The contribution stresses the contingent nature of change in governance and the need for a thorough understanding of the different dependencies that shape the process of change.

3. The Use of Scientific Knowledge

The complexity that characterizes coastal governance is also reflected in the development and use of scientific knowledge. One main challenge is developing in-depth scientific insights about the functioning of the coastal system, the interconnectivity of land and sea, and the many ways in which human activities impact that system (Trubbach et al., 2025). Leveraging scientific knowledge enables the creation of tools for monitoring and forecasting changes in interconnected systems, generates evidence that supports sound decision-making, and empowers policymakers and practitioners to respond to both immediate and long-term social-environmental challenges. It underpins the development of evidence-based policies capable of addressing the complex challenges inherent in coastal governance. Scientific studies can furthermore be useful for the evaluation of current policies and policy processes, as the contribution by Marušić & Gulič (2025) and González et al. (2025) clearly shows. The contribution by Kotta et al. (2025) explores how digital tools can be used to make scientific information available to people working on the formulation of policies and plans, while Grassi et al. (2025a) illustrates how scientific knowledge about the impact of climate change can be used in the development of scenarios and stakeholder dialogues. Also the other contributions reflect on the role of scientific knowledge in coastal governance, highlighting the relevance of scientific knowledge, but also how scientific knowledge is often marginalized to protect vested interest, how the contextualisation of scientific knowledge to specific practices is challenging due to a lack of resources and expertise, or how the dominance of technical expertise can actually hamper the transformation of coastal governance towards more integrative approaches (Vitale et al., 2025). Also, the interplay between scientific expertise and stakeholder views is a topic that deserves more attention (Nijamdeen et al., 2025).

4. Participatory Practices and Stakeholder Involvement

Participation implies the active inclusion of diverse stakeholders in planning and decision-making processes, ensuring that a broad spectrum of views, interests, and expertise is considered. Participation in the context of coastal governance might be particularly challenging, as different contributions show (e.g., Lujan et al., 2025; Grassi et al., 2025a; Losen et al., 2025; Vitale et al., 2025). The influence of participatory processes on decision-making and spatial development is often limited, as important issues are regularly discussed and decided on in different arenas. Planning and decision-making on coastal areas takes place in multiple jurisdictions, and the relationship between these jurisdictions can have a significant impact on the role and

influence of participation. The impact of participatory processes is limited, if more important decisions on the future of coastal areas are made elsewhere, in sectoral domains, or on higher levels. The fragmented nature of coastal governance can make it difficult to grasp power relations, increase stakeholder involvement, and ensure fair and just forms of participation.

5. The Development and Use of Strategic Foresight

Strategic foresight refers to the capacity to explore and navigate different futures and to anticipate particular developments and the opportunities and risks these might create (Grassi et al., 2025b). One key example is the capacity to gain better insights into the potential impact of climate change as a basis for developing appropriate responses. By bridging scientific evidence and experiential knowledge, foresight provides a holistic framework for visioning and decision-making. It equips policymakers with the tools to circumvent uncertainties, anticipate challenges, and seize opportunities, making it a crucial component in designing adaptive, inclusive, and sustainable long-term policies. The issue of strategic foresight has a central role in the contribution by Grassi et al. (2025a) that presents the findings of a stakeholder workshop that used different strategic foresight tools to engage stakeholders in a dialogue about the possible consequences of climate change and ways to anticipate these consequences. It shows how strategic foresight tools can be used to engage stakeholders, explore possible futures, and initiate dialogues about future pathways. It also reflects on important challenges such as inclusiveness, inequalities in adaptive capacity, and the need to enhance coordination within coastal governance. Strategic foresight also plays an important role in the implementation of EU policies, as the contributions on the Canary Islands (González et al., 2025) and Slovenia (Marušić & Gulič, 2025) show. It can help to gain a better understanding of the impact of climate change and to develop an integrated approach.

6. The Use of E-Governance Tools

Finally, the digital revolution offers ample opportunities to enhance policy formulation and implementation. Digital tools can be used to explore possible futures, to assess policies and plans, to monitor progress, or to involve stakeholders at various stages of the policy process. The contribution by Kotta et al. (2025) specifically focuses on this dimension and elaborates on the use of the web-based PlanWise4Blue tool for analysing cumulative effects of human activities on coastal ecosystems using a data-driven approach. This key example of a digital tool allows actors to compare different management scenarios and the potential impact of plans, policies, and specific measures. The contributions by Grassi et al. (2025a) and Losen et al. (2025), however, show that although such digital tools are widely used, their integration in decision-making is still limited.

7. Transforming Coastal Governance

The different contributions all reflect on the challenges of transforming coastal governance and present practical experiences as well as specific approaches and tools that can be used to work towards more integrated and sustainable forms of coastal governance. The different studies not only illustrate some of the shortcomings of current policies and practices, but also explore the challenges of transforming coastal governance systems. The studies focused on five dimensions in which governance systems can be improved. Each of these dimensions comes with different challenges, but the different contributions also show that

and how these dimensions are strongly interrelated and should be addressed in a coherent way (Nijamdeen et al., 2025).

In order to grasp the processes of change in coastal governance, different contributions have applied the conceptual framework of the evolutionary governance theory (Beunen et al., 2022; Van Assche et al., 2013). This framework is particularly useful for analysing the gradual evolution of coastal governance and the various dependencies that influence the process of transformation (Nijamdeen et al., 2025; Partelow et al., 2020). It offers a powerful lens to understand both the possibilities and limits of achieving transformations in coastal governance. It views governance as an ongoing process of co-evolution between actors, formal and informal institutions, power-knowledge dynamics, and the physical environment. This co-evolution means that intended and unintended changes occur simultaneously and that attempts to change governance can have consequences that are difficult to predict or control. Learning, adaptive management, participatory approaches, and policy experimentation are all useful in addressing these challenges of transforming coastal governance, but the problems and shortcomings of current governance systems will not be overcome easily because of path dependencies and current power relations. Together, the different contributions of this thematic issue show that while transformation of coastal governance is both possible and necessary, the processes of change are inherently constrained by the way current governance systems are organised and functioning, as well as by the ongoing strategizing of a diversity of actors, whose visions, interests, and ideas are not always aligned. Altogether, the contributions present insights and experiences that hopefully prove useful to those studying coastal governance and to the many practitioners working on putting coastal governance on pathways that are both more sustainable and just.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Conflict of Interests

The authors declare no conflict of interests.

References

Beunen, R., Van Assche, K., & Gruezmacher, M. (2022). Evolutionary perspectives on environmental governance: Strategy and the co-construction of governance, community, and environment. *Sustainability*, *14*(16), Article 9912. https://doi.org/10.3390/su14169912

Brown, K., Naylor, L. A., & Quinn, T. (2017). Making space for proactive adaptation of rapidly changing coasts: A windows of opportunity approach. *Sustainability*, *9*(8), Article 1408. https://doi.org/10.3390/su9081408

Evans, T. R., Ferraro, G., & Failler, P. (2025). Transformation across land-sea governance: Future research opportunities. *Ocean and Society*, *2*, Article 10319. https://doi.org/10.17645/oas.10319

González, A., Peña-Alonso, C., González-Dávila, M., Santana-Casiano, J., González-Santana, D., Ferraro, G., Naranjo-Almeida, L., & García-Romero, L. (2025). Governance challenges for the adaptation to sea-level

rise in the Canary Islands: A multilevel approach. *Ocean and Society*, *2*, Article 10505. https://doi.org/10.17645/oas.10505

Grassi, G., Zennaro, F., Climent, I. L., Barberà, O., Aldeguer-Cerdá, B., Ferrato, G., Douguet, M., & Furlan, E. (2025a). Bridging local and scientific knowledge in land–sea governance through strategic foresight: Unlocking transformative adaptation in Valencia. *Ocean and Society*, *2*, Article 10458. https://doi.org/10.17645/oas.10458

Grassi, G., Zennaro, F., Ferraro, G., Beunen, R., Douguet, J. M., & Furlan, E. (2025b). Strategic foresight analysis for the management of land-sea interface in a climate change context: A comprehensive literature review. *Environmental Science & Policy*, *171*, Article 10411.

Kotta, J., Douguet, J., Vollmer, E., Fetissov, M., Furlan, E., Grassi, G., Zennaro, F., Pagan, H., & Orav-Kotta, H. (2025). Assisting coastal and marine governance: Enhancing decision support through digital tools for cumulative impact assessment. *Ocean and Society*, *2*. Article 10300. https://doi.org/10.17645/oas.10300

Losen, B., Lagabrielle, E., & Aabid, S. (2025). Beyond ecology: Land-sea governance, policy and research in Réunion Island (2000–2024). *Ocean and Society*, *2*, Article 10341. https://doi.org/10.17645/oas.10341

Luján Climent, I., Enguer, J., Aldeguer, B., & Barberà, O. (2025). Governance innovation for coastal wetlands: Dependencies, challenges, and opportunities in the Valencian Community. *Ocean and Society*, *2*, Article 10286. https://doi.org/10.17645/oas.10286

Marušić, B. G., & Gulič, A. (2025). The process and procedures for the preparation of integrated maritime spatial planning: The case of Slovenia. *Ocean and Society*, *2*, Article 10452. https://doi.org/10.17645/oas.10452

Nijamdeen, T. W. G. F. M., Löhr, A., Van Assche, K., & Beunen, R. (2025). Strategies for transforming coastal governance: Addressing Interdependent dimensions. *Ocean and Society*, *2*, Article 10338. https://doi.org/10.17645/oas.10338

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., Hornidge, A. K., Le Tissier, M., Pittman, J., Song, A. M., Sousa, L. P., Văidianu, N., & Van Assche, K. (2020). Environmental governance theories: A review and application to coastal systems. *Ecology & Society*, *25*(4), Article 19. https://doi.org/10.5751/ES-12067-250419

Tocco, C. L., Frehen, L., Forse, A., Ferraro, G., & Failler, P. (2024). Land-sea interactions in European marine governance: State of the art, challenges and recommendations. *Environmental Science & Policy*, *158*, Article 103763. https://doi.org/10.1016/j.envsci.2024.103763

Trubbach, S., Sander, G., & Sævold, M. H. (2025). Beneath the surface: Can the Oslofjord plan create transformative change through institutional Layering? *Ocean and Society*, *2*, Article 10340. https://doi.org/10.17645/oas.10340

Van Assche, K., Beunen, R., & Duineveld, M. (2013). *Evolutionary governance theory: An introduction*. Springer.

Van Assche, K., Hornidge, A. K., Schlüter, A., & Vaidianu, N. (2020). Governance and the coastal condition: Towards new modes of observation, adaptation and integration. *Marine Policy*, *112*, Article 103413. https://doi.org/10.1016/j.marpol.2019.01.002

Vitale, C., Crabbé, A., Meijerink, S., Fletcher, C., Nijamdeen, T. W. G. F. M., & Wiering, M. (2025). Understanding flood governance in the Dutch-Flemish Scheldt estuary: An evolutionary governance perspective. *Ocean and society*, *2*, Article 10330. https://doi.org/10.17645/oas.10330

About the Authors

Raoul Beunen is a professor of environmental governance at the Open University, the Netherlands. His research explores the potentials and limitations of environmental policy and planning from the perspective of adaptive governance and sustainability. It focuses on innovation and evolution in governance, paying attention to the dynamics of policy implementation and integration, multi-level governance, stakeholder involvement, and the performance of institutional structures.

Gianluca Ferraro is an associate professor in environmental governance at the University of Portsmouth (Centre for Blue Governance) and a visiting professor at the University of Valencia. His research examines policy implementation, public participation, institutional change, and subnational governance. He is the scientific coordinator of the Horizon Europe project BlueGreen Governance.

Ocean and Society
2025 • Volume 2 • Article 10319
https://doi.org/10.17645/oas.10319

cogitatio

ARTICLE

Open Access Journal

Transformation Across Land-Sea Governance: Future Research Opportunities

Tegan Evans [1], Gianluca Ferraro [1], and Pierre Failler [2]

[1] Centre for Blue Governance, University of Portsmouth, UK
[2] UNESCO Chair in Ocean Governance

Correspondence: Tegan Evans (tegan.evans@port.ac.uk)

Submitted: 13 March 2025 **Accepted:** 14 May 2025 **Published:** 21 July 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Transformation is heralded as a solution to the diverse and interconnected crises threatening natural environments and the livelihoods of those who depend on them. Coastal governance does not exist in a vacuum, and integrated land-sea governance systems are a potential solution to the triple planetary threat of climate change, increasing pollution and biodiversity loss. A systematic literature review was undertaken to identify whether transformation is understood in a consistent manner across land-sea governance systems and to identify the status of knowledge regarding transformation across these scales to identify future research priorities. The results suggest that transformation is an emerging concept in freshwater governance compared to the well-established discussions of saltwater governance transformations. Of the 135 articles identified, 26 explicitly identified transformation, with only one article not positioning transformation as a radical social change, suggesting that a shared definition is emerging across the land-sea interface. A total of 62 case studies of transformation were identified across saltwater and freshwater environments, with articles detailing case study analyses of tools and approaches for transformation numbering 34, suggesting that place-based knowledge and analyses of transformation are well established in the literature, but that the tools or approaches to change are fragmented. These findings suggest a growing but uncoordinated body of work, which emphasises the need for future research into shared definitions, the role of transitional waters such as estuaries, and the governance landscapes that create transformation.

Keywords

blue governance; coastal governance; land-sea governance; marine governance; ocean governance; transformation; water governance

1. Introduction

Coastal environments are where global crises such as climate change, biodiversity loss, and increasing pollution are felt most tangibly through impacts such as coastal erosion, sea level rise, and the degradation of ecosystems that communities are reliant on (Armitage et al., 2017; Elliott, 2013). Solutions to such crises are called for across the land-sea interface, with governance often identified as the scale at which change should take place (Hulme, 2009). Coastal governance is an arena where multiple actors, interests, institutions, and processes co-exist and interact through various scales, sectors, and governance domains. It is the frontline where global agendas, local priorities, and resource constraints compete and coalesce into action and are experienced by local communities (Clement et al., 2024; Gerhardinger et al., 2020). Governance provides a crucial link between both social and ecological systems and represents a considerable leverage point for change, given its influence over planning and management (Clement et al., 2024). The challenges and limitations of coastal governance are well-defined in the literature, including ineffective and sectorally fragmented governance structures (Bausero-Jorcin et al., 2024; Blythe et al., 2021). The result of these deficiencies enable the continuing over-exploitation of diverse resources, habitat destruction, and species loss in critical estuarine, coastal, and marine resources at national, regional, and international levels (Elliott, 2013; Kelly et al., 2019; Rudolph et al., 2020).

At a time when the urgency of global crises is driving increased attention to identifying and operationalising solutions for transformation, the need to stocktake and understand the best ways forward is critical. An approach that prioritises and enables multiple wins across holistic systems is necessary. Coastal governance does not exist within a vacuum, and it is well established that the land-sea interface is inherently interconnected and complex, biophysically through the movement of material, organisms, and nutrients (Ensor et al., 2021) and socially through culture, economics, and reliance on resources (Barceló et al., 2024; Singh et al., 2021). These interconnections take place across the continuum of ocean, marine, coastal, water, and riverine environments (Gerhardinger et al., 2018). Land-sea governance is the integration of multiple layers of coastal, marine, and inland governance systems, managing both water and land-based activities.

Coupled with the impact of global crises, the ineffectiveness of governance has led to demands for transformation (Järnberg et al., 2023). The call for transformation in coastal and related ocean spaces has been made at diverse scales, including at the community level (Choudhury et al., 2021) and the national government level (Amundsen et al., 2018). Transformation has been positioned as a solution to global crises increasingly in literature (Bai et al., 2016; Fazey, Moug, et al., 2018; Fazey, Schäpke, et al., 2018; O'Brien, 2012), yet it remains a contested concept, fragmented in meaning and interpretation across diverse disciplines (Evans et al., 2023). Several different conceptualisations of transformation in ocean governance exist. In general, transformation can be defined in two separate ways: a radical, fundamental, and fast change that results in an unrecognisable system; or a slower, shallower, stepwise, and incremental process of change (Evans et al., 2023, 2024; O'Brien, 2012). As such, identifying which definition of transformation is most prevalent across the land-sea interface is important to ensure that future change is not paralysed by different definitions (Evans et al., 2025). Formal reviews by Evans et al. (2023) and Blythe et al. (2021) have led to a well-established understanding of the different characteristics of transformation. As such, transformation can be categorised into different meanings based on their theoretical backgrounds (Evans et al., 2023; Feola, 2015; Nalau & Handmer, 2015; Patterson et al., 2017), resulting in different definitions which in turn lead to opposing methods or principles applied in pursuit of achieving transformative change.

To date, there has been limited engagement between the concept of transformation and land-sea governance, meaning that establishing the baseline status of knowledge across these diverse spatial scales is imperative to direct future research more efficiently. Identifying whether the transformation has a consistent definition across land-sea governance systems is imperative from a theoretical perspective and for several practical reasons. From a theoretical perspective, Wittgenstein (1953) argues that for language to be meaningful, it needs to be consistent despite its need to be grounded within its use. More recently, the importance of consistency has been reasserted by Davelaar (2021), who identifies the importance of a consistent understanding of what transformation is and what it entails across complex scales. From a practical perspective, a common definition of transformation is required to ensure that action is synergistic across diverse spatial scales. In addition, a common definition of transformation is important to prevent greenwashing, whereby unsustainable practices are permitted under the guise of sustainability (Hamilton & Ramcilovic-Suominen, 2023). A common language across diverse spatial and related governance delineations would provide an entry point for change efforts towards a holistic approach to managing across the land-sea interface (Abson et al., 2017). Finally, ambiguity or conflicting definitions would present significant barriers to enacting transformation (Evans et al., 2023).

The aim of this literature review is therefore to identify and evaluate the status of knowledge and practice of transformation across the governance of the land-sea interface by examining how transformation is defined, understood, and operationalised and whether a common understanding of transformation exists. The analysis focuses specifically on how water is governed across the land-sea interface. Understanding how transformation is defined across land-sea governance systems—the what—is critical to understand if a common definition can be leveraged for change (Evans et al., 2025). Secondly, outlining the status of knowledge regarding key methods, tools, or principles used to create transformative change—the how—will provide insight into what approaches or avenues of transformation are common across different geographies and systems (Bentz et al., 2022). By drawing on these comparative insights, the findings of this review are used to recommend a future research agenda for transformation across land-sea governance. Section 2 outlines why exploring transformation across land-sea governance systems is necessary, followed by the methodological approach in Section 3. The results are detailed in Section 4, followed by the discussion and conclusions in Sections 5 and 6.

2. A Justification for Land-Sea Governance

Governing across the land-sea interface is a potentially transformative solution to many challenges facing the health and conservation of environments that are ultimately connected by water from both inland and offshore sources, including rivers and oceans (Tocco et al., 2024). The demand and call for integration in environmental, and particularly coastal governance, is not new, and stems from concerns regarding institutional fragmentation (Smith et al., 2011). Regional legal instruments such as the European Maritime Spatial Planning Directive 2014/89/EU, to some extent, advocate for governing across the land-sea interface through Articles 4(2) and 6(2)(a) and Article 7, although this is deemed insufficient (Zaucha et al., 2025) the Water Framework Directive 2000/60/EC also extends to 3 nautical miles offshore, further suggesting a rationale for land-sea governance. However, what land-sea governance looks like in practice remains poorly defined and characterised (Maragno et al., 2020; Neimane, 2020; Ramieri et al., 2024; Tocco et al., 2024). In practice, approaches that combine land and sea governance are unusual. Land and sea governance are separate, and often conflicting, spheres of governance that include policies, strategies, and

legal instruments to govern diverse activities (O'Hagan et al., 2020; Schlüter et al., 2022). Catalysed by the recognition that the health of a river will ultimately influence the health of coastal and marine environments, it is clear that solutions that promote more holistic governance structures are needed to ensure coherent and coordinated governance (Lawlor & Depellegrin, 2023; Partelow et al., 2020)

However, governance and management across the land-sea interface rarely consider these biophysical and social interdependencies, which instead are mostly considered distinct with unique priorities, approaches, and paradigms. This has previously been justified as necessary, due to the different actors, policies, resources, and conflicts present at each stage. The academic debate surrounding pathways to achieve integration of governance of land-sea governance is evolving (Tocco et al., 2024) along with growing consensus for change in the way oceans, seas, coastlines, and catchment areas are governed (McLaughlin, 2010; Rochette et al., 2015). Research regarding practical approaches to governing and managing the land-sea interface is growing (Pittman & Armitage, 2016). For example, Innocenti and Musco (2023) outline potential spatial approaches for management across the land-sea interface. Additionally, Pittman and Armitage (2016) explore how current institutions govern the land-sea interface, while Morf et al. (2022) explore how existing management approaches could consider the land-sea interface. Given the uncertainty and overlapping priorities and scales at play in land-sea governance (Banikoi et al., 2023), change is usually complex, necessitating a transformative approach (Ramesh et al., 2015).

Opportunity exists here to transform land-sea governance by creating governance systems that incorporate the complexity and overlaps. A promising and innovative way this land-sea interface has been embedded into policy is the African Union's (2019) Blue Economy Strategy, where the blue economy encompasses groundwater, rivers, lakes, coastal, and marine environments. However, examples such as this are scarce due to the complexity of managing such diverse environments holistically. To understand how transformation can be achieved across land-sea governance, it is necessary to outline firstly what transformation means across these domains, and how solutions are idealised.

3. Methods

3.1. Systematic Review Protocol

A systematic literature review was used to understand and outline the divergent interpretations of transformation used across varying spatial dimensions of the land-sea interface. Systematic reviews have been used in transformation literature (Evans et al., 2023) and in literature exploring land-sea governance (Pittman & Armitage, 2016) and are valuable tools in appraising the current status of knowledge and identifying future research needs. This article represents the first attempt at combining the two fields through a systematic review process.

The land-sea interface was segmented into different common spatial dimensions, and Boolean search terms were used, as outlined in Table 1. Search terms from an ocean perspective included "ocean," "marine," "coastal," and "blue," which represent the distinct spatial forms of governance that exist spatially. From a land-based water perspective, "watershed" and "catchment" search terms were used. These terms are deliberately broad, with the assumption that such terms would capture diverse forms of governance within these framings, including riverine—and lake-based governance. Various other land-based water search terms

Table 1. Search terms and justification.

Search term	Justification
Blue	An emerging paradigm related to blue growth, blue carbon, and the blue economy (Auad & Fath, 2022). Although used more commonly in socio-economic discussions, the spatial extent of "blue" differs depending on the context and can just include the ocean or more holistic interpretations of water for example through the inclusion of rivers, lakes, groundwater, marine, and coastal environments (AU-IBR, 2019).
Marine	A general descriptor that can be used to describe coastal areas to oceanic zones. Marine is most often used as a spatial descriptor of national governance and management approaches, such as marine spatial planning (Ramieri et al., 2024).
Ocean	A spatial description that specifically relates to offshore waters. Governance and management approaches can include sustainable ocean plans (Haas et al., 2021; High Level Panel for a Sustainable Ocean Economy, 2022).
Coastal	Coastal areas relate specifically to where land and ocean meet. Coastal governance and management tools include integrated coastal zone management (Pittman & Armitage, 2016).
Watershed	A watershed refers to drainage basins that include rivers, lakes, and streams. Watershed governance and management approaches include integrated water resource management (Volenzo & Odiyo, 2018).
Catchment	A catchment can refer to more specific or smaller watersheds and is often used in governance and management. Catchment governance and management also includes integrated water resource management and catchment plans.

were initially considered and rejected due to the volume of literature that was generated, the analysis of which would have been beyond the scope of this research to explore.

Based on the first search conducted, as evidenced in Table 2, watershed and catchment yielded extensive results and were thus deemed satisfactory for inclusion. It was challenging to identify appropriate search terms that would encompass a variety of governance systems, without being too granular and requiring numerous search terms and searches. The spatial terms outlined in Table 1 were chosen due to their ability to encompass a variety of spatial systems and their well-established governance works of literature. For example, a catchment is often used as a more localised form of governance but is also a part of a watershed, and the terms are often used interchangeably. Search terms were identified to capture literature engaging with governance processes, planning, and dynamics across the land-sea interface, and did not include specific legal terminology such as "foreshore," which would have biased the sample towards legal analyses. From a spatial perspective, blue can generally refer to combined inland and offshore water-based environments or can instead refer to marine and ocean environments. Coastal, ocean, and marine environments exist along the same spatial continuum, but with overlapping spatial and governance considerations. It is acknowledged here that the explicit definitions associated with the search terms in Table 1 may be contested, however, the intent is to illustrate the lack of standardisation in the spatial considerations of these terms. Thus, the research leverages these inherent overlaps and synergies to explore whether transformation can be used as a concept for change across these inherently interconnected environments.

The first search was conducted on Scopus on the 20th of May 2024, and limited to peer-reviewed articles, book chapters, and reviews. It is recognised that the exclusion of "grey" literature, such as independently

published policy, research, and guidance, is a limitation of this research, and it is recommended that this be included in future analyses. Articles were included based on several exclusion and inclusion criteria, for example, articles needed to have been published after 2010 (when transformation first gained prominence in literature, immediately prior to the publication of Gelchich et al., 2010, a critical article in the field of transformation and marine governance), and written in English. The first search per spatial dimension yielded extensive results that needed refinement, as noted in Table 2. A second search for water-related governance was conducted on the 13th of August 2024, using the same search parameters for the search terms outlined in Table 1. Catchment as a search term occasionally returned distinct areas, such as estuaries, with their own complex governance arenas. Based on how these areas were related to the initial search term, decisions were made to include or exclude these papers. For example, Daniell et al. (2020) defined estuarine governance as biophysically belonging to catchments, river basins, and coastal areas, and further discussed and defined estuarine governance in this complex governance context. As such, this paper was included in the analysis as it contributed to the research objectives.

The identified papers were subject to two screening processes. The first focused on the content of the abstract. Papers that did not include "transformation" in the abstract, or did not discuss governance were removed. At this stage, duplicates across the searches were identified and recategorised to the most appropriate spatial category. The second stage of screening included a content search in-text of "transformation" and "governance" to further refine articles for analysis. At this stage, papers were removed depending on the way transformation was described. For example, papers that used transformation as a geophysical descriptor, including describing geomorphology or land use changes, such as Bellaubi et al. (2021), were excluded from the analysis. Papers were also removed depending on how "governance" was used in the paper. For example, if governance was mentioned but not the focus or scope of the article, the paper was removed. Such refinements resulted in more manageable totals across spatial dimensions of transformation.

Table 2. Search terms and the results of the first search, abstract screening, and final content search.

Search terms	First search	Papers accepted following abstract screening and removal of duplicates	Papers accepted following content screening
"Ocean," "governance," and "transformation"	84	25	23
"Marine," "governance," and "transformation"	118	23	22
"Coastal," "governance," and" transformation"	162	46	38
"Blue," "governance," and" transformation"	62	4	4
"Catchment," "transformation," and "governance"	1,091	37	25
"Watershed," "governance," and "transformation"	1,051	40	23
Total	2,568	175	135

3.2. Coding and Analysis

A mixture of deductive and inductive techniques were used for analysis to understand the status of knowledge of transformation across different spatial scales and to understand the character of transformation (Baumann et al., 2023). Firstly, a deductive structured coding framework was initially used, informed by the research questions and similar to the approach used by Zimmermann et al. (2023). In this approach, accepted papers were categorised based on location in the land-sea interface, geographic scale and location, type of paper, keywords, and location of the article. These were later clustered into broader categories, outlined in Table 3, to facilitate comparative analyses based on similar locations in the land-sea interface. These high-level inventory style classifications allowed for an inventory of papers to be created for more targeted deep dives to be undertaken based on paper type and location within the land-sea interface, allowing for comparison across different spatial areas.

Following this initial categorisation, an inductive coding approach was used to explore how transformation was understood and theorised across the different spatial delineations identified (Table 3; Evans et al., 2023; Plummer et al., 2013). In this approach, each definition of transformation was coded inductively and thematically, resulting in codes such as "radical" and "incremental," which allowed for the synthesis of the general characteristics of transformation. The more granular "focus" of each article was also identified using keywords and a general assessment of the article, for example, whether the article was primarily focused on resilience. The tools analysed to create transformation were also explored through clustering and comparison across the different spatial delineations identified.

4. Results

4.1. General Findings

A total of 135 articles were identified for inclusion in the review following the screening protocol identified in Section 3 (a full list can be found in the Supplementary File, Table 1). The results of the final screening yielded diverse papers from different disciplinary domains, with transformation occasionally not being the sole focus of the article but instead a broader implication of the research. Articles were identified between 2010 and May 2024, when the first search began. 2017 marked a turning point in the rate of transformative literature published across all spatial areas identified, where the number of identified published papers in the review doubled and continued to grow (Supplementary File, Figure 1), suggesting that transformation in land-sea governance is still an early and evolving subject.

The review identified a range of articles that discussed transformative change in governance, spanning across diverse disciplines and perspectives (Supplementary File, Table 1). There was a mostly even spread of articles identified across the original spatial descriptions used for the Boolean search, except for "blue," which yielded four papers. This is unsurprising given its relatively recent traction in governance (Table 2). As outlined in Section 3, articles identified were further categorised into the specific location of the article in the land-sea interface addressed to allow for greater nuance and a clearer understanding of the status of literature, resulting in 11 distinct spatial categories across the land-sea governance system (Table 3). These categories were inductively categorised based on the results of the review, and are shown in Table 3. Water (n = 41), coast (n = 32), and ocean (n = 24) were the most popular categories, mostly linked to specific

geographic areas and case studies. For ease of analysis and comparison, they are clustered respectively into "saltwater" environments, transitional waters, and freshwater environments (Table 3).

To understand the types of transformative literature and to outline the status of knowledge, the type of article was categorised. These categories were identified through an inductive coding of the article's purpose and scope. The review identified six types of papers, the most common of which were place-based analyses (case studies) of transformation, which included either general studies of change or studies of specific tools or approaches for change (Table 3). Case studies of specific tools for change (n = 34) were common throughout saltwater environments, and most populous in water governance. Case studies of transformation (n = 62), except for "blue," were present across all land-sea environments. Calls for change (n = 11), which advocated for transformation as a result of conceptual arguments, opinions, or other analyses but did not test any pathways or tools to achieve change, were mostly limited to saltwater environments such as marine, ocean, and blue governance. One theory paper was identified in water governance that instead focused on the theoretical foundations of transformation. Tools for change (n = 23), which proposed different ways of achieving transformation but did not test these in any place-based analyses, were most populous across coast, marine, ocean, and water categories.

Table 3. Areas of land-sea governance against types of paper-coded.

	Specific category	Call for change	Case study	Guidance for transformation	Theory	Tool for change	Tool for change/case study
Saltwater	Blue	3	0	0	0	0	1
	Coast	1	17	2	0	5	7
	Marine	2	9	0	0	2	5
	Ocean	2	7	2	0	9	4
	Marine and coastal	0	2	0	0	1	0
Transitional waters	Water	3	16	0	1	6	15
	Land-sea interface	0	1	0	0	0	1
	Estuary	0	1	0	0	0	0
Freshwater	Catchment	0	1	0	0	0	0
	River basin	0	5	0	0	0	1
	Wetlands	0	3	0	0	0	0
Total		11	62	4	1	23	34

71% of the articles identified were linked to a specific geographic location such as continents, countries, and regions (Supplementary File, Table 1). Most of these papers were specific case studies of change processes, or case studies where tools for transformation were tested (Figure 1). 29 separate countries were identified as case studies or case studies where tools of transformation were explored (Supplementary File, Figure 2 and Table 1). 23 articles included multiple countries. When compared at a continental level, in general, there was a fairly even spread of articles across continents, suggesting a growing field of empirical study of transformation. Europe had nine case studies, and Asia, South America, and North America had seven case studies each. Africa and Oceania had five case studies each (Figure 1). Specific countries with the highest number of articles included Brazil (n = 7), Canada, Australia, and South Africa (n = 6 each). 11 countries had

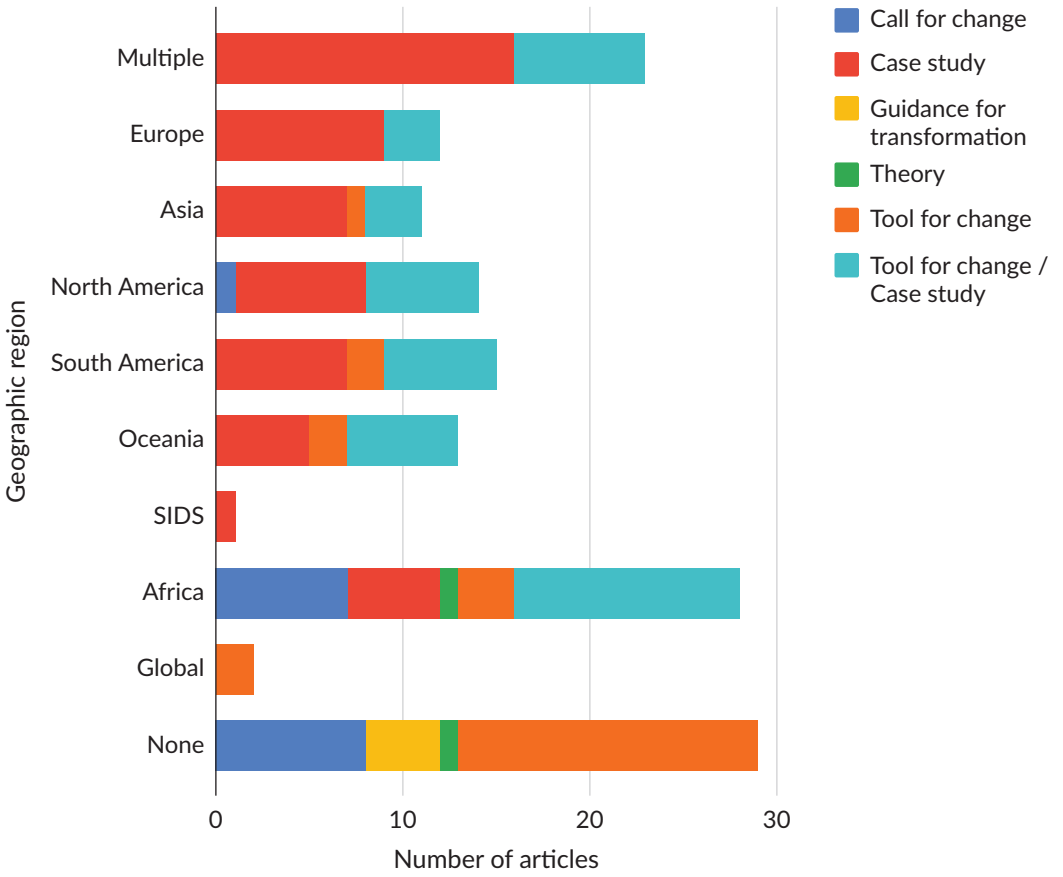


Figure 1. Geographic regions and types of paper identified.

only one article identified each, including Iran, Indonesia, Portugal, and the Maldives (Supplementary File, Table 1). The remaining papers not linked to a geographic location were mostly arguments and conceptualisations of different tools for change that were not linked to a case study (n = 16) and calls for change (n = 8; Supplementary File, Table 1).

In summary, there is a growing body of empirical research regarding transformation across land-sea governance. Water governance was the most popular category, yet difficult to parameterise and define, with the commonality across articles being that they concerned "water." Diverse article types were identified, including case studies of transformation in situ, ranging in scale from communities and sector-specific governance to national and regional approaches, to theoretical articles outlining considerations for transformative change. The high number of case study papers suggests an analytical turn to understanding how transformations occur, yet these tend to be national in scope.

4.2. The "What": Defining Transformation

Of the 135 articles identified in this analysis, only 26 (18%) provided a definition of transformation, representing a significant limitation in asserting which definitions of transformation can be leveraged for change across land-sea governance. Of the 26 articles that did define transformation, one conflated the concepts of transition (Ferguson et al., 2013), meaning that only 25 provided an explicit definition solely of

transformation, as the two concepts are not interchangeable (Hölscher et al., 2018). Of the 25, six were definitions of the author's conception, ranging in detail from institutional change (Dale et al., 2018) to detailed descriptions of the character of transformation (Schlüter et al., 2021). All but one definition of transformation described such change as being radical or fundamental in nature, representing a change that must address deeply entrenched norms, processes, and structures in order to facilitate the depth of change required (Temper et al., 2018). One article contrasted this perspective; Clement et al. (2024) described transformation as being incremental in character, which contrasted the prevailing view, and instead advocated for smaller, stepwise changes.

Of these 25 papers with definitions, 13 were case studies of change, six were evaluations of tools of change in a case study, five were descriptions of tools of change, and one provided guidance for transformation. Eight of the 25 papers with a definition of transformation were coastal, seven focused on water, and five focused on the ocean. Marine and coastal had two articles coded each, and catchment and land-sea interface had one definition each. These findings suggest that a more cohesive and standard understanding of transformation exists in coastal, water, and ocean literature.

These findings indicate that an early common understanding of transformation can be identified across land-sea governance systems, with this understanding of transformation being a radical and wide-ranging change. While the total number of papers that explicitly define transformation is small, areas for future research can be identified, as discussed in Section 5.

4.3. The "How": Understanding Methods, Tools, and Approaches to Transformation

Methods, approaches, or tools for transformation were diverse (Supplementary File, Table 1). In total, 57 articles discussed tools for transformation (including case studies where tools were evaluated). Tools are diverse, ranging from well-established concepts such as legitimacy, justice, and adaptive governance to more niche tools, such as virtualism, hope, and social networks (Supplementary File, Figure 3). Except for water ($n = 19$), most articles were identified in saltwater categories, with ocean ($n = 12$), coast ($n = 11$), and marine ($n = 7$) having the highest number of articles. In general, there were high levels of diversity across the types of tools identified, with 32 unique tools identified (Supplementary File, Figure 3). Only 14 tools had more than one article coded and identified (Figure 2). Resilience and adaptive governance, often linked to climate change adaptation, were the most identified, with resilience being identified in coastal literature ($n = 2$), and ocean and water governance literature ($n = 1$ each). The six most prevalent methods for transformation are all rooted in social science literature and approaches, representing well-established fields such as resilience, adaptation, stakeholder engagement, justice, and knowledge (Figure 2).

In addition to these more nuanced spatial categories, the scale of the article was also categorised to provide deeper insight into the distribution of tools for transformation. For example, national scale studies were most common, with 10 case studies, eight studies of tools of change in case studies, and four articles exploring tools for change. Community-level studies were the second most common with nine case studies and seven analyses of tools for change in specific case studies (Supplementary File, Figure 4).

In summary, diverse methods, tools, and approaches for transformation were identified, with limited consensus regarding the tools identified. Despite this, nearly all tools and approaches identified were

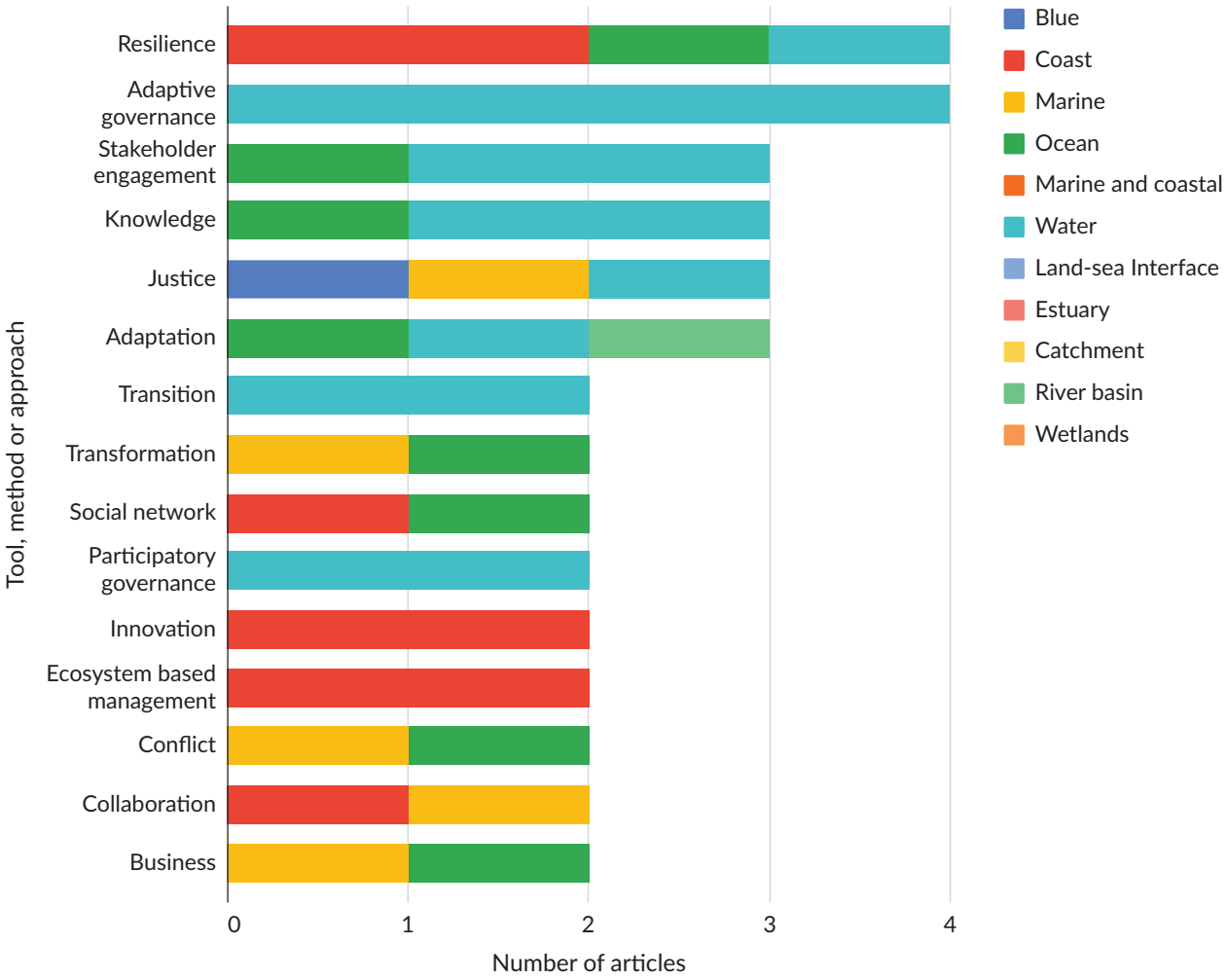


Figure 2. Number of tools, methods, and approaches identified across articles.

fundamentally social in character, suggesting that across land-sea governance systems, social tools can be leveraged to create change. It was also identified that tools for transformation are more established in saltwater governance than in freshwater.

5. Discussion

5.1. The "What": Comparing Definitions of Transformation

To generate a research agenda for transformation across land-sea governance, the status of knowledge and evidence must be appraised and common ground identified. Necessitated by the fact that divergent definitions of transformation can have implications for the nature and character of change that is employed to achieve it (Davelaar, 2021; Evans et al., 2025), this review has sought to identify opportunities for future research. Building on existing theoretical frameworks of transformation (Evans et al., 2023; Nalau & Handmer, 2015), the review identified an emerging common language of transformation across land-sea governance. Transformation was regarded as an inherently "fundamental" and socio-ecological process of change that mirrors existing literature. However, the finding that only 21 papers of 135 explicitly define

transformation suggests that across land-sea governance domains, a common understanding is still nascent. The lack of specific definitions of transformation adds weight to the assertion that definitions of transformation are generally assumed to be a widely agreed-upon concept, which presents major risks and challenges to the creation of transformative solutions (Evans et al., 2024).

Building on these synergies, the social character of transformation was observed across all definitions except one. In freshwater governance, transformation was particularly regarded by several articles as a process that expands beyond governance structures and processes driven by societal dependence on the health of water environments (Jentoft & Chuenpagdee, 2022; Knieper & Pahl-Wostl, 2016). Knieper and Pahl-Wostl (2016) recommend that the transformation of water governance be achieved through broader societal transformations towards sustainable water practices as a "whole of society" approach, including behaviour change, rather than focusing on the mitigation of such pressures. This mirrors approaches advocated for in catchment governance (Pringle et al., 2023) and ocean governance (Bennett et al., 2021). As explored in Section 5.2, this characterisation leads to significant opportunities to explore interconnected social tools and approaches to creating transformation.

Connected to the limited explicit definitions of transformation, are the contradictory calls for transformation across saltwater and environmental governance. Calls for change tended to be saltwater-centric (Bouwer et al., 2022; Jentoft & Chuenpagdee, 2022; Nagy & Nene, 2021) with fewer calls for change across freshwater governance, mirroring the assertion from Albrecht et al. (2023, p. 50) that water governance literature "lacks a nuanced, empirically reasoned, understanding of intentional change…[and] transformation." This suggests that transformation is more regarded as a desired solution in saltwater governance, and recognition of the drivers of transformation remains nascent in freshwater governance. Opportunity exists for a broader reflection of the drivers of change in freshwater governance systems, which will ground truth and contextualise transformative interventions. The review also identified limited articles that provided guidance for transformation, with guidance only identified in coastal governance (Kuhl et al., 2021) and ocean governance (Lombard et al., 2023). Opportunity therefore exists to create specific guidance for transformation across land-sea governance through a more detailed synthesis of the wealth of case studies identified in this research. Such guidance should include identifying common barriers and enablers of transformation, reflecting the practical experiences of transformation in motion.

5.2. The "How": Comparing Methods, Tools, and Approaches to Transformation

Understanding how transformation has been achieved throughout diverse case study contexts and scales is necessary to identify the best practices, potential barriers to change, and to understand potential synergies in approaches across spatial scales in land-sea governance systems. The abundance and diversity of case studies identified in this research, including those evaluating specific tools or approaches to transformation, is surprising, given previous demands for more empirical and localised studies of transformation in governance systems (Blythe et al., 2021; Evans et al., 2023). Case studies were identified across all identified categories of the land-sea interface, except for "blue," which remains an evolving concept. Case studies ranged in scale, with the most common being national-level analyses, but detailed analyses of transformative processes tended to be localised, for example, focusing specifically on marine small-scale fisheries (Chuenpagdee & Jentoft, 2022). Specific gaps exist regarding case studies of transformation in African states, Oceania, the Middle East, and SIDS, where little literature was identified suggesting specific research priorities. In addition, there is a

significant opportunity for greater comparative analysis across case studies to identify regional and contextual conditions shaping transformation. A significant opportunity exists to undertake a large-scale synthesis of these case studies to identify consistent barriers and opportunities to transformation.

A wealth of tools and approaches to achieve transformation were identified, the majority of which were social in character, mirroring the "whole of society" approach often identified. The majority of tools and approaches identified had isolated examples of use, suggesting that tools for transformation remain nascent. This confirms the argument that further research regarding transformation's practical applications is needed to identify how transformation is achieved in land-sea governance, mirroring the demand for practical tools for change in general transformational literature (Bai et al., 2016; Fazey, Schäpke, et al., 2018; O'Brien, 2012). Few tools were identified more than twice in literature, with the most discussed approach being resilience, although only four articles identified it in total, suggesting that this is still a potential niche approach to transformation. Alternatively, it may suggest the tools are not regarded as transferable and are instead tailored for a specific context. In general, no specific tool or approach to transformation can be considered common across land-sea governance, although the social character of the most common tools of change does represent a significant entry point into designing transformative interventions. For example, despite the overarching focus of the articles analysed being distilled into a singular category for the purposes of this research, many categories are interconnected and interdependent. The difficulty in identifying definitive tools for transformation may reflect broader conceptual and terminology inconsistencies in the literature regarding land-sea governance.

The interdependencies of social processes and tools for transformation were also observed. Power and knowledge were positioned by Jentoft and Chuenpagdee (2022) as having the combined potential to transform institutions of governance. For example, justice is positioned by Biancardi Aleu et al. (2022) as a way to reimagine the purpose of participatory governance processes in water governance (Foster et al., 2016). Recognising the interconnections of multiple pathways to transformation is critical in achieving change. A specific opportunity exists to link concepts of justice that were identified across the water, blue, and marine systems and explore how these can relate to freshwater governance systems and is an area for future research. Despite limited examples identified in this study regarding the importance of justice in transformational change, broader literature positions the inclusion and mainstreaming of these approaches as fundamental to achieving transformation.

5.3. Limitations of the Review and Future Research Suggestions

Several challenges were identified in this review of land-sea governance transformations, the most significant being the lack of conceptual clarity surrounding water governance. Reflecting the inherent conceptual challenges of governance, and exacerbated by the additional conceptual challenges of transformation, the ability to clearly articulate the inclusions and exclusions of water governance would be critical to identifying synergies and conflicts across land-sea governance. The growing importance of transformation in water governance, driven by climate change and the importance of water quality and access, represents an imperative for future research (Räsänen et al., 2019). As evidenced in this review, transformation in traditional saltwater governance systems is well-characterised, and its barriers and limitations are well-established. In contrast, only one article explicitly explored the concept of transformation in water governance and appraised the concept and its utility (Pahl-Wostl, 2020; Pahl-Wostl

et al., 2020). Pahl-Wostl (2020) identifies significant barriers to transformation in water governance, regardless of scale or context, that align with the barriers of saltwater governance.

Despite water being the overall most populous category, water was a difficult category of governance to delineate in this study. The scale of water governance is different to discern and depends on the context it is applied to, resulting in very different focuses and priorities, making common ground difficult to identify. For example, whether water governance includes a domestic river basin, transboundary basins, or water supply systems is often not clear (Knieper & Pahl-Wostl, 2016). Water governance, as evidenced in this review, has a similar diversity of scopes and spatial considerations, with limited consensus regarding what falls within or beyond its scope. The broadness of what is considered "water" was challenging to disaggregate into further categories for spatial comparison. Research to date has focused mostly on individual cases of water governance, yielding "substantially different" governance focuses, with limited synthesis of the general characteristics of water governance (Dale et al., 2018, p. 71). Thus, a significant future research opportunity lies in untangling what are the essential scope, characteristics, and parameters of "water" governance, which will provide a comparative baseline for future research.

Meissner and Jacobs (2016) suggest complexity theory as a pathway to understanding water governance, specifically as a way to understand the complicated networks as a way to understand diverse actors across international river basins. Building on the well-established characterisation of traditional saltwater governance as a messy and fragmented arena, with multiple priorities, actors, and perspectives shaping governance at different scales (Banikoi et al., 2023), complexity theory offers a way to understand interconnections between land-sea governance. Complexity theory centralises the dynamic, interconnected nature of both governance systems, and represents a significant pathway for further research (Folke, Carpenter, et al., 2004; Folke, Hahn, et al., 2005). Additionally, complexity theory lends well to adaptive governance, which was identified in this review as a potential tool or approach for change (Chaffin et al., 2016).

Governance of transitional environments, such as estuaries, was less explored in this review due to their lack of identification by the structured search protocol, representing a limitation of the study. Focusing on transitional environmental governance in the land-sea interface, such as estuaries, would be a valuable future research pathway, as land and sea-based governance do not manage these environments effectively (Daniell et al., 2020). Such transitional environments face both land-based and water-based pressures, and there is an urgent need to focus research on the governance of such areas to explore how these transitional areas can inform broader governance transformations.

Finally, the systematic review undertaken has several inherent methodological limitations, such as the potential for selection bias in the initial filtering phase or unintentional bias in reporting (Owens, 2021). The protocols used in this review aim to ensure that the results are transparent and reproducible, particularly through the reporting of the search terms in Table 1 and the full list of accepted articles in Supplementary File, Table 1. The exclusion of grey literature from the search terms is also a limitation of the study, which presents an interesting avenue of further study regarding how transformation and, particularly, the tools of transformation are operationalised.

6. Conclusion

In summary, while there is growing recognition of the need for transformation across land-sea governance systems, challenges remain in defining the concept clearly and developing practical tools for implementation. In particular, water governance remains fragmented as a concept with diverse interpretations and limited consensus regarding scope. Additionally, a more detailed exploration of transitional water environments, such as estuaries, should be prioritised as these were not identified in this study. This review has outlined the status of scientific knowledge surrounding the conceptualisation and operationalisation of transformation across land-sea governance systems, highlighting the challenges of integrated complex governance systems. Future research should address these gaps, with a focus on empirical case studies, the development of common frameworks, and the application of complexity and adaptive governance theories.

The review has identified an early shared understanding of transformation across land-sea governance systems, which, potentially through further research, can be leveraged for future change. While the concept is widely discussed, only a small portion of the literature provides clear definitions, highlighting the need for a more standardised understanding of transformation to guide governance practices effectively. Further research identifying how the shared "social" character of transformation across land-sea governance can be effectively operationalised is needed. In addition, this review has provided an inventory of transformation as a concept across the land-sea interface, providing a geographic, spatial, and analytical catalogue of transformative solutions, theory, and practice. Finally, this review has provided a comprehensive catalogue of transformative tools and approaches across land-sea governance systems, offering valuable geographic, spatial, and analytical frameworks to guide future efforts.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024-2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Conflict of Interests

In this article, editorial decisions were undertaken by Raoul Beunen (Open University of the Netherlands, The Netherlands).

Supplementary Material

Supplementary files are not copy-edited nor proofread by the Editorial Office, and it is the authors' responsibility to guarantee the scientific accuracy of these files.

References

Abson, D. J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C. D., Jager, N. W., & Lang, D. J. (2017). Leverage points for sustainability transformation. *Ambio*, *46*, 30–39. https://doi.org/10.1007/s13280-016-0800-y

AU-IBAR. (2019). *Africa blue economy strategy*. https://faolex.fao.org/docs/pdf/au228027.pdf

Albrecht, E., Lukkarinen, J., Hakkarainen, M., & Soininen, N. (2023). Hydropowering sustainability transformation: Policy frames on river use and restoration in Finland. *Fennia—International Journal of Geography*, *201*(1), 47–64. https://doi.org/10.11143/fennia.120946

Amundsen, H., Hovelsrud, G. K., Aall, C., Karlsson, M., & Westskog, H. (2018). Local governments as drivers for societal transformation: Towards the 1.5°C ambition. *Current Opinion in Environmental Sustainability*, *31*, 23–29. https://doi.org/10.1016/j.cosust.2017.12.004

Armitage, D., Alexander, S., Andrachuk, M., Berdej, S., Brown, S., Nayak, P., Pittman, J., & Rathwell, K. (2017). Communities, multi-level networks and governance transformations in the coastal commons. In D. Armitage, A. Charles, & F. Berkes (Eds.), *Governing the coastal commons* (pp. 231–251). Routledge. https://www.taylorfrancis.com/books/9781317421283/chapters/10.4324/9781315688480-13

Auad, G., & Fath, B. D. (2022). Towards a flourishing blue economy: Identifying obstacles and pathways for its sustainable development. *Current Research in Environmental Sustainability*, *4*, Article 100193. https://doi.org/10.1016/j.crsust.2022.100193

Bai, X., van der Leeuw, S., O'Brien, K., Berkhout, F., Biermann, F., Brondizio, E. S., Cudennec, C., Dearing, J., Duraiappah, A., Glaser, M., Revkin, A., Steffen, W., & Syvitski, J. (2016). Plausible and desirable futures in the Anthropocene: A new research agenda. *Global Environmental Change*, *39*, 351–362. https://doi.org/10.1016/j.gloenvcha.2015.09.017

Banikoi, H., Schlüter, A., & Manlosa, A. O. (2023). Understanding transformations in the marine coastal realm: The explanatory potential of theories of institutional change. *Marine Policy*, *155*, Article 105791. https://doi.org/10.1016/j.marpol.2023.105791

Barceló, M., Tengö, M., Simonetti, J. A., & Gelcich, S. (2024). Exploring links between local knowledge, values and livelihoods in land-sea interface: Insights on emerging tradeoffs and change in Southern Chile. *Ecosystems and People*, *20*(1), Article 2329562. https://doi.org/10.1080/26395916.2024.2329562

Baumann, L., Riechers, M., Celliers, L., & Ferse, S. C. A. (2023). Anticipating and transforming futures: A literature review on transdisciplinary coastal research in the Global South. *Ecosystems and People*, *19*(1), Article 2288957. https://doi.org/10.1080/26395916.2023.2288957

Bausero-Jorcin, S., Gelcich, S., Gianelli, I., Jorge-Romero, G., Lezama, C., & Defeo, O. (2024). Assessing the performance of a participatory governance transformation in small-scale fisheries: A case study from Uruguay. *Marine Policy*, *160*, Article 105964. https://doi.org/10.1016/j.marpol.2023.105964

Bellaubi, F., Mallarach, J. M., & Sardá, R. (2021). A geoethical approach to unlock a social-ecological governance problem: The case of the Tordera River (Catalonia, Spain). *Sustainability*, *13*(8), Article 4253. https://doi.org/10.3390/su13084253

Bennett, N. J., Blythe, J., White, C. S., & Campero, C. (2021). Blue growth and blue justice: Ten risks and solutions for the ocean economy. *Marine Policy*, *125*, Article 104387. https://doi.org/10.1016/j.marpol.2020.104387

Bentz, J., O'Brien, K., & Scoville-Simonds, M. (2022). Beyond "blah blah blah": Exploring the "how" of transformation. *Sustainability Science*, *17*, 497–506. https://doi.org/10.1007/s11625-022-01123-0

Biancardi Aleu, R., Kløcker Larsen, R., & Methner, N. (2022). Participation and marginalization in water governance: Probing the agency of powerholders. *Ecology and Society*, *27*(4), Article 33. https://doi.org/10.5751/ES-13680-270433

Blythe, J., Armitage, D., Bennett, N., Silver, J. J., & Song, A. M. (2021). Conditions and cautions for transforming ocean governance. In J. Baird & R. Plummer (Eds.), *Water resilience: Management and governance in times of change* (pp. 241–261). Springer. https://link.springer.com/book/10.1007/978-3-030-48110-0

Bouwer, L. M., Cheong, S. M., Jacot Des Combes, H., Frölicher, T. L., McInnes, K. L., Ratter, B. M. W., &

Rivera-Arriaga, E. (2022). Risk management and adaptation for extremes and abrupt changes in climate and oceans: Current knowledge gaps. *Frontiers in Climate*, *3*, Article 785641. https://doi.org/10.3389/fclim.2021.785641

Chaffin, B. C., Garmestani, A. S., Gunderson, L. H., Benson, M. H., Angeler, D. G., Tony, C. A., Cosens, B., Craig, R. K., Ruhl, J. B., & Allen, C. R. (2016). Transformative environmental governance. *Annual Review of Environment and Resources*, *41*, 399–423. https://doi.org/10.1146/annurev-environ-110615-085817

Choudhury, M.-U.-I., Haque, C. E., & Hostetler, G. (2021). Transformative learning and community resilience to cyclones and storm surges: The case of coastal communities in Bangladesh. *International Journal of Disaster Risk Reduction*, *55*, Article 102063. https://doi.org/10.1016/j.ijdrr.2021.102063

Clement, S., Jozaei, J., Mitchell, M., Allen, C. R., & Garmestani, A. S. (2024). How resilience is framed matters for governance of coastal social-ecological systems. *Environmental Policy and Governance*, *34*(1), 65–76. https://doi.org/10.1002/eet.2056

Dale, A. P., Vella, K., Gooch, M., Potts, R., Pressey, R. L., Brodie, J., & Eberhard, R. (2018). Avoiding implementation failure in catchment landscapes: A case study in governance of the Great Barrier Reef. *Environmental Management*, *62*, 70–81. https://doi.org/10.1007/s00267-017-0932-2

Daniell, K. A., Plant, R., Pilbeam, V., Sabinot, C., Paget, N., Astles, K., Steffens, R., Barreteau, O., Bouard, S., Coad, P., Gordon, A., Ferrand, N., Le Meur, P.-Y., Lejars, C., Maurel, P., Rubio, A., Rougier, J.-E., & White, I. (2020). Evolutions in estuary governance? Reflections and lessons from Australia, France and New Caledonia. *Marine Policy*, *112*, Article 103704. https://doi.org/10.1016/j.marpol.2019.103704

Davelaar, D. (2021). Transformation for sustainability: A deep leverage points approach. *Sustainability Science*, *16*, 727–747. https://doi.org/10.1007/s11625-020-00872-0

Elliott, M. (2013). The *10-tenets* for integrated, successful and sustainable marine management. *Marine Pollution Bulletin*, *74*(1), 1–5. https://doi.org/10.1016/j.marpolbul.2013.08.001

Ensor, J., Tuhkanen, H., Boyland, M., Salamanca, A., Johnson, K., Thomalla, F., & Lim Mangada, L. (2021). Redistributing resilience? Deliberate transformation and political capabilities in post-Haiyan Tacloban. *World Development*, *140*, Article 105360. https://doi.org/10.1016/j.worlddev.2020.105360

Evans, T., Fletcher, S., Failler, P., & Potts, J. (2023). Untangling theories of transformation: Reflections for ocean governance. *Marine Policy*, *155*, Article 105710. https://doi.org/10.1016/j.marpol.2023.105710

Evans, T., Fletcher, S., Failler, P., Fletcher, R., & Potts, J. (2024). Radical and incremental, a multi-leverage point approach to transformation in ocean governance. *Sustainability Science*, *19*, 1243–1258. https://doi.org/10.1007/s11625-024-01507-4

Evans, T., Fletcher, S., Failler, P., & Potts, J. (2025). Typologies of transformation—Visualizing different understandings of change for sustainability. *Sustainability*, *17*(9), Article 4075.

Fazey, I., Moug, P., Allen, S., Beckmann, K., Blackwood, D., Bonaventura, M., Burnett, K., Danson, M., Falconer, R., Gagnon, A. S., Harkness, R., Hodgson, A., Holm, L., Irvine, K. N., Low, R., Lyon, C., Moss, A., Moran, C., Naylor, L., . . . Wolstenholme, R. (2018). Transformation in a changing climate: A research agenda. *Climate and Development*, *10*(3), 197–217. https://doi.org/10.1080/17565529.2017.1301864

Fazey, I., Schäpke, N., Caniglia, G., Patterson, J., Hultman, J., van Mierlo, B., Säwe, F., Wiek, A., Wittmayer, J., Aldunce, P., Al Waer, H., Battacharya, N., Bradbury, H., Carmen, E., Colvin, J., Cvitanovic, C., D'Souza, M., Gopel, M., Goldstein, B., . . . Wyborn, C. (2018). Ten essentials for action-oriented and second order energy transitions, transformations and climate change research. *Energy Research and Social Science*, *40*, 54–70. https://doi.org/10.1016/j.erss.2017.11.026

Feola, G. (2015). Societal transformation in response to global environmental change: A review of emerging concepts. *Ambio*, *44*, 376–390. https://doi.org/10.1007/s13280-014-0582-z

Ferguson, B. C., Brown, R. R., & Deletic, A. (2013). A diagnostic procedure for transformative change based on transitions, resilience, and institutional thinking. *Ecology and Society*, *18*(4), Article 57. https://doi.org/10.5751/ES-05901-180457

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., & Holling, C. S. (2004). Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics*, *35*, 557–581. https://doi.org/10.1146/annurev.ecolsys.35.021103.105711

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources*, *30*, 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Foster, N., Collins, K., Ison, R., & Blackmore, C. (2016). Water governance in England: Improving understandings and practices through systemic co-inquiry. *Water*, *8*(11), Article 540. https://doi.org/10.3390/w8110540

Gerhardinger, L. C., Andrade, M. M. D., Corrêa, M. R., & Turra, A. (2020). Crafting a sustainability transition experiment for the brazilian blue economy. *Marine Policy*, *120*, Article 104157. https://doi.org/10.1016/j.marpol.2020.104157

Gerhardinger, L. C., Gorris, P., Gonçalves, L. R., Herbst, D. F., Vila-Nova, D. A., De Carvalho, F. G., Glaser, M., Zondervan, R., & Glavovic, B. C. (2018). Healing Brazil's blue Amazon: The role of knowledge networks in nurturing cross-scale transformations at the frontlines of ocean sustainability. *Frontiers in Marine Science*, *4*, Article 395. https://doi.org/10.3389/fmars.2017.00395

Haas, B., Mackay, M., Novaglio, C., Fullbrook, L., Murunga, M., Sbrocchi, C., McDonald, J., McCormack, P. C., Alexander, K., Fudge, M., Goldsworthy, L., Boschetti, F., Dutton, I., Dutra, L., McGee, J., Rousseau, Y., Spain, E., Stephenson, R., Vince, J., . . . Haward, M. (2021). The future of ocean governance. *Reviews in Fish Biology and Fisheries*, *32*, 253–570. https://doi.org/10.1007/s11160-020-09631-x

Hamilton, R. T. V., & Ramcilovic-Suominen, S. (2023). From hegemony-reinforcing to hegemony-transcending transformations: Horizons of possibility and strategies of escape. *Sustainability Science*, *18*, 737–748. https://doi.org/10.1007/s11625-022-01257-1

High Level Panel for a Sustainable Ocean Economy. (2022). *100% sustainable ocean management: An introduction to sustainable ocean plans*. https://oceanpanel.org/wp-content/uploads/2022/06/21_REP_Ocean-SOP_v10.pdf

Hölscher, K., Wittmayer, J. M., & Loorbach, D. (2018). Transition versus transformation: What's the difference? *Environmental Innovation and Societal Transitions*, *27*, 1–3. https://doi.org/10.1016/j.eist.2017.10.007

Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction and opportunity*. Cambridge University Press.

Innocenti, A., & Musco, F. (2023). Land–sea interactions: A spatial planning perspective. *Sustainability*, *15*(12), Article 9446.

Järnberg, L., Vulturius, G., & Ek, F. (2023). Strategic agency and learning in sustainability initiatives driving transformation: The symphony tool for ecosystem-based marine spatial planning. *Sustainability Science*, *18*, 1149–1161. https://doi.org/10.1007/s11625-022-01286-w

Jentoft, S., & Chuenpagdee, R. (2022). Interactive learning and governance transformation for securing blue justice for small-scale fisheries. *Administration and Society*, *54*(7), 1255–1282. https://doi.org/10.1177/00953997211073947

Kelly, C., Ellis, G., & Flannery, W. (2019). Unravelling persistent problems to transformative marine governance. *Frontiers in Marine Science*, *6*, Article 213. https://doi.org/10.3389/fmars.2019.00213

Knieper, C., & Pahl-Wostl, C. (2016). A comparative analysis of water governance, water management, and environmental performance in river basins. *Water Resources Management*, *30*, 2161–2177. https://doi.org/10.1007/s11269-016-1276-z

Kuhl, L., Rahman, M. F., McCraine, S., Krause, D., Hossain, M. F., Bahadur, A. V., & Huq, S. (2021). Transformational adaptation in the context of coastal cities. *Annual Review of Environment and Resources*, *46*, 449–479. https://doi.org/10.1146/annurev-environ-012420-045211

Lawlor, P., & Depellegrin, D. (2023). Managing land sea interactions: Case studies of coastal governance in four EU member states. In S. Partelow, M. Hadjimichael, & A-K. Hornidge (Eds.). *Ocean governance: Knowledge systems, policy foundations and thematic analyses* (pp. 209–230). Springer.

Lombard, A. T., Clifford-Holmes, J., Goodall, V., Snow, B., Truter, H., Vrancken, P., Jones, P. J. S., Cochrane, K., Flannery, W., Hicks, C., Gipperth, L., Allison, E. H., Diz, D., Peters, K., Erinosho, B., Levin, P., Holthus, P., Szephegyi, M. N., Awad, A., . . . Morgera, E. (2023). Principles for transformative ocean governance. *Nature Sustainability*, *6*, 1587–1599. https://doi.org/10.1038/s41893-023-01210-9

Maragno, D., dall'Omo, C. F., Pozzer, G., Bassan, N., & Musco, F. (2020). Land–sea interaction: Integrating climate adaptation planning and maritime spatial planning in the North Adriatic Basin. *Sustainability*, *12*(13), Article 5319.

McLaughlin, R. J. (2010). A review of coastal governance. *Ocean and Coastal Law Journal*, *16*(2), Article 12.

Meissner, R., & Jacobs, I. (2016). Theorising complex water governance in Africa: The case of the proposed Epupa Dam on the Kunene River. *International Environmental Agreements: Politics, Law and Economics*, *16*, 21–48. https://doi.org/10.1007/s10784-014-9250-9

Morf, A., Moodie, J., Cedergren, E., Eliasen, S. Q., Gee, K., Kull, M., Mahadeo, S., Husa, S., & Vološina, M. (2022). Challenges and enablers to integrate land-sea-interactions in cross-border marine and coastal planning: Experiences from the pan Baltic scope collaboration. *Planning Practice & Research*, *37*(3), 333–354. https://doi.org/10.1080/02697459.2022.2074112

Nagy, H., & Nene, S. (2021). Blue gold: Advancing blue economy governance in Africa. *Sustainability*, *13*(13), Article 7153. https://doi.org/10.3390/su13137153

Nalau, J., & Handmer, J. (2015). When is transformation a viable policy alternative? *Environmental Science and Policy*, *54*, 349–356. https://doi.org/10.1016/j.envsci.2015.07.022

Neimane, L. (2020, April 23–24). *Identifying challenges to implementation of maritime spatial plans in the Baltic States* [Paper presentation]. Proceedings of the 62nd Internafional Scienfific Conference of Daugavpils University, Daugavpils, Latvia.

O'Brien, K. (2012). Global environmental change II: From adaptation to deliberate transformation. *Progress in Human Geography*, *36*(5), 667–676. https://doi.org/10.1177/0309132511425767

O'Hagan, A. M., Paterson, S., & Le Tissier, M. (2020). Addressing the tangled web of governance mechanisms for land-sea interactions: Assessing implementation challenges across scales. *Marine Policy*, *112*, Article 103715. https://doi.org/10.1016/j.marpol.2019.103715

Owens, J. K. (2021). Systematic reviews: Brief overview of methods, limitations, and resources. *Nurse Author and Editor*, *31*(3/4), 69–72.

Pahl-Wostl, C. (2020). Adaptive and sustainable water management: From improved conceptual foundations to transformative change. *International Journal of Water Resources Development*, *36*(2/3), 397–415. https://doi.org/10.1080/07900627.2020.1721268

Pahl-Wostl, C., Knieper, C., Lukat, E., Meergans, F., Schoderer, M., Schütze, N., Schweigatz, D., Dombrowsky, I., Lenschow, A., Stein, U., Thiel, A., Tröltzsch, J., & Vidaurre, R. (2020). Enhancing the capacity of water governance to deal with complex management challenges: A framework of analysis. *Environmental Science & Policy*, *107*, 23–35. https://doi.org/10.1016/j.envsci.2020.02.011

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., Hornidge, A. K., Le Tissier, M., Pittman, J. B., Song, A. M., Sousa, L. P., Văidianu, N., & Van Assche, K. (2020). Environmental governance

theories: A review and application to coastal systems. *Ecology and Society*, *25*(4), Article 19. https://doi.org/10.5751/ES-12067-250419

Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., Hurlbert, M., Anderton, K., Sethi, M., & Barau, A. (2017). Exploring the governance and politics of transformations towards sustainability. *Environmental Innovation and Societal Transitions*, *24*, 1–16. https://doi.org/10.1016/j.eist.2016.09.001

Pittman, J., & Armitage, D. (2016). Governance across the land-sea interface: A systematic review. *Environmental Science & Policy*, *64*, 9–17. https://doi.org/10.1016/j.envsci.2016.05.022

Plummer, R., Armitage, D. R., & De Loë, R. C. (2013). Adaptive comanagement and its relationship to environmental governance. *Ecology and Society*, *18*(1), Article 21. https://doi.org/10.5751/ES-05383-180121

Pringle, C. B., Meissner, R., Biggs, R., Pahl-Wostl, C., Stuart-Hill, S., & Sitas, N. (2023). Exploring social processes in transformation: The case of a collaborative water partnership in South Africa. *Ecosystems and People*, *19*(1), Article 2213780. https://doi.org/10.1080/26395916.2023.2213780

Ramesh, R., Chen, Z., Cummins, V., Day, J., D'Elia, C., Dennison, B., Forbes, D. L., Glaeser, B., Glaser, M., Glavovic, B., Kremer, H., Lange, M., Larsen, J. N., Le Tissier, M., Newton, A., Pelling, M., Purvaja, R., & Wolanski, E. (2015). Land–ocean interactions in the coastal zone: Past, present and future. *Anthropocene*, *12*, 85–98. https://doi.org/10.1016/j.ancene.2016.01.005

Ramieri, E., Bocci, M., Brigolin, D., Campostrini, P., Carella, F., Fadini, A., & Barbanti, A. (2024). Designing and implementing a multi-scalar approach to maritime spatial planning: The case study of Italy. *Marine Policy*, *159*, Article 105911.

Räsänen, A., Schönach, P., Jurgilevich, A., Heikkinen, M., & Juhola, S. (2019). Role of transformative capacity in river basin management transformations. *Water Resources Management*, *33*, 303–317. https://doi.org/10.1007/s11269-018-2103-5

Rochette, J., Billé, R., Molenaar, E. J., Drankier, P., & Chabason, L. (2015). Regional oceans governance mechanisms: A review. *Marine Policy*, *60*, 9-19.

Rudolph, T. B., Ruckelshaus, M., Swilling, M., Allison, E. H., Österblom, H., Gelcich, S., & Mbatha, P. (2020). A transition to sustainable ocean governance. *Nature Communications*, *11*, Article 3600. https://doi.org/10.1038/s41467-020-17410-2

Schlüter, M., Caniglia, G., Orach, K., Bodin, Ö., Magliocca, N., Meyfroidt, P., & Reyers, B. (2022). Why care about theories? Innovative ways of theorizing in sustainability science. *Current Opinion in Environmental Sustainability*, *54*, Article 101154. https://doi.org/10.1016/j.cosust.2022.101154

Schlüter, M., Lindkvist, E., & Basurto, X. (2021). The interplay between top-down interventions and bottom-up self-organization shapes opportunities for transforming self-governance in small-scale fisheries. *Marine Policy*, *128*, Article 104485. https://doi.org/10.1016/j.marpol.2021.104485

Singh, G. G., Cottrell, R. S., Eddy, T. D., & Cisneros-Montemayor, A. M. (2021). Governing the land-sea interface to achieve sustainable coastal development. *Frontiers in Marine Science*, *8*, Article 709947. https://doi.org/10.3389/fmars.2021.709947

Smith, H. D., Maes, F., Stojanovic, T. A., & Ballinger, R. C. (2011). The integration of land and marine spatial planning. *Journal of Coastal Conservation*, *15*, 291–303.

Temper, L., Kothari, A., Temper, L., Walter, M., Kothari, A., Sangam, V., & Turhan, E. (2018). A perspective on radical transformations to sustainability: Resistances, movements, alternatives. *Sustainability Science*, *13*, 747–746.

Tocco, C. L., Frehen, L., Forse, A., Ferraro, G., & Failler, P. (2024). Land-sea interactions in European marine

governance: State of the art, challenges and recommendations. *Environmental Science & Policy*, *158*, Article 103763. https://doi.org/10.1016/j.envsci.2024.103763

Volenzo, T. E., & Odiyo, J. (2018). Ecological public health and participatory planning and assessment dilemmas: The case of water resources management. *International Journal of Environmental Research and Public Health*, *15*(8), Article 1635. https://doi.org/10.3390/ijerph15081635

Wittgenstein, L. (1953). *Philosophical investigations*. Blackwell Publishing.

Zaucha, J., Gee, K., Ramieri, E., Neimane, L., Alloncle, N., Blažauskas, N., Calado, H., Cervera-Núñez, C., Kuzmanović, V. M., Stancheva, M., Witkowska, J., Schütz, S. E., Zapatero, J. R., & Ehler, C. N. (2025). Implementing the EU MSP Directive: Current status and lessons learned in 22 EU member states. *Marine Policy*, *171*, Article 106425.

Zimmermann, S., Dermody, B. J., Theunissen, B., Wassen, M. J., Divine, L. M., Padula, V. M., von Wehrden, H., & Dorresteijn, I. (2023). A leverage points perspective on Arctic Indigenous food systems research: A systematic review. *Sustainability Science*, *18*(3), 1481–1500. https://doi.org/10.1007/s11625-022-01280-2

About the Authors

Tegan Evans is a research fellow with the University of Portsmouth Revolution Plastics Institute and Centre for Blue Governance. Her research interests include transformation, transition, plastic policy, ocean governance, and the blue economy.

Gianluca Ferraro is associate professor in environmental governance at the University of Portsmouth (Centre for Blue Governance) and visiting professor at the University of Valencia. His research examines policy implementation, public participation, institutional change, and subnational governance. He is the scientific coordinator of the Horizon Europe project BlueGreen Governance.

Pierre Failler is the UNESCO Chair in Ocean Governance and director of the Centre for Blue Governance. His extensive research history spans concepts such as the blue economy, blue governance, blue finance, and economics.

Ocean and Society
2025 • Volume 2 • Article 10300
https://doi.org/10.17645/oas.10300

cogitatio

ARTICLE

Open Access Journal

Assisting Coastal and Marine Governance: Enhancing Decision Support Through Digital Tools for Cumulative Impact Assessment

Jonne Kotta [1], Jean-Marc Douguet [2], Elis Vollmer [1], Mihhail Fetissov [1], Elisa Furlan [3], Gea Grassi [3], Federica Zennaro [3,4], Hector Charles Pagan [1], and Helen Orav-Kotta [1]

[1] University of Tartu, Estonia
[2] Université Paris-Saclay, France
[3] Euro-Mediterranean Center on Climate Change (CMCC Foundation), Italia
[4] Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Italy

Correspondence: Jonne Kotta (jonne.kotta@sea.ee)

Submitted: 9 March 2025 **Accepted:** 22 May 2025 **Published:** 17 July 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Coastal regions are increasingly pressured by diverse human activities, leading to cumulative effects that undermine ecosystem integrity and functioning, including disruptions to biodiversity, habitat degradation, and alterations of ecological processes. Understanding and addressing these complex interactions is a prerequisite for effective environmental management. This study demonstrates how the web-based PlanWise4Blue tool analyzes the cumulative effects of human activities on coastal ecosystems using a data-driven approach, enabling stakeholders to compare different management scenarios and identify options to mitigate ecological impacts or enhance marine health. By bridging the complexity of natural systems and decision-making, the tool strengthens e-governance, promoting more effective environmental management.

Keywords

coastal ecosystems; coastal management; ecosystem integrity; e-governance; environmental decision-making; environmental impact assessment; marine ecosystem health

1. Introduction

Coastal ecosystems face escalating pressures from a variety of human activities, which often produce overlapping stressor footprints and lead to cumulative effects (Halpern & Fujita, 2013; Thrush et al., 2021). Cumulative effects refer to the combined effects of multiple human activities, natural processes, and

environmental stressors on ecosystems or communities over time and space. These effects can result from the interaction of different factors that may be individually minor but collectively significant, potentially leading to profound ecological or societal changes (Halpern et al., 2008). These interactions include nonlinear dynamics, legacy effects, and ecosystem responses that are often spatially and temporally disconnected from the original stressors (Ellis et al., 2017). Consequently, these cumulative effects can erode ecosystem resilience, push systems toward tipping points, and result in irreversible ecological damage (Low et al., 2023; Norkko et al., 2002).

Effective management of cumulative effects is vital to mitigate the threats from complex interactions between human activities and natural systems (Hewitt et al., 2016). Understanding these interactions, including spatial and temporal variability, and sharing this knowledge with policymakers, managers, and communities are key to fostering resilience and adaptive governance for sustainable ecosystem health (Gladstone-Gallagher et al., 2019; Singh et al., 2017). Nonetheless, this task is challenging due to the complexities arising from the interactions between human activities, the pressures they generate, and the ways these cumulative pressures affect ecosystems.

Current cumulative effect assessments are largely expert-driven, focusing on stressor and activity footprints, yet they often overlook the complexity of dynamic ecosystem responses that emerge through indirect effects, legacy impacts, and context-specific interactions (Halpern et al., 2015; Thrush et al., 2021). Advancing these assessments requires the integration of data-driven frameworks that emphasize ecosystem response footprints, which account for nonlinear effects, resilience, and recovery dynamics (Hewitt et al., 2022). Such approaches should incorporate spatial and temporal variability, including legacy effects that persist beyond stressor cessation and the effects of multiple overlapping stressors (Ellis et al., 2017). The cumulative effect tool should prioritize methods that link response footprints with predictive models and management actions to foster integrated strategies (Low et al., 2023; Norkko et al., 2002; Thrush et al., 2013).

Traditional frameworks, often based solely on expert opinion, are insufficient for capturing the complexity of cumulative effects. However, the increasing intensity and diversity of human activities open opportunities to integrate ecological modelling into cumulative effect assessments. Data-driven methodologies provide structured approaches to analyzing and managing interactions within natural systems with greater accuracy and confidence.

The PlanWise4Blue tool, hosted under the Blue Bio Sites portal (https://gis.sea.ee/bluebiosites), is a decision support system developed to bridge the gap between scientific research and policymaking. It is designed for data-driven cumulative impact analysis, integrating scientific knowledge of geophysical environments, spatial distributions of natural assets, and the projected effects of various human activity scenarios. The tool predicts environmental outcomes in complex ecosystems, supporting sustainable marine development and effective conservation strategies for European seas amidst rapid human-induced environmental change. The platform is dynamic, continuously expanding its geographical scope and incorporating diverse nature assets, human impacts, and analytical tools.

This article demonstrates the real-world applicability of the PlanWise4Blue tool through a Baltic Sea case study. The case study highlights three key aspects: ecosystems subjected to multiple human-induced

pressures, the transboundary nature of these pressures, and the need for coordinated planning of human activities. As a regional test site, the Baltic Sea emphasizes the importance of a harmonized approach to addressing these challenges, positioning the PlanWise4Blue tool as a rewarding resource for bridging existing gaps in cumulative impact analysis and spatial planning.

2. PlanWise4Blue: Empowering Data-Driven Decision-Making for Sustainable Marine Management

PlanWise4Blue is a digital tool developed to support maritime spatial planning and sustainable marine management. Initially created for the Estonian maritime spatial planning, it has since been adapted for broader European use. The tool employs a unified framework to integrate customized analytical workflows for assessing cumulative effects, filling data gaps, and providing actionable insights through targeted case studies.

PlanWise4Blue employs a data-driven approach, that offers a robust, quantitative foundation for environmental impact assessments. Cumulative impact analysis requires three key components: (a) knowledge of the expected effects of human activities and resulting pressures, (b) spatial data on natural assets, and (c) spatial distribution of human activities defining the analysis scenario (Figure 1). The following section outlines these three key components.

To consolidate scientific evidence on the effects of various combinations of human activities on natural assets, PlanWise4Blue integrates systematic reviews, meta-analyses, and expert input to compile an impact matrix, serving as training data for cumulative impact modelling and effect prediction. Systematic reviews and meta-analyses provide a robust method for synthesizing quantitative data on environmental effects by consolidating evidence from scientific studies and organizing the data in a standardized format (Griffin et al., 2013; Harvey et al., 2013). During data harvesting, effect sizes are determined by calculating the ratio of the effect value to the reference value, reflecting the expected increase or decrease in a natural asset under specific human use combinations. When data are sparse or unevenly distributed across different combinations of human pressures and ecosystem components, extending search terms to include related geographic areas or taxonomic groups can help address data deficiencies at local or regional scales. Moreover, effects can be derived from existing monitoring datasets, such as those collected under the Water Framework Directive or other environmental impact assessments. All available effect sizes are then pooled, enabling comprehensive analyses that uncover overarching patterns, deepen insights into underlying processes and drivers, and highlight knowledge gaps. Importantly, systematic reviews and meta-analyses adhere to a clear, well-defined protocol, ensuring transparency and reliability in assessments. This approach also provides tangible metrics, such as species biomass or habitat loss/gain under different scenarios, rather than relying on arbitrary indices. While some cause-effect interactions continue to rely on expert judgment, PlanWise4Blue increasingly integrates empirical data as it becomes available.

Another persistent limitation of cumulative effect assessments is the lack of spatial detail (Corrales et al., 2020) or reliance on overly coarse spatial resolutions, such as assessments conducted at the scale of entire seas or large sub-basins (e.g., Ojaveer et al., 2023). However, since management decisions often operate at finer spatial scales, such as those required for maritime spatial planning, it is important to improve the spatial granularity of these assessments. The PlanWise4Blue tool integrates distributional data with advanced spatial

modelling (Qazi et al., 2022; Robinson et al., 2017) to deliver detailed maps of nature assets for the region of interest. While a comprehensive review of species distribution modelling methods is beyond the scope of this article, numerous tutorials exist to guide the selection of appropriate techniques. Spatial modelling must differentiate between presence-only models, like maxent (Elith et al., 2020; Valavi et al., 2022), and traditional models, which require both presence and absence data. Presence-only models address data biases caused by observational datasets that often lack absence records, while traditional models are suited for taxa with well-documented distributions. Despite their correlative nature and limited ecological insights (Lee-Yaw et al., 2022), species distribution modelling remains essential for conservation and management, offering valuable insights and detailed data that would otherwise take years to compile.

The third component of the PlanWise4Blue tool is the spatial arrangement of human activities, which defines the scenarios for cumulative impact analyses. Users can either use existing datasets, such as human activity maps from the European Marine Observation and Data Network or create custom scenarios to assess the environmental impacts of specific human use patterns on selected natural assets. Climate change can also be integrated into the cumulative effect assessment of the PlanWise4Blue tool. However, due to the complex interactions between different realms (e.g., sea and land), regional or local climate models must first be run to generate scenario-specific maps of climate pressures and natural assets. These climate-specific datasets can then be incorporated into analyses alongside other human pressures.

The cumulative effect assessment in the PlanWise4Blue tool is conducted by analyzing the spatial overlap of human activities and natural assets within each grid cell of the study area. The grid cell size is determined by the spatial resolution of natural asset data, typically set at 1 km^2 for regional seas and 50 m^2 for local case studies. Natural asset maps in the tool are sourced from open-access databases, case studies, or generated using spatial modeling algorithms.

The assessment process begins by identifying the intensities of human pressures (e.g., underwater noise and contamination) and the values of natural assets (e.g., species presence, habitat cover, and biomass) within each grid cell. These data are then combined with human use-specific and nature asset-specific effect sizes (sometimes referred to as impact scores) derived from meta-analyses of scientific literature and available datasets. The cumulative effect for each natural asset is calculated as the product of the asset value and the average effect size of specific human pressure–asset combinations. Uncertainty in effect estimates is addressed by incorporating variations in both effect sizes and natural asset indicators, using an expression based on Taylor series expansion (Kotta et al., 2020, 2025; Taylor & Kuyatt, 1994).

Designed to be user-friendly, the tool provides marine managers and policymakers without scientific backgrounds access to high-quality knowledge and data for informed decision-making, presented as interactive maps and summary statistics. By integrating diverse datasets, including global and case-specific environmental data, the tool generates baseline profiles for each case study area. Such baselines serve as essential reference points for assessing the effects of proposed activities or interventions and guiding effective management strategies.

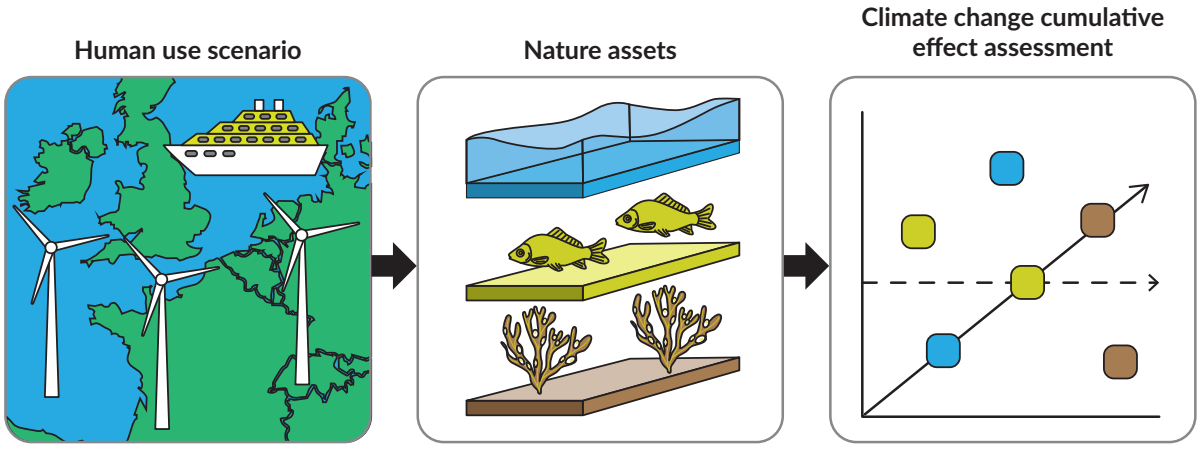


Figure 1. PlanWise4Blue: A tool for quantitative environmental assessment, scenario analysis, and climate megatrend evaluation. Note: PlanWise4Blue enables users to explore climate megatrends, assess the cumulative effects of climate change and human activities, and identify key risks to various natural assets.

3. Assessing the Real-World Applicability of the PlanWise4Blue Tool: A Baltic Sea Case Study

The Baltic Sea is a semi-enclosed brackish water basin in Northern Europe, shared by eight EU countries (Germany, Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, and Poland) as well as Russia. Its limited connection to the open ocean through the Danish Straits restricts water exchange, making it particularly sensitive to external influences. The extensive watershed area further amplifies the ecosystem's vulnerability, causing it to respond rapidly to various pressures.

The governance context for the Baltic Sea region is shaped by a complex network of international, regional, and national frameworks. The Helsinki Convention provides the overarching framework for regional cooperation, coordinating the implementation of commitments aimed at protecting the Baltic Sea. Although each Baltic Sea state implements environmental policies in line with regional agreements, national priorities and governance structures differ significantly. These differences can result in diverse approaches to managing trade-offs and conservation efforts, potentially complicating coordinated management across the region.

This is troubling, as the Baltic Sea faces significant management challenges due to the inability to effectively control widespread external pressures, such as eutrophication driven by legacy nutrients, and land-based activities like industrial discharges and agricultural runoff. In addition, transboundary pressures such as wind farm construction and the spread of non-indigenous species through shipping remain inadequately addressed. These issues are further compounded by limited financial and human resources, fragmented datasets, and low stakeholder engagement, hindering effective decision-making and the achievement of biodiversity goals. Despite these challenges, stakeholders recognize the value of data-driven decision-making and the application of cumulative impact tools to integrate pressures across transboundary scales and prioritize mitigation actions. If such analyses are conducted using accessible online tools, targeted training for managers can enhance the capacity for the effective use of spatial tools in future management efforts.

The PlanWise4Blue tool is currently accessible in its consolidated version, PlanWise4Blue Europe, developed under the BlueGreen Governance project. The tool is entirely internet-based, removing the need

for downloads. The platform integrates the latest spatial datasets on nature assets, including species, habitats, and ecosystem services. These datasets are generated using advanced modelling techniques such as maxent, boosted regression trees, random forests, and generalized additive models, using the best available biological and environmental data from national and regional monitoring programs, European data infrastructures like Copernicus, and scientific publications. Information about the human pressure layers and nature asset datasets can be found under the guides of the tool.

Users can create new scenarios by defining specific study areas in the Baltic Sea region and setting up workspaces in PlanWise4Blue. Currently, the platform allows the inclusion of 909 nature assets and 44 human activities in cumulative effects assessment. The spatial resolution of the analysis is set at 1 km^2 due to data availability. However, the scale will be refined to 250 m^2 in the next 1–2 years, following the delivery of harmonized key species and habitat maps through the Horizon project Protect Baltic. Human activities can represent current conditions or future management scenarios, with options to adjust spatial arrangements. In the PlanWise4Blue Europe version, users can adjust parameters for specific human activities, allowing the tool to project potential environmental outcomes under various development scenarios. For instance, planners and environmental managers can evaluate the cumulative effects of offshore wind farm development by specifying turbine density and types (e.g., monopile and gravity base), as different configurations are likely to exert varying impacts on marine biota. These specific offshore developments can then be assessed alongside other pressures, such as fisheries or shipping lanes, to identify impact hotspots and quantify the relative effects of different human activities on selected nature assets. Users can also generate a single map that consolidates all the asset-specific effects in nature. However, such an aggregated map may oversimplify the complexity of cumulative effects, potentially overlooking the distinct management needs of different assets. Effective management relies on maintaining the granularity of analyses to address diverse impacts comprehensively.

We demonstrated the PlanWise4Blue tool to stakeholders responsible for nature protection and management in January–February 2025, in the transboundary context of Estonian and Latvian marine waters in the Gulf of Riga. The area is proposed for wind farm development to increase green energy production, yet it is also a significant fishing zone where pelagic trawling for herring and sprat is widespread. The region is also characterized by eutrophication and the presence of multiple non-indigenous species. Stakeholders expressed interest in understanding the relative contribution of wind farm development to cumulative effects, considering interactions between energy infrastructure, fisheries, eutrophication, and invasive species. Specifically, they aimed to identify the nature assets most affected and explore how the negative impacts could be mitigated or avoided (Figure 2).

In the PlanWise4Blue tool, users began by creating a workspace, defining the spatial extent of the analysis (e.g., the Gulf of Riga), and selecting relevant human activities and nature assets. After running the cumulative effect model, they accessed the assessment results once the analysis was complete. Outputs were visualized as detailed maps and summary statistics, offering clear insights into cumulative effects and plausible mitigation opportunities (Figure 3). The cumulative effect analysis of the current scenario revealed that all human-induced pressures contributed to changes in nature assets, with wind farm development accounting for an average of 3% of the expected changes. Eutrophication contributed 28%, pelagic trawling 2%, round goby (*Neogobius melanostomus*) 43%, and mud crab (*Rhithropanopeus harrisii*) 25%. However, in absolute terms, the impact of wind farm development was minimal, affecting only a few species and

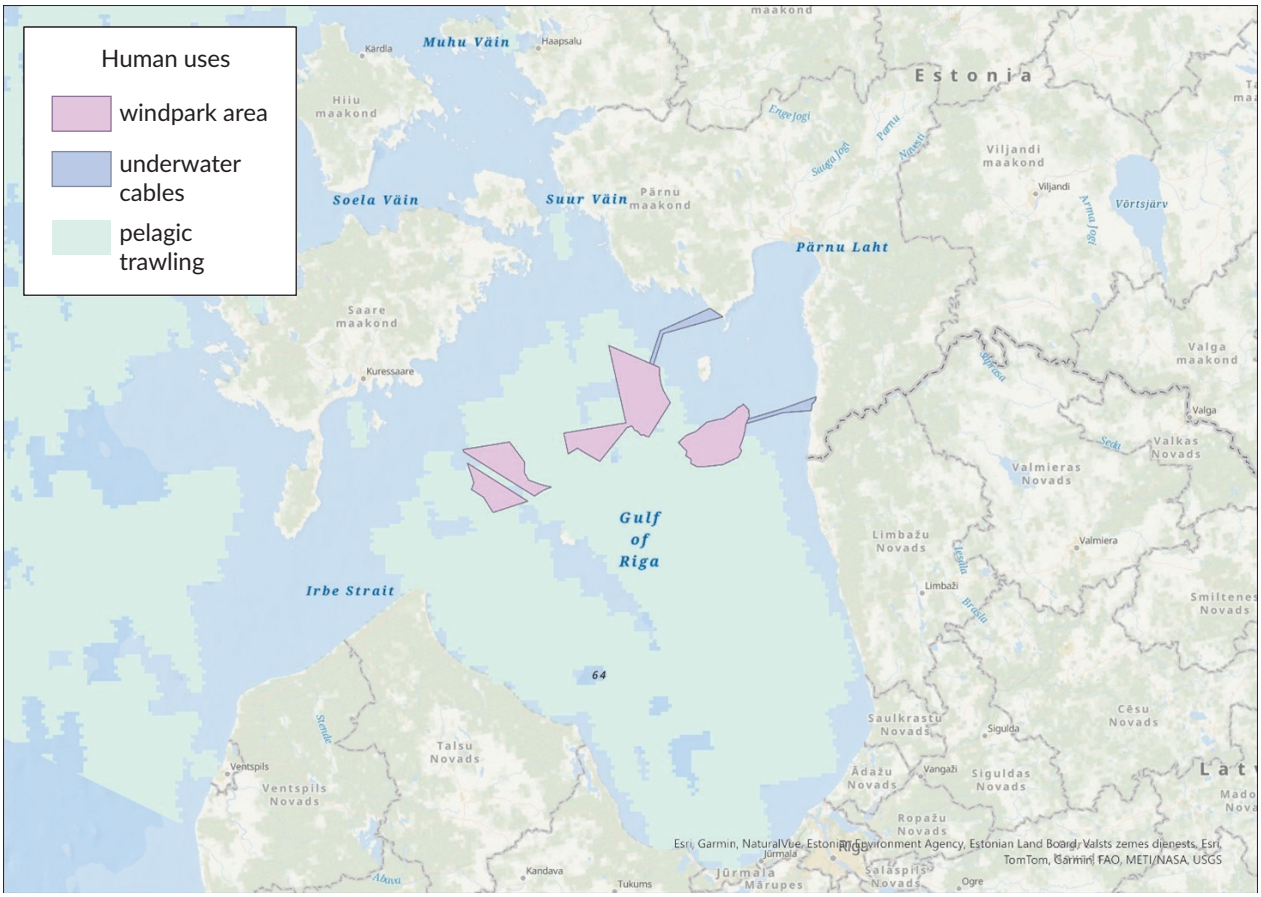


Figure 2. Transboundary case study in the Gulf of Riga: Location of the proposed wind farm and underwater cable areas alongside existing pelagic trawling zones. Notes: Eutrophication effects are evident throughout most of the gulf, while the round goby (*Neogobius melanostomus*) and mud crab (*Rhithropanopeus harrisii*) are the most prominent non-indigenous species in the region; the round goby is widespread across the gulf, whereas the mud crab is primarily concentrated in the southern and northeastern coastal areas.

impacting less than 5% of their populations in the Gulf of Riga, with recovery considered likely. The most pronounced effects of wind farm development were observed in specific bird species, highlighting the importance of setting wind farms away from key concentration areas. In addition, moderate impacts were noted on soft-bottom seafloor habitats. Given their relatively quick recovery rates, these effects could be mitigated by selecting construction methods that minimize disturbance to benthic habitats. Environmental impact assessments are often conducted sector by sector, without considering the relative contributions of different human activities or the cumulative effects of pressures arising from them. This sectoral focus can overlook pressures not directly associated with a specific sector, such as the influence of non-indigenous species, leading to underestimation or neglect of significant impacts.

The functionality of PlanWise4Blue empowers users to explore future environmental scenarios, evaluate trade-offs, and develop informed, actionable strategies that balance ecological health with human activity. By envisioning and evaluating potential outcomes of future scenarios, these tools stimulate decision-makers' imagination regarding the long-term implications of environmental changes. They also facilitate comparative assessments of various management strategies, providing a valuable framework for informed decision-making (Hukkinen et al., 2024).

The PlanWise4Blue tool does not aim to synthesise objective realities and, in doing so, persuade and inform stakeholders of objectified problem definitions in relation to land–sea governance issues. Instead, it provides an interface for mediating environmental knowledge, enabling stakeholders to access and interpret objective scientific insights from local and regional observations or past experiences (Geurts et al., 2022). Environmental asset indicators are presented through an intuitive interface tailored to the needs of natural resource managers, offering practical support for decision-making (Downs et al., 2023). By bridging the gap between scientific research and practical governance, PlanWise4Blue offers robust, quantitative analyses that move beyond traditional expert-based assessments. Its co-development with stakeholders ensures alignment with real-world challenges, fostering transparency, inclusivity, and sustainability. The tool's versatility and adherence to a common methodological framework make it a valuable resource for policymakers and planners seeking to enhance the governance of coastal and marine environments.

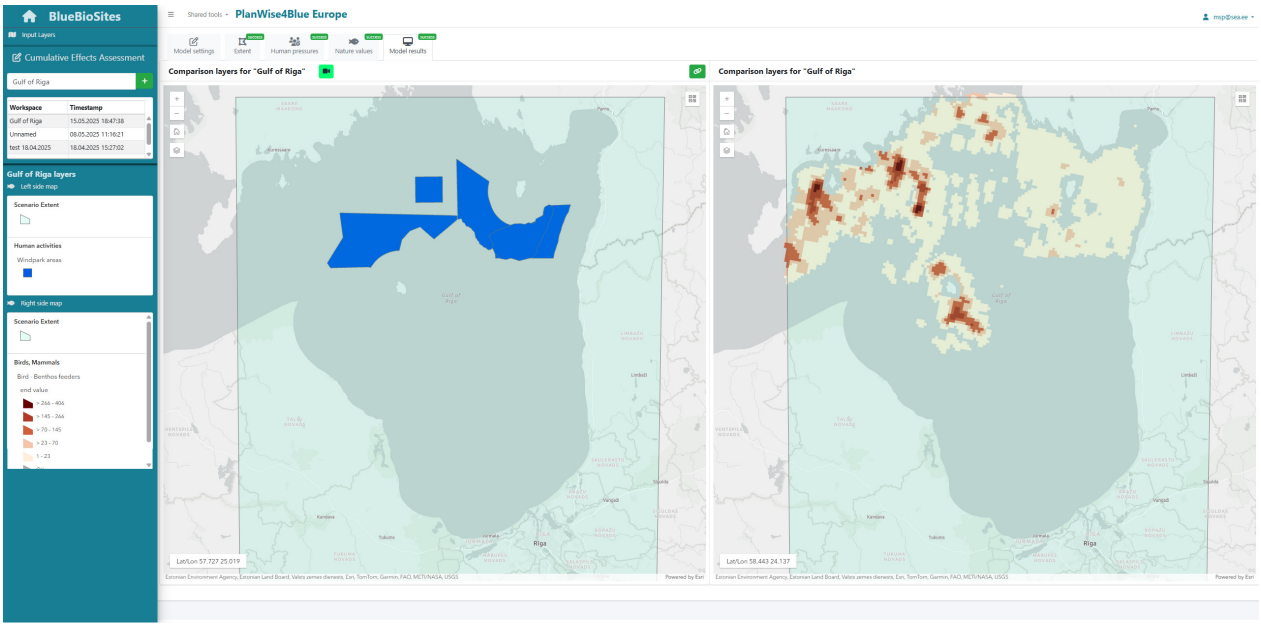


Figure 3. The PlanWise4Blue tool interface guides users through key steps in cumulative effect analysis, including defining the spatial extent, selecting human activities, choosing nature assets, and running the analysis. Notes: The results display provides various indicators, such as human use scenarios and changes in nature assets (e.g., benthos-feeding birds) based on the selected human activities; each scenario is saved in the user workspace, allowing for later modification; in addition, users can download the results as maps and summary statistics for further analysis and reporting.

4. Addressing Barriers and Unlocking Opportunities for PlanWise4Blue in Maritime Spatial Strategy and Environmental Management

Ensuring effective use of a web-based tool requires a clear understanding of barriers, constraints, and enabling factors. While technology holds significant potential, its successful implementation involves addressing challenges related to data management and integration, advanced modelling, stakeholder engagement, and institutional alignment.

From a data perspective, the PlanWise4Blue tool integrates information from various local to global repositories (e.g., Copernicus and the Ocean Biodiversity Information System), with regular updates

reflecting current environmental conditions. However, the spatial resolution of these datasets may not be sufficient for local-scale analyses, necessitating the inclusion of locally specific maps. Employing machine learning algorithms and spatial modelling techniques can improve data accuracy, particularly in areas with sparse observational data, resulting in a more comprehensive depiction of marine ecosystems.

A persistent challenge is the lack of harmonized data products across European seas, leading to discrepancies that may reflect inconsistencies in datasets rather than true ecological differences. This issue is being addressed through initiatives like the European Digital Twin, which aims to provide more detailed and harmonized products in the future.

However, nature asset data in public repositories remains limited. While extensive datasets on physical and chemical conditions are accessible, comprehensive, fine-scale, pan-European data on underwater habitats, fish, birds, and mammals are scarce. Although the European Marine Observation and Data Network offers harmonized human activity data, its spatial resolution may be insufficient, and some layers may not be fully updated. To mitigate these limitations, PlanWise4Blue users can upload custom datasets or adjust existing human activity layers to better align with specific project needs.

Until now, data extraction for cumulative effect assessments has been performed manually, a process that is highly time-consuming and impractical for handling large datasets. However, with the rapid increase in available information and published evidence, there is an urgent need to transition to automated digital solutions. Future developments of the PlanWise4Blue tool will include an AI-driven multimodal information retrieval system to extract and process effect-related data from scientific publications for seamless integration into predictive models. While such AI systems are not yet available, our development team is currently working on designing the analysis pipeline. Current systems face challenges in processing visual and textual data together. To overcome this, the enhanced tool will batch-process PDFs, extracting data from tables, figures, captions, and text, aligning it within studies or experiments, and converting it into structured numerical formats. By employing a state-of-the-art AI retrieval pipeline validated through active learning with expert feedback, this system will significantly improve the efficiency and accuracy of environmental impact assessments.

One of the key social challenges is the disparity between the theoretical benefits of participatory processes and their actual implementation in practice. Many initiatives struggle to move beyond formal agreements, with participation often limited to paper-based commitments rather than active involvement. Inconsistent or sporadic engagement, particularly when certain stakeholder groups dominate discussions or when some are excluded, can lead to power imbalances and ineffective decision-making. These discrepancies hinder the potential of digital tools to foster equitable and inclusive governance.

Moreover, there are practical barriers to ensuring that technology is accessible to all relevant stakeholders. A lack of trust or willingness to engage with scientific data and models may prevent some groups from participating in the decision-making process. This is particularly true when stakeholders feel that their values and concerns are not adequately represented, leading to scepticism or even resistance. In such cases, overcoming these barriers requires careful management of expectations and the establishment of trust through transparent communication and ongoing dialogue. Addressing these challenges can be achieved by providing intuitive, user-friendly interfaces, implementing transparent methodologies, and actively incorporating stakeholder input throughout the process.

An essential factor for successfully implementing digital tools is establishing robust, multi-sectoral networks that promote collaboration across diverse stakeholder groups. Whether operating at local, national, or transboundary levels, these networks are important for integrating varied perspectives and values into the assessment process. By fostering these connections, the digital tool can act as a central platform for collaborative decision-making, combining data-driven insights with local and traditional knowledge.

Sustaining these networks requires adequate financial and human resources, as well as integrating the tool into broader initiatives such as the European Digital Twin. This would ensure continued support for the platform's operations and long-term impact. Furthermore, to maximize the effectiveness of digital tools, there is a need to develop a shared understanding among stakeholders. Creating a common narrative around key challenges and opportunities can bridge differing viewpoints and facilitate consensus on mutually beneficial solutions. While scientific data integration is important, presenting this information in a clear, accessible manner is equally vital. Effective communication ensures that technology becomes an inclusive tool for informed decision-making rather than a barrier to stakeholder engagement.

5. Conclusion

Coastal ecosystems are increasingly impacted by overlapping human-induced pressures, leading to cumulative effects that can undermine ecosystem resilience and push systems toward ecological tipping points. Addressing these complex interactions requires comprehensive, data-driven assessments that consider both direct and indirect effects over time and space. The PlanWise4Blue tool provides a valuable framework for integrating scientific data, predictive modelling, and stakeholder input to assess cumulative effects across marine and coastal environments. By enabling spatially explicit analyses of human activity scenarios and their potential environmental impacts, the tool supports evidence-based decision-making for sustainable marine management. The Baltic Sea case study illustrates the tool's capacity to identify impact hotspots, quantify stressor interactions, and inform strategic planning efforts, highlighting its potential as a valuable resource for harmonizing environmental management across regional seas.

Acknowledgments

The research leading to this work was conducted in the framework of the projects BlueGreen Governance (2024–2027) and MarTe (Marine technology excellence hub for sustainable blue economy in Baltics). The BlueGreen Governance project is co-funded by the European Union (EU) under the Horizon Europe Programme (GA no. 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). The MarTe project is co-funded by the European Union (EU) under the Horizon Europe Programme (GA no. 101186498). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

This study did not generate any new data. All analyses were conducted using previously published or publicly available datasets.

References

Corrales, X., Katsanevakis, S., Coll, M., Heymans, J. J., Piroddi, C., Ofir, E., & Gal, G. (2020). Advances and challenges in modelling the impacts of invasive alien species on aquatic ecosystems. *Biological Invasions*, *22*, 907–934. https://doi.org/10.1007/s10530-019-02160-0

Downs, P. W., Biedenharn, D., Cox, A., Haring, C., Little, C., Soar, P., & Thorne, C. (2023, May 8–12). *From forecast to foresight: A decision-support framework for visioning channel evolution in river management* [Paper presentation]. Proceedings of the Sedimentation and Hydrologic Modeling (SEDHYD) 2023 Conference, St. Louis, Missouri, United States. https://www.sedhyd.org/past

Elith, J., Graham, C., Valavi, R., Abegg, M., Bruce, C., Ferrier, S., Ford, A., Guisan, A., Hijmans, R. J., Huettmann, F., Lohmann, L., Loiselle, B., Moritz, C., Overton, J., Peterson, A. T., Phillips, S., Richardson, K., Williams, S., Wiser, S. K., . . . Zimmermann, N. E. (2020). Presence-only and presence-absence data for comparing species distribution modeling methods. *Biodiversity Informatics*, *15*(2), 69–80. https://doi.org/10.17161/bi.v15i2.13384

Ellis, J. I., Clark, D., Atalah, J., Jiang, W., Taiapa, C., Patterson, M., & Hewitt, J. (2017). Multiple stressor effects on marine infauna: Responses of estuarine taxa and functional traits to sedimentation, nutrient, and metal loading. *Scientific Reports*, *7*, Article 12013. https://doi.org/10.1038/s41598-017-12323-5

Geurts, A., Gutknecht, R., Warnke, P., Goetheer, A., Schirrmeister, E., Bakker, B., & Meissner, S. (2022). New perspectives for data-supported foresight: The hybrid AI-expert approach. *Futures & Foresight Science*, *4*(1), Article e99. https://doi.org/10.1002/ffo2.99

Gladstone-Gallagher, R. V., Hope, J. A., Bulmer, R. H., Clark, D. E., Stephenson, F., Mangan, S., & Thrush, S. F. (2019). Old tools, new ways of using them: Harnessing expert opinions to plan for surprise in marine socio-ecological systems. *Frontiers in Marine Science*, *6*, Article 696. https://doi.org/10.3389/fmars.2019.00696

Griffin, J. N., Byrnes, J. E. K., & Cardinale, B. J. (2013). Effects of predator richness on prey suppression: A meta-analysis. *Ecology*, *94*(10), 2180–2187. https://doi.org/10.1890/13-0179.1

Halpern, B. S., Frazier, M., Potapenko, J., Casey, K. S., Koenig, K., Longo, C., Lowndes, J. S., Rockwood, R. C., Selig, E. R., Selkoe, K. A., & Walbridge, S. (2015). Spatial and temporal changes in cumulative human impacts on the world's ocean. *Nature Communications*, *6*, Article 7615. https://doi.org/10.1038/ncomms8615

Halpern, B. S., & Fujita, R. (2013). Assumptions, challenges, and future directions in cumulative impact analysis. *Ecosphere*, *4*(10), 1–11. https://doi.org/10.1890/ES13-00181.1

Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., D'Agrosa, C., Bruno, J. F., Casey, K. S., Ebert, C., Fox, H. E., Fujita, R., Heinemann, D., Lenihan, H. S., Madin, E. M. P., Perry, M. T., Selig, E. R., Spalding, M., Steneck, R., & Watson, R. (2008, February 15). A global map of human impact on marine ecosystems. *Science*, *319*(5865), 948–952. https://doi.org/10.1126/science.1149345

Harvey, B. P., Gwynn-Jones, D., & Moore, P. J. (2013). Meta-analysis reveals complex marine biological responses to the interactive effects of ocean acidification and warming. *Ecology and Evolution*, *3*(4), 1016–1030. https://doi.org/10.1002/ece3.516

Hewitt, J. E., Ellis, J. I., & Thrush, S. F. (2016). Multiple stressors, nonlinear effects, and the implications of climate change impacts on marine coastal ecosystems. *Global Change Biology*, *22*(8), 2665–2675. https://doi.org/10.1111/gcb.13176

Hewitt, J. E., Gladstone-Gallagher, R. V., & Thrush, S. F. (2022). Disturbance–recovery dynamics inform seafloor management for recovery. *Frontiers in Ecology and the Environment*, *20*(10), 564–572. https://doi.org/10.1002/fee.2562

Hukkinen, J. I., Vihma, P., Janasik, N., Mäkelä, A., Reinekoski, T., Järvensivu, P., Lähde, V., Parviainen, T.,

Lehikoinen, A., & Salomaa, A. (2024). *Dashboard for narrating to policymakers the urgency of preparedness for chronic climate crisis*. Global Environmental Change.

Kotta, J., Fetissov, M., Szava-Kovats, R., Aps, R., & Martin, G. (2020). Online tool to integrate evidence-based knowledge into cumulative effects assessments: Linking human pressures to multiple nature assets. *Environmental Advances*, *2*, Article 100026. https://doi.org/10.1016/j.envadv.2020.100026

Kotta, J., Ojaveer, H., Kaasik, A., Szava-Kovats, R., Nurkse, K., Outinen, O., Einberg, H., Zaiko, A., Lehtiniemi, M., Orav-Kotta, H., & Barboza, F. R. (2025). Universal framework for assessing the environmental impact of marine non-indigenous species in different situations of data availability. *Hydrobiologia*, *852*, 2507–2519. https://doi.org/10.1007/s10750-024-05619-x

Lee-Yaw, J. A., McCune, L., Pironon, S., & Sheth, S. N. (2022). Species distribution models rarely predict the biology of real populations. *Ecography*, *2022*(6), Article e05877. https://doi.org/10.1111/ecog.05877

Low, J. M. L., Gladstone-Gallagher, R. V., Hewitt, J. E., Pilditch, C. A., Ellis, J. I., & Thrush, S. F. (2023). Using ecosystem response footprints to guide environmental management priorities. *Ecosystem Health and Sustainability*, *9*(1), Article 0115. https://doi.org/10.34133/ehs.0115

Norkko, A., Thrush, S. F., Hewitt, J. E., Cummings, V. J., Norkko, J., Ellis, J. I., & MacDonald, I. (2002). Smothering of estuarine sandflats by terrigenous clay: The role of wind-wave disturbance and bioturbation in site-dependent macrofaunal recovery. *Marine Ecology Progress Series*, *234*, 23–42. https://doi.org/10.3354/meps234023

Ojaveer, H., Einberg, H., Lehtiniemi, M., Outinen, O., Zaiko, A., Jelmert, A., & Kotta, J. (2023). Quantifying impacts of human pressures on ecosystem services: Effects of widespread non-indigenous species in the Baltic Sea. *Science of the Total Environment*, *858*, Article 159975. https://doi.org/10.1016/j.scitotenv.2022.159975

Qazi, A. W., Saqib, Z., & Zaman-ul-Haq, M. (2022). Trends in species distribution modelling in the context of rare and endemic plants: A systematic review. *Ecological Processes*, *11*, Article 40. https://doi.org/10.1186/s13717-022-00384-y

Robinson, N. M., Nelson, W. A., Costello, M. J., Sutherland, J. E., & Lundquist, C. J. (2017). A systematic review of marine-based species distribution models (SDMs) with recommendations for best practice. *Frontiers in Marine Science*, *4*, Article 421. https://doi.org/10.3389/fmars.2017.00421

Singh, G. G., Sinner, J., Ellis, J., Kandlikar, M., Halpern, B. S., Satterfield, T., & Chan, K. M. A. (2017). Mechanisms and risk of cumulative impacts to coastal ecosystem services: An expert elicitation approach. *Journal of Environmental Management*, *199*, 229–241. https://doi.org/10.1016/j.jenvman.2017.05.032

Taylor, B. N., & Kuyatt, C. E. (1994). *Guidelines for evaluating and expressing the uncertainty of NIST measurement results*. National Institute of Standards and Technology.

Thrush, S. F., Hewitt, J. E., Gladstone-Gallagher, R. V., Savage, C., Lundquist, C., O'Meara, T., & Pilditch, C. (2021). Cumulative stressors reduce the self-regulating capacity of coastal ecosystems. *Ecological Applications*, *31*(1), Article e02223. https://doi.org/10.1002/eap. 2223

Thrush, S. F., Hewitt, J. E., Lohrer, A. M., & Chiaroni, L. D. (2013). When small changes matter: The role of cross-scale interactions between habitat and ecological connectivity in recovery. *Ecological Applications*, *23*(1), 226–238. https://doi.org/10.1890/12-0793.1

Valavi, R., Guillera-Arroita, G., Lahoz-Monfort, J. J., & Elith, J. (2022). Predictive performance of presence-only species distribution models: A benchmark study with reproducible code. *Ecological Monographs*, *92*(1), Article e01486. https://doi.org/10.1002/ecm.1486

About the Authors

Jonne Kotta is a professor in marine ecology at the Estonian Marine Institute of the University of Tartu. His research focuses on benthic ecology, species interactions, nonindigenous species, GIS modelling, linking ecosystem functioning to services, bioeconomy, and climate change. He leads the development of digital decision-making tools to quantify the cumulative impacts of human activities on different nature assets.

Jean-Marc Douguet is a senior lecturer in economic sciences at the Paris-Saclay University. His research areas are part of an ecological economics and post-normal science perspective. He mainly focus on environmental evaluation, integrative analysis, circular economy, risk and environmental governance, knowledge mediation, and deliberative e-tools.

Elis Vollmer is a project manager at the Institute of Ecology, University of Tartu, and the head of the Centre of Renewable Energy at the Estonian University of Life Sciences. She has an MSc in environmental protection. She is a board member of CEESEN and leads the UN SDG workgroup at EMU.

Mihhail Fetissov is a research software engineer at the Estonian Marine Institute of the University of Tartu. His work focuses on the development of spatial decision support systems for ecosystem-based marine management, contributing both to their conceptual design and technical implementation.

Elisa Furlan is a senior scientist at Euro-Mediterranean Centre on Climate Change (CMCC) and scientific coordinator of the EU Mission projects DesirMED and GRACE. Her research focuses on transformative climate adaptation, nature-based solutions, and territorial resilience, with expertise in risk modelling and co-design. She also teaches at Ca' Foscari University of Venice.

Gea Grassi is a junior researcher at the RAAS (Risk Assessment and Adaptation Strategies) Division of CMCC, where she works on the BlueGreen Governance and TRANSEATION projects. Her research focuses on strategic foresight, generative AI, and climate change adaptation in marine-coastal ecosystems, with a focus on land–sea interface.

Federica Zennaro is a postdoctoral researcher at the Euro-Mediterranean Centre on Climate Change (CMCC), where she works on European projects focusing on blue-green governance and nature-based solutions. Her work advances innovative land–sea governance frameworks based on scientific evidence and societal input and monitors the effectiveness of marine and coastal nature-based solutions.

Hector Charles Pagan MPA is the executive director of CEESEN and has taught and conducted research on stakeholder engagement for almost 20 years. He has also worked in the civil society sector for over 25 years and has led or participated in multiple applied research projects focused on local governance and sustainability.

Helen Orav-Kotta is a marine ecologist and associate professor of marine biology at the Estonian Marine Institute at the University of Tartu. Her activities focus on marine conservation and climate change, blue economy development, and teaching blue literacy to various stakeholders and dissemination to the public (policymakers, students, companies, and communities).

Ocean and Society
2025 • Volume 2 • Article 10340
https://doi.org/10.17645/oas.10340

cogitatio

ARTICLE

Open Access Journal

Beneath the Surface: Can the Oslofjord Plan Create Transformative Change Through Institutional Layering?

Saskia Trubbach, Gunnar Sander, and Maren Helene Sævold

Norwegian Institute for Water Research, Norway

Correspondence: Saskia Trubbach (saskia.trubbach@niva.no)

Submitted: 15 March 2025 **Accepted:** 28 May 2025 **Published:** 22 July 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

The Oslofjord ecosystem experiences significant degradation due to cumulative anthropogenic pressures, including nutrient-induced eutrophication, overfishing, and habitat destruction. Existing institutional arrangements for coastal management in Norway have proven insufficient in addressing these complex challenges. In response, the Norwegian government launched an action plan specifically for the Oslofjord in 2021, aiming to restore a clean and healthy fjord that is accessible to all. This unique policy initiative can be studied through the lens of institutional layering. Rather than directly replacing existing institutions, layering describes the addition of new elements. Over time, the new layer may gradually shift the trajectory and influence of established institutions on societal behaviour and lead to transformative changes in policy outcomes. The design of the Oslofjord Plan, intended to "complement, coordinate, and reinforce" existing arrangements, can be understood as a deliberate attempt at layering, through the addition of instruments, actors, and changed perceptions. However, despite the Plan's ongoing implementation, the ecological status of the fjord remains degraded. Our analysis offers two key explanations. First, several measures introduced by the Plan need time after being put into action before they start to work, underscoring the need to consider the temporal dimension when evaluating the Plan's capacity to meet its objectives. Second, although the measures are beginning to shift institutional trajectories and societal behaviours, we argue that they remain insufficient to create transformative change. This is primarily due to institutional barriers embedded within existing institutional arrangements, which the Plan does not adequately address. These create lock-ins, constraining the Plan's transformative potential.

Keywords

coastal governance; evolutionary governance theory; fjord; institutional layering; land-sea interactions; Norway

1. Introduction

The Oslofjord is in an ecological crisis, which has gradually become a public concern over the past 15 years. Following centuries of intensive use, significant improvements were achieved in the early 2000s through efforts to reduce industrial and sewage discharges (Thaulow & Grande, 2015). However, monitoring and user reactions showed that earlier efforts were insufficient, with unresolved issues and new problems emerging. Reports of declining cod and other demersal fish stocks raised concerns about overfishing, and high contaminant levels made fish from the inner fjord unsafe to consume. Algae blooms and oxygen-depleted dead zones were observed, both symptoms of eutrophication. The main causes were linked to discharges of nitrogen and particles from agriculture and wastewater across the catchment rather than transboundary pollution from ocean currents, as previously contended. Moreover, shoreline development has reduced public access and degraded valuable habitats (Norwegian Environment Agency [NEA], 2019).

Recognising problems does not necessarily lead to efforts to solve them (Cohen et al., 1972; Kingdon, 1984). Sustained efforts by politicians, scientists, public authorities, and NGOs were required before the environmental challenges in the Oslofjord were defined and recognised as being a national concern, thereby prompting governmental intervention. In 2021, the government presented a comprehensive action plan for the Oslofjord (hereafter "the Oslofjord Plan"; Ministry of Climate and Environment [MCE], 2021a).

The Plan is a high-level strategic plan aiming to achieve a clean and healthy fjord that is easily accessible for outdoor recreation. It outlines what actions need to be taken, including acquiring new knowledge, and specifies the responsible public authorities for each action. The Plan does not replace any existing legal and administrative structures. Instead, it aims to "supplement, coordinate, and reinforce" all ongoing positive efforts (MCE, 2021a, p. 5). We argue that the Oslofjord Plan can be seen as an additional "layer" added to the existing institutional arrangements that govern the Oslofjord.

In institutional research, layering is described as a type of policy intervention where "something new" is added to existing institutions (Capano, 2019). The concept is associated with gradual change, in contrast to theories that emphasise abrupt shocks, typically caused by external factors. Still, it has been argued that gradual and incremental changes over time can lead to transformative change (Streeck & Thelen, 2005). However, due to various interpretations of layering, the analytical capacity of the concept to explain institutional change has been debated (van der Heijden, 2011). This mainly concerns the definitions of institutional change and what type of change can be attributed to layering. Another aspect concerns whether layering inevitably leads to change or if it might preserve stability (Capano, 2019; van der Heijden, 2011). Our article contributes to reflections on the theory of layering and its linkages with various modes of change by applying it to the Oslofjord as a case study. We raise two research questions:

RQ1: Which approaches to layering can be identified in the institutional design of the Oslofjord Plan?

RQ2: Do we observe transformative changes due to the Oslofjord Plan's layered approach?

The article begins with a review of theories that discuss layering and how it relates to various modes of change. After describing our methodology, we present the empirical findings on the Oslofjord Plan. This includes a description of the motivation behind the policy intervention, an overview of the planning process, a description

of the Plan's structure, and the outcomes observed during implementation. These empirical findings are then discussed in light of the two research questions.

2. Theory

2.1. The Concept of Layering

Institutions have been termed the "building blocks of social order" by establishing rules, norms, and procedures that govern societal behaviour (Streeck & Thelen, 2005, p. 9; see also Mahoney & Thelen, 2009). A broad definition of institutions, as suggested by Streeck and Thelen (2005), encompasses the roles of organisations and actors, such as public policy authorities, as well as the policies themselves. Traditional theories of institutional analysis regarded institutions as stable entities, and change was largely explained through exogenous shocks, causing abrupt and radical change. The importance of gradual and incremental change driven by endogenous processes, however, did increasingly receive scholarly attention (Mahoney & Thelen, 2009; Pierson, 2004; Streeck & Thelen, 2005; van der Heijden, 2011). While these two theoretical approaches—attributing change to either external shocks or gradual processes—are often viewed as conflicting, it has been proposed that they provide complementary approaches in the study of institutional change (van der Heijden, 2011). Within the realm of incremental institutional change theories, Streeck and Thelen (2005) and Mahoney and Thelen (2009) have established a typology of institutional change patterns. These include processes of change whereby institutions are redirected, experience drift, or are gradually displaced. Another mode of change is referred to as institutional layering, which will provide the theoretical framework for this article.

Institutional layering has been applied to analyse various contexts, and there is no universally applicable definition (van der Heijden, 2011). In essence, layering describes the addition of new elements to existing institutional arrangements. In a review of layering theories, van der Heijden (2011) grouped layering into two approaches: the creation of a new arena of actors ("thickening") or the addition of new instruments onto existing institutional arrangements ("regulatory ratchet"). Capano (2019) discussed a third approach, whereby an "ideational layer" is introduced. This layer redefines the conceptualisation of policy problems and solutions, such as by incorporating new policy goals into the existing institutional arrangement.

2.2. From Layering to Changes in Outcomes?

Capano (2019) noted that layering has often been conflated and equated with any type of institutional change in an underspecified way. This concerns whether layering is merely used to describe changes in institutional structures or whether it actively drives changes in institutional dynamics and behaviour, altering policy outcomes. This has led to inconsistent interpretations of the concept in academic literature, an observation also found in van der Heijden (2011). Therefore, Capano (2019) argued for a minimalistic and refined definition of layering as a mode of institutional design, describing how "something new" is added to an existing institutional arrangement. By doing so, he excludes the potential effects that layering may have on policy outcomes from the definition of layering. He suggests a two-tiered analytical approach to layering: (a) consider the effects of the new layer on the existing institutional arrangement, and (b) then assess the effects in terms of changes in policy outcomes. He advocates for this differentiation because, while layering as a mode of design may lead to a change in existing structures and, eventually, policy outcomes, it may also

maintain the stability of the existing institutional arrangement. Kelly et al. (2018, 2019) expressed similar views, arguing that path dependencies may prevent the layered arrangement from addressing the existing institutional barriers. In this article, we will use Capano's (2019) definition of layering as a mode of institutional design and follow his two-tiered analytical approach.

Streeck and Thelen (2005) emphasised that institutions are not static but continuously interpreted and enacted by various actors. They refer to this as the "logic of action," being the shared expectations and patterns through which institutions shape societal behaviour. This logic influences which policies are acceptable and how they are implemented, determining whether their intended outcomes are realised. Achieving far-reaching changes in policy outcomes—those that significantly deviate from the status quo—therefore require a transformative change in the prevailing logic of action. This perspective aligns with Hall's (1993) work on systemic change, where a paradigm shift involves a fundamental reconfiguration of dominant ideas and problem framings. Streeck and Thelen (2005) argue that transformative change can emerge through layering. Rather than directly confronting the existing institutional arrangements ("the core"), the layered elements ("the fringe") interact with the core structures and, over time, may gradually reshape institutional trajectories. This mechanism, termed differential growth, can cause actors to adopt a new logic of action.

In sum, layering offers analytical lenses to study the addition of institutional layers to existing arrangements. While most research on layering has focused on how institutions are changed (van der Heijden & Kuhlmann, 2017), Capano (2019) highlights a gap in linking layering as a design mode to its effects on changing policy outcomes.

3. Method

This article forms part of the BlueGreen Governance project. It draws on a combination of document studies, research interviews, consultations with a reference group, and participatory observations at various events on the Oslofjord.

To understand the development of the Oslofjord Plan, we conducted a comprehensive document analysis, including not only the Plan itself but also notes from parliamentary discussions, political statements, governmental white papers, consultation documents, status reports, and media coverage. However, these provided limited insight into the internal processes in the government apparatus that led to the adoption of the Plan. Between March 2023 and October 2024, to address this, we conducted eight semi-structured interviews with politicians and civil servants involved in the planning and implementation of the Plan (see Table 1). The interviews, each lasting between one and two hours, were conducted either in person or online. The interviewees were asked about the planning process and how they viewed the effect of the Plan's implementation. Interviewee selection was discussed with a stakeholder reference group, which also provided feedback on the research process. Moreover, we participated in several conferences, meetings, and workshops related to the Oslofjord, which contributed supplementary empirical material. In particular, we were granted access to meetings of the Oslofjord Council. These venues offered valuable opportunities to observe and engage in informal discussions with a wide range of stakeholders, including mayors, municipal and regional authorities from various sectors, environmental NGOs, representatives from agricultural and fisheries interest organisations, as well as the Secretariat of the Oslofjord Plan.

This article also draws on insights from two parallel research projects (MAREA and CrossGov), which focus on governance challenges in the Oslofjord. Although these projects address slightly different aspects of governance, the empirical data collected through them have significantly informed our understanding of the environmental and institutional dynamics in the Oslofjord.

Table 1. Overview of formal interviews conducted, specifically focusing on the Oslofjord Plan.

Identification	Interviewees
Interview 1	Former minister of the Ministry of Climate and Environment
Interview 2	Former state secretary for the Minister of Climate and Environment (a kind of deputy minister with a key role in coordination with other ministries)
Interview 3	Civil servants at the MCE, responsible for freshwater and marine planning (group interview)
Interview 4	Project leaders for the Oslofjord Plan at the NEA (group interview)
Interview 5	Civil servant at the NEA, participating in the Forum for Integrated Ocean Management (responsible for scientific assessments of the ocean)
Interview 6	Employee at the County Governor (representing the government at the regional level)
Interview 7	Civil servant responsible for water management in a coastal municipality
Interview 8	River basin management authority

4. Results

4.1. The Creation of the Plan

The Oslofjord Plan was developed at a time when the deteriorating condition of the fjord was widely acknowledged (Interview 4), and the need for more coordinated policy action beyond established institutional arrangements was recognised.

4.1.1. A Shared Understanding of Problems

In the autumn of 2017, three members of the Liberal Party (Venstre) submitted a Private Member's Bill to the parliament (Stortinget), proposing the development of a management plan for the Oslofjord that should address the cumulative pressures (Elvestuen et al., 2017; Figure 1). The Private Members' Bill highlighted the significance of the fjord and its surroundings for two million people engaged in various outdoor activities. It expressed particular concern about declining cod stocks, as well as the condition of seabirds and other wildlife in an ecosystem that they argued required restoration. Pollution from land-based sources was identified as a major issue, and the need to preserve and ensure public access to the area's cultural heritage was emphasised. These concerns were broadly supported by the Standing Committee on Energy and the Environment and in the subsequent parliamentary plenary discussion (Standing Committee on Energy and the Environment, 2018). Other approaches to address these challenges were considered as well, including drafting a separate law for the fjord and tightening restrictions on construction near the shoreline. In 2018, a consensus was reached, and a parliamentary resolution was unanimously passed in Parliament: "The Parliament requests the government to present a comprehensive plan for the Oslofjord—with the goal of achieving good environmental status, restoring important natural values, promoting active outdoor recreation, and preserving the biological diversity of the fjord" (Stortinget, 2018).

4.1.2. The Planning Process

The government assigned the MCE the responsibility of coordinating the planning process. A key challenge was to ensure support from all relevant ministries, including those responsible for economic sectors such as industry, fisheries, and agriculture, as well as regional and municipal planning. Such internal mechanisms in the government include a combination of meetings between ministries and cabinet meetings that issue mandates, address disagreements, and finally, approve the result (Sander, 2018). According to the state secretary, who managed the inter-ministerial processes, this was one of Norway's largest and most complex plans, considering the involvement of 118 municipalities, four counties, and many different interests. However, the process encountered relatively few conflicts:

> There was full political agreement in the parliament. This was noted by the ministers, so everybody understood that there was a need to do something….Thus, the starting point was better. It wasn't like the tough uphill battles I faced in a couple of other cases, to put it that way. (Interview 2)

During the initial stages of the planning process, including at a consultation conference with 260 participants, there were differing views about what type of plan should be developed. Two issues concerning the relationship to existing plans and policies help explain why a layered design was chosen for the Oslofjord Plan.

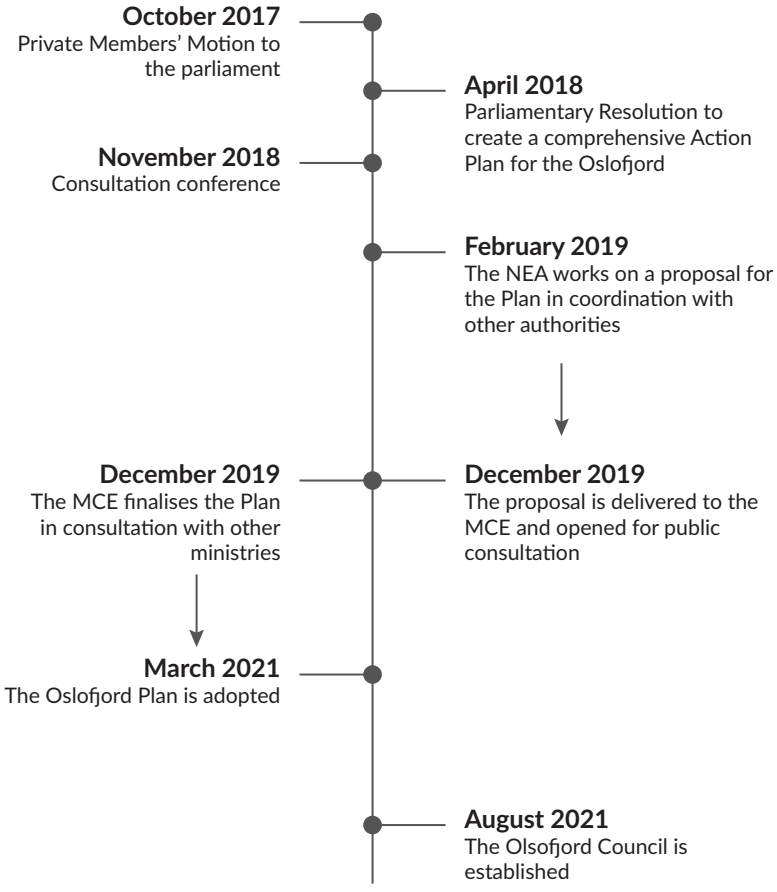


Figure 1. Timeline of the planning process for the Oslofjord Plan.

The first issue was the relationship to the River Basin Management Plans (RBMPs). These are prepared following the EU's Water Framework Directive, aiming to achieve good chemical and ecological status of waters through holistic management of catchments. The focus in the Water Framework Directive is on freshwater, but the geographical scope also includes coastal waters extending out to one nautical mile from the baseline. Given Norway's unique coastal geography, this delineates a large coastal zone, including the Oslofjord (Sander, 2023). The Oslofjord and its large catchment are covered by two RBMPs (Figure 2). However, large parts of the marine ecosystems, such as fish, seabirds, and marine mammals, are excluded when assessing the ecological status in coastal waters in the RBMPs (Sander, 2023). Since the status assessment is the baseline for identifying policy measures, this narrow focus inhibits broad policy action against all pressures. The importance of the RBMPs had already been emphasised in the Private Members' Motion (Elvestuen et al., 2017). In a letter to parliament, the minister of Climate and Environment initially opposed a separate Oslofjord plan, arguing that existing RBMPs already covered key elements and that efforts should focus on better implementation and coordination (Standing Committee on Energy and the Environment, 2018). However, following parliamentary and stakeholder discussions, along with a change in minister, this position was altered. When the Ministry commissioned NEA to develop a proposal for an Oslofjord Plan in 2019, it stated that the RBMPs should constitute an important element in the planning (MCE, 2019). The Ministry also defined the geographical scope to the inner and outer Oslofjord, supplemented by the catchment area, as in the RBMPs, to cover pollution from land. The then minister of Climate and Environment, who had previously initiated the Private Members' Bill, argued that the RBMPs "lack force and are too technical" and emphasised the need for mobilisation across levels (Interview 1). Similarly, his former state secretary explained:

> Sector-specific plans alone typically don't solve holistic problems. They only address a few specific challenges….The problems [of the Oslofjord] involve physical constructions and sewage, fisheries, agriculture, and spatial planning on land. There are many issues here, and therefore, a holistic plan was needed, as RBMPs alone wouldn't solve them all. (Interview 2)

The second issue concerned how to engage the various interests, particularly the counties and municipalities, considering whether the plan should be prepared by the government, adopted regionally by the counties, or a combination of both. The MCE instructed NEA to prepare the proposal with governmental agencies from different sectors and involve other interests. It was further specified that the Plan was to be over-arching, cross-sectoral, and strategic, aiming to "coordinate, supplement, and reinforce ongoing positive efforts" (MCE, 2019, p.1).

Throughout 2019, NEA collaborated with eight directorates, county governors, and four counties, supported by additional consultation meetings. The entire planning process was delegated to the directorates, including the assessment of the ecological status and pressures, as well as the proposal of policy measures. According to the project leader at NEA, they engaged in multiple rounds of dialogue with certain directorates to encourage them to "dig deeper into their toolboxes" when considering policy measures. The informant expressed positive surprise at the progress achieved and noted that consensus among the directorates would facilitate subsequent processes within the ministries (Interview 4). In December 2019, the NEA submitted its proposal to the MCE, which opened it for public consultations (NEA, 2019). For over a year, the proposal was discussed between the ministries, led by the MCE, before the cabinet approved it in 2021.

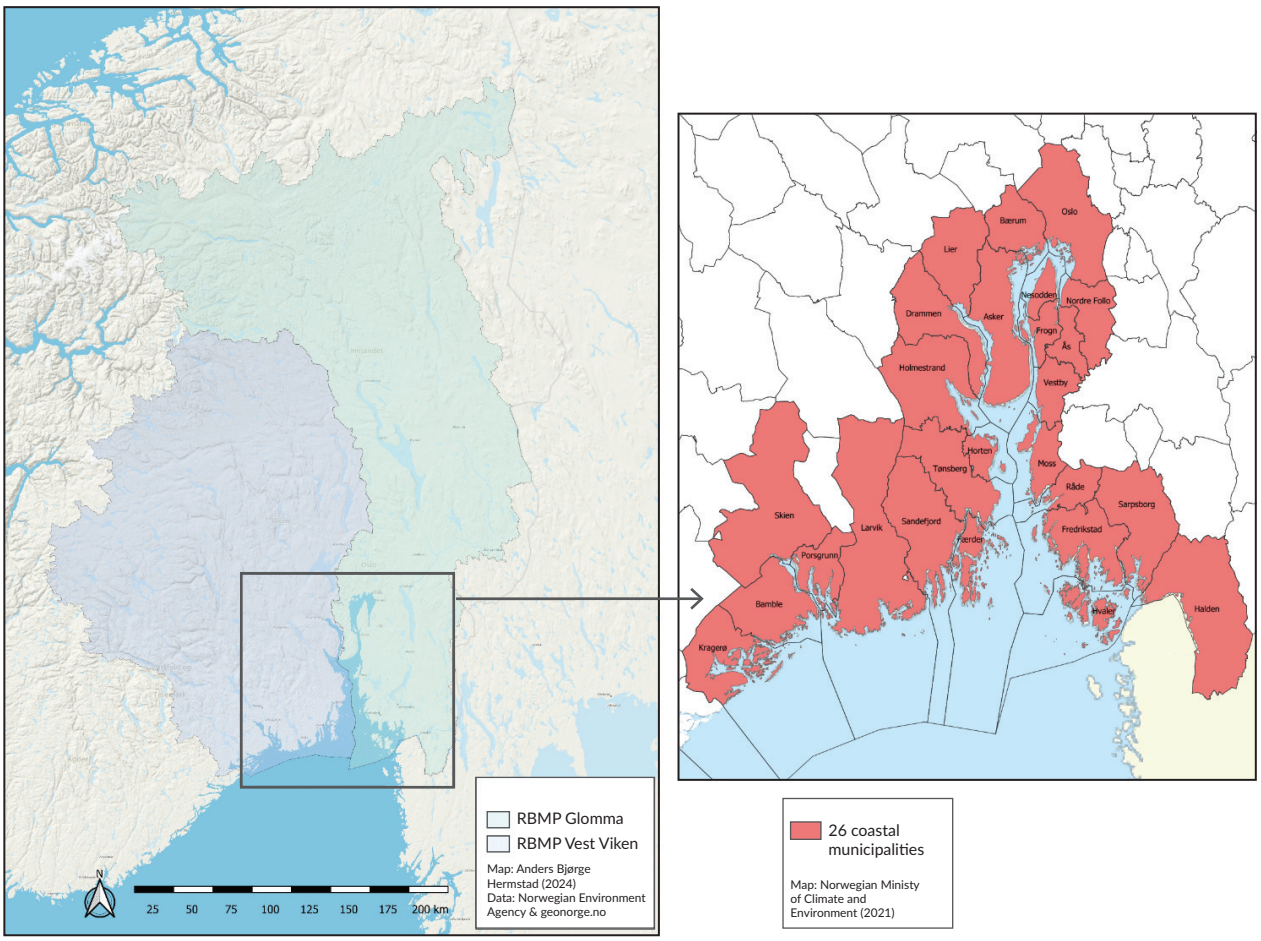


Figure 2. Oslofjord Plan's geographical coverage. Notes: The supplementing area for land-based pollution aligns with the two RBMPs covering the catchment area (left); the focus area covers the coastal zone (right). Sources: Sander et al. (2025); MCE (2021a).

4.1.3. The Adopted Plan

The adopted Plan became a clear-cut action plan with 63 measures aimed at achieving the objectives set by parliament, referring to all background information in NEA's proposal. The extent to which the Plan's 63 measures would meet the objectives set by the parliament was not specified; rather, a course was set with an unprioritised list of actions. The measures are organised into seven action areas, three of which build directly on the RBMPs: (1) reducing discharges from wastewater; (2) reducing agricultural run-off; and (3) reducing pollution from chemicals, litter, and microplastics. Objectives related to biodiversity beyond what was covered by the RBMPs and cultural heritage are grouped under action areas: (4) protective measures, primarily addressing fisheries and introduced alien species; and (5) restoration. Action area (6) focuses on measures specifically aimed at promoting outdoor recreation. Cross-cutting issues are covered in action area (7), including spatial planning and mechanisms for following up the Plan by establishing an Oslofjord Council. For each measure, the Plan identifies the responsible public authority (MCE, 2021a).

The nature of the 63 measures is diverse. Since the Plan is meant to "supplement, coordinate, and reinforce," 50 measures are continuations of ongoing initiatives, seeking to strengthen efforts through existing

instruments; only 13 are new. The Plan also includes 19 measures to generate new knowledge on environmental conditions, the impacts of activities, and the effectiveness of measures. Interesting in the context of layering is the group of approximately 15 measures that explicitly aim to change the instrumentation within existing sectoral structures or call for the preparation of additional plans. Examples include finalising regulations for the use of agricultural fertilisers, further restricting rules for access to protected bird habitats, and assessing the potential for stricter regulation of trawling. The latter went beyond merely referring to the detailing of measures in later planning; it concealed a political disagreement. Both informants from NEA and MCE commented that fisheries were the sector where the Plan remained the least concrete. "This is how far we got at that time," they reasoned (interviews 1 and 4). Both considered it most important to adopt a Plan with universal support, trusting that the continued process would lead to further improvements.

4.2. The Implementation Phase

Our analysis focuses on the Plan's environmental objectives, particularly in action areas targeting water quality and marine ecosystems (action areas 1, 2, 4, and 7), with selected measures addressing key pressures (Figure 3). Following Capano's first-tier approach, we present how the Oslofjord Plan has contributed to changes in the existing arrangements and policy implementation.

4.2.1. The Oslofjord Council

The measure to establish an Oslofjord Council was added by the MCE during the final phase of the planning. The Plan sets out that the Council should ensure regional and local support and support implementation through coordination, status reporting, and sharing of experience (MCE, 2021a). The Council is chaired by the minister of Climate and Environment and has convened twice a year since its inception. The Council's participant base has expanded over time. The members include the respective county mayors, county governors, and political representatives from a selection of coastal municipalities, including a few from the inland part of the catchment. Additionally, some NGOs and interest organisations representing environmental, recreational, fishing, and farming organisations were included. Moreover, an Oslofjord Secretariat—comprising representatives from NEA and county governors—was created to follow up with those responsible for implementing the measures and provide annual status reports on the progress.

4.2.2. The Effects on the Existing Institutional Arrangements

The Oslofjord Plan is a strategic plan, with the measures being implemented through existing institutional arrangements. The interactions of the Oslofjord Plan as a new layer with the existing institutional arrangements are depicted in Figure 3.

Several informants emphasised increased political and societal awareness as the most important result of the Oslofjord Plan and Council. The elaboration of the Plan by the national government, as well as the ministerial lead and engagement of mayors in the Oslofjord Council, demonstrates a clear political mobilisation. This has also gradually encouraged greater engagement from sectoral, regional, and local authorities. A key mechanism for establishing support and commitment has been the annual requirement for authorities to report on the progress of implementing the measures for which they are responsible (NEA, 2025). These

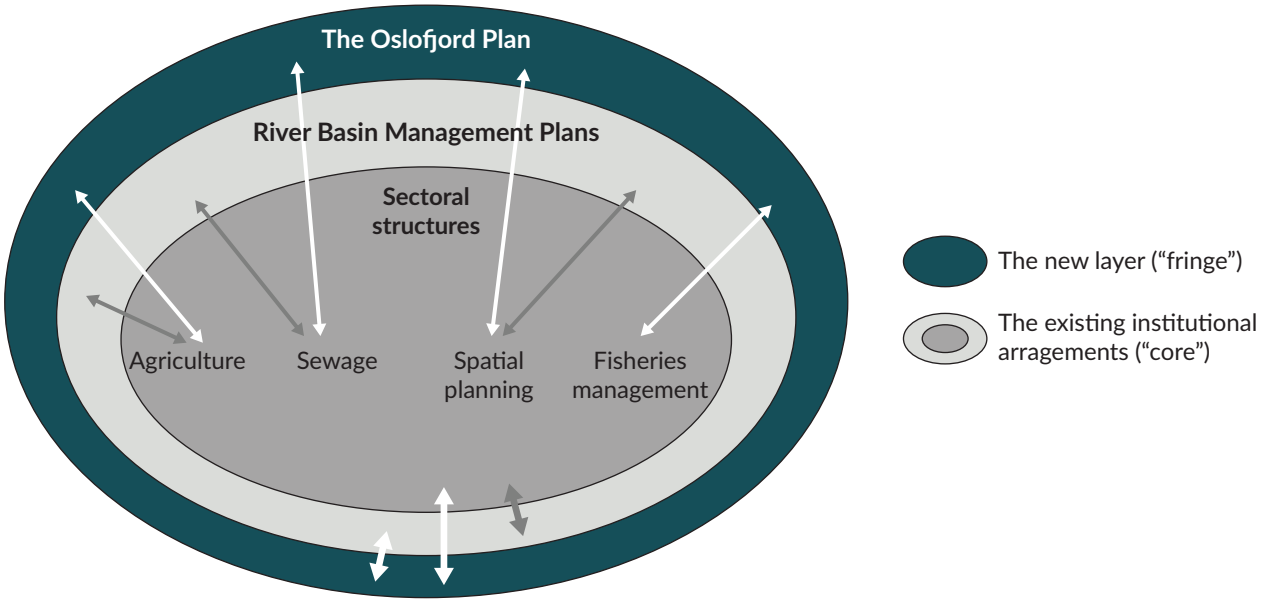


Figure 3. A conceptual illustration of the layered Oslofjord Plan and interactions with existing institutional arrangements. Notes: This includes sectoral structures and RBMPs, which also constitute strategic plans directed partly towards the same sectors; only those sectors this article focuses on are depicted here.

reporting obligations have been combined with dedicated meetings at political and administrative levels, influencing planning and decision-making processes at lower governance levels. Some counties and municipalities have formally incorporated the Plan's objectives and measures into their strategic documents, and the MCE has encouraged others to follow their example (MCE, 2023). A municipal informant noted that:

> The Oslofjord Plan has increased the focus on the Oslofjord across the municipal organisation…It's an important document we are working towards, across all relevant units….And we also received a clear instruction from our municipal council to further increase the focus on the fjord. (Interview 7)

The RBMPs, on which the Oslofjord Plan builds, are strategic plans that coordinate various authorities' efforts towards achieving good water quality. However, they lack additional legal force, and the designation and implementation of policy measures depend on the will and the financial and legal capacity of sectoral authorities and municipalities (Hanssen et al., 2017; Sander, 2023). Considering that both the Oslofjord Plan and the RBMPs are strategic plans addressing many of the same authorities with similar soft power (Figure 3), it is interesting that several informants note that "the Oslofjord Plan has been a support to the RBMPs, making them more relevant" (Interview 6) and thus facilitated their implementation (Interview 3 and 8). The RBMPs are coordinated by river basin authorities, a role assigned to the counties. However, counties lack a dedicated environmental mandate and hold a relatively weak position in Norwegian planning. Combined with limited and irregular reporting requirements, this hampers their ability to oversee and follow up with sectoral authorities. In contrast, the Oslofjord Plan assigns coordination to national environmental authorities. Alongside stronger political attention and stricter reporting obligations, this has enhanced their coordinative and proactive role towards sectoral authorities. Another challenge with the RBMPs is their limited capacity to address upstream-downstream issues in large catchments due to their focus on individual waterbodies as the primary unit of management. The Oslofjord Plan is increasingly shifting attention towards the Oslofjord as the final recipient and object to be managed, requiring policy action in the entire

catchment. This has gradually mobilised inland municipalities, with environmental consequences on the fjord now more often cited to justify objections in spatial planning.

In addition, we observe changes in the sectoral structures of the existing arrangements. This includes new or modified rules, additional grants or budgets, and new guidance and information (NEA, 2025). There are, however, notable differences among the action areas:

- Action area 1 (municipal wastewater): Key measures of the Plan in this area include improving municipal wastewater nitrogen treatment by constructing modern treatment plants and upgrading pipeline infrastructure to prevent sewage leaks and inflow of rainwater. Under the 1987 North Sea Declaration, Norway committed to reducing nutrient discharges by 50%. However, initiatives for nitrogen removal faced severe protests from municipalities responsible for wastewater treatment, given the high costs, immature technology for the Norwegian climate, and their contention that the main sources of pollution originated abroad. Consequently, the government withdrew the requirement. Today, only six plants remove nitrogen, three of which are in the Inner Oslofjord (Thaulow & Grande, 2015). This policy has changed. Municipalities renewing discharge permits must now remove nitrogen, and the NEA has instructed all catchment municipalities to prepare for the nitrogen removal requirement (MCE, 2023). The latest status report highlights an increase in both human and economic resources for the wastewater sector, leading to new guidance documents, allocation of funds to support planning, and stricter enforcement measures. Four municipalities have started constructing new nitrogen-removing plants (NEA, 2025). Coordination between municipalities is necessary to build effective treatment plants that meet new requirements and to share costs. Several feasibility studies have been undertaken, but discussions among municipalities and reaching final decisions take time.
- Action area 2 (agriculture): The second action area focuses on reducing nutrient and particle runoff from agricultural surfaces. Agricultural policy builds on a combination of binding regulations and voluntary schemes. Under the influence of the Plan, subsidies earmarked for measures that will reduce discharges into the Oslofjord catchment area have been set aside during the annual agricultural negotiations between the government and the farmers' associations (NEA, 2025). This has resulted in a substantial expansion of the area covered by measures for improving water quality (NEA, 2025). The Oslofjord Plan indicated that voluntary measures alone are insufficient and called for the implementation of additional regulations in accordance with agricultural legislation (MCE, 2021a). Regional environmental regulations, including restrictions on ploughing fields in the autumn, had already been adopted in some counties before the Plan was approved. During its implementation, such regulations have been expanded to other counties (County Governor of Oslo and Viken, 2024). Additionally, a regulation that restricts the application and storage of fertilisers was finally concluded and entered into force in 2025 (Ministry of Agriculture and Food & Ministry of Trade, Industry and Fisheries, 2025).
- Action area 4 (fisheries): During the drafting of the Plan, discussions concerned the ecological impacts of trawling and the cascading effects of depleted fish stocks. Decades of overfishing had led to the collapse of cod and other benthic fish populations, disrupting marine food webs and promoting the growth of opportunistic algae. Prior to the adoption of the Oslofjord Plan, the Ministry of Trade, Industry and Fisheries had adopted a set of regulations that restricted cod fishing in the Oslofjord (Ministry of Trade, Industry and Fisheries, 2019). The Oslofjord Plan required an assessment of which additional measures would be needed. In 2025, the Ministry of Trade, Industry and Fisheries presented a regulatory proposal

at the Oslofjord Council meeting, based on the recommendations of two directorates. The proposal introduced comprehensive and stringent regulations, including the creation of large no-take zones, and is currently being assessed based on comments from public hearings (Ministry of Trade, Industry and Fisheries & Ministry of Climate and Environment, 2025).

- Action area 7 (spatial planning): In Norway, construction within "the 100-metre belt" along the shoreline has been prohibited for decades, unless authorised through a spatial plan. A major problem is that many municipalities grant dispensations, gradually degrading habitats and denying public access to the shoreline. Several measures in the Plan aim to ensure stricter practices regarding dispensations and better coordination in municipal spatial planning. Another measure suggested was to assess the potential for a regional spatial plan for the Oslofjord area. However, this has been rejected by the four counties involved. The latest status report indicates that spatial management issues remain among the areas where the least progress has been made. There is, however, a slight decrease in new dispensations granted, and several municipalities have reviewed and updated their spatial plans (NEA, 2025).

5. Discussion

5.1. Approaches to Layering in the Institutional Design of the Oslofjord Plan

The Oslofjord Plan provides an interesting empirical case to study layering. As argued in Section 2.2, we follow Capano's definition of layering as a mode of institutional design (Capano, 2019). To better understand what "adding something new" to an institutional arrangement implies, he suggests focusing on the substantive content of these additions. He differentiates between three distinct approaches that policymakers can use: adding instruments, adding actors, and changing perceptions. We argue that the institutional design of the Oslofjord Plan contains all three approaches.

The adoption of the Oslofjord Plan as a strategic action plan can be seen as adding a new instrument as an extra layer ("regulatory ratchet"; Capano, 2019; van der Heijden, 2011; see also Vedung, 2017). The Plan has sharpened existing measures and introduced new ones. Among scholars, there are differing views on whether layering is a deliberate and conscious decision by policymakers or an unintended by-product of their decisions (Capano, 2019; Carey et al., 2019). In the case of the Oslofjord Plan, policymakers deliberately chose layering as the institutional design approach, defining the role of the new instrument as one that "supplements, coordinates, and reinforces" existing arrangements, which were considered insufficient in scope and strength to address the complex challenges. This approach closely aligns with Streeck and Thelen's (2005) view that layering does not seek confrontation with existing structures but rather offers an alternative path by introducing an additional layer.

The establishment of the Oslofjord Council represents a "thickening" of actors (Capano, 2019; van der Heijden, 2011) by adding a new arena to the institutional arrangements. Several of these actors collaborate in existing arenas, such as the river basin districts, which address specific policy issues or limited geographical areas. The Oslofjord Council is novel in gathering relevant actors in the entire catchment. Van Assche et al. (2020) argued that a common challenge in coastal governance is the limited recognition of the coast as an area and object of governance in its own right, with fragmented governance structures failing to integrate land–sea interactions. They advocate for the establishment of governance arenas specifically

recognising and addressing coastal challenges, and we argue that the Oslofjord Council represents such an attempt. However, there are differing views on its role and success. The meetings were recognised by the interviewees as facilitating peer learning through the exchange of implementation experiences (Interview 1 and 8). However, the Council has not operated as an arena for substantive political debate or decision-making. This absence of overarching steering is viewed by some informants as a weakness. Conversely, it has been argued that the Council was never intended to serve as a decision-making body, but rather as a coordination mechanism (Interview 1). In this context, several informants have called for stronger political leadership from the entire government, and one informant noted the need to complement this with more bottom-up coordination initiatives, for instance, initiated by the large sewage treatment operators (Interview 1).

The introduction of shared policy goals related to the entire Oslofjord aligns with what Capano (2019) refers to as the "ideational layer." The Oslofjord Plan and Council, through its political leadership and mobilisation, have provided a new framing of the problem and a sense of urgency. Additionally, the Plan's preparation and implementation have been supported by scientific assessments and various reports, offering a better understanding of the complex challenges. The Oslofjord Plan is a government initiative targeting public authorities, as reflected in its assigned responsibilities and the composition of the Oslofjord Council. Nevertheless, it has indirectly spurred mobilisation among NGOs and industries, resulting in parallel initiatives and collaborative networks. Simultaneously, media attention has raised broader societal awareness.

5.2. Do We Observe Transformative Change Due to the Oslofjord Plan's Layered Design?

The ecological crisis in the Oslofjord has not been sufficiently addressed by existing institutional arrangements. The Oslofjord Plan establishes an ambitious objective of a clean, healthy, and accessible fjord. Achieving this requires a radical transformation from current trajectories. The critical question is whether the layered structure created by the Plan will be capable of initiating the necessary dynamics.

As discussed in Section 2.2, Capano (2019) emphasised that there is no guarantee that layering, as a mode of institutional design, will lead to changes in policy outcomes. This depends on the interactions between the new layer ("the fringe") and the existing institutional arrangements ("the core"). Differential growth refers to the mechanism by which the fringe gradually reconfigures the institutional dynamics and trajectory of the core, thereby fostering the emergence of a new logic of action. In the absence of differential growth—for instance, when institutional lock-ins prevent reshaping the core—layering does not result in changed policy outcomes and thus fails to initiate transformative change.

In 2025, a new status report on the ecological state of the Oslofjord was presented (Frigstad et al., 2025). With some exceptions, the report depicts a concerning picture of the Oslofjord, with the ecological condition mostly continuing to deteriorate or showing no improvement. The report indicates that the Plan is unlikely to achieve its objectives in the near term, certainly not by 2026, which is its time horizon. Consequently, the minister of the MCE and the secretariat have signalled the need to extend the initiative. The absence of visible progress on policy outcomes raises the question of whether the Oslofjord Plan failed to initiate a mechanism of differential growth or whether the layering theory offers other explanations. We propose two explanations (E1 and E2).

E1: Transformative change is not observed because the Oslofjord Plan does not address the existing institutional barriers, which create lock-ins and hinder differential growth. As a result, the institutional trajectory remains unchanged.

E2: Transformative change takes time because differential growth is a gradual process. This explains why changes in policy outcomes have not yet been observed.

5.2.1. Transformative Change Is Not Observed Due to Institutional Lock-ins (E1)

Kelly et al. (2018, 2019) note that a common barrier to achieving transformative outcomes is that "persistent problems" and the institutional complexity of the existing arrangements are not addressed by the new governance system. They attribute this to path dependencies, where policymakers' interventions are influenced and restricted by past decisions. Other contributing factors may include power imbalances among stakeholders seeking to preserve the status quo or conflicts between new policy objectives and those of the existing arrangements (Trubbach et al., 2024). Consequently, the status quo is not challenged, and lock-ins of the incumbent institutional arrangements are reproduced (Kelly et al., 2018, 2019). In the case of the Oslofjord Plan, it is thus relevant to ask whether institutional barriers from the existing institutional arrangements can be observed and whether these create institutional lock-ins that undermine differential growth.

The principle of local self-government is deeply embedded in Norwegian governance, leading to resistance towards overriding the municipalities' decision-making powers. The latest status report identified spatial management as one of the action areas with the least progress (NEA, 2025). We argue that the principle of local self-government often acts as a barrier, as each municipality is responsible for spatial planning within its own boundary. An informant at the County Governor's Office, involved in providing input to municipal spatial plans, noted that their role in ensuring holistic planning across the entire Oslofjord remains limited and suggested that national environmental authorities may be needed to improve coordination across municipal borders (Interview 6). While the Oslofjord Plan encouraged counties to consider establishing an interregional plan for the Oslofjord, the counties chose not to pursue this initiative (NEA, 2025). This resonates with previous literature highlighting challenges in achieving holistic spatial planning in Norway due to the delegation of planning responsibilities to the municipalities and the constrained role and limited legal status of regional planning (Hersoug et al., 2012; Stokke, 2021). Local self-government also creates challenges regarding municipal wastewater management. This is also largely delegated to the municipalities, raising questions about who is responsible for coordinating beyond municipal borders. While the Oslofjord Plan and sectoral policy on wastewater advocate greater cooperation, an informant at the County Governor's Office explained that "we can encourage and recommend, but we cannot impose it on them—the government does not have that tool at its disposal" (Interview 6). A municipal agent from a coastal municipality noted, "Cooperation is a necessity in order to meet the requirements, but there are other municipalities that don't think along the same lines." (Interview 7). Regarding how coordination across all municipalities could be achieved, the agent reflected that "regional sewage plans, as a form of overarching steering, could have high potential" (Interview 7).

The government's strict application of the polluter pays principle is a recurring issue in discussions on municipal wastewater management. Around 2000, the government stopped subsidising wastewater

infrastructure, making the municipalities fully responsible for funding the operation, maintenance, and upgrading of the infrastructure, including wastewater plants. In line with the polluter pays principle, municipalities finance these costs through a sewage fee imposed on homeowners and industries (the polluters), earmarked for the purpose. Two paradoxes, however, challenge this principle and have slowed down municipal efforts. The first concerns the perceived uneven distribution of costs and benefits between coastal and inland municipalities; while all municipalities bear costs, inland municipalities see fewer benefits of an improved fjord. The second concerns the intergenerational distribution of costs since the fjord's deteriorated state is the result of decades of insufficient municipal investments in sewage infrastructure. In 2021, Oslofjord mayors petitioned the government to assist in covering the costs, finding it unreasonable that inhabitants alone should bear the costs of saving the fjord through large increases in the fees, e.g., a 50% increase over four years (Mayors for the Oslofjord, 2022). The mayors were also concerned that the rising fees could become politically sensitive, potentially affecting local elections and complicating efforts to implement nationally decided measures. The government has upheld the polluter pays principle but offered limited funds to support the planning of new infrastructure in response (NEA, 2025).

The principle of sectoral responsibility for the environment creates challenges towards integrated environmental management in Norway. To achieve environmental objectives, sectoral authorities must themselves implement policy measures within their respective regulatory and financial frameworks, while environmental authorities play a coordinative and facilitative role (MCE, 1997; Persson, 2004). However, this creates tensions around which measures sectors are willing to implement, especially when environmental objectives do not align with their core sectoral mandates. The Oslofjord Plan layers reinforced environmental objectives without contravening the principle of sectoral responsibility, which may even intensify tensions between misaligned policy objectives. For instance, during an Oslofjord Council meeting, representatives from the agricultural sector pointed to the trade-off between the goal of increasing Norway's self-sufficiency in agricultural products from 40% to 50% and several measures for improving water quality that may reduce harvest yields. These discrepancies in the Plan's holistic policy ambitions, layered onto a sectoral structure in the existing institutional arrangement, align with similar findings in the literature (Indset et al., 2010; Vince, 2015).

5.2.2. It Takes Time to Set Differential Growth in Motion (E2)

The Oslofjord Plan was introduced four years ago. We argue that the temporal dimension is one important factor that can explain why we do not yet observe changes in policy outcomes towards a "clean and healthy" fjord. Several policy measures in the Oslofjord Plan were designed to be developed and specified over time, explaining the temporal delay. When the Plan was created, there was uncertainty regarding the efficiency and effectiveness of several measures, as well as unclear scientific recommendations. To avoid further delays, the Plan was adopted even though measures for some issues had not yet been specified. Instead, knowledge-building and assessment-oriented measures were included, with the aim that these would later be developed into concrete policy measures. For example, one measure of the Plan was to assess the possibility of regulating fisheries rather than setting regulations. As more information has become available and political processes have advanced, a proposal with extensive fishing restrictions has recently been presented. Similar examples include restrictions on the discharge of boat sewage and agricultural regulations related to fertilisers.

Another point to support this explanation is that the majority of the measures are a continuation of existing initiatives, with the Plan seeking to reinforce their implementation. As demonstrated in Section 4.2.2, we observe several reinforcements within the existing institutional arrangements. Examples include increased and earmarked financial aid for environmental agricultural measures and the adoption of regulations on agricultural practices. In the area of wastewater management, this includes dedicated planning funds, increased human resources, and enhanced guidance (NEA, 2025). The Oslofjord Plan's positive effects on the implementation of policy measures in the RBMPs, driven by its political mobilisation and more rigorous reporting regime, serve as another illustration. This demonstrates how the Oslofjord Plan is reinforcing the implementation of policy measures in the existing arrangements, which contribute positively to the intended outcomes. However, these changes occur gradually.

Another explanation for some measures pertains to the temporal delay between measures and positive effects on the fjord. First, it takes time to plan and implement a measure. This is especially visible in the municipal wastewater sector, with long and complicated planning of nitrogen-removing plants, followed by a construction phase and fine-tuning of the processes. Even though the first new nitrogen-removing plants may start operating in 2026, many others will not start before 2030 or later (NEA, 2025). Second, it takes time before the reductions in discharges of nitrogen and particles lead to the recovery of the marine ecosystem. Delayed ecological responses to measures are also evident in fish stocks, which have not yet shown signs of recovery despite initial restrictions on commercial fishing (Knutsen et al., 2022).

5.2.3. Reflections on Research Design

One important limitation of our analysis is the challenge of establishing causation, which is an inherent difficulty in policy research (Falleti & Lynch, 2009). While empirical findings from interviews and document analysis suggest that observed changes can be attributed to the Oslofjord Plan, it is essential to recognise that the Plan does not operate in isolation, as other policy and societal developments occur simultaneously. For example, while fisheries regulations are clearly linked to the Oslofjord Plan, another explanatory factor is the parallel initiatives on pilot areas for marine conservation in the Oslofjord-Skagerrak area (MCE, 2021b; Interview 3). Similarly, new policies in the wastewater sector are influenced not only by the Oslofjord Plan but also by the ongoing revision of the EU's Urban Wastewater Directive.

6. Conclusion

The Oslofjord has undergone serious ecological degradation due to long-term human pressures, including nutrient pollution, overfishing, and habitat loss. Research on coastal governance highlights that traditional institutional arrangements are often inadequate for addressing the complex dynamics between land and sea, which is also evident in the Oslofjord. The Oslofjord Plan, introduced by the government to restore the fjord, exemplifies a case of institutional layering. The Plan aims to "supplement, coordinate, and reinforce" existing arrangements through the addition of instruments, actors, and changed perceptions. We analysed how this new layer interacts with established institutional arrangements. This involves understanding whether the Plan (the fringe) gradually reshapes the trajectory and predominant logic of action created by existing institutional arrangements (the core), or whether institutional lock-ins obstruct such differential growth. Analysing these institutional dynamics is crucial to determining whether the Plan can create transformative change. Current reports suggest the Plan has not yet achieved its intended policy outcome, as the ecological status of the fjord

has not improved. We proposed two complementary explanations: (a) the Oslofjord Plan does not address existing institutional barriers, resulting in lock-ins that hinder differential growth and prevent transformative change; and (b) the absence of observable changes in policy outcomes reflects the gradual nature of differential growth and the time required for transformative change to unfold.

We argue that several governance principles deeply embedded in the Norwegian system pose barriers to the Plan's implementation. Its holistic ambitions—particularly in spatial and wastewater management—are challenged by the principle of local self-government, which resists coordinated steering from above. The Plan relies on soft power and political mobilisation, which has increased efforts and awareness across municipalities, but this only partially mitigates the challenges posed by local self-government. Similarly, we find that despite the Plan having increased the societal acceptance of costly measures to upgrade sewage infrastructure, the polluter-pays principle—where inhabitants bear the costs of investments in new sewage treatment plants—remains a key barrier. As a result, we conclude that in the policy areas of wastewater and spatial planning, the Oslofjord Plan is currently insufficient to achieve its objectives due to persistent institutional barriers that create lock-ins. Because of the sectoral responsibility principle, achieving environmental policy objectives becomes difficult when these objectives and the necessary measures conflict with a sector's primary objectives, limiting sectoral authorities' ability or willingness to implement environmental measures. However, we do observe greater environmental integration within sectoral structures, particularly in policy areas where the Oslofjord Plan reinforces the RBMPs. This may be attributed to heightened political attention and a more stringent reporting regime, as well as the fact that the coordination role towards sectoral authorities under the Oslofjord Plan is assumed by national environmental authorities, unlike the RBMPs, where counties without a specific environmental mandate and more limited authority are responsible. We therefore conclude that, while challenges from conflicting objectives under sectoral responsibility persist, the Plan offers stronger steering toward environmental objectives than existing institutional arrangements. However, the changes within sectoral structures occur gradually, and due to the Plan's design, where many measures are intended to be specified and will be implemented over time, it takes time before these lead to visible improvements in the fjord's health and accessibility.

Achieving the Oslofjord Plan's ambitious objectives requires a fundamental reconfiguration of the logic of action across all sectors and actors. While the Plan has gradually initiated differential growth, persistent institutional lock-ins lead us to conclude that it is insufficient in generating transformative change and achieving its ambitious objectives. The Plan was adopted in 2021 despite scientific uncertainty, as initiating action was prioritised over further delay. The Plan outlines a general direction but lacks prior assessment of the expected results of the measures and prioritisation among the actions. The Plan's first phase runs until 2026, and the initiative will likely continue beyond. Our analysis offers several recommendations for a potential revision of the Plan. First, we argue that greater attention must be paid to the institutional barriers embedded in existing arrangements, as these can obstruct change. Second, a clearer understanding of the effectiveness and efficiency of proposed measures is needed. Arguably, the increased knowledge and political as well as societal mobilisation achieved during the first phase of the Plan would likely facilitate a revision of measures.

Although this article focuses on the Oslofjord Plan, it informs broader discussions on institutional layering. We support Capano's (2019) view that it is important to distinguish between layering as a mode of design

and its effects in terms of policy outcomes. Choosing layering as a design mode of the Oslofjord Plan was based on the recognition that existing arrangements should remain the key to change, but that they needed to be supplemented, coordinated, and reinforced. Likely due to existing societal and political awareness of the fjord's condition, this approach faced minimal resistance. However, implementation depends on dynamic interactions between the new layer and existing arrangements and has proven more complex. This highlights the importance of paying greater attention to implementation processes to understand how layering can lead to transformative change.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). The research has been supported by material collected through the CrossGov (2022–2025) project, funded by the European Union under the Grant Agreement ID 101060958. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them. We extend our sincere gratitude to the interview candidates and other informants for their time and valuable contributions, which greatly enriched our research. We also thank the Ministry of Climate and Environment for enabling our participation in the Oslofjord Council meetings. Additionally, we appreciate the anonymous reviewers and academic editors for their constructive feedback and suggestions.

Conflict of Interests

The authors declare no conflict of interests.

References

Capano, G. (2019). Reconceptualising layering—From mode of institutional change to mode of institutional design: Types and outputs. *Public Administration*, *97*(3), 590–604. https://doi.org/10.1111/padm.12583

Carey, G., Kay, A., & Nevile, A. (2019). Institutional legacies and "sticky layers": What happens in cases of transformative policy change? *Administration & Society*, *51*(3), 491–509. https://doi.org/10.1177/0095399717704682

Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. *Administrative Science Quarterly*, *17*(1), 1–25. https://doi.org/10.2307/2392088

County Governor of Oslo and Viken. (2024). *Forskrift om regionale miljøkrav i jordbruket, Østfold, Buskerud, Oslo og Akershus og Gran kommune, Innlandet*. https://lovdata.no/dokument/LF/forskrift/2024-06-10-952/KAPITTEL_1#KAPITTEL_1

Elvestuen, O., Grimstad, C.-E., & Raja, A. Q. (2017). *Representantforslag om en helhetlig forvaltningsplan for Oslofjorden*. Stortinget. https://www.stortinget.no/no/Saker-og-publikasjoner/Publikasjoner/Representantforslag/2017-2018/dok8-201718-051s

Falleti, T. G., & Lynch, J. F. (2009). Context and causal mechanisms in political analysis. *Comparative Political Studies*, *42*(9), 1143–1166. https://doi.org/10.1177/0010414009331724

Frigstad, H., Ramon, P., Borgersen, G., Engesmo, A., Staalstrøm, A., Naustvoll, L.-J., Lerch, S., Schøyen, M., Ruus, A., Strohmeier, T., Falkenhaug, T., Freitas, C., Moland, E., Haugen, T. O., Hoff, S., Jentoft, S., Mo, T. A., Rinde, E., Hanssen, S., & Walday, M. (2025). *Tilstandsrapport for Oslofjorden* (No. M–2885). Norwegian Institute for Water Research. https://www.miljodirektoratet.no/publikasjoner/2025/januar-

2025/tilstandsrapport-for-oslofjorden/#:~:text=Tilstandsrapport%20for%20Oslofjorden%20gir%20en%20oversikt%20over%20milj%C3%B8tilstanden,rik%20og%20tilgjengelig%20for%20alle%20fram%20mot%202026

Hall, P. A. (1993). Policy paradigms, social learning, and the state: The case of economic policymaking in Britain. *Comparative Politics*, *25*(3), 275–296. http://www.jstor.org/stable/422246

Hanssen, G. S., Hovik, S., Indset, M., & Klausen, J. E. (2017). *Sammen om vannet? Erfaringer fra vannforvaltningen etter EUs vanndirektiv* (No. 2016:22). Norwegian Institute for Urban and Regional Research. https://oda.oslomet.no/oda-xmlui/bitstream/handle/20.500.12199/5538/2016-22%20med%20forside.pdf?sequence=1&isAllowed=y

Hersoug, B., Borch, T., & Johnsen, J. (2012). Kystsoneplanlegging i Lofoten—Et middel i kampen om arealer, ressurser eller symboler? In B. Hersoug, T. Borch, & J. Johnsen (Eds.), *Kampen om plass på kysten* (pp. 81–101). Universitetsforlaget. https://doi.org/10.18261/9788215050966-2012-06

Indset, M., Naustdalslid, J., & Stokke, K. B. (2010). *Kollektiv handling fullt og helt, eller stykkevis og delt?* (Nos. 2010–3). Norwegian Institute for Urban and Regional Research. https://oda.oslomet.no/oda-xmlui/bitstream/handle/20.500.12199/5600/2010-3.pdf?sequence=1&isAllowed=y

Kelly, C., Ellis, G., & Flannery, W. (2018). Conceptualising change in marine governance: Learning from transition management. *Marine Policy*, *95*, 24–35. https://doi.org/10.1016/j.marpol.2018.06.023

Kelly, C., Ellis, G., & Flannery, W. (2019). Unravelling persistent problems to transformative marine governance. *Frontiers in Marine Science*, *6*, Article 213. https://doi.org/10.3389/fmars.2019.00213

Kingdon, J. W. (1984). *Agendas, alternatives, and public policies*. Brown and Company.

Knutsen, H., Heiberg Espeland, S., & Moland, E. (2022). *Evaluering av tiltak for vern av kysttorsk i sør innført juni 2019*. Havforskningsinstituttet. https://www.hi.no/hi/nettrapporter/rapport-fra-havforskningen-2022-48

Mahoney, J., & Thelen, K. (2009). A theory of gradual institutional change. In J. Mahoney & K. Thelen (Eds.), *Explaining institutional change: Ambiguity, agency, and power* (pp. 1–37). Cambridge University Press. https://doi.org/10.1017/CBO9780511806414.003

Mayors for the Oslofjord. (2022). *Statsbudsjettet 2023: Det haster med tiltak og investeringer for en frisk Oslofjord*. Bærum Municipality. https://www.baerum.kommune.no/globalassets/korona/uttalelse-fra-ordforere-for-oslofjorden-om-statsbudsjettet-20.01.22.pdf

Ministry of Agriculture and Food., & Ministry of Trade, Industry and Fisheries. (2025). *Forskrift om produksjon, omsetning og import av gjødselvarer av organisk opphav og visse uorganiske gjødselvarer (gjødselvareforskriften)*. https://lovdata.no/dokument/SF/forskrift/2025-01-29-116?q=gj%C3%B8dselvareforskriften

Ministry of Climate and Environment. (1997). *Miljøvernpolitikk for en bærekraftig utvikling—Dugnad for framtida*. https://www.regjeringen.no/no/dokumenter/st-meld-nr-58_1996-97/id191317

Ministry of Climate and Environment. (2019). *Supplerende tildelingsbrev ifm Helhetlig plan for Oslofjorden, kap. 1400 post 21*. https://www.regjeringen.no/contentassets/d53e8761ccb042c3b29224b3fc205493/supplerende-tildelingsbrev-ifm-helhetlig-plan-for-oslofjorden-kap.-1400-post-1.pdf

Ministry of Climate and Environment. (2021a). *Helhetlig tiltaksplan for en ren og rik Oslofjord med et aktivt friluftsliv*. https://www.regjeringen.no/no/dokumenter/helhetlig-tiltaksplan-for-en-ren-og-rik-oslofjord-med-et-aktivt-friluftsliv/id2842258

Ministry of Climate and Environment. (2021b). *Helskapleg nasjonal plan for bevaring av viktige område for marin natur*. https://www.regjeringen.no/no/dokumenter/meld.-st.-29-20202021/id2843433

Ministry of Climate and Environment. (2023). *Kommunenes ansvar for oppfølging av tiltakene i helhetlig tiltaksplan for en ren og rik Oslofjord*. https://www.regjeringen.no/contentassets/ce8407328dc441c38945102a413b1ad9/brev-til-kommunene.pdf

Ministry of Trade, Industry and Fisheries. (2019). *Forskrift om forbud mot fiske i gytefelt for torsk* (FOR-2019-03-20-321). https://lovdata.no/dokument/SF/forskrift/2019-03-25-321/%C2%A71#%C2%A71

Ministry of Trade, Industry and Fisheries., & Ministry of Climate and Environment. (2025). *Høringsnotat—Om fiskeritiltak i Oslofjorden*. https://www.regjeringen.no/no/dokumenter/horing-om-fiskeritiltak-i-oslofjorden/id3084210

Norwegian Environmental Agency. (2019). *Forslag til helhetlig plan for Oslofjorden*. https://www.miljodirektoratet.no/publikasjoner/2019/desember-2019/forslag-til-helhetlig-plan-for-oslofjorden

Norwegian Environmental Agency. (2025). *Gjennomføring av helhetlig tiltaksplan for Oslofjorden—Rapport for året 2023–2024*. https://www.miljodirektoratet.no/publikasjoner/2025/januar-2025/gjennomforing-av-helhetlig-tiltaksplan-for-oslofjorden-rapport-for-aret-2023-2024

Persson, Å. (2004). *Environmental policy integration: An introduction*. Stockholm Environmental Institute. https://mediamanager.sei.org/documents/Publications/Policy-institutions/EPI.pdf

Pierson, P. (2004). *Politics in time: History, institutions, and social analysis*. Princeton University Press. http://www.jstor.org/stable/j.ctt7sgkg

Sander, G. (2018). Against all odds? Implementing a policy for ecosystem-based management of the Barents Sea. *Ocean & Coastal Management*, *157*, 111–123. https://doi.org/10.1016/j.ocecoaman.2018.01.020

Sander, G. (2023). *Innføring i vannforvaltningen i Norge etter EU sitt vanndirektiv*. Norwegian Institute for Water Research. https://framsenteret.no/wp-content/uploads/2023/04/niva-rapport-7853-2023-innforing-i-vannforvaltningen-i-norge.pdf

Sander, G., Stokke, K. B., Movik, S., & Trubbach, S. (2025). Hvor nyttig er naturregnskap i planlegging for Oslofjorden? *Kart og Plan*, *118*(2), 138–152. https://doi.org/10.18261/kp.118.2.5

Standing Committee on Energy and the Environment. (2018). *Innstilling fra energi—Og miljøkominteen om representantforslag om en helhetlig forvaltningsplan for Oslofjorden (Innst. 203 S)*. Stortinget. https://www.stortinget.no/no/Saker-og-publikasjoner/Publikasjoner/Innstillinger/Stortinget/2017-2018/inns-201718-203s/?all=true

Stokke, K. B. (2021). Planlegging i sjø—Behov for sterkere regional styring. In K. Broch Hauge & K. Bjørn Stokke (Eds.), *Integrert kystsoneforvaltning* (pp. 340–354). Universitetsforlaget. https://doi.org/10.18261/9788215045078-2021-18

Stortinget. (2018). *Representantforslag om en helhetlig forvaltningsplan for Oslofjorden* (Dokument 8:51 S (2017–2018), Innst. 203 S (2017-2018) Vedtak 575). https://www.stortinget.no/no/Saker-og-publikasjoner/Vedtak/Vedtak/Sak/?p=69948

Streeck, W., & Thelen, K. (Eds.). (2005). Introduction: Institutional change in advanced political economies. In S. Wolfgang & T. Kathleen (Eds.), *Beyond continuity: Institutional change in advanced political economies* (pp. 1–39). Oxford University Press. https://doi.org/10.1093/oso/9780199280452.003.0001

Thaulow, H., & Grande, S. (2015, September 8). *The cleanup of the Oslo fjord: From the past to the future*. [Paper presentation]. IWA-EWA workshop on history of sanitation and wastewater treatment in large towns, Prague, Czech Republic.

Trubbach, S., Johannesen, E., & Platjouw, F. (2024). *Archetypical patterns of barriers and enablers to policy coherence in European marine and coastal governance: A systematic review*. Manuscript submitted for publication.

Van Assche, K., Hornidge, A.-K., Schlüter, A., & Vaidianu, N. (2020). Governance and the coastal condition: Towards new modes of observation, adaptation and integration. *Marine Policy*, *112*, Article 103413. https://doi.org/10.1016/j.marpol.2019.01.002

van der Heijden, J. (2011). Institutional layering: A review of the use of the concept. *Politics*, *31*(1), 9–18. https://doi.org/10.1111/j.1467-9256.2010.01397.x

van der Heijden, J., & Kuhlmann, J. (2017). Studying incremental institutional change: A systematic and critical meta-review of literature from 2005 to 2015. *Policy Studies Journal*, *45*(3), 535–554. https://doi.org/10.1111/psj.12191

Vedung, E. (2017). Policy instruments: Typologies and theories. In Bemelmans-Videc, M.-L., Rist, R. C., & Vedung, E. (Eds.), *Carrots, sticks & sermons: Policy instruments & their evaluation* (Vol. 2, pp. 21–58). Routledge. https://doi.org/10.4324/9781315081748

Vince, J. (2015). Integrated policy approaches and policy failure: The case of Australia's Oceans Policy. *Policy Sciences*, *48*, 159–180. https://doi.org/10.1007/s11077-015-9215-z

About the Authors

Saskia Trubbach is an environmental policy researcher at the Norwegian Institute for Water Research (NIVA). Her research focuses on the integrated management of marine and coastal areas, studying the implementation and interaction of policy frameworks.

Gunnar Sander is a senior researcher at NIVA, with a background in planning, law of the sea, and implementation studies. His research mostly focuses on integrated management of oceans and coasts, with a special interest in ecosystem-based management.

Maren Helene Sævold is an environmental economist and research assistant at NIVA. Her research focuses on coastal and marine planning, with particular emphasis on trade-offs between different societal interests and nature conservation.

Ocean and Society
2025 • Volume 2 • Article 10286
https://doi.org/10.17645/oas.10286

cogitatio

ARTICLE

Open Access Journal

Governance Innovation for Coastal Wetlands: Dependencies, Challenges, and Opportunities in the Valencian Community

Irene Luján Climent, Joan Enguer, Bernabé Aldeguer, and Oscar Barberà

Department of Constitutional Law and Political Science, University of Valencia, Spain

Correspondence: Joan Enguer (joan.enguer-saus@uv.es)

Submitted: 12 March 2025 **Accepted:** 17 June 2025 **Published:** 30 July 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Coastal wetlands rank among the world's essential ecosystems, and yet, despite decades of conservation efforts, they continue to face degradation, transformation, and loss. This ongoing decline underscores the need for innovative approaches to their governance. However, much of the existing literature remains broadly focused on littoral governance and does not address the specific challenges of coastal wetland planning and management. In response, this article provides a specific assessment of coastal wetland governance, examining challenges and opportunities across five key dimensions: land–sea management integration, scientific knowledge, stakeholder participation, strategic foresight, and digital tools. Grounded in the evolutionary governance theory and informed by a focus group and in-depth interviews, the study explores the extent to which innovative strategies drive the evolution of governance in six protected littoral wetlands of the Valencian Community: l'Albufera, El Hondo, Lagunas de La Mata y Torrevieja, Marjal de Pego-Oliva, Prat de Cabanes-Torreblanca, and Salinas de Santa Pola. The findings reveal that the opportunities linked to dependencies in the Valencian context can help to overcome barriers to innovation, particularly in the areas of scientific knowledge, stakeholder involvement, and e-governance tools. Notably, common obstacles persist across the five dimensions, including the lack of coordination between government bodies, rigid regulations, frequent political changes, and funding instability, all of which underline the critical importance of addressing institutional and organizational dependencies.

Keywords

coastal wetlands; digital tools; evolutionary governance; land–sea integration; scientific knowledge; stakeholder participation; Valencian community

1. Introduction

On October 29, 2024, intense floods occurred in the Valencian community and had devastating effects in numerous flood-prone areas, such as those near ravines in the coastal wetland of l'Albufera. This event exposed the heightened risk of environmental disasters that coastal wetlands face, especially in a Mediterranean region where such ecosystems are already under significant environmental and anthropogenic pressure (Camacho et al., 2024). At the same time, it underscored their crucial role in mitigating flood impacts by retaining excess water (Barua et al., 2021). As well as highlighting the function of coastal wetlands as habitats for diverse flora and fauna and their capacity for carbon storage, this emphasizes the critical need for their protection and conservation. However, achieving effective preservation remains particularly challenging due to the complexity of their governance, shaped by overlapping jurisdictions and competing priorities, including persistent tensions between conservationist and productivist interests (Jégou & Sanchis-Ibor, 2019).

The first significant step taken by the international community toward wetland conservation can be traced back to the Ramsar Convention in 1971 (Erwin, 2009). This treaty aimed to protect wetlands' ecological functions and cultural significance while promoting sustainable socio-economic development (Gardner & Finlayson, 2018). Although countries all over the world subscribed to this convention and participated in research on their protection and sustainable use, the total wetland area has continued to shrink worldwide, and its ecological quality has declined (Gardner et al., 2015). Notably, coastal wetlands are among the most severely damaged littoral ecosystems, having experienced significant deterioration, transformation, and loss due to rapid population growth, urban expansion, and the associated human activities such as tourism (Barbier et al., 2011; Cvetkovic & Chow-Fraser, 2011). Additionally, rising global sea-levels caused by climate change are further intensifying the degradation of this specific typology of wetlands (Edenhofer, 2015).

Such issues emphasize the urgent need for innovative approaches in coastal wetland governance. In this regard, a comprehensive understanding of the adaptive capacities and trajectory-shaping mechanisms—known as dependencies—that arise from interactions between institutions and actors is crucial for effective governance reform. Thus, recent studies on littoral governance rely on an innovation-driven model that balances the opportunities and constraints posed by dependencies across five fundamental dimensions: the integration of land–sea management, the application of scientific knowledge, stakeholder engagement, strategic foresight, and the use of digital governance tools (Fobé et al., 2024). Nevertheless, the expectations derived from the literature based on this general model cannot be directly extrapolated to the unique characteristics of coastal wetlands (Barua et al., 2021).

Against this background, this article presents a coastal wetland-based assessment of the five dimensions presented in six critical ecosystems in the Valencian community: l'Albufera, El Hondo, Lagunas de La Mata y Torrevieja, Marjal de Pego-Oliva, Prat de Cabanes-Torreblanca, and Salinas de Santa Pola. It seeks to address the following core research question: How do innovative approaches contribute to the evolution of coastal wetland governance? Grounded in evolutionary governance theory, the study draws on a focus group and several in-depth interviews with a total of 31 stakeholders. It begins by reviewing the current state of the art on governance innovation in coastal areas and particularly littoral wetlands. It then provides background information on the study region and methodology, before discussing the key findings. Finally, the article discusses the results and concludes with a summary of the insights gained from the research and their implications for future wetland governance.

2. Evolutionary Governance in Coastal Wetlands

This article builds on the theoretical and conceptual framework of evolutionary governance theory (Beunen et al., 2015; Van Assche et al., 2020), which conceptualizes governance as the outcome of a co-evolutionary process shaped by interactions among various elements (Schlüter et al., 2020). Within this framework, actors evolve through engagement with one another and the institutions that coordinate them, both formally (e.g., policies, laws, and plans) and informally (e.g., parallel coordination mechanisms).

Through these strategic and routine interactions, governance systems develop adaptive capacities and trajectory-shaping mechanisms, which evolutionary governance theory defines as dependencies (Beunen et al., 2015). Each governance system has a unique configuration of these dependencies, which collectively define its evolutionary trajectory. While dependencies can impose constraints, they also create opportunities for transformation. Indeed, introducing conscious changes based on accumulated learning over time is essential for fostering innovation (Aldeguer, 2016). In the context of coastal governance, this process requires addressing both the barriers and opportunities associated with five key dimensions of institutional innovation identified in recent literature reviews: land–sea management integration, the use of scientific knowledge, stakeholder participation, strategic foresight, and digital governance tools (Fobé et al., 2024).

The first dimension highlights innovations capable of integrating governance across multiple institutional levels and policy sectors (Platjouw et al., 2024). A notable example is the Action Plan developed by the Norwegian government to address the degradation of the Oslofjord ecosystem (Norwegian Ministry of Climate and Environment, 2021). Faced with a situation in which governmental responsibilities were fragmented, the plan takes a comprehensive approach, considering the fjord as a whole and engaging relevant authorities and stakeholders across different governance levels and sectors. Another key example is the development of multi-use platforms, such as the ones proposed by the H2Ocean project (Stuiver et al., 2016). These platforms facilitate the coexistence of traditional maritime activities such as aquaculture, with land-based measures, and renewable energy generation, thus optimizing shared infrastructure for a more integrated and sustainable resource management.

Scientific knowledge plays a crucial role in promoting evidence-based adaptive policymaking, overcoming barriers such as lack of communication, institutional fragmentation, and limited access to research (Connor et al., 2009). Advances in this area include the development of knowledge-based innovation ecosystems, which foster collaboration between public, private, and scientific actors to generate technological solutions for coastal governance challenges (Gifford et al., 2021). In Spain, for example, the regional government of the Canary Islands relies on advisory committees to guide policy decisions. Some, such as the Climate Change Committee (Canary Islands Government, 2018), consist exclusively of scientists, while others, including the Nature Conservation and Agenda 2030 Committees, incorporate diverse stakeholders for broader input (Canary Islands Government, 2024). For its part, in collaboration with local and regional governments, the University of Valencia established l'Albufera Biological Station to conduct and disseminate scientific research (Universitat de València News, 2023).

Stakeholder participation is crucial for enhancing governance, building stronger political support, and reinforcing the legitimacy of policy decisions (Singh & Ort, 2020). Recent years have seen an increase in

community-led initiatives, fostering collaborative networks and polycentric coastal governance systems (Koning et al., 2021). For instance, on the Isle of Wight, conflict resolution mechanisms have been developed to promote dialogue and cooperation among stakeholders (Directorate of Economy and Environment, 2010). Similarly, the Flemish-Dutch Scheldt Commission plays a key role in translating high-level political ambitions into administrative and technical measures for the cross-border management of the Western Scheldt. This institution includes the Scheldt Council, composed of various stakeholder groups, such as port authorities, environmental and agricultural organizations, and representatives of regional and local governments in Flanders and the Netherlands (de Mulder, 2008).

Strategic foresight is instrumental for long-term, proactive policymaking that shifts away from the prevailing reliance on current and past experiences (Serrao-Neumann et al., 2016). A key innovation in this field is marine spatial planning, which not only addresses current land and sea uses but also incorporates future challenges such as climate change and coastal urbanization (Monteiro & Dal Borgo, 2023). Another significant example is the Dutch Delta Program for the 21st century, which aims to anticipate and mitigate flood risks in the Netherlands (Hermans et al., 2024). Unlike reactive approaches, this initiative adopts a forward-looking strategy, integrating geo-ecological changes (e.g., climate change, sea-level rise, and subsidence) with socio-economic trends (e.g., demographic and economic shifts) to develop four delta scenarios for 2050 and 2100.

Last but not least, digital tools can enable the adoption of an integrated, interactive, and forward-looking approach to coastal governance (European Commission, 2022). They do so by improving the availability of information, enhancing transparency, increasing accessibility, and fostering participation as well as feedback between policymakers and stakeholders. Key innovations include geoportals that integrate data from diverse sectors and sources, fostering collaboration among stakeholders (both private actors and the broader public) alongside policymakers in governance (Davret et al., 2023). Likewise, the Adriatic region has been a pioneer in implementing such technologies, as exemplified by the EU Strategy for the Adriatic and Ionian Region Platform (Enrico & Christiaan, 2022), a digital tool that enables policymakers, stakeholders, and organizations to exchange ideas, engage in joint planning, and implement projects, fostering economic, social, and environmental benefits across the region.

Applying innovative approaches across each of the five dimensions may help to overcome challenges related to governance dependencies and foster the evolution of coastal systems. However, these aims may need to be adapted to the unique challenges and opportunities faced by coastal wetlands, due to the complex interactions among physical, anthropogenic, and biological factors (Barua et al., 2021). Indeed, these ecosystems have experienced transformation, deterioration, and loss due to rapid population growth, urban expansion, and human activities such as sewage discharge, land/wetland reclamation, and sea enclosures (Barbier et al., 2011; Cvetkovic & Chow-Fraser, 2011). At the same time, the global sea-level rise caused by climate warming from the increase in anthropogenic activities has a huge impact on coastal wetland ecosystems (Edenhofer, 2015).

While some research suggests potential improvements in wetland protection, such as better outcomes when the decision-making process integrates water, land, human, and wildlife sectors (Endter-Wada et al., 2020, in the case of the US), few studies to date have focused explicitly on land–sea integration in coastal wetlands. A similar gap exists in the study of strategic foresight. Nor has the role of scientific knowledge in littoral wetland governance been examined in detail, since only a few evidence-based studies have focused directly

on this issue. Some of these investigations emphasize their significance for environmental initiatives in the French Atlantic wetlands, such as the designation of protected areas and the evaluation of the ecological effectiveness of conservation measures (Steyaert et al., 2007).

Likewise, only a handful of experimental research papers specifically assess the benefits of electronic tools in coastal wetlands, such as radar methods for tracking the temporal evolution of water depth in the Yellow River Delta in China, which are crucial for long-term health assessments (Xie et al., 2015). While research on stakeholder participation is also limited, it provides a few more insights: for instance, certain observational studies emphasize the benefits of stakeholder and community involvement, whether in preserving environmental quality and resources in South Asian coastal wetlands (Ramesh et al., 2017) or in enhancing ecotourism management in the Chilika marsh in India (Samal & Dash, 2024).

Thus, building on the insights from the existing experiences of coastal governance, this study operates under the central expectation that innovative approaches will help to overcome challenges linked to governance dependencies and thus guide the evolution of coastal wetland governance systems. Based on this premise, we propose the following five expectations:

> E1: Integrated land–sea management and planning enhance policy coherence and governance efficiency in coastal wetlands.
>
> E2: The effective integration of scientific knowledge into coastal wetland governance fosters more adaptive and evidence-based policymaking.
>
> E3: Inclusive stakeholder participation and engagement strengthen the legitimacy, acceptance, and overall effectiveness of coastal wetland governance.
>
> E4: Strategic foresight in coastal wetland governance enhances their long-term resilience and adaptability, particularly in response to climate change.
>
> E5: The adoption of digital governance tools improves transparency, efficiency, and stakeholder participation in coastal wetland governance.

3. The Case Study: Wetland Protection in the Valencian Community

This case study was carried out in the coastal wetlands of the Valencian community. This selection was based on the premise that wetland governance is most effectively assessed at the local level. Additionally, the region presents significant opportunities for learning and innovation, given the interplay of specific risks faced by its coastal wetlands and the complexity of the multilevel framework for their protection.

The Valencian community has a high concentration of coastal wetlands, whose Mediterranean location exposes them to a series of demanding challenges. On the one hand, they face significant environmental risks, including the increasing frequency of extreme climate events such as prolonged droughts, heat waves, and rising temperatures, along with greater variability in precipitation patterns (Kim et al., 2019). These challenges are further exacerbated by climate change, which acts as a key risk factor, particularly concerning water

resources, amplifying existing vulnerabilities and introducing new threats (Semenza, 2020). On the other hand, the region is also subject to substantial anthropogenic pressures, such as competition between agricultural water demands and environmental water needs (Fornés et al., 2008), rapid urban and infrastructure expansion (Sebastiá-Frasquet et al., 2014), and the continued growth of mass tourism (Viñals, 2024).

Facing such risks and pressures, an extensive legal framework has evolved, engaging multiple levels of government (Viñals, 2024). One of the most significant at the international level is the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (known as the Ramsar Convention), signed in 1971. This treaty aimed to promote the conservation and sustainable use of wetlands by establishing the first global list of wetlands of international importance, which now includes approximately 2,471 sites. Spain ratified the convention in 1982 and by 2025, had 76 listed sites, 28 of which are coastal. The Valencian community, in turn, has seven Ramsar wetlands, six of which are coastal (Secretariat of the Ramsar Convention on Wetlands, 2025).

The EU also plays a crucial role in wetland protection (Viñals, 2024). Among the most relevant directives are the Habitats Directive (Directive 92/43/EEC, 1992), adopted in 1992, which required the designation of "special areas of conservation" for habitats supporting a high number of plant and animal species (excluding birds), and the Birds Directive (Directive 2009/147/EC, 2009), adopted in 2009, which declared certain areas as "special protection areas for birds" based on their importance for avian species. Together, these directives led to the creation of the Natura 2000 Network, a European-wide conservation system comprising special areas of conservation and special protection areas for birds. Spain currently has 392 wetlands included in this network, 29 of which are in the Valencian community (Sanchís Ibor & Ibáñez Martí, 2024). Beyond these rules, other key European regulations include the 2000 Water Framework Directive (2000/60/EC), the 2007 Directive on Flood Risk Assessment and Management (2007/60/EC), and the recently approved 2024 Nature Restoration Regulation (2024/1991).

Spain first embraced the growing momentum for wetland protection with the enactment of the Conservation of Natural Areas and Wild Flora and Fauna Act (Law 4/1989; Da Costa & Ramil-Rego, 2023). This law set up the Spanish Wetland Catalogue, which was to be compiled by the country's regions (known as autonomous communities). However, its implementation progressed slowly, as its regulatory framework was not established until 15 years later with the Royal Decree on the National Wetlands Inventory (RD/435/2004). Spain also developed the Spanish Strategy for the Conservation and Sustainable Use of Biological Diversity following its ratification of the Convention on Biological Diversity (or Rio Convention) in 1993. Additionally, the protection of Ramsar wetlands was formally incorporated into Spanish legislation through the Natural Heritage and Biodiversity Act (Law 42/2007).

In response to Law 4/1989 (Conservation of Natural Areas and Wild Flora and Fauna Act), Spanish regions began taking significant steps toward the environmental protection of wetlands. Notable examples include the adoption of natural resource management plans, such as Decree 89/1986, which established the legal framework for l'Albufera Natural Park, and Decree 49/1995, which approved the master plan for use and management of the Lagunas de La Mata y Torrevieja Natural Site (Rosa-Moreno, 2008). However, the outstanding milestone is probably the Protected Natural Areas Act of the Valencian Community (Law 11/1994), which laid the foundation for the designation, management, and protection of various protected landscapes, including natural parks, reserves, and natural monuments (Almenar-Muñoz, 2016).

This law was further expanded through subsequent regional regulations, such as Decree 161/2004, which governs municipally protected areas known as Municipal Natural Sites, and the publication of the Valencian Community Wetlands Catalogue on September 10, 2002. The catalogue comprises six coastal wetlands also designated under the Ramsar Convention—l'Albufera, El Hondo, Lagunas de La Mata y Torrevieja, Marjal de Pego-Oliva, Prat de Cabanes-Torreblanca, and Salinas de Santa Pola—which constitute the principal units of analysis in this study (Figure 1 and Table 1). Significantly, the recent enactment of Law 7/2016 has expanded legal protection to all wetlands, irrespective of their prior inclusion in the regional catalogue (Almenar-Muñoz, 2016).

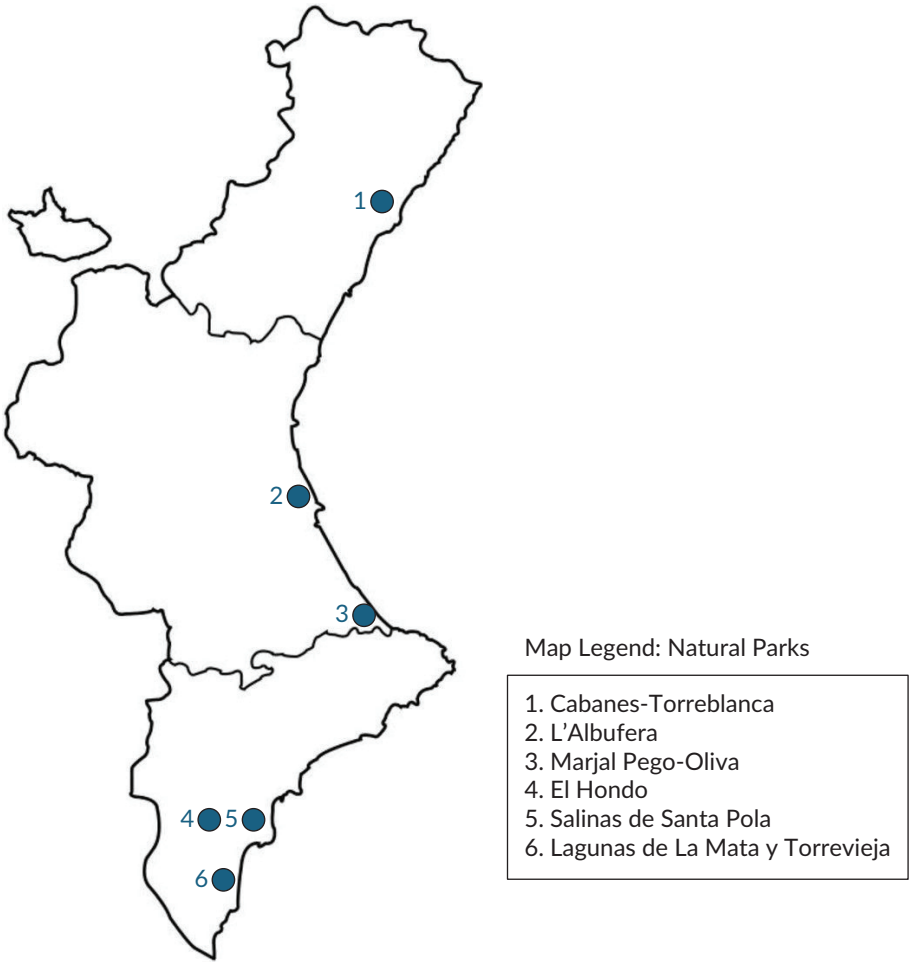


Figure 1. Geographic distribution of the coastal wetlands studied in the Valencian Community.

Table 1. Coastal wetlands of the Valencian community: area, origin, and significance (from North to South).

Coastal wetland	Area (Ha)	Geomorphological origin and coastal evolution context	Significance
Prat de Cabanes-Torreblanca	866,3	Formed by the natural infilling of an ancient lagoon approximately 6,000 years ago, due to the creation of a sandbar from materials carried by the Cuevas or San Miguel rivers. Over time, peat accumulation from wetland vegetation created the current landscape	The most important wetland in the province of Castellón and one of the least altered wetland habitats in the entire Valencian community. One of its most notable features is its rich wildlife, with a significant presence of endemic species. Birds are the best-represented faunal group. Human activities include agriculture, livestock farming, commercial peat extraction, hunting, tourism, and recreation
L'Albufera	21,120	Originated from a subsiding geological depression filled with Quaternary alluvial sediments. The formation of a coastal sandbar, due to sediment deposition from the Turia and Júcar rivers, isolated the bay from the sea, creating the lagoon. This process began approximately 6,000 to 4,500 years ago	The largest freshwater littoral wetland in Spain, which plays a crucial role in the conservation of numerous species of aquatic birds. Currently, the three most important traditional uses of the area are fishing, hunting, and agriculture, particularly rice cultivation. In addition, it is a major periurban green zone for the city of Valencia, attracting significant levels of tourism for birdwatching, boat trips, gastronomy, and environmental education
Marjal Pego-Oliva	1,255	Remnant of an ancient lagoon which has taken on its present form due to an advanced silting process. Two main rivers flow through the area: the Bullent (or Vedat) in the northern part, and the Racons (or Molinell) in the southern section. In addition, the wetland is fed by numerous tributaries and natural springs, the latter locally known as ullals	Rich in biodiversity, as well as in water quality and resources, the wetland supports agricultural activities, particularly citrus and rice cultivation, and serves as a habitat for several protected species, including the Samaruc (Valencia toothcarp, *Aphanius iberus*). It also supports low-impact tourism, especially nature walks and birdwatching
El Hondo	2,387	Located on land that once formed part of the large Elche lagoon, which existed until the 18th century. The local place names, such as almarjales and saladares, reflect this historical past. The original lagoon disappeared due to natural sedimentation and extensive drainage works	It hosts a wide variety of bird species, including several that are threatened, and serves as a vital stopover for migratory birds and a key area for the conservation of aquatic species. In total, 172 species have been recorded. The wetland holds considerable ecological and economic value, contributing to the local economy through agriculture, tourism, birdwatching, and regulated hunting and fishing

Table 1. (Cont.) Coastal wetlands of the Valencian community: area, origin, and significance (from North to South).

Coastal wetland	Area (Ha)	Geomorphological origin and coastal evolution context	Significance
Salinas de Santa Pola	2,469,7	Geologically, the area is a large tectonic depression that has been subsiding since the Miocene, bordered to the south by the Bajo Segura reverse fault and to the north by the current folding zone of Altet. The gradual infilling of this expansive gulf was driven by sediment contributions from the Segura and Vinalopó rivers, as well as numerous ravines descending from the surrounding mountain ranges. Over time, marine deposits formed sandbars that eventually separated the area from the sea, giving rise to a large coastal lagoon. This wetland, together with El Hondo, once constituted a vast wetland known as the Elche lagoon. Continued sedimentation, primarily from the Vinalopó River, ultimately led to the lagoon's complete isolation from the sea, resulting in the formation of inland wetlands known as almarjales	It includes salt production facilities, freshwater ponds with varying salinity levels, a dune and beach area, and a small portion of farmland. The diversity of environments supports a wide range of plant formations and animal groups, which are distributed according to the water's salinity and depth
Lagunas de la Mata y Torrevieja	3,743	Located in the Bajo Segura basin, these wetlands were formed by the isolation of a coastal bay through the development of a sandbar during the Holocene. The area exhibits characteristics of a subsiding neotectonic basin with Holocene sedimentary infill. The area consists of two lagoons separated by an anticlinal called El Chaparral. A canal connects the two depressions, which are also artificially linked to the sea through two other channels known as *acequiones*, thus forming a unit for salt exploitation	Together with El Hondo and the Salinas de Santa Pola, they form a triangle of wetlands that are crucial for the biological cycles of numerous species, which use them during migration, nesting, or wintering. The area contributes to the local economy through salt production, sustainable tourism, environmental education, and birdwatching

Environmental planning is closely linked to territorial planning at the regional level (De Leonardo, 2018). In the Valencian community, the Law on Territorial Planning and Landscape Protection (Law 4/2004) is particularly notable (Rosa-Moreno, 2008). More recently, the Territorial Action Plan for the Green Infrastructure of the Coast (PATIVEL; Generalitat Valenciana, 2022) was created under the Law on Territorial Planning, Urban Development, and Landscape (Law 58/2018). This plan serves as the key framework for organizing environmental assets from an eco-hydrological perspective within the region (Jódar-Abellán & Molina, 2019).

The role of the regional level in wetland protection within the Valencian community must be understood in the broader context of the gradual consolidation of environmental responsibilities, both within the region's

parliament (Les Corts) and across various government departments with executive functions. Thus, a key milestone in this process was the establishment of a permanent legislative commission during the regional parliament's third legislature. This commission retained the name Environment until the eighth legislature (2011), when it was renamed the Commission on Environment, Water, and Territorial Planning. At the same time, Les Corts has set up several commissions in response to major catastrophic or disruptive events for the purposes of research, monitoring, and evaluation.

Within the regional executive branch, the territorial ministries (Consellerias) responsible for environmental affairs have played a central role, serving as the highest-ranking political and administrative bodies within the Valencian government. Initially, environmental matters fell under the jurisdiction of the Conselleria de Obras Públicas, Urbanismo y Transporte. In 1991, a new ministry was established to manage environmental responsibilities. Since then, this institution has undergone several processes of restructuring and name changes, reflecting the shifting political and environmental priorities over time. It is currently known as the Conselleria de Medio Ambiente, Infraestructuras y Territorio.

4. Methods

This study analyses the perspectives of key institutional actors and stakeholders on the challenges and opportunities presented by governance innovation in coastal wetlands within the Valencian community. The period of analysis spans from the early 1990s, when the autonomous communities began to take on a progressively important role in this field, until the present day.

Data collection included a combination of a focus group and several in-depth individual and collective interviews with stakeholders of different profiles, including activists, representatives of the economic sector, protected area managers, as well as academics specializing in coastal wetlands in the Valencian community (Table 2). This diversity of participants ensured that multiple perspectives were represented, thus achieving a more comprehensive understanding of the factors influencing wetland governance. The focus group was held in June 2024, and the interviews were conducted between November and December 2024.

The stakeholders were selected using a systematic two-stage procedure. First, a prospective analysis was carried out to identify relevant actors, followed by a prioritization based on a matrix of two variables: the stakeholders' degree of interest in the issues addressed in the interviews and the level of influence on the issues analysed. This ensured that the initial interviews captured the opinions of both people who were deeply engaged in the issues and of decision-makers. To broaden and validate our sample, we then applied a chain (snowball) sampling, in which each interviewee recommended additional contacts, thus allowing the network of participants to expand organically until reaching thematic saturation. A total of 31 stakeholders were involved.

The focus group, which included 11 participants, applied a participatory methodology and was structured in two main sessions. Each was divided into two sub-sessions to facilitate a progressive analysis of the barriers and facilitators in coastal wetland governance (see Supplementary File, Appendix A). While the first session aimed to identify and categorize key challenges in littoral wetland governance, the second one focused on the design of potential solutions and strategies for improvement. Both sessions lasted between 90 and 120 minutes.

Table 2. Focus group and interviews.

Code	Actors			
	Institutional	Political	Social	Academic
FG01	X		X	X
I01	X			X
I02	X			
I03	X			X
I04			X	
I05	X			
I06				X
I07	X			
I08	X			
I09	X			
I10				X
I11				X
I12		X		
I13	X			

In-depth interviews provided an opportunity to gather more detailed and specific information on the topics under study. Prior to conducting the interviews, a set of questions was carefully designed to ensure a comprehensive exploration of key issues related to coastal wetland governance (see Supplementary File, Appendix B). The duration of the interviews ranged from 60 to 120 minutes.

The qualitative data obtained through the focus group and in-depth interviews were analysed using thematic analysis (Enguer & Schaub, 2024). In the first step, we transcribed and reviewed the recorded interviews. We then applied open coding to the descriptive content related to the challenges and opportunities associated with each of the key governance dimensions considered in our study. The coded statements were subsequently grouped into five overarching themes: (a) land–sea management integration, (b) the use of scientific knowledge, (c) stakeholder participation, (d) strategic foresight, and (e) digital governance tools. Once these themes were defined, excerpts of particular interest were selected.

5. Coastal Wetland Governance Dependencies and Innovation in the Valencian Community

5.1. Integrated Land–Sea Planning Management

Spain's accession to the EU in 1986 and the subsequent adoption of European directives into national law have been pivotal in protecting the country's coastal wetlands and in enhancing land–sea integration. Key directives include the Birds Directive (2009/147/EC), the Habitats Directive (92/43/EEC), and the Water Framework Directive (2000/60/EC). As one interviewed stakeholder noted: "The entry into the EU has been a blessing…The Water Framework Directive sets the framework for protection and includes inland waters" (I10). By establishing a unified regulatory framework, these directives have fostered coordination and efficiency in natural resource management while promoting the conservation of biodiversity and

environmental sustainability in littoral wetlands. The benefits of EU integration also extend to Spain's participation in protected area networks, such as the Natura 2000 Network, which has made a significant contribution to safeguarding threatened habitats and species within these protected sites.

At the national level, the Law on Natural Heritage and Biodiversity (Law 42/2007) introduced modern conservation principles, such as ecosystem connectivity, to better integrate environmental policies into territorial planning. This legislation is implemented through the autonomous communities' adoption of the Natural Resources Management Plan and the Master Plan for Use and Management. These documents are essential for the planning and administration of coastal wetlands, as they establish protection zones, regulate permitted activities, and define sustainable land uses (I03).

Regional regulations have further advanced land–sea management. Decree 89/1986 laid the legal foundation for the protection of l'Albufera, designating it as the region's first natural park. Another milestone came with the Law on Protected Natural Spaces of the Valencian Community (Law 11/1994), which established a framework for the designation and conservation of natural areas and parks in this Autonomous Community. The approval of the Law on Spatial Planning and Landscape Protection in 2004 (Law 4/2004) marked further progress, reinforcing the region's commitment to coastal wetland conservation. This commitment was strengthened in 2018 by the adoption of the first Territorial Action Plans (I02, I09), alongside the PATIVEL (Law 58/2018; Generalitat Valenciana, 2022), which has played a crucial role in integrating the management and planning of the Valencian coastline (I07). However, its recent repeal through the Administrative Simplification Decree-Law (7/2024) is raising concerns about the future of coastal wetland protection and management (I09, I12).

A further challenge in integrated land–sea governance is the lack of adequate human and financial resources. Coastal wetlands continue to suffer from insufficient staff and funding: "The problem is that they don't have resources for anything. They do what they can and try to learn as much as they can" (I11); "The lack of human and financial resources remains a significant barrier, and the environmental administration needs more personnel and funding to make adequate investments" (I06). Additionally, poor coordination between administrative services presents a major obstacle: "One of the problems we might have now, and I hope it will be resolved, is that there is no coordination between two services that belong to the same sub-directorate" (I08). Rigid institutional structures and inflexible regulations further limit the ability to respond to rapid environmental changes. This issue, which is particularly pronounced when state and regional government bodies interact (I09), is to some extent mitigated when political leaders at different levels share the same political orientation (I05, I13).

Along these lines, it is important to emphasize the impact of political parties on the management of coastal wetlands, with shifts in policy direction and priorities often being influenced by the party in power at the regional level. A persistent challenge for land–sea governance has been the lack of continuity in management and the inconsistency in policy implementation, as the leadership of these protected areas changed based on political considerations (I06, I01, I05). After the change in the regional government in 2015 and the reform of the Law on Protected Natural Spaces (Law 7/2016), the management of coastal wetlands saw a major shift toward professionalization. Civil servants began overseeing these areas instead of political appointees, leading to a more specialized approach to management that is less susceptible to political influence (FG01, I01, I08, I02, I03). This transition has the potential to enhance policy coherence and governance efficiency over time.

For this reason, among other previously discussed factors, we consider that further research is necessary to clarify the extent to which the first expectation of this study may ultimately be validated.

5.2. Scientific Knowledge

The integration of scientific data into the governance of coastal wetlands has facilitated more informed and adaptive decision-making. In this context, collaboration with universities and research centres has been essential for the development of studies of littoral wetlands and their monitoring: "We have monitored the coastal wetlands with the Polytechnic University…we have developed numerous studies on fauna, ornithology, and vegetation that would not have been possible" (I13). This cooperation, combined with the use of advanced technologies such as sensitization and digital twins, has significantly enhanced the understanding and management of these areas (I06, I08).

The role of scientific knowledge is particularly important in aquifer conservation and the prevention of marine intrusion in coastal wetlands. This significance is reflected in efforts such as species reintroduction and the management of sluice gates to maintain appropriate water levels (I01): "To maintain a series of sectional reports on the conservation status of habitats and species required by European legislation, we need not only the common sense and technical expertise of the responsible authorities but [scientific] analysis as well" (I07).

The substantial progress made in this dimension of wetland governance has resulted in numerous examples of successful practices. The Devesa Albufera office is among the institutions that has achieved the most LIFE projects in Spain, showcasing a strong capacity to write and develop projects, integrate scientific knowledge, and collaborate with government bodies and universities (FG01, I06, I13). These studies have been fundamental in the planning and management of natural resources in the region.

Despite the undeniable progress made, the application of scientific knowledge still faces certain challenges. Interestingly, most stakeholders agree that scientific knowledge is available, but attribute the shortcomings to insufficient progress in its practical use. These challenges primarily involve the interaction between science and political parties, administrative structures, and the general public. Regarding the political parties, stakeholders underline both the difficulty of transmitting scientific knowledge and the dependency of its application on the changing political leadership of the regional government (I02, I10).

This lack of political continuity means that administrative staff do not have "the time and resources to apply [scientific knowledge] effectively" (I11, I03, I05). Indeed, resource availability is often reactive, tied to exceptional events such as the reddening of l'Albufera wetland observed in 2023: "When the red Albufera issue occurred, they immediately contacted us for the communiqué." Similarly, these improvements tend to rely on contexts of economic prosperity: "Explanations are provided during times of economic growth." However, as interviewed stakeholders emphasize, "there is no follow-up afterwards. Despite the significant effort required, the information is ignored and our contributions go unrecognized. As a result, we are increasingly reluctant to waste time on this" (FG01, I10).

These difficulties within the administration are compounded by the disconnect between technical staff and high-ranking officials (I05). This is further aggravated by the ongoing challenges the administration faces in aligning its work with other research institutions like universities: "The timing of the universities and the

administration are very different, though communication is increasing" (I03). Finally, regarding the public, interviewees emphasize the difficulty in ensuring that scientific knowledge reaches a broader audience. When it does, it often comes in a very limited and summarized form, which diminishes its impact (I13). All in all, despite the barriers that remain regarding this dimension, the progress in governance brought about by its implementation leads us to partially validate the second expectation of this article.

5.3. Participatory Practices and Stakeholder Involvement

The steady progress in participatory practices and stakeholder involvement in the Valencian community has been largely driven by the creation of governing boards, which bring together a diverse range of relevant actors. In this regard, stakeholders recognize governing boards as "the primary body of public participation" (I06) and note that "almost all relevant actors are represented in the governing boards, although there may even be too many representatives of the administration" (I08). Moreover, stakeholders emphasize their specific role in fostering dialogue and collaboration: "the governing boards have helped us get to know each other better and maintain an ongoing dialogue" (I07).

Governing boards are evaluated both as governance and representation bodies and as management tools. From a governance perspective, stakeholders highlight that these boards emerged as participatory mechanisms to "represent interests following developments in government after the designation of wetlands as Natural Parks" (I03). From a management standpoint, they are regarded as valuable instruments for strategic planning, with stakeholders noting that "the governing board should serve as an ideal tool for long-term planning" (I11).

The involvement of volunteers in conservation projects and citizen science initiatives also plays a crucial role in coastal wetland governance, for example, in the monitoring of biodiversity. As one stakeholder noted, "citizen participation drives and significantly enhances the quality of the measures that can be proposed in a transformative change such as the one ahead of us" (I12). Indeed, citizen participation consistently improves both the process and the quality of measures proposed by government offices. In some cases, it even surpasses institutional efforts, for example, the 2021 Citizens' Assembly for Climate reached bolder conclusions than any political party (I12).

Despite stakeholders' reports that the participation of local actors and civil society has increased over time, they also highlight significant ongoing challenges. One interviewee stated that "collaboration between institutions and society needs to be intensified" (I04), while another noted that "participation has improved but remains insufficient and is often instrumentalized" (I03). These respondents focus specifically on the importance of leadership skills and individual profiles within governing boards, beyond the mere existence of institutional frameworks (I06, I05). An example of this is l'Albufera Governing Board, which had not functioned effectively until its recent change in leadership. In addition, certain groups, such as small local bodies, remain underrepresented in governing boards (I08).

Regarding voluntary participation, stakeholders emphasize the scarcity of appropriate channels to represent their interests within citizen assemblies (I05). Another shortcoming is the fact that the agreements reached by these participatory bodies are not binding, a circumstance that underscores the power imbalance between the desires of the general public and the strong political influence of economic powers (I12). The stakeholders also

highlighted issues such as saturation and fatigue among certain volunteer groups who find themselves obliged to oversee almost all of the projects and actions (I10). The lack of any other non-volunteer groups representing communities near protected areas is notable, as is the absence of certain economic sectors (I07, I05). This adds to the tensions that persist between environmental managers and other actors such as farmers and local government bodies (I07, I05).

Other factors also play a crucial role in participatory mechanisms. Despite advances in data digitization, improvements in e-governance tools are still needed to enhance participation (I09). The lack of continuity in governance and policy implementation is an issue that comes in for a great deal of criticism. For example, the establishment of participatory structures at the regional level gained significant momentum under the leftist coalition government in power between 2015 and 2023 (I06, I08, I03). Additionally, stakeholders express concerns about the "lack of coordination between administrations and the absence of multidisciplinary and cross-sectoral teams that integrate all necessary perspectives" (I06). In conclusion, while innovation in participatory practices has been evident, the problems identified can be generally considered as issues pending for the strengthening of the progress, rather than "hard" barriers. Therefore, our third expectation is confirmed.

5.4. Strategic Foresight

The past decade has seen a steadily increasing emphasis on proactive foresight strategies for coastal wetland governance in the Valencian community (I08). Thus, our case study highlights certain instances that integrate the use of prospective and predictive strategic planning tools. Among these, the most important are digital models and sensorization, which are used to evaluate the cumulative impacts of climate change on natural parks. As noted by our interviewees, data are being "used for a cumulative impact assessment of the possible effects of climate change on the natural parks" (I08) and "hydraulic models for flood risk prevention" (I09).

Along these lines, zoning, based on the recovery capacity of each area, and dune regeneration are key strategies. For example, in the case of l'Albufera wetland, historical data and cartography have been used to project and consider future erosion trends: "Management included the use of historical aerial photographs and comparative cartography to predict erosion trends" (I13). Similarly, the use of updated cartographic tools and monitoring systems such as the Water Material Suction System are fundamental for strategic planning and informed decision-making (I05).

Beyond issues related to the unpredictability of the climate (I10), particularly precipitation (I09), the important but still modest progress reflected in the previous examples highlights the ongoing predominance of reactive management strategies (I11). This issue, noted in both the political and technical fields, will not improve in the immediate future: "We are not there and no improvement is expected" (I10).

This limited general approach is further compounded by other barriers, such as those stemming from "institutional fragmentation and lack of coordination in decision-making and policy integration" (I01). This obstacle has a particularly negative impact on the coherence and effectiveness of coastal wetland governance due to the lack of cohesion sometimes observed between the Spanish Ministry of the Environment, responsible for nationwide coastal matters, and the Generalitat Valenciana, which is

responsible for water management (I07). Respondents note the absence of a unifying prevention body: "There is no body, let's say, for prevention…that globally analyses all risks" (I09).

The lack of political continuity also represents a significant barrier. Priorities frequently change with electoral cycles, generating distrust and hindering the development of sustainable long-term projects. According to one stakeholder, "short-term thinking is always prevalent…political support disappears or the commitment of the council is not there" (I11). This reactive approach limits the ability to plan with a strategic vision.

Additionally, current regulations are often too strict and inflexible to deal with the dynamic challenges posed by climate change. For one respondent, "the regulations and our plans are decrees of the Council that often have a rigidity of the norms that does not allow you to change much" (I07). Added to this is the fact that the management of protected areas largely depends on the government, limiting autonomy and innovation in governance (I11).

The lack of evaluation in many projects is also mentioned: "Here no one evaluates the plans, or the projects, or anything…no one is required to make an assessment of whether this plan that I implemented has turned out well or badly" (I06). This absence of feedback on the results prevents the adjustment of strategies and the improvement of governance. The assessment of the results of past actions must be established as an integral part of prospective governance so as to ensure that the policies and strategies fit the realities of the area. Moreover, this feedback approach must be continuous and include the input of experts and local actors. These actors "want…to give feedback on existing tools, or on what we consider may be missing" (I03). The limited innovations observed in this dimension, which highlight the widespread dominance of a reactive vision of coastal wetland governance, oblige us to reject the fourth expectation of this article.

5.5. E-Governance Tools

Digital tools play a crucial role in fostering transparency and access to management information regarding coastal wetlands. In some of the natural parks, management reports are digitized and made available online: "The management reports are on the website, and you can consult them" (I01). This allows "the city council to know where the data are or, at least, where to obtain them" (I03) and provides the public with access to information: "All those records were also available…having it digitized and available to the public is also very useful" (I09).

In the field of environmental monitoring and adaptive decision-making, digital tools provide key data for the management of ecosystems in real-time. In the littoral wetland of Alicante, "noise sensors have been installed to promote natural spaces as places of well-being" (I08). Additionally, these technologies help predict ecological problems, such as the synchronization of bird reproduction with food availability: "We can predict whether the main food, which is a crustacean called artemia, will synchronize its hatching with bird reproduction" (I08). Real-time data-driven decision-making allows for more flexible and effective management: "With these media, in real-time, we can observe daily data that is updated every five minutes" (I08).

Digital tools also play a significant role in the participation of the general public and the communication between actors. In the coastal wetland of Pego-Oliva, mobile applications have been introduced to provide information to visitors without the need for physical signage: "We set up mobile applications where you go

to a place and they tell you things" (I01). Furthermore, educational initiatives like "a podcast, and the participation of environmental educators on Radio Pego" (I01) have been implemented. The new facilities that digitization has provided for the public to lodge allegations are also highlighted: "It was very difficult before, for example, to submit an allegation because of the lack of access" (I09).

Regarding the management of invisible resources such as groundwater, digitization facilitates transparency and efficiency in their use. A notable example is the E-Groundwater project, implemented in l'Albufera wetland, which allowed local owners to report water extractions through a mobile application in exchange for agroclimatic information (I05). This project generated trust among the actors involved by improving transparency: "Transparency results in trust" (I05). Additionally, AI tools and digital viewers integrate information on climatology, geology, and fauna, facilitating environmental studies: "AI itself has a significant role here…providing all the existing data as open data" (I03).

However, despite its potential, the implementation of digital tools is still in its early stages and needs to be made more dynamic. Some interviewees point out that "many demonstrative projects and many pilot actions are needed for this to be seen and for it to gradually take hold" (I03). They also note that already existing tools, like the radio programme La Marjal Curiosa, are not being used extensively, highlighting the need for greater promotion and adaptation: "La Marjal Curiosa has existed for years…but I don't think it's used that much" (I03).

In the technical field, the operation of tools like sensors and digital twins also presents limitations. For example, calibration problems and software failures have been identified in the Natural Parks of the South of Alicante: "The software is the crux of the matter…fine-tuning the sensor, calibrating it, and developing the graphs you need" (I08). These limitations also impact the transparency and accessibility of information, as it is still difficult to identify the source of data in existing viewers: "What we lack is a clear understanding of the source of the viewer's data…and how to integrate it" (I03). Nonetheless, although our study reflects that the implementation of digital tools requires greater dynamism, the advances in innovation within this dimension lead us to partially confirm the fifth expectation of the article.

6. Discussion and Conclusion

Through the lens of the evolutionary governance theory, this article has investigated the extent to which innovative approaches have contributed to the evolution of coastal wetland governance. Specifically, it has examined the barriers and opportunities that have shaped the governance of coastal wetlands in the Valencian community since the 1990s. This has been achieved through insights gathered from a focus group and in-depth interviews with stakeholders involved in six protected coastal wetlands, all listed in the Valencian community and Ramsar catalogues of protected areas: L'Albufera, El Hondo, Lagunas de La Mata y Torrevieja, Marjal de Pego-Oliva, Prat de Cabanes-Torreblanca, and Salinas de Santa Pola.

Regarding land–sea governance, the study reveals that despite progress made through the implementation of key European, national, and regional legislation in recent decades, certain dependencies specific to the Valencian context continue to pose significant barriers to governance innovation. Among the most critical barriers identified are excessive institutional rigidity, inflexible legal frameworks, and poor coordination between government bodies. These findings are consistent with previous research in coastal governance, particularly regarding horizontal coordination challenges caused by siloed sectoral responsibilities and limited

inter- and intra-organizational collaboration (O'Hagan et al., 2020). Similarly, our study reinforces earlier conclusions by identifying additional obstacles such as insufficient human and financial resources, as well as a lack of continuity in policy direction due to changes in government (Fobé et al., 2024). This reflects a broader tension between long-term environmental objectives and short-term economic or political agendas (Neal et al., 2018). Consequently, while our findings contribute valuable insights to the academic debates on land–sea management integration, the results related to the first expectation remain inconclusive.

The situation in Valencia demonstrates how scientific knowledge can drive governance innovation, particularly in aquifer conservation and the prevention of marine intrusion, through collaboration with universities and research centres. These interactions tend towards the creation of broader science–policy–society ecosystems, with higher potential for innovation through increased attention to scientific insights (Neilson & São Marcos, 2019). Nevertheless, this research also reports that progress remains limited by persistent communication gaps between universities and government bodies, as well as by challenges in making scientific knowledge accessible to the public. These deficiencies underscore ongoing issues related to the disorganized supply of scientific evidence and associated barriers that hinder its communication and availability to policymakers (Elliott et al., 2023). Further publications even highlight the risks posed by the erosion of scientists' credibility due to populist political discourses (Piwowarczyk & Wróbel, 2016). The latter issue aligns with additional evidence from the present study that reflects political instability and inconsistent funding—factors that may arise from concerns voiced and the electoral success achieved by skeptical actors. The complex balance of arguments regarding the second expectation allows for partial validation.

The findings confirm previous conclusions in the literature that inclusive participation enhances the legitimacy, acceptance, and effectiveness of governance (Day et al., 2021). In the Valencian community, this has been facilitated by the establishment of governing boards and increased voluntary participation in bodies such as citizen assemblies. In line with this, our study underlines the importance of building and utilizing networks across multiple sectors and shareholders (Singh & Ort, 2020), thus suggesting that the third expectation is fulfilled. It should be noted that challenges remain, including the lack of attention to leadership quality in governing boards, the underrepresentation of certain groups in both institutional and participatory bodies, and the limited influence of participatory assemblies compared to that of economic interests. Therefore, our results echo previously identified gaps between the rhetoric and the reality of participation, which have frequently limited meaningful engagement and have prevented the full realization of its expected benefits (de Vivero et al., 2008). Indeed, these misalignments often stem from inconsistent stakeholder involvement or power imbalances among groups (Grorud-Colvert et al., 2021).

Although early steps have been taken towards proactive planning, such as the use of digital models and sensor technologies to anticipate environmental changes, management still tends to be reactive. Thus, despite the positive emphasis in current scholarship on systems that incorporate extended policy horizons in coastal governance (Fobé & Brans, 2013), practical implementation in our case study presents significant challenges that lead us to reject the fourth expectation. Specifically, this research underscores the impact of institutional fragmentation, rigid regulatory frameworks, inadequate evaluation mechanisms, and frequent political shifts. These observations are consistent with broader literature highlighting persistent issues such as the difficulty of accessing integrated (as opposed to sector-specific) information for anticipating future developments and trends (Muccitelli et al., 2023), as well as the mismatch between foresight time horizons and the short-term focus commonly applied in democratic policymaking (Neal et al., 2018).

Digital tools enhance efficiency in littoral wetland governance by providing key data and making the information more transparent and accessible. Relatedly, e-governance tools strengthen stakeholder engagement, for example, through mobile applications and educational projects or by facilitating the submission of comments and objections by members of the public. The outcomes of this study contribute to the growing body of evidence on the benefits of digital tools for coastal management (European Commission, 2022). These include improved transparency and accessibility of environmental information, more effective monitoring and reporting of environmental policies, stimulation of innovation in green technologies, and greater integration of evidence and stakeholder input into decision-making processes (Casiano Flores & Crompvoets, 2023). Notably, implementation remains in its early stages and faces challenges such as underutilization, technical limitations, and accessibility issues. Accordingly, our findings also reflect the presence of specific structural, technical, and organizational barriers that shape the trajectory and effectiveness of e-governance projects (Wilson & Mergel, 2022). Based on these findings, we conclude that the fifth expectation is partially confirmed.

The specific findings for each expectation suggest that the opportunities arising from dependencies in the Valencian region indicate the clear presence of innovation in three of the five dimensions analysed: scientific knowledge, participatory practices and stakeholder involvement, and e-governance tools. Notably, across all five dimensions, three interlinked enablers consistently underpin innovation: first, coordination bodies that can formalize continuous dialogue among actors; second, digital platforms that aggregate real-time data into shared dashboards; and third, adaptive management cycles that institutionalize learning from pilots and emerging trends. Together, these cross-dimensional mechanisms can help create a self-reinforcing system in which coordinated governance structures leverage digital tools to capture stakeholders' insights and scientific knowledge, and adaptive processes can translate those insights into flexible, forward-looking policies.

Likewise, several barriers are common across dimensions, including the lack of coordination between different levels of government, inflexible regulations, frequent political changes, and irregular funding, underscoring the importance of institutional and organizational dependencies. Yet these very barriers can be reframed as enablers when leveraged in concert: cross-sector research networks can break down silos and secure more stable financing; multi-stakeholder governance bodies can embed continuity against political change; and interoperable digital platforms can unify data streams, streamline workflows between different levels of government, and introduce adaptive regulatory feedback. In this light, sustainable innovation in coastal wetland governance largely depends both on amplifying existing enablers and on transforming entrenched barriers into elements of reinforcement across interconnected dimensions.

While this case study offers a detailed examination of a specific context, its findings cannot be directly generalized to other regions. Future research could compare the results presented here across different regions to assess their broader applicability, particularly regarding the expectations discussed here, which were only partially confirmed or remain inconclusive. Further studies might also examine governance innovation in coastal wetlands through alternative dimensions or by focusing on other environmentally significant topics within this context (e.g., biodiversity conservation, water resource management, human impact, and so on).

Acknowledgments

The research leading to this work was conducted under the framework of the Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). The views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data supporting this study is owned by the BlueGreen Governance (BGG) team at the University of Valencia and can be made available upon reasonable request.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Aldeguer, B. (2016). La regeneración constitucional de la democracia española contemporánea: El papel de la innovación institucional. In R. Tur Ausina (Ed.), *Poderes públicos y privados ante la regeneración constitucional democrática* (pp. 319–338). Editorial Dykinson.

Almenar-Muñoz, M. (2016). El reciente avance en la protección de las zonas húmedas en la comunidad Valenciana. *Actualidad Jurídica Ambiental*, (63), 1–10.

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., & Silliman, B. R. (2011). The value of estuarine and coastal ecosystem services. *Ecological Monographs*, *81*(2), 169–193. https://doi.org/10.1890/10-1510.1

Barua, P., Rahman, S. H., & Eslamian, S. (2021). Coastal zone and wetland ecosystem: Management issues. In W. L. Filho, A. M. Azul, L. Brandli, A. L. Salvia, & T. Wall (Eds.), *Life below water* (pp. 1–19). Springer.

Beunen, R., Van Assche, K., & Duineveld, M. (2015). *Evolutionary governance theory*. Springer. https://doi.org/10.1007/978-3-319-12274-8

Camacho, A., Garrigues, D. M., Santamans, A. C., & Ibáñez, C. (2024). Humedales costeros y cambio climático. In C. Sanchís Ibor & C. Ibáñez Martí (Eds.), *Los humedales costeros de la península ibérica* (pp. 489–530). Tirant Humanidades.

Canary Islands Government. (2018). *861 Decreto 27/2018, de 26 de febrero, por el que se crea y regula el Comité de Personas Expertas para el estudio del cambio climático de Canarias y fomento de la economía circular y azul*. https://www.gobiernodecanarias.org/boc/2018/041/001.html

Canary Islands Government. (2024). *2056 Decreto 74/2024, de 17 de junio, del Presidente, por el que se crea y regula el Comité de Personas Expertas para la Agenda Canaria 2030*. https://www.gobiernodecanarias.org/boc/2024/124/001.html

Casiano Flores, C., & Crompvoets, J. (2023). Climate change adaptation: The role of geospatial data in sustainable infrastructures. *ISPRS International Journal of Geo-Information*, *12*(2), Article 68. https://doi.org/10.3390/ijgi12020068

Connor, M. O., Cooper, J. A. G., & McKenna, J. (2009). Integrating science into shoreline management practice and policy: An Irish perspective. *Journal of Coastal Research*, *56*,1267–1270.

Cvetkovic, M., & Chow-Fraser, P. (2011). Use of ecological indicators to assess the quality of great lakes coastal wetlands. *Ecological Indicators*, *11*(6), 1609–1622. https://doi.org/10.1016/j.ecolind.2011.04.005

Da Costa, J. F., & Ramil-Rego, P. (2023). Protecting wetlands: Insights from the northern Iberian Peninsula (Galicia, NW Spain). *New insights into protected area management and conservation biology*. https://doi.org/10.5772/intechopen.109060

Davret, J., Trouillet, B., & Toonen, H. (2023). The digital turn of marine planning: A global analysis of ocean geoportals. *Journal of Environmental Policy & Planning*, *26*(1), 75–90. https://doi.org/10.1080/1523908X.2023.2283081

Day, S. A., O'Riordan, T., Bryson, J., Frew, P., & Young, R. (2015). Many stakeholders, multiple perspectives: Long-term planning for a future coast. In R. Nicholls, R. Dawson, & S. Day (Eds.), *Broad scale coastal simulation* (Vol. 49, pp. 299–323). Springer. https://doi.org/10.1007/978-94-007-5258-0_12

De Leonardo, E. G. (2018). *Aspectos jurídicos de la ordenación del territorio en la comunitat Valenciana: Pasado y actualidad* (Vol. 23). Universitat de València.

de Mulder, J. (2008). The institutional context for transboundary environmental impact assessment in Belgium: Multi level setting—A matter of smooth governance? *Impact Assessment and Project Appraisal*, *26*(4), 277–288. https://doi.org/10.3152/146155108X379622

de Vivero, J. L. S., Mateos, J. C. R., & del Corral, D. F. (2008). The paradox of public participation in fisheries governance. The rising number of actors and the devolution process. *Marine Policy*, *32*(3), 319–325. https://doi.org/10.1016/j.marpol.2007.06.005

Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. *Council of the European Communities*. OJ L 206, 22.7.1992, p. 7–50. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31992L0043

Directive 2009/147/EC of 30 November 2009 on the conservation of wild birds. *European Parliament and the Council*. OJ L 20, 26.1.2010, p. 7–25. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009L0147

Directorate of Economy and Environment. (2010). *Isle of Wight shoreline management plan 2: Appendix B—Stakeholder engagement*. Isle of Wight Council. https://www.coastalwight.gov.uk/smp

Edenhofer, O. (2015). *Climate change 2014: Mitigation of climate change* (Vol. 3). Cambridge University Press.

Elliott, M., Borja, Á., & Cormier, R. (2023). Managing marine resources sustainably—Ecological, societal and governance connectivity, coherence and equivalence in complex marine transboundary regions. *Ocean & Coastal Management*, *245*, Article 106875. https://doi.org/10.1016/j.ocecoaman.2023.106875

Endter-Wada, J., Kettenring, K. M., & Sutton-Grier, A. (2020). Protecting wetlands for people: Strategic policy action can help wetlands mitigate risks and enhance resilience. *Environmental Science & Policy*, *108*, 37–44. https://doi.org/10.1016/j.envsci.2020.01.016

Enguer, J., & Schaub, S. (2024). Local preferences for the adoption and modification of climate policy instruments under a radical left government: Unveiling the impact and legacy of Barcelona in common. *Local Government Studies*. Advance online publication. https://doi.org/10.1080/03003930.2024.2400284

Enrico, D., & Christiaan, V., (2022.) *The EU Strategy for the Adriatic and Ionian Region (EUSAIR)*. EPRS: European Parliamentary Research Service. Belgium. https://coilink.org/20.500.12592/nm5mcs

Erwin, K. L. (2009). Wetlands and global climate change: The role of wetland restoration in a changing world. *Wetlands Ecology and Management*, *17*(1), 71–84. https://doi.org/10.1007/s11273-008-9119-1

European Commission. (2022). *Staff working document—Supporting and connecting policymaking in the member states with scientific research*. https://knowledge4policy.ec.europa.eu/file/staff-working-document-supporting-connecting-policymaking-member-states-scientific-research_en

Fobé, E., Blatrix, C., Douguet, J. M., Salès, K., Đinh, L., Trubbach, S., Platjouw, F. M., Johannesen, E., Kvanneid, A. J., Beunen, R., & Nijamdeen, M. (2024). *Blue green governance project deliverable 1.1*. https://bggovernance.eu/wp-content/uploads/2024/10/BGG_Deliverable1_1_PolicyReport.pdf

Fobé, E., & Brans, M. (2013). Policy-oriented foresight as evidence for policy-making: Conditions of (mis)match. *Evidence & Policy*, *9*(4), 473–492.

Fornés, J. M., de la Hera, A., Ballesteros, B., & Aragón, R. (2008). Conflictos entre el desarrollo de las aguas subterraneas y la conservacion de los humedales del litoral mediterraneo espanol. *Boletin Geologico y Minero*, *119*(2), 231–246.

Gardner, R. C., Barchiesi, S., Beltrame, C., Finlayson, C. M., Galewski, T., Harrison, I., Paganini, M., Perennou, C., Pritchard, D. E., Rosenqvist, A., & Walpole, M. (2015). *State of the world's wetlands and their services to people: A compilation of recent analyses*. Ramsar Convention Secretariat. http://doi.org/10.2139/ssrn.2589447

Gardner, R. C., & Finlayson, C. (2018). *Global wetland outlook: State of the world's wetlands and their services to people* (Research Paper No. 2020-5). Stetson University College of Law. https://ssrn.com/abstract=3261606

Generalitat Valenciana. (2022). *Documento de inicio de la Evaluación Ambiental y Territorial Estratégica del Plan de Acción Territorial de la Infraestructura Verde del Litoral de la Comunitat Valenciana*. Conselleria d'Habitatge, Obres Públiques i Vertebració del Territori. https://www.upv.es/contenidos/CAMUNISO/info/U0714876.pdf

Gifford, E., McKelvey, M., & Saemundsson, R. (2021). The evolution of knowledge-intensive innovation ecosystems: Co-evolving entrepreneurial activity and innovation policy in the West Swedish maritime system. *Industry and Innovation*, *28*(5), 651–676. https://doi.org/10.1080/13662716.2020.1856047

Grorud-Colvert, K., Sullivan-Stack, J., Roberts, C., Constant, V., Horta e Costa, B., Pike, E. P., Kingston, N., Laffoley, D., Sala, E., Claudet, J., Friedlander, A. M., Gill, D. A., Lester, S. E., Day, J. C., Gonçalves, E. J., Ahmadia, G. N., Rand, M., Villa Gommez, A., Ban, N. C., . . . Lubchenco, J. (2021). *The MPA guide: A framework to achieve global goals for the ocean*. *Science*, *373*, Article 6560. https://doi.org/10.1126/science.abf0861

Hermans, T. H., De Winter, R. C., Storms, J. E., Dunn, F. E., Gelderloos, R., Diermanse, F., Haer, T., Le Bars, D., Haasnoot, M., Huismans, Y., Kreemers, L. M., Van der Linden, E. C., Pearson, S. G., Rietbroek, R., Slangen, A. B. A., Winjnberg, K. M., Winter, G., & Van De Wal, R. S. (2024). *An integrated view on the uncertainties of sea-level rise, hazards and impacts, and adaptation*. Authorea. https://doi.org/10.22541/au.173437064.40047859/v1

Jégou, A., & Sanchis-Ibor, C. (2019). The opaque lagoon. Water management and governance in l'Albufera de València wetland (Spain). *Limnetica*, *38*(1), 503–515. https://doi.org/10.23818/limn.38.29

Jódar-Abellán, A., & Molina, A. (2019). El Plan de Acción Territorial de la Infraestructura Verde del Litoral (PATIVEL) de la comunidad Valenciana (España). https://doi.org/10.14198/Congreso-Nacional-del-Agua-Orihuela-2019

Kim, G. U., Seo, K. H., & Chen, D. (2019). Climate change over the Mediterranean and current destruction of marine ecosystem. *Scientific Reports*, *9*, Article 18813. https://doi.org/10.1038/s41598-019-55303-7

Koning, S., Steins, N., & van Hoof, L. (2021). Balancing sustainability transitions through state-led participatory processes: The case of the Dutch North Sea Agreement. *Sustainability*, *13*(4), Article 2297. https://doi.org/10.3390/su13042297

Monteiro, B., & Dal Borgo, R. (2023). *Supporting decision making with strategic foresight: An emerging framework for proactive and prospective governments*. OECD. https://doi.org/10.1787/1d78c791-en

Muccitelli, S., Pozzi, C., D'Ascanio, R., & Magaudda, S. (2023). Environmental contract: A collaborative tool to improve the multilevel governance of european MPAs. *Sustainability*, *15*(10), Article 8174. https://doi.org/10.3390/su15108174

Neal, W. J., Pilkey, O. H., Cooper, J. A. G., & Longo, N. J. (2018). Why coastal regulations fail. *Ocean & Coastal Management*, *156*, 21–34. https://doi.org/10.1016/j.ocecoaman.2017.05.003

Neilson, A. L., & São Marcos, R. (2019). Reframing marine resource management with relational ontologies and hybrid entanglements: Fishing for empathy between Azorean fishers and scientists. *Marine Policy*, *105*, 30–37. https://doi.org/10.1016/j.marpol.2019.04.004

Norwegian Ministry of Climate and Environment. (2021). *Helhetlig tiltaksplan for en ren og rik Oslofjord med et aktivt friluftsliv*. https://www.regjeringen.no/contentassets/7e80a758716344cbbb97adc5c7c27f18/t-1571b.pdf

O'Hagan, A. M., Paterson, S., & Tissier, M. L. (2020). Addressing the tangled web of governance mechanisms for land-sea interactions: Assessing implementation challenges across scales. *Marine Policy*, *112*, Article 103715. https://doi.org/10.1016/j.marpol.2019.103715

Piwowarczyk, J., & Wróbel, B. (2016). Determinants of legitimate governance of marine Natura 2000 sites in a post-transition European Union country: A case study of Puck Bay, Poland. *Marine Policy*, *71*, 310–317. https://doi.org/10.1016/j.marpol.2016.01.019

Platjouw, F. M., Friedrich, L., Trubbach, S., Sander, G., Boteler, B., Passarello, C., Soininen, N., Soares de Oliveira, C., Kyronviita, J., Belinskij, A., Puharinen, S.-T., & Albrecht, E. (2024). *The crossgov policy coherence evaluation framework—A methodological framework to assess policy coherence and cross-compliance with the European Green Deal*. CrossGov.

Ramesh, R., Abhilash, K. R., Purohit, M., Krishnan, P., Lakshmi, A., Purvaja, R., & Kingsley, P. W. (2017). Involvement of community in managing coastal wetlands in South Asia: Status, issues and challenges. In B. A. Kumar Prusty, R. Chandra, & P. A. Azeez (Eds.), *Wetland science: Perspectives from South Asia*, (pp. 545–562). Springer. https://doi.org/10.1007/978-81-322-3715-0_28

Rosa-Moreno, J. (2008). Política ambiental de la comunidad Valenciana. In *Anuario de derecho ambiental. Observatorio de políticas ambientales* (pp. 627–654). Boletín Oficial del Estado.

Samal, R., & Dash, M. (2024). Stakeholder engagement in advancing sustainable ecotourism: An exploratory case study of Chilika wetland. *Discover Sustainability*, *5*, Article 50. https://doi.org/10.1007/s43621-024-00233-2

Sanchís Ibor, C., & Ibáñez Martí, C. (2024). Los humedales costeros de la península ibérica: Más allá del dilema productivismo vs conservacionismo. In C. Sanchís Ibor & C. Ibáñez Martí (Eds.), *Los humedales costeros de la Península Ibérica* (Vol. 1, pp. 11–32). Tirant lo Blanch.

Schlüter, A., Van Assche, K., Hornidge, A. K., & Văidianu, N. (2020). Land-sea interactions and coastal development: An evolutionary governance perspective. *Marine Policy*, *112*, Article 103801.

Sebastiá-Frasquet, M.-T., Altur, V., & Sanchis, J.-A. (2014). Wetland planning: Current problems and environmental management proposals at supra-municipal scale (Spanish Mediterranean coast). *Water*, *6*(3), 620–641. https://doi.org/10.3390/w6030620

Secretariat of the Ramsar Convention on Wetlands. (2025). *The list of wetlands of international importance*. https://www.ramsar.org/sites/default/files/2023-08/sitelist.pdf

Semenza, J. C. (2020). Cascading risks of waterborne diseases from climate change. *Nature Immunology*, *21*, 484–487. https://doi.org/10.1038/s41590-020-0631-7

Serrao-Neumann, S., Davidson, J. L., Baldwin, C. L., Dedekorkut-Howes, A., Ellison, J. C., Holbrook, N. J., Howes, M., Jacobson, C., & Morgan, E. A. (2016). Marine governance to avoid tipping points: Can we adapt the adaptability envelope? *Marine Policy*, *65*, 56–67. https://doi.org/10.1016/j.marpol.2015.12.007

Singh, P. A., & Ort, M. (2020). Law and policy dimensions of ocean governance. In S. Jungblut, V. Liebich, & M. Bode-Dalby (Eds.), *YOUMARES 9—The oceans: Our Research, Our Future* (pp. 45–56). Springer. https://doi.org/10.1007/978-3-030-20389-4_3

Steyaert, P., Barzman, M., Billaud, J. P., Brives, H., Hubert, B., Ollivier, G., & Roche, B. (2007). The role of knowledge and research in facilitating social learning among stakeholders in natural resources management in the French Atlantic coastal wetlands. *Environmental Science & Policy*, *10*(6), 537–550. https://doi.org/10.1016/j.envsci.2007.01.012

Stuiver, M., Soma, K., Koundouri, P., Van den Burg, S., Gerritsen, A., Harkamp, T., Dalsgaard, N., Zagonari, F., Guanche, R., Schouten, J-J., Hommes, S., Giannouli, A., Söderqvist, T., Rosen, L., Garção, R., Norrman, J., Röckmann, C., De Bel, M., Zanuttigh, B., . . . Møhlenberg, F. (2016). The governance of multi-use platforms at sea for energy production and aquaculture: Challenges for policy makers in European seas. *Sustainability*, *8*(4), Article 333. https://doi.org/10.3390/su8040333

Universitat de València News. (2023). *La Universitat, el Ayuntamiento y la Generalitat acuerdan la creación de la Estación Biológica de la Albufera*. https://www.uv.es/uvweb/uv-noticias/es/noticias/universitat-ayuntamiento-generalitat-acuerdan-creacion-estacion-biologica-albufera-1285973304159/Novetat.html?id=1286316082926&plantilla=UV_Noticies/Page/TPGDetaillNews

Van Assche, K., Hornidge, A. K., Schlüter, A., & Viadianu, N. (2020). Governance and the coastal condition: Towards new modes of observation, adaptation and integration. *Marine Policy*, *112*, Article 103413. https://doi.org/10.1016/j.marpol.2019.01.002

Viñals, M. J. (2024). El marco jurídico para la protección, conservación y uso público de los humedales en España. In C. Sanchís Ibor & C. Ibáñez Martí (Ed.), *Los humedales costeros de la Península Ibérica* (Vol. 1, pp. 389–424). Tirant lo Blanch.

Wilson, C., & Mergel, I. (2022). Overcoming barriers to digital government: Mapping the strategies of digital champions. *Government Information Quarterly*, *39*(2), Article 101681.

Xie, C., Xu, J., Shao, Y., Cui, B., Goel, K., Zhang, Y., & Yuan, M. (2015). Long term detection of water depth changes of coastal wetlands in the Yellow River Delta based on distributed scatterer interferometry. *Remote Sensing of Environment*, *164*, 238–253. https://doi.org/10.1016/j.rse.2015.04.010

About the Authors

Irene Luján Climent is a PhD candidate in political science, developing her thesis at the University of Valencia as part of the Horizon-funded project BlueGreen Governance (BGG). Her research focuses on the governance of coastal wetlands, aiming to contribute to environmental sustainability and effective public management.

Joan Enguer is a postdoctoral researcher at the University of Valencia, working on the Horizon-funded project BlueGreen Governance (BGG). In December 2024, he completed his PhD at Heidelberg University as part of the ERC-funded project DeepDCarb. His current research focuses on environmental policy and governance in coastal areas.

Bernabé Aldeguer is an associate professor of political science at the University of Valencia, where he leads the BlueGreen Governance project (BGG). Likewise, he is part of the Complutense Institute of Administrative Science (ICCA-UCM) and a board member of the Spanish Association of Political Science and Administration (AECPA).

Oscar Barberà is an associate professor of political science at the University of Valencia. He is a member of the BlueGreen Governance project (BGG) and the working group leader of the Relink2 project (COST Action). Since 2023, he has been the coordinator of the Digital Transformation Lab of Forthem Alliance.

Ocean and Society
2025 • Volume 2 • Article 10458
https://doi.org/10.17645/oas.10458

cogitatio

ARTICLE

Open Access Journal

Bridging Local and Scientific Knowledge in Land–Sea Governance Through Strategic Foresight: Unlocking Transformative Adaptation in Valencia

Gea Grassi [1,2], Federica Zennaro [1,2], Irene Luján Climent [3], Oscar Barberà [3], Bernabé Aldeguer-Cerdá [3], Gianluca Ferraro [4], Jean-Marc Douguet [5], and Elisa Furlan [1,2]

[1] Euro-Mediterranean Center on Climate Change (CMCC Foundation), Italia
[2] Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Italy
[3] Department of Constitutional Law and Political Science, University of Valencia, Spain
[4] Centre for Blue Governance, University of Portsmouth, UK
[5] University Paris Saclay, France

Correspondence: Elisa Furlan (elisa.furlan@cmcc.it)

Submitted: 31 March 2025 **Accepted:** 23 July 2025 **Published:** 10 September 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Land–sea interfaces (LSIs) are complex areas where terrestrial and marine ecosystems intersect, leading to intricate ecological, social, economic, and political interactions. These regions face pressures from both land-based and maritime activities, with climate change amplifying threats to communities and natural environments. Strategic foresight analysis, focused on co-designing future scenarios, offers a promising approach to developing sustainable strategies for LSIs. Central to this approach is stakeholder engagement, which involves participatory practices in scientific planning to improve LSI governance. This article presents outcomes from a workshop held in June 2024 in Valencia, where stakeholders from the Valencian Community participated in activities using strategic foresight tools like horizon scanning and scenario planning. The aim was to address climate pressures, identify beneficiary and affected sectors, understand community needs, and explore tools for managing environmental challenges. Based on the workshop's outputs, future adaptation perspectives were developed, each targeting different goals, such as sustainable economy, environmental behaviour, and integrated governance. This process underscored the value of participatory processes that combine local knowledge with scientific expertise to enhance understanding of LSIs' challenges and opportunities, build shared visions, and develop actionable strategies. The participatory nature of the workshop fostered a sense of ownership and supported an inclusive decision-making process that promotes long-term commitment and cross-disciplinary learning, ultimately leading to more resilient and context-sensitive strategies.

Keywords
climate change adaptation; coastal governance; land–sea interface; stakeholders engagement; strategic foresight analysis; Valencian Community

1. Introduction

The land–sea interface (LSI) represents a complex and dynamic area, where terrestrial and marine habitats converge and interact across ecological, social, and economic dimensions. This interface is shaped by a variety of physical and ecological processes, including freshwater inflow, sediment transport, and nutrient exchange from land to sea, as well as critical biological functions such as fish spawning and carbon sequestration (Innocenti & Musco, 2023; Singh et al., 2021). These interlinked cycles make LSI regions not only ecologically vital but also economically strategic, supporting sectors such as tourism, fisheries, and aquaculture (Ramieri et al., 2018).

In addition to their interdependent nature, LSIs host a significant portion of the world's population and represent spaces of intense social, economic, and political interactions, making them particularly vulnerable to environmental and anthropogenic pressures (Glavovic et al., 2015). This complexity often results in fragmented governance, where land and sea are frequently managed through separate, poorly coordinated institutional frameworks. This institutional disconnect impedes integrated responses to intersystem pressures that originate in one subsystem (land or sea) but have effects on the others (Álvarez-Romero et al., 2011; Singh et al., 2021). This LSI perspective explicitly highlights the need for integrated management across terrestrial and marine domains, allowing the identification of misalignments in jurisdictional responsibilities, sectoral priorities, and instruments, to explore opportunities for more adaptive and collaborative responses.

The Valencian Community represents a highly relevant region of the Mediterranean due to its ecological, economic, and cultural richness. With over 500 km of coastline, this region is characterised by a strong interconnection between terrestrial and marine systems and presents a rich mosaic of ecosystems of great ecological importance, such as coastal lagoons, wetlands, and seagrass meadows, which support biodiversity and provide essential services for both marine and terrestrial environments (Generalitat Valenciana, n.d.-a). Its coastal economic relevance is driven by its agriculture and tourism sectors, and growing urban centres (Jato-Espino & Mayor-Vitoria, 2023; Martí & García-Mayor, 2020). The combination of anthropogenic pressures, conflicting sectoral interests, and fragmented governance makes this region particularly vulnerable to climate change, with serious impacts on coastal communities and ecosystems (Martí & García-Mayor, 2020; Olcina Cantos & Miró Pérez, 2017).

In light of these challenges, traditional decision-making approaches may be insufficient to address the complexity of interconnected social, economic, and environmental issues, as was demonstrated during the isolated high-altitude depression (DANA, in Spanish) that affected the region in October 2024. Therefore, it is crucial to explore new methodologies of engagement and co-creation that foster a shared strategic vision. In this context, strategic foresight analysis emerges as an innovative approach to explore the future to anticipate changes, develop possible transition paths, and resist shocks. Bridging the gap between complex scientific discoveries and practical applications, this methodology aims to support a broader participatory

dialogue, fostering innovation to better manage future uncertainties (United Nations Development Programme, 2018, 2022). In recent years, several international studies have demonstrated the potential of strategic foresight to address the complexity of LSI management (Grassi et al., 2025). In Uruguay, for example, Nagy and Gutiérrez (2018) applied scenario planning and vulnerability assessments to explore coastal climate adaptation pathways, integrating climate forecasts with stakeholder (SH) perceptions. Furthermore, in the Netherlands, Roggema et al. (2021) adopted a prospective approach to co-design adaptive landscapes to what concern sea level rise, salinity, biodiversity loss, and land subsidence. In the UK, Roy et al. (2014) combined horizon analysis with expert consensus to identify invasive alien species that threaten land and marine biodiversity, producing a priority list that informed management policies.

Drawing on these experiences, this study aims to test strategic foresight analysis for participatory governance and climate adaptation in the Valencian Community. Two characteristic and widely used tools of strategic foresight, horizon scanning and scenario planning, were applied during a workshop with SHs. This event aimed to initiate an ad hoc dialogue between relevant national, regional, and local actors to inform decision-making (or "policy dialogue"). The exercises and dialogue prompts proposed are designed to explore areas of conflict, consensus, and compromise in the region, with the aim of leading to the construction of an SHs network that can be institutionalised in a long-term land–sea partnership and territorial observatory.

The article is structured as follows. Section 2 presents the case study of the Valencian Community, outlining its governance and socio-environmental characteristics. Section 3 describes the research questions, methodology, and structure of the workshop organised in Valencia. Section 4 provides the outcomes obtained from the different exercises and an analysis of the emerging challenges. Section 5 unfolds the possible future pathways for transformative adaptation identified during the final exercises. Finally, Section 6 presents the conclusions, identifying the remaining gaps, and discussing the need for future workshop experiences and co-design approaches.

2. Case Study Description

The Valencian Community, located on the Mediterranean coast of the eastern Iberian Peninsula, covers 23,255 km^2 and is home to over five million inhabitants. Administratively, it is divided into three provinces: Castellón, Valencia, and Alicante (Generalitat Valenciana, n.d.-b).

This region highlights how multi-level governance in coastal management is shaped by the interplay between historical institutional dependencies, sectoral policies, and SH interests. Its regional governance system involves a dense network of institutions operating at national, regional, provincial, and local scales, where the Generalitat Valenciana (the Valencian regional government) plays a pivotal coordinating role across spatial planning, environmental protection, and water management. However, the fragmented distribution of responsibilities between different administrative levels often creates coordination gaps, particularly in addressing cross-cutting challenges like coastal erosion or drought management. Recent governance innovations, such as advisory committees, including the governing boards of natural parks (Juntas Rectoras de Parques Naturales), and participatory planning processes, aim to enhance horizontal and vertical coordination while integrating scientific knowledge and the participation of key SH groups into decision-making. Nevertheless, persistent tensions between economic development priorities and environmental conservation efforts underscore the need for more adaptive and collaborative governance

frameworks in the Valencian coast (Capdepón Frías, 2016; del Romero Renau & Trudelle, 2011; Galvez-Hernandez et al., 2025).

Its vulnerability was demonstrated when, on 29 October 2024, the Valencian Community suffered a catastrophic DANA event. This meteorological phenomenon brought extreme rainfall to the region, causing devastating flash floods (Agencia Estatal de Meteorología, 2024). The combination of rising atmospheric temperatures increased the storm's strength, resulting in increased humidity. At the same time, the region's vulnerability was accentuated by frequent droughts occurred in the previous seasons, making the soils abnormally dry and hydrophobic (Copernicus, 2024; World Meteorological Organization, 2024). The heavy rainfall of the event caused more than 210 deaths, dozens of missing people, and significant damage to infrastructure, as well as severe disruptions in electricity supply and transport and significant losses in key sectors such as industry and tourism (Bayo Pérez, 2024; Caballero, 2024; Bono, 2024; La Moncloa, 2024; Sociedad Española de Radiodifusión, 2024).

3. Methodology for Exploring SH Insights

A preliminary desk review was conducted to gain a detailed understanding of the Valencian Community's socio-environmental and economic context, with a special focus on coastal governance dynamics and emerging challenges related to climate change and anthropogenic pressures. Building on the collected information, a one-day workshop was held at the University of Valencia in June 2024 to better capture insights about the Valencian Community and gather SH perspectives. Participants were selected with the primary objective of engaging state and non-state actors in improving coastal governance within the region and fostering community empowerment through multi-SH engagement.

In this research, the term SH refers to individuals or organizations that are directly or indirectly affected by, or have the capacity to influence, decisions related to the governance (Reed et al., 2009) of coastal areas and LSIs in the Valencian Community. These include representatives of public administrations, Non-Governmental Organizations (NGOs), companies, and academic institutions. Within this broad category, we also find experts, defined as SHs with formal knowledge or technical expertise in relevant fields such as environmental science, climate adaptation, or policy design (Turnhout et al., 2013). Finally, citizens are also considered key SHs, as they bring local experiences and contextual knowledge crucial for inclusive and effective governance to contrast their lack of direct decision-making power (Chilvers & Kearnes, 2019).

A total of 11 SHs from different sectors, plus 7 team members (social science and climate change researchers), participated in the workshop (Figure 1). The selection of SHs followed a structured two-step process. Initially, a prospective analysis was conducted to identify key actors. This was followed by a prioritisation phase based on a matrix combining two criteria: (a) the SHs' level of interest in the topics addressed in the focus group and (b) their degree of influence or decision-making power on the issues analysed. Additionally, a snowball sampling technique was applied, enabling the expansion of the participant network beyond the initial contacts (Ackermann & Eden, 2011; Stocker et al., 2020).

While the size of the SHs group was intentionally chosen to foster meaningful interaction and dialogue, it is important to recognize that the 11 participants do not represent the full diversity of perspectives and that the contributions collected offer valuable insights but cannot be considered exhaustive.

To address this limitation, the workshop was conceived as a first step within a broader participatory process. This aims to include a more representative sample, including marginalised communities, sectoral actors, and additional public officials to help ensure inclusive adaptive governance pathways.

Sector	Represented institutions
Public administration	Ministry of Ecological Transition
	Nature 2000 Network
	Biodiversity Foundation
	Project INTEMARES
	Valencia City Council (Health service, Albufera Park)
Economic sector	HOSBEC — Hotel and Tourism Association of the Valencian Community
Foundations/NGOs	Oceanogràfic Foundation
	Climate Assembly
	"Per l'Horta" (For the Orchard)
	Ecology Action Agró
Academic & research sector	University of Portsmouth (Blue Green Governance Project)
	Chair of Ecology at the University of Valencia
	Cavanilles Institute of the University of Valencia (Office of the Vice-Rector for Sustainability, Cooperation and Development)
	University Paris Saclay
	Euro-Mediterranean Center on Climate Change (CMCC)
	Faculty of Law of the University of Valencia

Figure 1. Sector representatives in the workshop of Valencia, June 7th, 2024, comprehensive of SHs and team members.

The workshop was designed through the use of two strategic foresight analysis tools: horizon scanning and scenario planning. Horizon scanning focuses on the identification and aggregation of early indications of change or emerging signals that could potentially exert significant impacts when they develop. Scenario planning involves the description of plausible future states based on assumptions about key relationships between drivers of change and trends (United Nations Development Programme, 2022).

The workshop design was supported by four main research questions aimed at understanding the challenges and opportunities regarding the management of environmental threats at the LSI in the Valencian Community:

RQ1: What are the main climate hazards affecting the Valencian Community LSI?

RQ2: Who loses and who gains from the impact of these climate hazards?

RQ3: What tools are available and which would be needed to manage the interlinked land–sea environmental challenges in the Valencian Community?

RQ4: Which actions are needed to support a transformative adaptation pathway across the LSI?

To address them, four interactive exercises were conducted (as detailed in Figure 2), each designed to engage participants in a discussion and facilitate opinions and knowledge exchange, and foster collaboration among SHs from diverse sectors. Horizon scanning was applied in the first two exercises to identify key climate

hazards and their impacts on different sectors. The third and fourth exercises combined horizon scanning and scenario planning to define the necessary tools, barriers, and actions for possible future adaptation pathways. Figure 3 presents photos of some outputs of the interactive foresight exercise, offering visual insight into the results of the engagement process.

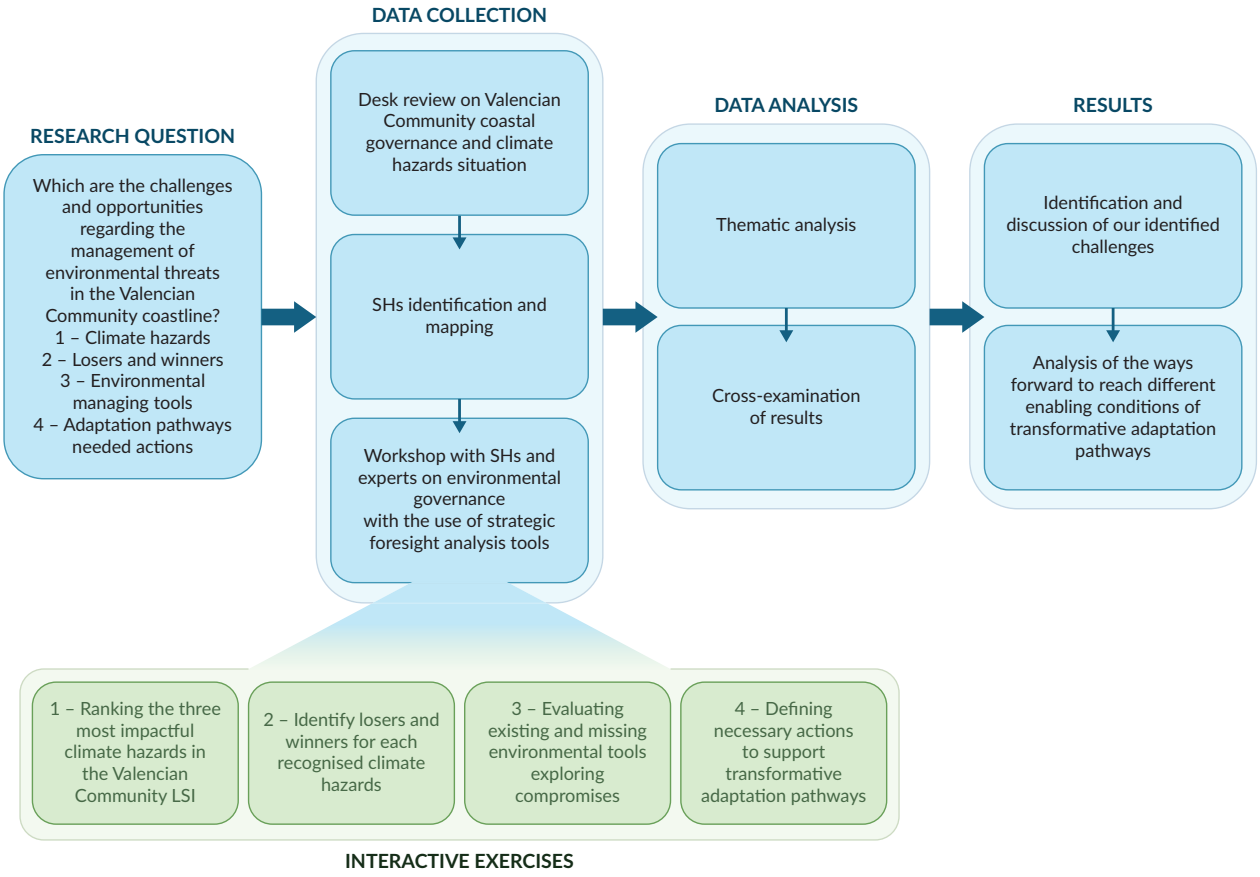


Figure 2. Step-by-step methodological framework, including the main topics addressed.

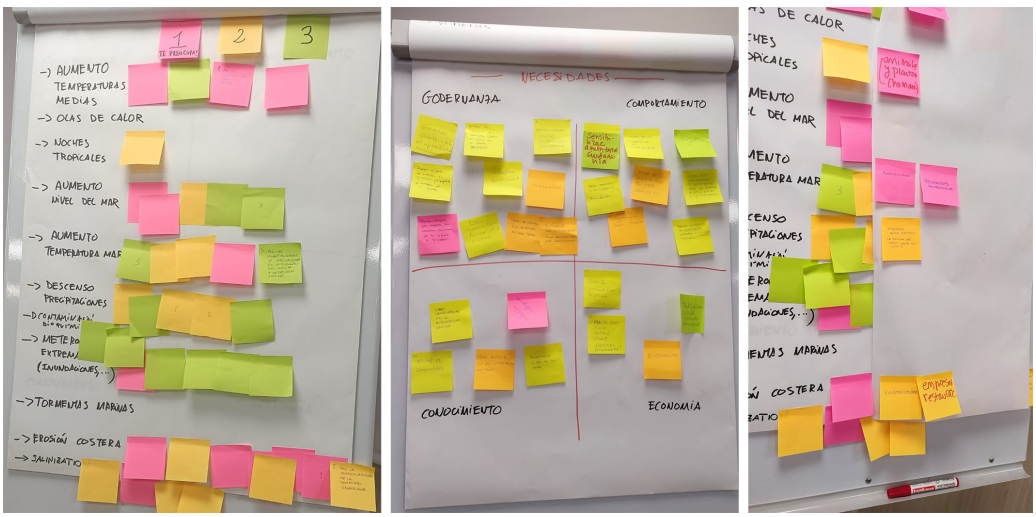


Figure 3. Visual insights from foresight exercises.

4. Analysis of Valencian Community Land–Sea Challenges

The procedures used during the workshop activities were designed to encourage participants to identify prospects and complexities related to the LSI in the Valencian Community and stimulate the recognition of systemic connections.

However, it is important to underline that the SH contributions revealed a predominant focus on coastal issues (e.g., sea level rise, coastal erosion, and impacts on coastal communities and infrastructure; see Sections 4.1 and 4.2). This orientation emerged spontaneously during the discussions, reflecting the most immediate concerns and direct experiences of the participants, who are highly exposed to the visible effects of "sea-to-land" phenomena.

Although the broader interdependencies between land and marine systems, particularly those related to internal factors that increase coastal vulnerability, were not at the centre of the debate, the challenges addressed in the workshop are nevertheless an integral part of LSI dynamics. Future participatory events may benefit from stimuli and activities more explicitly oriented to balance the attention between "land-to-sea" and "sea-to-land" dynamics, promoting a more complete understanding of systemic interactions and thus strengthening the approach to integrated land–sea governance.

Four main challenges emerged based on the four research questions mentioned in the methodology: the different perceptions of main climate hazards (Section 4.1), the dichotomy between those who benefit and those who are most affected by climate threats (Section 4.2), the need to create coordination in the use of environmental management tools (Section 4.3), and finally the necessity for an adaptation process that is integrated between the different society sectors (Section 4.4).

4.1. Main Climate Hazards Perception

This section addresses the first research question that guided the workshop activities: What are the main climate hazards affecting the Valencian Community LSI? The objective was to explore which climate threats are perceived as most urgent in the Valencian Community by the SHs and how these perceptions align with scientific evidence. During the exercise, a broad range of hazards was discussed, and each participant assigned a score from 1 to 3 to associate their perception of increasing importance and priority.

The results showed how coastal erosion was identified as the top concern with a total of 18 points, followed by rising average temperatures and sea level rise, both scoring 10 points (Figure 4). This classification reflects a focus on phenomena that visibly influence coastal dynamics and are considered direct threats to the local economy and the safety of communities, increasingly concentrated in coastal areas (Olcina Cantos & Miró Pérez, 2017).

One finding worth highlighting is the large difference between the climate hazards perceived as more impactful and the values obtained by others that, despite being identified in the literature as relevant, were considered of less urgency by the participants. In particular, phenomena such as a decrease in rainfall, biochemical contamination, and tropical nights were perceived as less relevant for coastal management (with rainfall having 8, biochemical contamination 8, and tropical nights 2 points). This is despite their potential

impact on local communities and ecosystems, especially in terms of public health, the state of marine biodiversity, and consequently effects on the fishing sector (Andreu et al., 2024; Calvo et al., 2021; Camarasa-Belmonte & Butrón, 2015; Cutillas-Lozano et al., 2023; Lehoczky et al., 2017).

In addition, heatwaves, although identified in the literature as a significant risk for the Valencian Community (Royé et al., 2020; Wei & Sobrino, 2024), did not receive any score from the workshop participants. Similarly, storm surges, which studies indicate no general positive trend along the entire Spanish coast related to climate change, but an upward trend specifically in the Valencia region (Lin-Ye et al., 2020; Toledo et al., 2024), also failed to receive any scores from the participants. This mismatch may stem primarily from a lack of understanding of the terms or from the fact that these have been potentially included in the broader category of "extreme weather events."

Climate hazards	1st highest concern (3 points)	2nd highest concern (2 points)	3rd highest concern (1 point)	Total concern score
Coastal erosion	12	6	0	18
Increase in average temperatures	9	0	1	10
Sea level rise	6	2	2	10
Sea temperature increase	3	4	2	9
Extreme weather	3	0	6	9
Salinization	3	6	0	9
Decrease in rainfall	0	6	2	8
Biochemical contamination	0	6	2	8
Tropical nights	0	2	0	2
Heat waves	0	0	0	0
Sea storms	0	0	0	0

Figure 4. Climatic hazard concerning scores by SHs' perception.

It is also important to highlight how extreme events, such as floods, were not among the climate hazards considered most worrying. These results provide an opportunity to discuss the possible reasons behind the underestimation of some hazards compared to others, especially in the context of extreme impact events caused by the DANA. A possible explanation is that the perception of risk is influenced by direct experience, generating a cognitive bias that leads to considering visible phenomena as more relevant and urgent, while less evident, but potentially equally harmful hazards, being overlooked. This trend, if confirmed, could negatively affect the ability to adopt preventive management strategies for phenomena that, if disregarded, could compromise coastal resilience and have significant impacts in the medium-long term. Furthermore, neglecting phenomena such as storm surges or salinization could lead to underestimating cumulative risks that could worsen in the future, requiring more expensive and complex interventions (Gill & Malamud, 2016).

4.2. Winner and Loser Dichotomy

The second research question that guided the workshop was: Who loses and who gains from the impact of these climate hazards? The goal was to explore how different SH groups perceive and experience the distribution of risks and opportunities generated by climate change.

This analysis highlighted a strong dichotomy between the "loser sectors," usually defined as the ones suffering significant losses due to climate change and facing increased vulnerability, and the "winner sectors," which are characterised by improved conditions, opportunities, and economic benefits from the new climate conditions (Figure 5) (O'Brien & Leichenko, 2003). Sectors defined as losers by SHs, such as agriculture, fisheries, tourism, and marine biodiversity, risk suffering irreversible damage that compromises both their economic sustainability and the resilience of local communities. On the contrary, some winners, such as energy production, real estate, and risk management industries, could exploit the new market opportunities generated by climate change.

Climate Hazards	Identified Losers	Identified Winners
Coastal erosion	• Local inhabitants, tourism sector	• Construction companies • Environmental restoration companies
Increase in average temperatures	• All living beings including people	• Energy sector • Air conditioning industry
Sea level rise	• Climate refugees • Natural environment managers (as representatives of society on conservation issues)	/
Sea temperature increase	• Biodiversity • Professional fishermen • Marine flora and fauna	• Tourism
Extreme weather	• Biodiversity in agriculture • Floods managers • Farmers	• Real estate
Salinization	/	/
Decrease in rainfall	/	• Tourism sector companies and tourists looking for places without rain • Farmers • Desalination plants
Biochemical contamination	/	• Industry
Tropical nights	• Animals, plants and humans	• Thermal industry
Heat waves	/	/
Sea storms	/	/

Figure 5. Identified winners and losers associated to the selected climate hazards.

This dichotomy constitutes a central challenge in the Valencian Community, with the risk of generating inequalities in adaptation and mitigation strategies, while leaving part of the local coastal communities without adequate support.

First, concerning the uneven response capacity, some losing sectors, such as agriculture and fisheries, operate in fragile economic contexts and with more limited profit margins (Paavola & Adger, 2006). Their capacity to invest in adaptation measures, such as changes in production practices, resilient infrastructure, or new technologies, is significantly lower than that of winning sectors (Islam & Winkel, 2017). This

dichotomy risks deepening economic and social inequalities, creating an ever-widening imbalance that could fuel tensions between interest groups with divergent goals. In particular, sectors that stand to benefit from climate-related market shifts (winning sectors) may resist ambitious mitigation policies, fearing potential constraints on emerging economic opportunities related to climate change (Srivastav & Rafaty, 2022).

The potential resistance of winning sectors could delay or compromise the adoption of effective policies to reduce climate risks. Furthermore, failure to recognize the needs of losing sectors could fuel social tensions, leading to protests or passive resistance to adaptation and mitigation policies (United Nations Environment Programme, 2023). This could create divisions in local communities and reduce the social cohesion needed to effectively address climate challenges. As one SH noted: "Only those who have direct interests participate. While local issues may attract attention, broader or more general policies often generate indifference." Another added:

> There used to be more willingness to participate, but this is fading. Participation is now seen as a waste of personal time; only those for whom it is a job remain engaged. Without a strong personal motivation, people disengage out of fatigue.

These perspectives highlight how structural inequalities in participation, often driven by sectoral interests, resource asymmetries, and differing levels of institutional trust, can hinder inclusive governance and compromise the legitimacy of collective decision-making processes.

If not adequately addressed, the perception of unequal treatment between "winning" and "losing" sectors could reduce the willingness of SHs to collaborate on common solutions. The absence of equitable adaptation strategies could erode SH trust in institutions, creating a cycle of disengagement and resistance, weakening policies effectiveness.

4.3. Cooperation and Optimization of Environmental Management Tools

Knowing the hazards and the associated actors involved, the analysis focused on understanding which are the existing tools for tackling climate and environmental challenges in the Valencian Community. The aim was to assess their perceived effectiveness and accessibility and to identify gaps in implementation and coordination across institutions and governance levels following the third research question. A detailed analysis conducted during the workshop highlights interesting points of discussion (summarised in Figure 6). It emerged that, although there are numerous operational tools, such as marine monitoring stations, land management organizations, and numerous data collection networks, some of these are not fully exploited or are not adequately integrated into decision-making processes. Among these are the annual report on the state of the environment (e.g., *Environmental Indicators Portal*), free legal assistance, and the various monitoring portals (e.g., GVA Open Environment Portal).

The presence of tools that are not fully exploited, because they are unknown or not easy to use, diminishes their potential impact on decision-making processes and consequently slows down the capacity to respond to climate change (Belaïd & Unger, 2024).

As remarked by workshop participants, "the tools exist but they are not used" and "there is total availability of data in the EU, but it is not used for any reason," underscoring a systemic disconnection between data

availability, institutional practices, and their concrete implementation in governance processes. The reasons behind this limited use are multiple and include, among others: poor promotion; not easy use; lack of training for difficult tools; fragmentation among different entities that manage them; poor communication between different SHs; and the perception that co-participation platforms, for example through reporting, do not lead to concrete results (Ulibarri et al., 2022). This situation represents a crucial obstacle since the lack of strategic use of existing tools reduces the effectiveness and potential impact of environmental policies and hinders the ability to respond to climate challenges. The issue is not only to develop new tools, but to build a coordinated system that makes the most of existing resources and promotes integrated and participatory environmental management (Belaïd & Unger, 2024).

On the other hand, the lack of some specific tools has been highlighted. These include regulatory compliance indicators that allow monitoring adherence with environmental regulations by different sectors, favouring a more rigorous application of the laws. Other missing tools are environmental metadata cataloguing platforms, which facilitate the collection, organization, and sharing of environmental data in an accessible and transparent way for all SHs. Emission monitoring and control plans are also needed to monitor and reduce polluting emissions, especially in coastal areas. Finally, tools for monitoring tourist carrying capacity are necessary to sustainably manage coastal tourist destinations, preventing overcrowding and related environmental impacts.

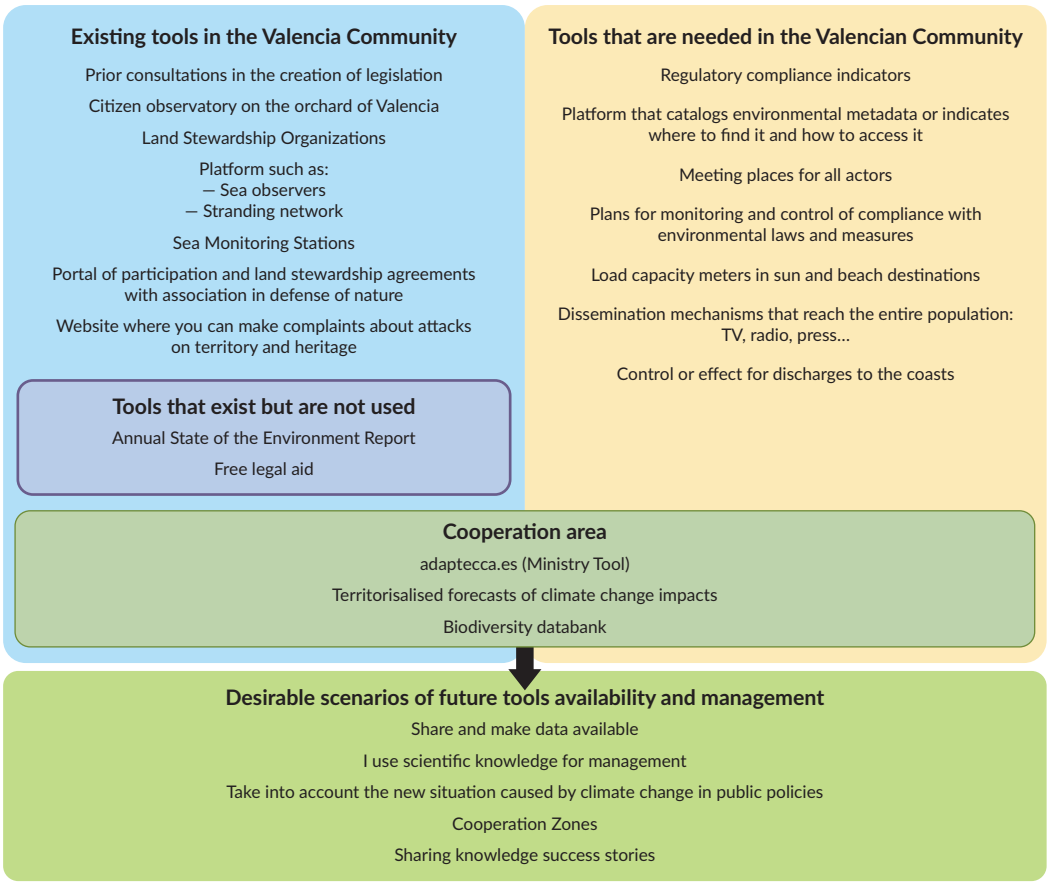


Figure 6. Mapping of tools in the Valencian Community, including existing, underutilised, and essential tools for enhanced environmental management, as well as areas of collaboration and optimal conditions for tools availability and integration.

One of the main critical issues that emerged from the discussions concerns the fragmentation of the available tools, which are used in isolation with poor communication and coordination between the various bodies that manage them. This reduces the ability to develop integrated strategies and increases the risk of duplication of efforts. Although some cooperative tools, such as the Plataforma sobre Adaptación al Cambio Climático en España—AdapteCCa and the Banco de Dados de Biodiversidad, represent positive examples of collaboration, there is no integrated system that consolidates all available tools and ensures consistent access to information.

The absence of a centralised system for sharing information causes reduced acceptance of environmental policies, a lack of SH participation, and unequal access to information. The absence of mechanisms for the dissemination of information to the entire population could amplify inequalities, with some communities less informed and therefore less prepared to face environmental challenges (Faus Onbargi, 2022; Huber et al., 2023; Newig et al., 2018). By fostering collaboration, different sectors could work together to tackle shared challenges, while facilitating the exchange of information, resources, and best practices, which can serve as models and inspiration for other communities and sectors.

4.4. Enabling Conditions for Transformative Action

This section addresses the fourth research question: Which actions are needed to support a transformative adaptation pathway across the LSI? The focus was put on identifying enabling conditions that could foster systemic change in the region's approach to climate resilience (Duguma et al., 2014).

Environmental governance processes often emphasize the need for transformation towards sustainability without addressing the "how" of this transformation (Bentz et al., 2022). To improve the resilience of communities, it is crucial to consider four key domains: governance and engagement, behavioural change, finances and resources, and knowledge and data. These serve as enabling conditions to support and accelerate systemic transformation in adapting to climate change and guide transformative adaptation pathways (European Commission, 2024). Climate resilience cannot be seen as an end state, but as a dynamic and constantly evolving process. In this sense, enabling conditions must be interpreted as tools to accompany this transformative journey, ensuring that different actors can adapt to changing conditions and face emerging challenges (Bentz et al., 2022; European Commission, 2024). These four domains offer an integrated approach to the management of environmental challenges and represent a conceptual framework for improving environmental governance in the Valencia region, filling existing gaps with appropriate tools, while promoting active cooperation between the actors involved. The workshop highlighted the need for an integrated and multidimensional approach to effectively address the challenges posed by climate change in the region (as described in Figure 7). As was noted by a SH: "Each municipality has its own specificities and follows different procedures" and "there are no coordinated metropolitan policies." These testimonies highlight the jurisdictional complexity and institutional fragmentation that limit coherent action across administrative boundaries. The main challenge is to ensure that these four domains work in a coordinated manner, overcoming the current shortcomings and fragmentation in decision-making processes.

Regarding the domain of *governance and engagement*, it was highlighted that fragmentation between local, regional, and national administrations complicates the coherence and effectiveness of environmental policies. Strengthening cooperation mechanisms between entities is essential to ensure integrated territory management. Furthermore, the need to involve local communities and scientific knowledge more in

decision-making processes, adopting a multidisciplinary approach that represents different perspectives, has emerged.

Finally, the need to improve the continuity of strategic mitigation and adaptation policies emerged, which must be maintained over time, regardless of changes in government. The lack of political stability can compromise the coherence and effectiveness of long-term policies, thus creating a lack of continuity in terms of time of environmental policies.

The *behavioural change* domain highlighted the importance of positively influencing citizen behaviour to foster a cultural change toward sustainability.

Under this point, the suggestion to establish citizen assemblies and public discussion spaces to promote the direct involvement of citizens in political choices and sustainable practices—for greater active participation—emerged.

At the same time, the promotion of educational programs for all age groups, with particular attention to young people, must have a role in building a culture of sustainability in the long term.

These two points are essential for increasing citizen environmental awareness and consciousness of the importance of environmental protection and their active role in the process of adapting to climate change. Finally, given the strong tourist presence within the Valencian Community, it would be necessary to find methods to increase awareness for tourists, as well as residents.

The third domain considered was *finances and resources*. The discussion highlighted the need for a transition to a sustainable economic model, compatible with the limits of the planet. First, it is central to restructure the local economy to favour activities compatible with environmental protection and reduce the impact of economic activities on natural systems. Furthermore, the need to adopt measures that internalize environmental costs in the prices of goods and services has emerged, encouraging more sustainable practices by businesses and consumers. Finally, the concept of degrowth was discussed, emphasizing the importance of balancing economic growth with the protection of natural resources.

The last domain, *knowledge and data*, focused on the need for easy data access and information sharing. This has been identified as a crucial element to support informed decisions and promote cooperation between SHs.

First, ensuring that all actors involved have access to updated and reliable data is essential to developing policies based on scientific evidence. To do this, it is necessary to develop digital platforms that facilitate the sharing of information between institutions, citizens, and businesses, promoting collective intelligence and improving the capacity to respond to environmental challenges. Furthermore, these platforms could limit the circulation of fake news and inaccurate information, a fundamental step to ensure that political decisions and individual behaviours are based on real and proven knowledge.

To ensure effective outcomes, a cohesive integration between the four enabling conditions is necessary. Without effective coordination between the identified domains of governance, behaviour, economy, and knowledge, mitigation and adaptation policies risk being disjointed and ineffective. The lack of awareness

and involvement of citizens can slow down the process of cultural and social transformation necessary to address climate challenges.

Without the integration of environmental externalities in prices, economic activities will continue to generate uncompensated environmental damage, reducing long-term sustainability. Finally, without an adequate information infrastructure, some communities or interest groups could be excluded from the decision-making process, increasing inequalities and reducing social cohesion.

The implementation of these pathways would require the coordinated involvement of institutions and actors from multiple governance levels. At the EU level, the support of the Commission (e.g., vice-presidency for a Clean, Just and Competitive Transition) and the European Parliament would be instrumental in providing clear priorities and objectives. At the national level, institutions such as the Ministry for Ecological Transition

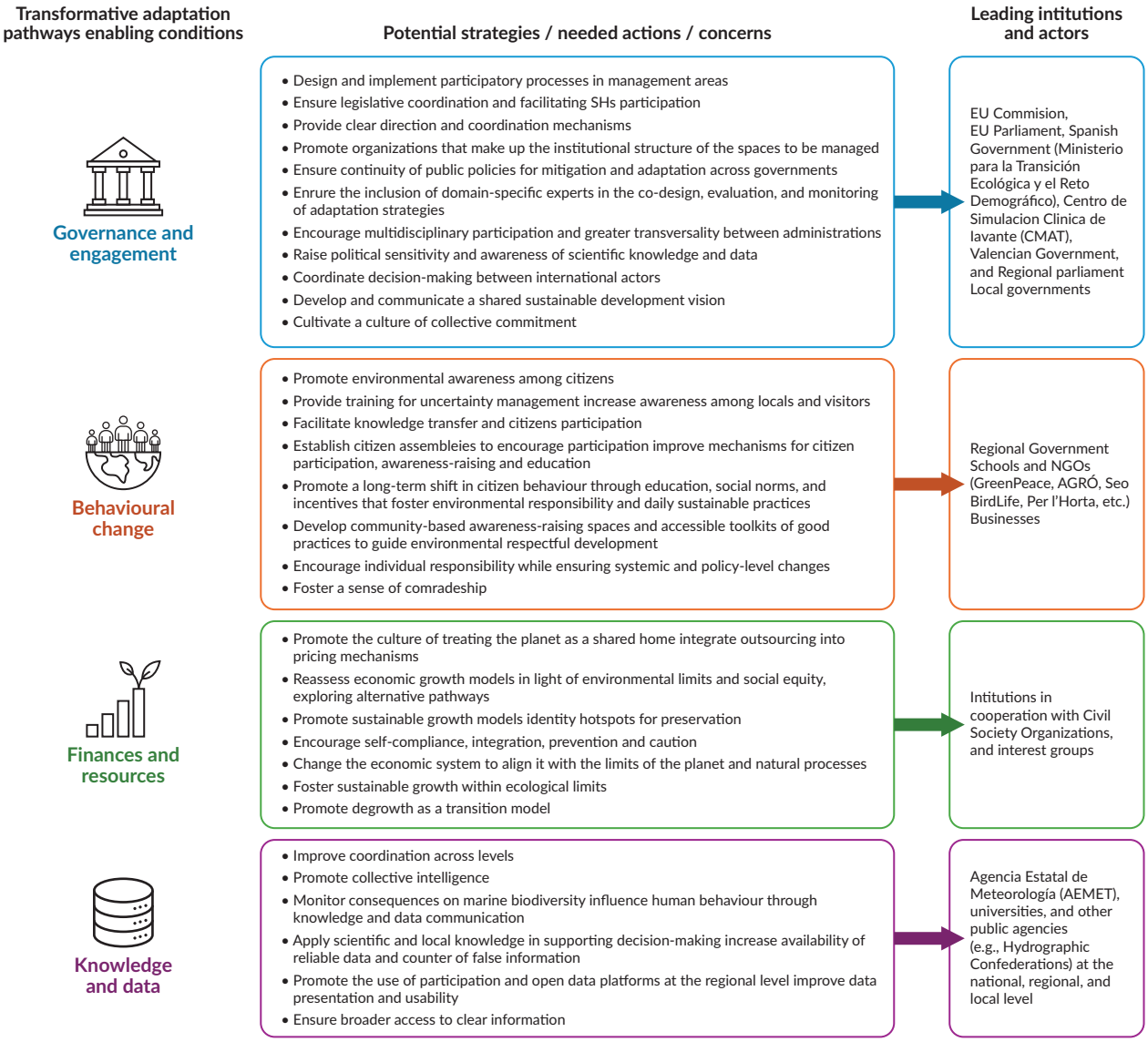


Figure 7. Potential strategies, necessary actions, and main concerns associated with the four enabling conditions for transformative adaptation pathways in the Valencian Community.

and Demographic Challenge and the Spanish legislative could strengthen regulation, funding, and facilitate vertical and horizontal institutional coordination. State agencies like Agencia Estatal de Meteorología or the National Geographic Institute can help strengthen national data systems. At the regional level, the Department of Environment, Infrastructure and Territory might play a key role in policy design, public participation initiatives, and environmental education that would also need the active support from the regional legislature. Local governments (municipalities and associations of municipalities) might also prove essential for adapting actions to specific territorial realities, organizing participatory processes, and engaging directly with residents and tourists. In addition, public universities and research centres (e.g., Universitat de València, Universitat Politècnica de València, Universidad de Alicante, and Consejo Superior de Investigaciones Científicas) are central for integrating scientific expertise and managing data. Schools, civil society organizations, environmental NGOs, and local knowledge networks such as Greenpeace, Acció Ecologista AGRÓ, Seo-BirdLife, Per l'Horta, etc. can serve as facilitators of behaviour change, educators, and bridge the public with the institutions.

5. Recommendations for Transforming Adaptation Pathways

The results obtained and discussed have highlighted that, to effectively address the identified challenges of LSI in the Valencian Community, it is necessary to enhance several key aspects, including (a) the strengthening of integrated and resilient governance, (b) the promotion of active environmental citizenship, (c) the transition to a sustainable economy, and (d) the use of knowledge and collective intelligence to guide decisions.

The recommendations for the future pathways proposed are based on the key reflections that emerged during the workshop.

To reach an *integrated and resilient governance*, it is essential to strengthen institutional coordination at all levels, ensuring coherence with climate challenges. Vertical and horizontal intergovernmental institutions indeed exist in environmental policies (Ferraro & Failler, 2024). That said, significant governance challenges persist. Coordination is often hindered by overlapping institutional mandates, administrative fragmentation, and insufficient communication between the local, regional, and national levels, issues that are especially pronounced when different political parties govern at each level. Frequent changes in government across these levels further complicate continuity, underscoring the need to safeguard regulations through multi-year funding commitments or by securing their future budgets. This limited cohesion can also weaken SHs' ability to effectively articulate and channel their demands. As a result, the successful implementation of cross-sectoral adaptation strategies and the development of long-term, integrated planning frameworks may face additional challenges. These difficulties can become more evident in land-use conflicts, where efforts to balance economic development with environmental protection and climate risk reduction remain complex (Schippers et al., 2015; Wang et al., 2024). However, even when the same political parties are in power at different levels, conflicts and diverging interests can still emerge based on different territorial needs or priorities, further complicating coordination efforts.

In this context, ensuring policy cohesion and continuity becomes essential to maintaining a long-term vision capable of guiding gradual but constant adaptation, implementing and improving upon existing measures over time, and enhancing resilience. In consequence, there might be the need for new cooperation zones and dialogue forums at various institutional levels, ensuring a more structured and coordinated approach to

LSI governance. Such forums could act as platforms providing comparative knowledge, good practices, and success stories. Moreover, they could also help strengthen new forms of citizen participation, integrating knowledge systems, facilitating the identification of future challenges, and promoting the use of strategic foresight methods and tools. These new governance schemes could foster dialogue and alleviate potential tensions between institutions and other political actors (academia, civil society, and key economic sectors), not yet always formally recognised in existing deliberative mechanisms.

While strengthening governance could improve institutional alignment and information accessibility, challenges may persist related to the complexity of inter-institutional coordination, integrating large volumes of heterogeneous data. As shown during the 2024 DANA, the smart and easy-to-use access to the datasets and information from different sources could be crucial in helping emergency institutions (Cabezuelo, 2024). Hence, ensuring that institutions and even citizens base their decisions on transparent and meaningful information is still a challenge. To enhance information-sharing and improve the decision-making process and transparency, new data hubs could be promoted in collaboration with universities and research centres at different institutional levels. Such data hubs could help in facilitating real-time access to environmental data. Moreover, the collection and monitoring of data thanks to citizen science actions and digital tools, such as the COSEA App and the Nodo Nacional de Información en Biodiversidad, could also raise greater SH involvement.

Focusing on *cultural and behavioural change* to promote active citizenship and awareness of environmental challenges is also very timely. Environmental issues have increasingly been discussed in mainstream media and schools for a long time now in the Valencian Community. Nevertheless, several challenges remain (e.g., communication risks and conflicting information).

Citizen participation mechanisms, such as participatory budgeting, have been strengthened in the Valencian Community during the last decade (Pineda Nebot & Abellán López, 2024); however, many of such procedures are not well known and still lack citizen involvement. Indeed, cultural change and civic participation require time and resources. A considerable investment may be needed to adequately educate and raise awareness among the population. Plus, many initiatives will not have an immediate impact, meaning that, in the short term, concrete results may not be seen. Furthermore, not all segments of the population may be willing or able to immediately adopt sustainable behaviours. The most vulnerable or least informed citizens may be excluded from these processes, reinforcing inequalities.

To address such issues, educational initiatives should not be limited to schools but also include targeted awareness campaigns through television ads, social media content, and public service programs for adults. Furthermore, strengthening public awareness could be supported by promoting citizen science to enable people to actively engage in environmental data collection while raising awareness. Moreover, citizen assemblies at the local level could raise citizen awareness of environmental issues, making sustainable behaviours the norm and strengthening civic participation. Involving citizens in processes through participatory mechanisms could help bridge the gap between “losers” and “winners,” aiming to ensure a more balanced distribution of benefits and responsibilities.

Substantial economic and social benefits might still need to be put in place to ease behavioural changes among the population most directly affected. For instance, assistance programs to support voluntary

relocation of activities or housing in flood-prone areas, also considering the 2024 DANA event. Additionally, regulatory measures, such as fees or penalizations, could be considered for individuals, industries, or cities polluting natural areas and contributing to the LSI degradation. Ultimately, the adoption of sustainable behaviours by citizens could have long-term effects, reducing the overall environmental impact, fostering a culture of environmental responsibility, and increasing the sense of belonging and collective commitment.

The Valencian Community might also consider the benefits of strengthening its commitment to transitioning towards a *more sustainable economic model*. Recent climate-related impacts have highlighted the underestimated costs of not taking a more active approach towards a sustainable economic model, including increased infrastructure damage, long-term economic and social burdens, and, in some cases, serious health consequences or threats to human life (Galvez-Hernandez et al., 2025; Talens, 2025; Tarazona Vento, 2017). Integrating environmental costs into the prices of products and services can be part of the solution. This approach would not only promote economic growth compatible with planetary limits but also create financial mechanisms to support behavioural change. In fact, integrating environmental costs into prices could incentivize more sustainable behaviours by businesses and consumers, favouring green innovation and waste reduction. The transition to a more sustainable economy might bring long-term benefits, creating new job opportunities in many sectors such as renewable energy and clean technologies. However, a wider societal dialogue, as promoted for the cultural transformation, might also be needed on how to ease the transition of citizens, industries, and cities that are lagging or might need more resources and technical expertise to implement such a transition.

Finally, to ensure that these strategies are effectively implemented and that the transition towards climate resilience is inclusive and equitable, it is crucial to consider the role of *knowledge and collective intelligence* in guiding data-driven decisions. While governance, behavioural change, and economic transitions provide the structural and societal foundations for adaptation, the capacity to collect, analyse, and share reliable and accessible knowledge is essential to understanding social and human complexities and supporting evidence-based policymaking. In this regard, the Valencian Community has substantially strengthened scientific knowledge and data on environmental issues in recent decades. The main problems, as discussed in Section 5, have mostly to do with how to integrate such knowledge into policymaking and governance, as well as to facilitate public participation to strengthen collective intelligence. All the aforementioned measures and tools may not be completely beneficial if not integrated into the political agendas. In this light, to support decision-making processes, regular simulations and training sessions with political entities could help evidence-based policies and accelerate response times when necessary. Moreover, open participation platforms would enable citizens to actively contribute to data collection and evidence-based policy formulation, promoting collective intelligence. Access to scientific data and sharing information should lead to increased transparency and improved decision-making. This scenario could also foster innovation, stimulating new ideas and approaches through collective intelligence.

6. Conclusions

This research provides insights into the application of strategic foresight as a method to guide LSI and climate adaptation planning. The use of horizon scanning and scenario planning tools enabled a structured exploration of potential adaptation pathways, fostering a long-term vision for environmental governance.

Among the results, the gap between available environmental tools and their actual implementation was revealed as a major obstacle to adaptive governance. Despite the existence of monitoring systems, legal frameworks, and participatory platforms, their potential impact is weakened by governance fragmentation and a lack of coordination. Strengthened data-sharing mechanisms, policy continuity, and cross-sectoral collaboration remain key to improving the effectiveness of adaptation strategies. Moreover, the "winners" and "losers" dynamic that emerged from the discussions revealed deep inequalities in adaptive capacity. If not carefully managed, these imbalances could exacerbate social tensions and hinder the adoption of inclusive and sustainable climate policies.

Different possible pathway focuses were identified, highlighting complementary strategies for shaping the region's future. These pathways emphasize key opportunities and risks, underscoring the need for integrated and multidimensional governance approaches that foster collaboration between institutions, economic actors, and civil society.

The extreme event that occurred in October 2024 further highlighted the urgent need for transformative resilience-building measures in the Valencian Community. The devastating floods and extreme weather impacts reaffirm the importance of science-based short and long-term planning, and the integration of climate risk assessments and disaster management into policy frameworks. This event also emphasised the importance of developing an integrated approach between different levels of governance, from local to international, that can consider both climate change mitigation and adaptation needs, and sustainable resource management.

SH's involvement emerged as a crucial aspect, enriching the analysis by integrating local perspectives with scientific expertise. This collaboration is essential to develop possible realistic adaptation strategies, as it highlights socio-political dynamics often overlooked in data-driven analyses alone.

However, challenges such as communication gaps, conflicting perspectives, and priorities between economic development, environmental conservation, and governmental actors emerged. While experts emphasised the need for long-term planning to address climate pressures, SHs prioritised short-term damage management and anthropogenic pressures. This revealed that while participatory processes enhance inclusiveness, they also introduce complexity into decision-making.

To address this limitation and acknowledging that the small size of the SHs group does not reflect the full diversity of perspectives, the workshop was conceived as a first step within a broader participatory process. This process aims to include a more representative sample, including marginalised communities, sectoral actors, and additional public officials, to validate these first results and contribute to more inclusive adaptive governance pathways.

Testing innovative models of participatory governance will be essential to enhance the role of strategic foresight analysis as a transformative tool in environmental planning.

The fact that difficulties emerged during the workshop in explicitly focusing the discussion on LSI highlights that, although this theme is central, it is still perceived as fragmented by the actors involved. The complexity of LSI governance, shaped by overlapping institutional dynamics and sectoral responsibilities, requires a move

away from standard administrative approaches to develop innovative governance modalities that can mobilize diverse actors and regulatory frameworks towards collective actions.

However, this complexity also implies longer timescales for effective action, as it requires the coordination of fragmented expertise and the co-creation of shared priorities among SHs with different interests and time horizons.

Future-proofing land–sea governance requires a combination of strategic vision, SH collaboration, and science-based decision-making. In regions such as the Valencian Community, which are particularly vulnerable to extreme events, this integrated approach is essential to ensure that both short-term responses and long-term adaptation measures are robust, socially legitimate, and ecologically sustainable.

Acknowledgments

The workshop leading to this study was funded by the University of Portsmouth REF2029 BaL Impact Funding Scheme 2024. The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them. The authors gratefully acknowledge all participants in the workshop for their valuable contributions, insights, and engagement, which significantly enriched the research process.

Conflict of Interests

In this article, editorial decisions were undertaken by Raoul Beunen (Open University of the Netherlands).

References

Ackermann, F., & Eden, C. (2011). Strategic management of stakeholders: Theory and practice. *Long Range Planning*, *44*, 179–196.

Agencia Estatal de Meteorología. (2024). *Avance climatológico de octubre de 2024 en la Comunitat Valenciana*. https://www.aemet.es/documentos/es/serviciosclimaticos/vigilancia_clima/resumenes_climat/ccaa/comunitat-valenciana/avance_climat_val_oct_2024.pdf

Álvarez-Romero, J. G., Pressey, R. L., Ban, N. C., Vance-Borland, K., Willer, C., Klein, C. J., & Gaines, S. D. (2011). Integrated land-sea conservation planning: The missing links. *Annual Review of Ecology, Evolution, and Systematics*, *42*, 381–409. https://doi.org/10.1146/annurev-ecolsys-102209-144702

Andreu, V., Gimeno, E., Pascual, J. A., & Campo, J. (2024). The Anthropocene fingerprint: Hazardous elements in waters of a coastal Mediterranean alluvial plain (Valencia, Spain). *Heliyon*, *10*(17), Article e36044. https://doi.org/10.1016/j.heliyon.2024.e36044

Bayo Pérez, B. (2024, November 29). DANA Valencia: Objetivos, consecuencias y narrativas desinformativas en redes. *RTVE*. https://www.rtve.es/noticias/20241129/dana-valencia-objetivos-consecuencias-narrativas-desinformativas-redes/16351634.shtml

Belaïd, F., & Unger, C. (2024). Crafting effective climate, energy, and environmental policy: Time for action. *Humanities and Social Sciences Communications*, *11*, Article 1357. https://doi.org/10.1057/s41599-024-03762-3

Bentz, J., O'Brien, K., & Scoville-Simonds, M. (2022). Beyond "blah blah blah": Exploring the "how" of transformation. *Sustainability Science*, *17*, 497–506. https://doi.org/10.1007/s11625-022-01123-0

Bono, F. (2024, October 30). La peor gota fría en décadas deja al menos 95 víctimas mortales, decenas de desaparecidos y pueblos anegados. *El País*. https://elpais.com/espana/comunidad-valenciana/2024-10-30/la-peor-gota-fria-del-siglo-devasta-valencia-con-victimas-mortales-desaparecidos-y-pueblos-anegados.html

Caballero, A. (2024, Novermber 17). *La DANA en Valencia 2024, una "clase magistral de destrucción climática."* RTVE Noticias. https://amp.rtve.es/noticias/20241117/dana-valencia-2024-clase-magistral-destruccion-climatica/16330622.shtml

Cabezuelo, P. (2024, October 31). Cuál es el protocol lo de emergencia en el caso de DANA como la vivida en la Comunitat. *Las Provincias*. https://www.lasprovincias.es/comunitat/el-tiempo/cecopi-protocolo-emergencia-dana-vivida-comunitat-20241031193230-nt.html

Calvo, S., Romo, S., Soria, J., & Picó, Y. (2021). Pesticide contamination in water and sediment of the aquatic systems of the Natural Park of the Albufera of Valencia (Spain) during the rice cultivation period. *Science of the Total Environment*, *774*, Article 145009. https://doi.org/10.1016/j.scitotenv.2021.145009

Camarasa-Belmonte, A. M., & Butrón, D. (2015). Estimation of flood risk thresholds in Mediterranean areas using rainfall indicators: Case study of Valencian Region (Spain). *Natural Hazards*, *78*, 1243–1266. https://doi.org/10.1007/s11069-015-1769-8

Capdepón Frías, M. (2016). Conflictos ambientales derivados de la urbanización turístico-residencial. Un caso aplicado al litoral alicantino. *Boletín De La Asociación De Geógrafos Españoles*, *71*, 31–57. https://doi.org/10.21138/bage.2273

Chilvers, J., & Kearnes, M. (2019). Remaking participation in science and democracy. *Science, Technology, & Human Values*, *45*(3), 347–380. https://doi.org/10.1177/0162243919850885

Copernicus. (2024). *Devastating flooding in valencia, Spain*. https://www.copernicus.eu/es/node/69626

Cutillas-Lozano, L. G., López, M. S. C., Velasco, A. P., Andrés-Doménech, I., & Olcina-Cantos, J. (2023). Local-scale regionalisation of climate change effects on rainfall pattern: Application to Alicante City (Spain). *Theoretical and Applied Climatology*, *154*(1/2), 377–402. https://doi.org/10.1007/s00704-023-04565-3

del Romero Renau, L., & Trudelle, C. (2011). Mega events and urban conflicts in Valencia, Spain: Contesting the new urban modernity. *Urban Studies Research*. Advance online publication. https://doi.org/10.1155/2011/587523

Duguma, L. A., Wambugu, S. W., Minang, P. A., & Van Noordwijk, M. (2014). A systematic analysis of enabling conditions for synergy between climate change mitigation and adaptation measures in developing countries. *Environmental Science & Policy*, *42*, 138–148.

European Commission. (2024). *Adaptation to climate change: Support at least 150 European regions and communities to become climate resilient by 2030*. https://research-and-innovation.ec.europa.eu/system/files/2021-09/climat_mission_implementation_plan_final_for_publication.pdf

Faus Onbargi, A. (2022). The climate change–inequality nexus: Towards environmental and socio-ecological inequalities with a focus on human capabilities. Journal of Integrative Environmental Sciences, 19(1), 163–170. https://doi.org/10.1080/1943815X.2022.2131828

Ferraro, G., & Failler, P. (2024). Biodiversity, multi-level governance, and policy implementation in Europe: A comparative analysis at the subnational level. Journal of Public Policy, 44(3), 546–572. https://doi.org/10.1017/S0143814X24000072

Galvez-Hernandez, P., Dai, Y., & Muntaner, C. (2025). The DANA disaster: Unraveling the political and economic determinants for Valencia's floods devastation. *International Journal for Equity in Health*, *24*(1), Article 64. https://doi.org/10.1186/s12939-025-02435-0

Generalitat Valenciana. (n.d.-a). *Hábitats prioritarios*. https://mediambient.gva.es/es/web/biodiversidad/habitats-prioritarios

Generalitat Valenciana. (n.d.-b). *Datos básicos de la Comunitat Valenciana*. https://pegv.gva.es/es/dbcv

Gill, J. C., & Malamud, B. D. (2016). Hazard interactions and interaction networks (cascades) within multi-hazard methodologies. *Earth System Dynamics*, *7*(3), 659–679. https://doi.org/10.5194/esd-7-659-2016

Glavovic, B. C., Limburg, K., Liu, K. K., Emeis, K. C., Thomas, H., Kremer, H., Avril, B., Zhang, J., Mulholland, M. R., Glaser, M., & Swaney, D. P. (2015). Living on the margin in the Anthropocene: Engagement arenas for sustainability research and action at the ocean-land interface. *Current Opinion in Environmental Sustainability*, *14*, 232–238. https://doi.org/10.1016/j.cosust.2015.06.003

Grassi, G., Zennaro, F., Ferraro, G., Beunen, R., Douguet, J.-M., & Furlan, E. (2025). Strategic foresight analysis for the management of land-sea interface in a climate change context: A comprehensive literature review. *Environmental Science & Policy*, *171*, Article 104111. https://doi.org/10.1016/j.envsci.2025.104111

Huber, J. M., Newig, J., & Loos, J. (2023). Participation in protected area governance: A systematic case survey of the evidence on ecological and social outcomes. *Journal of Environmental Management*, *336*, Article 117593. https://doi.org/10.1016/j.jenvman.2023.117593

Innocenti, A., & Musco, F. (2023). Land–sea interactions: A spatial planning perspective. *Sustainability*, *15*(12), Article 9446. https://doi.org/10.3390/su15129446

Islam, S. N., & Winkel, J. (2017). Climate change and social inequality. *Department of Economic & Social Affairs*, *DESA Working Paper No. 152 ST/ESA/2017/DWP/152*, 1–247. https://www.un.org/esa/desa/papers/2017/wp152_2017.pdf

Jato-Espino, D., & Mayor-Vitoria, F. (2023). A statistical and machine learning methodology to model rural depopulation risk and explore its attenuation through agricultural land use management. *Applied Geography*, *152*, Article 102870. https://doi.org/10.1016/j.apgeog.2023.102870

La Moncloa. (2024). Seguimiento de las actuaciones del Gobierno tras la DANA. Gobierno de España. https://www.lamoncloa.gob.es/info-dana/Paginas/2024/031224-datos-seguimiento-actuaciones-gobierno.aspx

Lehoczky, A., Sobrino, J., Skoković, D., & Aguilar, E. (2017). The urban heat island effect in the city of Valencia: A case study for hot summer days. *Urban Science*, *1*(1), Article 9. https://doi.org/10.3390/urbansci1010009

Lin-Ye, J., García-León, M., Gràcia, V., Ortego, M. I., Lionello, P., Conte, D., Pérez-Gómez, B., & Sánchez-Arcilla, A. (2020). Modeling of future extreme storm surges at the NW mediterranean coast (Spain). *Water*, *12*(2), Article 472. https://doi.org/10.3390/w12020472

Martí, P., & García-Mayor, C. (2020). The huerta agricultural landscape in the Spanish mediterranean arc: One landscape, two perspectives, three specific *huertas*. *Land*, *9*(11), Article 460. https://doi.org/10.3390/land9110460

Nagy, G. J., & Gutiérrez, O. (2018). Scenario planning toward climate adaptation: The Uruguayan coast. In W. Leal Filho & L. Esteves de Freitas (Eds.), *Climate change adaptation in Latin America: Managing vulnerability, fostering resilience* (pp. 457–476). Springer. https://doi.org/10.1007/978-3-319-56946-8_28

Newig, J., Challies, E. D., Jager, N. W., Kochskaemper, E., & Adzersen, A. (2018). The environmental performance of participatory and collaborative governance: A framework of causal mechanisms. *Policy Studies Journal*, *46*(2), 269–297. https://doi.org/10.1111/psj.12209

O'Brien, K. L., & Leichenko, R. M. (2003). Winners and losers in the context of global change. *Annals of the Association of American Geographers*, *93*(1), 89–103. https://doi.org/10.1111/1467-8306.93107

Olcina Cantos, J., & Miró Pérez, J. J. (2017). *Actividad turística y cambio climático en la Comunidad Valenciana*. Universidad de Alicante. https://doi.org/10.14198/2017-actividad-turistica-comvalenciana

Paavola, J., & Adger, W. N. (2006). Fair adaptation to climate change. *Ecological Economics*, *56*(4), 594–609. https://doi.org/10.1016/j.ecolecon.2005.03.015

Pineda Nebot, C., & Abellán López, M. Á. (2024). Análisis de las experiencias de presupuesto participativo de la Comunitat Valenciana a través de una taxonomía. *Arxius de Ciències Socials*, *43*. https://doi.org/10.7203/acs.43.29084

Ramieri, E., Bocci, M., & Marković, M. (2018). *Land sea interactions in the framework of ICZM and MSP*. Priority Actions Programme/Regional Activity Centre. https://paprac.org/storage/app/media/Meetings/Land%20Sea%20Interactions.pdf

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C. H., & Stringer, L. C. (2009). Who's in and why? A typology of stakeholder analysis methods for natural resource management. *Journal of Environmental Management*, *90*(5), 1933–1949. https://doi.org/10.1016/j.jenvman.2009.01.001

Roggema, R., Tillie, N., & Hollanders, M. (2021). Designing the adaptive landscape: Leapfrogging stacked vulnerabilities. Land, *10*(2), Article 158. https://doi.org/10.3390/land10020158

Roy, H. E., Peyton, J., Aldridge, D. C., Bantock, T., Blackburn, T. M., Britton, R., Clark, P., Cook, E., Dehnen-Schmutz, K., Dines, T., Dobson, M., Edwards, F., Harrower, C., Harvey, M. C., Minchin, D., Noble, D. G., Parrott, D., Pocock, M. J. O., Preston, C. D. . . . Walker, K. J. (2014). Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. *Global Change Biology*, *20*(12), 3859–3871. https://doi.org/10.1111/gcb.12603

Royé, D., Codesido, R., Tobías, A., & Taracido, M. (2020). Heat wave intensity and daily mortality in four of the largest cities of Spain. *Environmental Research*, *182*, Article 109027. https://doi.org/10.1016/j.envres.2019.109027

Schippers, P., van der Heide, C. M., Koelewijn, H. P., Schouten, M. A. H., Smulders, R., Cobben, M. M. P., & Verboom, J. (2015). Landscape diversity enhances the resilience of populations, ecosystems and local economy in rural areas. *Landscape Ecology*, *30*, 193–202. https://doi.org/10.1007/s10980-014-0136-6

Singh, G. G., Cottrell, R. S., Eddy, T. D., & Cisneros-Montemayor, A. M. (2021). Governing the land-sea interface to achieve sustainable coastal development. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.709947

Sociedad Española de Radiodifusión. (2024). *Inundaciones DANA octubre 2024*. https://cadenaser.com/tag/inundaciones_dana_octubre_2024/a

Srivastav, S., & Rafaty, R. (2022). Political strategies to overcome climate policy obstructionism. *Perspectives on Politics*, *21*(2), 640–650. https://doi.org/10.1017/S1537592722002080

Stocker, F., de Arruda, M. P., de Mascena, K. M., & Boaventura, J. M. (2020). Stakeholder engagement in sustainability reporting: A classification model. *Corporate Social Responsibility and Environmental Management*, *24*, 64–68.

Talens, A. (2025, March 21). Impacto de la DANA en la Comunitat Valenciana: 306.000 personas afectadas, 11.242 viviendas, 141.000 coches y 800km de carreteras. *Cadena SER*. https://cadenaser.com/comunitat-valenciana/2025/03/21/impacto-de-la-dana-en-la-comunitat-valenciana-306000-personas-afectadas-11242-viviendas-141000-coches-y-800km-de-carreteras-radio-valencia

Tarazona Vento, A. (2017). Mega-project meltdown: Post-politics, neoliberal urban regeneration and Valencia's fiscal crisis. *Urban Studies*, *54*(1),68–84. https://doi.org/10.1177/0042098015625025

Toledo, I., Pagán, J. I., López, I., Olcina, J., & Aragonés, L. (2024). Storm surge in Spain: Factors and effects on the coast. *Marine Geology*, *476*, Article 107373. https://doi.org/10.1016/j.margeo.2024.107373

Turnhout, E., Stuiver, M., Klostermann, J., Harms, B., & Leeuwis, C. (2013). New roles of science in society: Different repertoires of knowledge brokering. *Science and Public Policy*, *40*(3), 354–365. https://doi.org/10.1093/scipol/scs114

Ulibarri, N., Ajibade, I., Galappaththi, E. K., Joe, E. T., Lesnikowski, A., Mach, K. J., Musah-Surugu, J. I., Nagle Alverio, G., Segnon, A. C., Siders, A. R., Sotnik, G., Campbell, D., Chalastani, V. I., Jagannathan, K., Khavhagali, V., Reckien, D., Shang, Y., Singh, C., & Zommers, Z. (2022). A global assessment of policy tools to support climate adaptation. *Climate Policy*, *22*(1), 77–96. https://doi.org/10.1080/14693062.2021.2002251

United Nations Development Programme. (2018). *Foresight manual—Empowered futures for the 2030 agenda*.

United Nations Development Programme. (2022). *UNDP RBAP: Foresight playbook*.

United Nations Environment Programme. (2023). *Adaptation gap report 2023: Underfinanced. Underprepared. Inadequate investment and planning on climate adaptation leaves world exposed*. https://doi.org/10.59117/20.500.11822/43796

Wang, Z., Wang, T., Zhang, X., Wang, J., Yang, Y., Sun, Y., Guo, X., Wu, Q., Nepovimova, E., Watson, A. E., & Kuca, K. (2024). Biodiversity conservation in the context of climate change: Facing challenges and management strategies. *Science of the Total Environment*, *937*, Article 173377. https://doi.org/10.1016/j.scitotenv.2024.173377

Wei, L., & Sobrino, J. A. (2024). Surface urban heat island analysis based on local climate zones using ECOSTRESS and Landsat data: A case study of Valencia city (Spain). *International Journal of Applied Earth Observation and Geoinformation*, *130*, Article 103875. https://doi.org/10.1016/j.jag.2024.103875

World Meteorological Organization. (2024). *Devastating rainfall hits Spain in yet another flood-related disaster*. https://wmo.int/media/news/devastating-rainfall-hits-spain-yet-another-flood-related-disaster

About the Authors

Gea Grassi is a junior researcher at the Euro-Mediterranean Center on Climate Change (CMCC), where she works on the BlueGreen Governance and TRANSEATION European projects. Her research focuses on strategic foresight analysis, generative AI, and climate change adaptation in marine-coastal ecosystems, with a focus on the land–sea interface.

Federica Zennaro is a postdoctoral researcher at the Euro-Mediterranean Center on Climate Change (CMCC), where she works on European projects focusing on blue-green governance and nature-based solutions. Her work advances innovative land–sea governance frameworks based on scientific evidence and societal input and monitors the effectiveness of marine and coastal nature-based solutions.

Irene Luján Climent is a PhD candidate in political science at the University of Valencia, where she is conducting her research within the Horizon-funded project BlueGreen Governance (BGG). Her work focuses on the governance of coastal wetlands, with the aim of advancing environmental sustainability and enhancing the effectiveness of public management.

Oscar Barberà is an associate professor of political science and public administration at the University of Valencia. Visiting professor at several European (Florence, Lausanne, and Lille) and UK universities (Edinburgh, Exeter, and Aston). Expert in Spanish politics, digital politics, territorial politics, and democratic innovations in political organisations.

Bernabé Aldeguer-Cerdá is an associate professor in political science and public administration at the University of Valencia. His academic research focuses on the study of parliamentary elites, particularly from a gender perspective, as well as on public ethics, good governance, institutional integrity, and the governance of coastal natural resources. He is the principal investigator of the European HORIZON project BlueGreen Governance.

Gianluca Ferraro is an associate professor in environmental governance at the University of Portsmouth (Centre for Blue Governance) and visiting professor at the University of Valencia. His research examines policy implementation, public participation, institutional change, and subnational governance. He is the scientific coordinator of the Horizon Europe project BlueGreen Governance.

Jean-Marc Douguet is a senior lecturer in economics at the University of Paris-Saclay. His research is based on ecological economics. It focuses primarily on building partnerships for sustainable development to reintegrate economic activities into the cycles of the biosphere.

Elisa Furlan is a senior scientist at Euro-Mediterranean Center on Climate Change (CMCC) and scientific coordinator of the EU Mission projects DesirMED and GRACE. Her research focuses on transformative climate adaptation, nature-based solutions, and territorial resilience, with expertise in risk modelling and co-design. She also teaches at Ca' Foscari University of Venice.

Ocean and Society
2025 • Volume 2 • Article 10330
https://doi.org/10.17645/oas.10330

cogitatio

ARTICLE

Open Access Journal

Understanding Flood Governance in the Dutch-Flemish Scheldt Estuary: An Evolutionary Governance Perspective

Corinne Vitale [1], Ann Crabbé [2], Sander Meijerink [1], Cory Fletcher [2], Mafaziya Nijamdeen [3], and Mark Wiering [1]

[1] Nijmegen School of Management, Radboud University, The Netherlands
[2] Centre for Research on Environmental and Social Change, University of Antwerp, Belgium
[3] Department of Environmental Sciences, Open University, The Netherlands

Correspondence: Corinne Vitale (corinne.vitale@ru.nl)

Submitted: 14 March 2025 **Accepted:** 8 July 2025 **Published:** 5 August 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

This article presents a comparative account of the evolution of flood governance in the Dutch (Western Scheldt) and Flemish (Sea Scheldt) regions of the Scheldt estuary through the lens of evolutionary governance theory. Evolutionary governance theory is based on three assumptions: governance is continuously evolving, change is contingent, and discourses are drivers of change. Employing a comparative research design and secondary data analysis, this study examines how institutional, material, and discursive factors, goals, path dependencies, and interdependencies have shaped flood risk governance and influenced the integration of nature conservation goals alongside traditional flood safety objectives. While dike reinforcement prioritizes flood safety, integrated strategies—such as transitional polders and dike setbacks—aim to balance flood protection with ecological restoration. This is particularly pertinent in the Scheldt estuary, where ecological degradation has raised concerns regarding the long-term loss of biodiversity and ecosystem services. A significant challenge in transforming the governance of the estuary is anticipating long-term risks while pursuing ecological and flood safety objectives. Through a longitudinal cross-case comparison, this study identifies barriers to the adoption of nature-based solutions in flood risk management. The findings emphasize the need for a more integrated approach that aligns flood safety and nature conservation development policies for resilient and long-term climate solutions.

Keywords

evolutionary governance theory; flood risk governance; nature conservation; Scheldt estuary; Sea Scheldt; Western Scheldt

1. Introduction

Flood risk governance has emerged as a critical field of inquiry within environmental governance, especially in low-lying coastal regions bustling with activities yet vulnerable to hydrological extremes (Aukes et al., 2020; van Slobbe et al., 2013). In riverine and estuarine systems, the interplay between flood management, spatial planning, and the environment has far-reaching implications. For a long time, floods have represented a driving force in the process of developing delta landscapes (Francesch-Huidobro et al., 2017). Audacious structural actions have allowed communities to keep water away from cities (Sayers et al., 2021). As a result, the Netherlands and parts of Flanders have been made inhabitable thanks to the complex system of waterworks, such as dredging works, dikes, land reclamation, and dams (Disco, 2002; Francesch-Huidobro et al., 2017). While having enormously contributed to the actual welfare of these countries, infrastructural water works—expression of the *hydraulic mission*—have been questioned due to their economic, social, and environmental impacts (Molle et al., 2009).

Principles of sustainable development started to emerge following a prolonged discursive struggle instigated in the late 1950s and extended into the 1970s (Allan, 2003). Ecological consciousness about the damage being done to nature prompted the so-called *ecological turn* in water management, first globally and then locally (Allan, 2006; Disco, 2002). Rising concern about ecological risks led to strong public opposition to large infrastructure projects. This brought environmental issues into the political spotlight and helped drive major changes in environmental laws in many democratic countries. Nature was reconsidered as intrinsically valuable, and it was emphasized that "civilization had been incurring heavy ecological debts" (Disco, 2002, p. 208). Such ecological uptake became evident and was also observed in the Scheldt estuary. For example, while the closing of the Oosterschelde was initially praised as a major work of civil engineering, it was soon described as an environmental catastrophe (Disco, 2002). Although hard control infrastructure had not yet "exhausted the technological means available" to cope with climate challenges, hard engineering approaches began to be substantially questioned (van Slobbe et al., 2013, p. 949). The ecological turn in water management was, however, mostly political rather than technical.

As flood control technologies became more reliable, flood-prone areas began to experience increased urbanization driven by demographic and economic factors. This highlighted an important consequence: the increasing exposure and vulnerability to flooding in the event of defense failures. It was then that innovative concepts such as building with nature began to emerge as an alternative option to the hard engineering approach, in response to both environmental and community concerns (van Slobbe et al., 2013). Nature-based solutions began to be praised for their ability to achieve water security goals while adapting to climatic and environmental changes, ecological values, and socio-economic functions (van Slobbe et al., 2013). However, while the implementation of nature-based solutions for flood safety has been increasingly advocated, the integration of ecological expertise into hydraulic engineering bureaucracies remains contested, and the extent of actual change is still debated (Disco, 2002). These approaches continue to face persistent barriers rooted in the dominant engineering paradigm of hydraulic bureaucracies or *hydrocracies*, which have historically relied on command-and-control methods (Molle et al., 2009). In coastal regions, especially, decision-making is further complicated by a diverse group of stakeholders, conflicting interests, and pre-existing institutional frameworks (Aukes et al., 2020). Understanding how these institutional and technical path dependencies shape the uptake of nature-based solutions is essential for exploring new modalities of knowledge co-production and the potential reconfiguration of flood governance. This manuscript takes up that task.

By adopting an evolutionary governance theory (EGT) perspective, this article offers a comprehensive and nuanced understanding of the factors shaping flood risk governance, with particular attention to the challenges of integrating ecological objectives alongside flood safety goals. EGT is particularly well-suited for this study because it captures the complex, dynamic, and historically embedded nature of governance in the Scheldt estuary by focusing on three fundamental premises: governance systems are continuously evolving, influenced by both internal dynamics and external pressures; change is contingent, meaning that it depends on a complex set of contextual factors, historical trajectories, and stakeholder interactions; and discourses, or how issues are framed and communicated, play a pivotal role in driving governance change (Beunen et al., 2022; Van Assche et al., 2014). This enables a deeper understanding of how governance evolves in response to environmental changes, stakeholder interactions, and shifting priorities, making it ideal for analyzing the integration of nature-based solutions alongside engineering approaches. This article contributes to flood risk governance literature by highlighting the long-term, path-dependent processes through which ecological and flood safety goals are negotiated in complex estuarine settings. In doing so, this research emphasizes the often-overlooked role of physical conditions in shaping governance choices—an aspect that institutional analyses, typically focused on actors, rules, and resources, tend to underplay in flood governance research. Moreover, the article advances evolutionary governance scholarship by applying the EGT framework to the field of flood governance, which remains relatively underexplored from this theoretical perspective.

Shared by the Netherlands and Flanders, the Scheldt estuary offers a unique and dynamic case for examining these interdependencies. Originating in France, the Scheldt (355 km) flows through Belgium and the Netherlands before reaching the North Sea; in Flanders, the tidal section is known as the Sea Scheldt, extending to the Dutch border, where it becomes the Western Scheldt (Vlaams-Nederlandse Scheldecommissie, 2019, 2025). The Sea Scheldt and Western Scheldt together form the tidal Scheldt estuary. As one of Western Europe's youngest and most natural estuaries (Zheng et al., 2021), it holds significant ecological value. It plays a crucial role in nature conservation, water quality, and ecology, while also supporting diverse interests such as fisheries, sand mining, tourism, and cultural heritage. Both the Netherlands and Flanders have developed distinct governance strategies over time, shaped by their specific socio-political contexts, historical developments, and environmental challenges. Flood risk management in the Netherlands (Western Scheldt) has traditionally relied on engineering-based solutions like dike enhancements, while Flemish strategies (Sea Scheldt) have increasingly incorporated nature-based approaches. Conventional measures prioritize flood protection, but integrated strategies, such as transitional polders and dike setbacks, seek to balance protection with ecological restoration. For example, in contrast to poldering, which involves controlling water to reclaim and retain dry land, transitional polders are reclaimed areas intentionally re-exposed to tidal influence (temporarily and partially) to restore natural processes such as sedimentation and land elevation. By focusing on the Scheldt estuary, where ecological degradation threatens biodiversity and ecosystem services, this study examines historical barriers and evolving challenges to advancing sustainable, integrated flood risk management. The longitudinal analysis begins with the catastrophic 1953 North Sea flood, which served as a critical juncture prompting major shifts in flood governance, infrastructure, and institutional approaches in both the Netherlands and Flanders.

The manuscript is organized as follows. Section 2 outlines the theoretical frameworks that underpin this research. Section 3 explains the case selection and research methodology. Section 4 presents the findings from the longitudinal analysis of flood governance in Flanders and the Netherlands. Section 5 offers a comparative discussion of the results and Section 6 concludes the study.

2. EGT

2.1. Introducing EGT

Throughout history, the progress of human societies has been shaped by institutional change. Institutional change can be defined as the ongoing process through which governance institutions comprising formal rules, informal norms, and actor interactions evolve in response to shifting societal priorities, environmental conditions, and historical legacies (Beunen & Van Assche, 2021; Van Assche et al., 2024). As a result, social and economic development processes have always been closely linked to institutional change, whether driven by a conscious willingness to deviate from established paths or triggered by external circumstances such as crises or shocks (Micelotta et al., 2017; Samadi & Alipourian, 2021). Institutional change in ocean and coastal governance consists of the continual evolution in how the resources in these realms are managed and protected. Among the others, institutional change can be driven by the dynamic interplay between shifting societal priorities and emerging resource scarcities (Schlüter et al., 2013). For example, when marine resources were abundant, there was little need for regulatory institutions because regulation was unnecessary. However, as these resources became scarcer and demand increased, institutions began to emerge to manage and protect them.

An alternative view on how institutional change can be explained is through the EGT. This perspective suggests that changes in the environment and the way institutions—understood here as established systems of rules, norms, and practices—respond to these changes gradually drive institutional evolution and, potentially, lead to institutional change. While some institutions adapt to changing conditions over time, others may persist despite inefficiencies due to historical path dependencies, the influence of entrenched interests such as dominant coalitions, or actors who benefit from the status quo, or the inherent complexity of the governance process. Institutional change is not necessarily a matter of survival of the fittest, but rather an ongoing process of adaptation and reconfiguration shaped by different selection pressures and governance contexts. Institutions can be diverse because they are influenced by selection pressures and the environmental conditions they encounter. Furthermore, institutions carry a form of heredity associated with the evolution of habits (Hodgson, 2004). However, unlike genetic inheritance, which tends to produce exact copies apart from occasional mutations, habits are not replicated with the same precision across long-standing institutions (Sperber, 1996).

Moreover, EGT views governance as a constantly evolving process, driven by co-evolution between actors and institutions (Van Assche et al., 2013). Changes in governance occur even without intentional steering, as actors and institutions continuously interact and influence each other. While this dynamic interaction may appear similar to what discursive or constructivist institutionalist perspectives describe as path-shaping change, EGT distinguishes itself by emphasizing evolution as a non-linear, recursive, and multi-dimensional process. In EGT, evolution refers not only to shifts in actor strategies or institutional structures but also to how discourses, power dynamics, and rule systems co-evolve in unpredictable and contingent ways. This evolutionary process unfolds without a central guiding logic, driven instead by constant feedback loops and historical embeddedness. Actors adapt through their engagement with institutions, which function as coordination mechanisms ranging from simple rules to complex political laws, while also interacting with informal institutions such as social norms, traditions, and unwritten practices. Actors are not static but evolve through these interactions and discursive means, using knowledge and narratives to strategize and

understand themselves, even as discourse shapes and constrains their strategies (Schlüter et al., 2020; Van Assche et al., 2013, 2024).

In the literature on environmental governance, there is frequent advocacy for significant institutional change, such as reform, innovation, and transformation, to effectively address several pressing environmental governance issues (Beunen & Patterson, 2019). Institutional change is driven by purposive actions but also by ongoing patterns of interpretation and behavior, all of which are shaped by the various dependencies that define the governance context. Therefore, reforms in the context of institutional change in any country, especially those with an impact on the economy or the environment, must consider the country's unique local and cultural contexts. Because institutional change is often an incremental process, countries with rich cultural traditions and deep historical roots need to quickly identify and address the key drivers of change (economic change, social stress, or environmental crisis) that may accelerate or inhibit the change process (Faghih & Samadi, 2021). Viewing environmental governance through an evolutionary lens implies adopting a holistic approach, thereby emphasizing the critical role of the temporal dimension and the impact of past policies (Beunen & Van Assche, 2021; Beunen et al., 2022).

EGT offers a distinctive perspective when compared to other institutional and discursive governance theories. While EGT fits within the broader landscape of governance theories, its dynamic and multidimensional approach contrasts with more static or linear theories. For example, traditional institutionalism, including rational choice and historical institutionalism, focuses on institutional stability and incremental change (Thelen, 1999). In contrast, EGT conceptualizes governance as inherently evolutionary, emphasizing the co-evolution of institutions, actors, and power relations over time (Van Assche et al., 2013). EGT highlights path dependency and co-evolutionary processes, providing a more dynamic perspective than traditional institutionalism (Fürstenberg, 2016). Another interesting element is that discourse analysis and EGT complement each other in understanding governance dynamics. Both approaches acknowledge the influence of power/knowledge relationships and discourses (Hardy & Thomas, 2015; Rydin, 2021). EGT links discourses to material changes in governance, emphasizing the co-evolution of knowledge, power, and institutions (Van Assche et al., 2014). While discourse analysis focuses on language, narratives, and power in shaping governance outcomes (Rydin, 2021), EGT extends this by linking discourses to broader governance frameworks and actor configurations. In comparison, sociological institutionalism and discursive institutionalism differ in their focus on the social and cultural context of institutions. Sociological institutionalism emphasizes the role of norms, values, and cultural frameworks in shaping institutional behavior and governance dynamics. It focuses on how institutions are shaped by broader societal structures and ideologies (Saurugger, 2017). On the other hand, discursive institutionalism emphasizes the role of ideas, discourse, and narratives in shaping institutional change (Zurnić, 2014). Like EGT, it emphasizes language and ideas as the primary drivers of change, rather than the co-evolution of institutions, actors, and power dynamics.

EGT is particularly useful for examining how co-evolutionary processes shape governance and options for change (Partelow et al., 2020). In sum, the key contribution of EGT is its multidimensional and temporal depth, recognizing the continuously evolving configuration, shaped by interdependent institutions, discourses, actors, and power relations. While some strands of institutionalist theory, such as discursive or constructivist approaches, emphasize institutional change and path-shaping dynamics, EGT offers a more explicit focus on co-evolution and recursive feedback across multiple dimensions. Its emphasis on historical

contingency and non-linear change complements institutional, discursive, and network theories, while offering a more integrated framework for understanding complex, long-term governance transformations. EGT also offers a promising framework for understanding institutional change over time, making it suitable for longitudinal case studies. It views governance as an evolutionary process shaped by cognitive capacities, ideas, and decision-making (Lewis & Steinmo, 2012). EGT emphasizes the co-evolution of governance systems, highlighting how steering options emerge from unique governance paths and contextual factors (Beunen & Van Assche, 2021). This approach is particularly important for analyzing experimental governance arrangements, where decision-making roles between governments and citizens shift and are institutionalized differently across cases (Ubels et al., 2019).

2.2. EGT Dimensions

Through the lens of EGT, the evolution of governance is characterized by the continuous interplay of multiple dimensions, each of which exerts a shaping and constraining influence on decision-making processes over time (see Figure 1). These dimensions encompass institutional structures, material realities, discursive influences, governance goals, historical path dependencies, and interdependencies, all of which co-evolve to form the governance landscape.

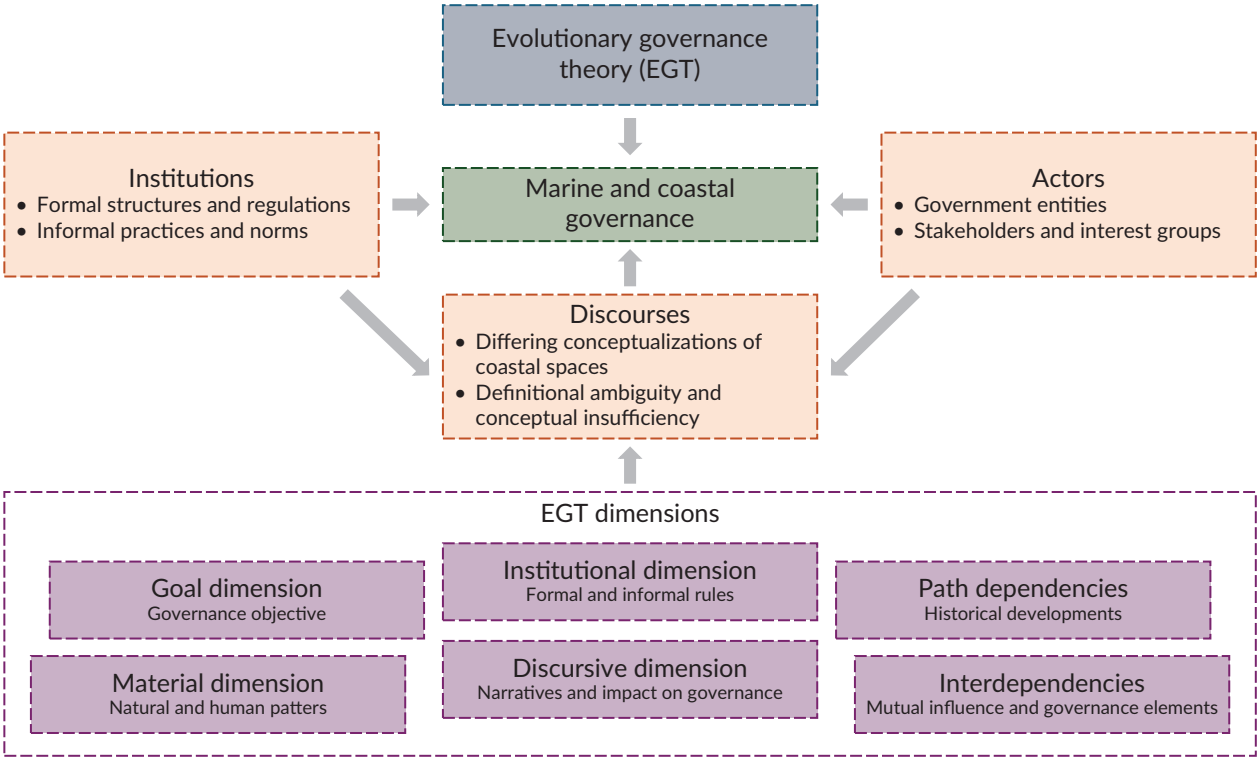


Figure 1. Key dimensions and dynamics shaping marine and coastal governance through an EGT lens.

The institutional dimension captures the interaction between formal and informal rules, network-based steering, and knowledge systems (Van Assche et al., 2014). Governance arrangements emerge from the dynamic relationship between political and regulatory structures, shaping how institutions evolve and influence decision-making processes. Over time, formal legal frameworks, including laws, regulations, and

formally adopted policies and guidelines, interact with informal norms and practices, leading to gradual transformations in governance structures.

The material dimension refers to the role of natural and man-made elements in shaping governance. In marine and coastal governance, environmental conditions, resource availability, and man-made infrastructure, such as ports or artificial reefs, influence governance dynamics. As governance must adapt to ecological constraints, technological advances, and socio-economic needs, the presence or absence of these material factors affects decision-making processes. Changes in these patterns can significantly alter governance strategies and institutional responses, such as ecosystem degradation or technological innovation.

Language, narratives, and framing play a central role in governance through the discursive dimension. EGT highlights how discourse acts both as a tool for influencing policy and as a constraint on governance options (Partelow et al., 2020). Governance strategies often take the form of "productive fictions," meaning they are based on narratives that must be continuously adapted as they rarely unfold exactly as expected (Van Assche et al., 2020). The dominance of particular narratives can shape policy directions, define governance priorities, and reinforce power structures within governance systems.

The goal dimension emphasizes how existing goals and aspirations shape governance decisions. Along with path dependence and interdependence, goal dependency is one of the three core dependencies in EGT; this influences how governance systems evolve in response to their external environment (Van Assche et al., 2013). Goals within a governance system are not static but evolve through historical trajectories, interactions among actors, and the broader socio-political context (Beunen et al., 2015). The long-term visions embedded in governance structures guide decision-making processes but also constrain the range of available policy options.

Path dependency highlights the enduring impact of historical decisions and institutional legacies on the evolution of governance. Past policy choices, institutional structures, and vested interests shape current governance configurations, often creating inertia that makes rapid transitions difficult (Van Assche et al., 2024). Self-reinforcing mechanisms consolidate existing institutional frameworks, making it challenging to break away from established governance patterns (Vergne & Durand, 2010). The interplay between path dependence, interdependence, and goal dependence determines how governance systems adapt or resist change over time. Recognizing these historical constraints is essential for designing effective governance innovations that acknowledge institutional realities rather than assuming the possibility of rapid structural overhauls (Schmidt & Spindler, 2002).

Finally, interdependency is a fundamental concept in the study of governance that underscores the mutual influence and reliance among governance elements, including actors, institutions, and knowledge systems (Schlüter et al., 2020; Van Assche et al., 2024). Governance does not operate in isolation. Rather, it is shaped by intricate connections and feedback loops, where changes in one component often trigger responses in others. To illustrate this dynamic interdependence, consider the potential consequences of a newly implemented regulation that restricts fisheries in a coastal region. Such a regulation could lead to economic shifts among fishing communities, prompting changes in livelihood strategies, shifts in market dynamics, or even increased pressure on alternative marine resources. In turn, these socio-economic changes may influence future policy decisions, illustrating the dynamic and co-evolutionary nature of governance interdependencies.

This interconnected nature of governance is particularly evident in complex systems such as coastal governance, where terrestrial and marine environments interact, creating dynamic interdependencies within social-ecological systems, which have ecological components and governance rules, regulations, and resource users in the social component (Dahdouh-Guebas et al., 2021; Eger et al., 2021). The relationships between governance actors, regulatory frameworks, and material realities such as resource availability and environmental conditions add further layers of complexity. These intricate interdependencies exert a profound influence on decision-making processes, the effectiveness of policy, and the adaptability of governance. Consequently, the design of integrated frameworks that can effectively respond to the evolving challenges posed by these intricate interdependencies is imperative.

By integrating these dimensions, EGT establishes a comprehensive framework for understanding governance as a continuously evolving process shaped by institutional structures, material conditions, discursive influences, long-term goals, and historical constraints. This perspective underscores the complexity of governance evolution and highlights the need for adaptive strategies that account for co-evolutionary dynamics.

3. Methodology

This study employs a comparative research design grounded in qualitative methods. Desk research draws on a variety of sources, including governmental reports, policy documents from Dutch and Flemish authorities, legislation, and scientific studies. These materials pertain to key flood management initiatives such as dike reinforcement (Room for the River program) and nature-based solutions. Central to the analysis are major policy frameworks, including the Dutch Delta Plan and the Flemish Sigma Plan, supplemented by recent policy updates like the Dutch High Water Protection Programme (Hoogwaterbeschermingsprogramma, 2021) and the Flemish Integrated Water Policy Plan (Coördinatiecommissie Integraal Waterbeleid, n.d.-a). Data analysis followed a primarily deductive approach, structured according to the dimensions of the theoretical framework.

The Scheldt basin covers a total catchment area of approximately 21,863 km² and is home to over 10 million people (on average 477 inhabitants per km²; Mees et al., 2016). The Scheldt river originates in Saint-Quentin, France, and flows for 355 km, primarily through Flanders (Belgium), before reaching the North Sea near Vlissingen (the Netherlands). The river can be divided into distinct sections (see Figure 2): from its source to Ghent, it remains a non-tidal freshwater river known as the Upper Scheldt; beyond Ghent, it transitions into a predominantly tidal river extending to Temse, where it becomes the Sea Scheldt (Zeeschelde). This section consists of a brackish upper stretch from Temse to Antwerp and a lower saltwater stretch from Antwerp to the Belgian–Dutch border. Beyond this point, the river continues as the Western Scheldt, flowing through Dutch territory and branching into multiple channels before reaching the North Sea (Baeyens et al., 1997; Meire et al., 2005).

The Dutch Western Scheldt and the Flemish Sea Scheldt are both highly vulnerable to flooding due to their low-lying geography and proximity to the North Sea. The Western Scheldt serves as a major shipping route to the port of Antwerp and is part of the Dutch Delta, renowned for its advanced flood defense systems. Over the past two decades, flood risk management in the region has shifted from traditional infrastructure-based solutions, such as dike reinforcement, to more integrated approaches, such as depoldering and nature-based solutions. Depoldering involves restoring previously reclaimed land to the

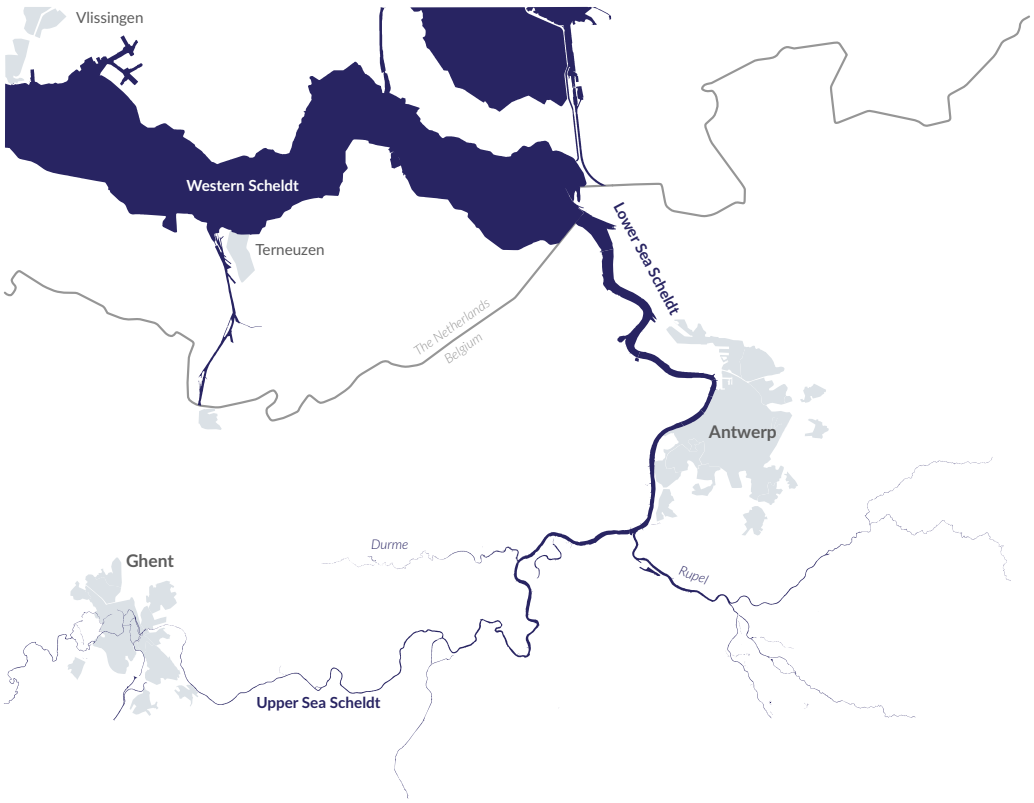


Figure 2. Sea Scheldt and the Western Scheldt.

estuary by breaching dikes and allowing tidal waters to re-enter low-lying areas; this provides additional capacity for tidal waters, thereby mitigating flood hazards. This shift was driven, in part, by the recognition of the deteriorating biodiversity conditions within the estuary, prompting a reorientation towards nature conservation and ecosystem restoration. The Sea Scheldt plays a pivotal role in both flood management and ecological restoration. While facing flood risk challenges analogous to those experienced in the Netherlands, Flanders' governance is influenced by distinct institutional, discursive, and material dependencies. Historically, flood risk management in the Sea Scheldt has centered on dike construction and reinforcement. However, in recent decades, Flanders has been recognized for its efforts in floodplain restoration and adaptive management, reflecting a gradual shift towards more integrated water management approaches.

Two main reasons for the cross-case comparative approach are identified in this study. First, the cross-border nature of the Scheldt estuary provides a valuable opportunity to explore how institutional responses to flood risks have developed in parallel yet distinct ways in the Netherlands and Flanders. Although both regions share a long history of flood risk management, their governance trajectories have diverged over time, shaped by different socio-political and institutional contexts. Second, understanding these differences is a crucial step toward the future harmonization of cross-border policies—an essential goal for achieving environmental objectives, reducing flood risks, and protecting biodiversity, especially considering evolving European regulatory frameworks. By analyzing the Dutch (Western Scheldt) and Flemish (Sea Scheldt) contexts through the lens of evolutionary governance, this study not only identifies key similarities and differences but also stresses the need for coordinated strategies that integrate flood protection with ecological restoration when promoting long-term resilience and sustainability in shared river systems.

4. Results

This section explores the evolution of flood risk governance in the Western Scheldt (Section 4.1) and Sea Scheldt (Section 4.2), followed by an examination of their interactions (Section 4.3). The study offers insights into how past dependencies influence present and future governance responses. A summary of the main empirical findings—organized by case and EGT dimensions—is presented in Table 1 for the Western Scheldt and Table 2 for the Sea Scheldt.

4.1. Western Scheldt (The Netherlands)

4.1.1. Dike Reinforcements After the Storm Surge of 1953 (1953–2005)

Following the catastrophic storm surge of 1953, which claimed 1,836 lives, the Dutch government enacted the Delta Act in 1957 and the Delta Plan, whose works (*Deltawerken*) began in 1958. The Delta Plan was primarily based on a strategy of coastline shortening (Meijerink, 2005), proposing the construction of large dams to close off the estuaries in the southwestern delta. The Delta Plan was based on a strong belief in engineering solutions (discourse dimension). During the implementation of the Delta Plan, most of the estuaries of the rivers Rhine, Scheldt, and Maas were closed off in order to shorten the coastline and to better protect the southwestern delta from sea flooding, demonstrating a clear goal dependency. However, the Western Scheldt estuary was an exception to this closure strategy. To maintain navigational access to the Belgian port of Antwerp (material dimension), the authorities opted to reinforce the dikes along the estuary instead of closing it, thus causing a change in the material dimension. These dikes meet the flood safety standards that were legally defined in the aftermath of the 1953 disaster (institutional dimension). As a result, the Western Scheldt remains the only natural estuary in the southwestern delta, preserving a significant ecological value (Saeijs et al., 2004, p. 5; material dimension). It encompasses several important natural reserves that serve as critical habitats for bird species. Notable sites include the Verdronken Land van Saeftinghe (about 3,500 ha), designated a Ramsar site since 1995 and located near the Belgian border, the Schor van Waarde (100 ha) near Hansweert, and the Verdronken Zwarte Polder (73 ha) in the mouth of the estuary (Sistermans & Nieuwenhuis, 2004). Although the Western Scheldt has remained open, ongoing activities such as channel deepening and maintenance dredging works to support navigation have caused significant morphological alterations to the estuary and significant habitat degradation (changes in the material dimension). In 2005, the Dutch government concluded new international agreements with the Flemish region and the Flemish community on the joint management of the Scheldt estuary, dredging works, and ecological compensation measures (institutional dimension). These international agreements included plans to compensate for the ecological damage caused by the dredging by returning land to the estuary through depoldering.

4.1.2. Conflicts Over Depoldering Along the Estuary (2005–2022)

Ecological experts have consistently emphasized that depoldering is the only effective strategy for restoring nature in the Scheldt estuary (Smits et al., 2006). This approach—returning land to the water to compensate for ecological losses—is part of a new discourse that challenges the long-standing tradition of protecting the land from sea and river floods by building dikes. However, the plans for depoldering were met with significant opposition from the majority of Zeeland's residents, politicians, and landowners, particularly

farmers (A. Van Buuren et al., 2010). Opposition extended to the provincial government, the Dutch parliament, and the court. Much of this opposition can be partly attributed to Zeeland's history and cultural identity. Following the devastating storm surge of 1953, dikes were reinforced, and the land was protected from flooding. The idea of giving land back to the sea or the river did not fit into the deeply rooted culture of controlling nature. Additionally, landowners strongly opposed giving up their property, reflecting entrenched path dependencies. In the course of protracted debates over depoldering, alternative plans were proposed, but depoldering proved to be legally necessary to compensate for ecological losses in the estuary (institutional dimension).

In 2022, 17 years after the decision was made, the depoldering of Hedwige polder was finally carried out, marking a significant transformation in the material dimension. While depoldering is widely regarded as an effective measure to restore nature and compensate for ecological damage in the Western Scheldt, its contribution to flood safety remains minimal. For example, the depoldering of the Hedwige polder, situated near the Belgian border at the narrowest point of the estuary, reduces upstream water levels by only a few centimeters. Further downstream, where the estuary widens significantly, similar interventions have no measurable effect on water levels. However, depoldering can indirectly improve flood safety by restoring natural floodplains, promoting sedimentation, and creating buffer zones that absorb storm surges. Unlike rigid seawalls and dikes, which can fail under extreme conditions, restored wetlands and tidal areas adapt dynamically, strengthening coastal resilience over time. These natural barriers help dissipate wave energy, lower flood risks, and adapt to rising sea levels. However, their effectiveness depends on local conditions, sediment availability, and management strategies. In many cases, depoldering alone is not sufficient for flood protection and must be integrated with other measures in broader coastal protection strategies. Research demonstrates that various human interventions in the estuary, such as channel deepening, sediment extraction for infrastructure development, and commercial sand mining, have caused significant changes in the material dimension. These activities have widened the underwater trench, further altering the ecological and hydrodynamic balance of the estuary. The wider main trench has caused the tidal wave from the North Sea to move more quickly through the estuary. This effect is amplified by sea level rise and meteorological conditions, leading to higher water levels and greater water volumes (Nicolai et al., 2023).

4.1.3. The Implementation of New Flood Risk Standards and Innovative Dike Concepts (2022–Present)

Rising concerns about the impacts of climate change led to significant institutional changes (institutional dimension), culminating in the enactment of the Delta Act in the Netherlands in 2012. This act serves as the foundation for the Delta Programme, a national program focused on flood risk management and freshwater supply. The Act establishes the role of the Delta Programme commissioner, responsible for advising on the programming of the Delta Programme measures and ensuring long-term financial security through the Delta fund (Ministerie van Infrastructuur en Waterstaat, 2018). The Ministry defines flood protection policies and sets frameworks for other authorities (goal dimension). Since 1953, significant population and economic growth, along with the effects of climate change, have driven a revision of flood risk standards (institutional dimension). Enhanced land protection behind the dikes has led to substantial investments in these areas (material dimension), and while the frequency of disasters has declined (material dimension), the potential for damage has increased considerably (Saeijs et al., 2004, p. 4). Under the new standards, flood protection infrastructure across the Netherlands, including the dikes along the Scheldt estuary, requires reinforcement. The national government and regional water authorities jointly fund these reinforcements.

The Flood Protection Programme (*Hoogwaterbeschermingsprogramma*) primarily aims to meet flood safety standards but also explores opportunities to integrate additional objectives, such as recreation and nature development (*Meekoppelkansen*; Avoyan & Meijerink, 2021). However, the costs associated with these additional objectives are not covered by the program and must be financed through other policy sectors. Due to budgetary constraints, the program follows a "sober and efficient" approach, which strives to use existing resources as efficiently as possible and by making sure no additional costs are incurred (Hoogwaterbeschermingsprogramma, 2021). The national government and regional water authorities jointly fund the dikes' reinforcements along the Scheldt estuary.

From a flood safety perspective, the most effective measures along the Western Scheldt involve reinforcing existing dikes, which is why dike reinforcement remains the predominant approach. As a result, the Flood Protection Programme reinforces past strategies (path dependency). Whereas, from an ecological standpoint, depoldering or dike realignment would be the preferred alternative. However, the program does invest in innovative dike concepts, such as transitional polders (Weisscher et al., 2022). This approach involves temporarily reopening dike-protected areas to tidal influence, allowing sediment to accumulate until the land rises well above mean sea level, after which it can be returned to its original function (Weisscher et al., 2022). This nature-based solution leverages natural sedimentation processes, integrating flood safety with ecological objectives. Regarding the interplay between power and knowledge systems (institutional dimension and interdependencies), expertise in flood risk management and climate change scenarios remains central and highly influential. Additionally, the cross-border Flemish-Dutch Scheldt Commission (Vlaams-Nederlandse Scheldecommissie) with the Dutch-Flemish Schelderaad as an advisory board, conducts long-term system analyses on both nature conservation and the accessibility of the Scheldt. In the Flemish-Dutch Scheldt Commission, Flanders and the Netherlands work together on a sustainable and vital Scheldt estuary. As an impressive economic hub and valuable natural area at the same time, the estuary is of vital importance to the environment. These insights will be integrated into a revised long-term vision for the Scheldt in the coming years.

Table 1 shows how flood management of the Western Scheldt (in the Netherlands) has changed over time.

Table 1. Evolution of flood governance of the Western Scheldt (the Netherlands) from an evolutionary governance perspective.

Western Scheldt (the Netherlands)			
EGT dimensions	**Phase 1**	**Phase 2**	**Phase 3**
Goal dimension: Governance objective	Flood protection	Flood safety, but also depoldering to compensate for ecological degradation	Flood safety and updated flood safety standards
Material dimension: Natural and human patterns	Dike heightening and dike enforcement, closing of the estuaries with the exception of the Western Scheldt	Attempt to depolder while channel deepening, sediment extraction, and commercial sand mining continue	Strengthening the dikes: Innovative dike concepts like transitional polders integrate sedimentation and nature-based solutions alongside traditional reinforcement

Table 1. (Cont.) Evolution of flood governance of the Western Scheldt (the Netherlands) from an evolutionary governance perspective.

Western Scheldt (the Netherlands)			
EGT dimensions	Phase 1	Phase 2	Phase 3
Discursive dimension: Narratives and impact on governance	Control over nature via hydraulic engineering and navigation concerns towards balancing safety and economy	Ecological turn: water system perspective, working with nature. Depoldering challenges traditional flood control approaches based on dikes	Strengthening the dikes: possibilities for nature restoration, "building with nature" becomes a popular discourse
Institutional dimension: Formal and informal rules	The Delta Act and Deltaplan define the framework for intervention and flood safety standards	Nature compensation was legally required to compensate for ecological damage in the estuary	Delta Programme commissioner, funding mechanism, Flood Protection Programme, and strengthening of flood safety
Path dependencies: Historical developments	The 1953 disaster shaped Dutch flood protection policy; historical navigation needs ensured the Western Scheldt remained open	Zeeland's post-1953 flood protection created a culture of controlling nature with dikes. Landowners opposed depoldering due to its clash with regional identity	The Flood Protection Programme reinforces historical practices, especially dike reinforcement, reflecting path dependencies in flood management
Interdependencies: Mutual influence of governance elements	Safety standards balance with navigation needs, keeping the Western Scheldt open for economic and historical maritime reasons	Ecological turn. Dike culture and landowner resistance challenge nature-based approaches amid ongoing dredging	Depoldering to offset ecological damage, yet flood safety continues with strengthening the dikes

4.2. Sea Scheldt (Belgium)

4.2.1. Dike Reinforcements and Controlled Flood Areas After 1976 (1976–2005)

Significant flood events occurred in 1953 and 1976, causing extensive human, infrastructural, and environmental damage. While the 1953 flood sparked discussions in Belgium about the need for risk management, it was the 1976 flood that ultimately led to the development of the Belgian Sigma Plan. In 1976, conditions for inundation triggered a storm surge that flooded Ruisbroek. The failure of the Vliet dike on the Rupel, a tributary of the Scheldt, resulted in two fatalities and severe property damage (Sigmaplan, n.d.-a). In response, the Sigma Plan was introduced, drawing inspiration from the Dutch Delta Plan (institutional dimension). Ratified in 1977, the Sigma Plan outlined a series of projects prioritizing flood safety (goal dimension). The plan's flood control strategy included three key interventions, namely: heightening river embankments, establishing flood-controlled areas, and constructing a storm surge barrier downstream of Antwerp (material dimension; Broekx et al., 2011; Kellens et al., 2013). Heavily influenced by the Dutch approach, the plan reflected a reliance on hydraulic engineering to control natural forces, reinforcing a discursive dependency. Following institutional reforms in the 1980s, water governance was transferred to the regions, granting Flanders water management authority and establishing the legal

framework for the Flemish government to implement the Sigma Plan. Since the 1980s, the Flemish region has been responsible for managing both navigable and unnavigable waterways. However, oversight was divided among multiple administrative authorities, each tasked with implementing integrated water management. The legal aspects of this governance structure are discussed later in this section, following an overview of the events and dependencies that shaped the Sigma Plan.

The prevailing discourse of control over nature aligned with the programmatic framework for a corps of engineers to manage water in line with the Sigma Plan's objectives, illustrating a discursive dimension and a form of institutional dependency. Implementation efforts continued throughout the 1980s, initially focusing on smaller flood control areas (Vikolainen et al., 2015). By the 1990s, 75% of the Sigma Plan projects had been completed, although the planned storm surge barrier at Oosterweel was canceled due to excessive costs (Heyse, 1997). Meanwhile, larger projects—such as the Kruibeke-Bazel-Rupelmonde—faced delays due to stakeholder opposition over the use of polders as flood control areas (interdependency). The Kruibeke-Bazel-Rupelmonde case demonstrates how, over 35 years beginning in the 1970s, water management evolved from a purely technical engineering approach to a more integrated flood risk management strategy (Vikolainen et al., 2015). However, the perceived success of flood control areas may have contributed to public complacency. As dike construction facilitated urban expansion, it created a path dependency that influenced decision-making in subsequent phases.

4.2.2. More Controlled Flooding Areas After 2005, in a coalition Between Hydraulic Engineers and Ecologists (2005–2025)

Over three decades, a series of problem-framing shifts reshaped the implementation strategy, moving away from the hydraulic engineering solutions of the 1970s and 1980s. In the 1990s, environmental considerations became central, followed by a shift in the 2000s toward stakeholder involvement and compensation-based approaches. To address opposition, a gradual transition toward a multi-purpose space for the river approach emerged, integrating flood security, ecological restoration, compensation, and local value creation. As policy goals expanded (goal dependencies) to encompass flood safety, environmental concerns, and later compensation, the material dimensions became increasingly interwoven. This resulted in a complex set of challenges in balancing dike-heightening measures with depoldering to manage flood risk in an environmentally sustainable manner.

In the early 21st century, Flemish authorities engaged in international cooperation with the Dutch, aligning with developments at the EU level, including the adoption of the Water Framework Directive (2000/60/EC) and the EU Birds and Habitats Directive (2009/147/EC). At the same time, they updated the Sigma Plan, restructuring it around four key pillars: safety, environment, economy, and recreation (Sigmaplan, n.d.-b). The Sigma Plan evolved in parallel with EU legislation, reflecting a new form of institutional dependency. By incorporating new scientific insights, the Sigma Plan's core focus shifted toward a multifunctional approach to flood protection, including cross-border cooperation. This marked a transition from a traditional flood control response to a risk-based approach, prioritizing nature restoration and recognizing the river's economic significance (interdependency; Kellens et al., 2013).

While the updated Sigma Plan continues to prioritize safety through dike construction, a discursive dependency emerged as a result of the ecological turn; this called for a water system perspective and a

commitment to work with nature. This approach aimed to create more space for the river through floodplains (Mees et al., 2016). Rather than attempting to prevent floods, the plan adopted a strategy focused on protecting densely populated and industrialized areas from flood damage (Broekx et al., 2011). The combination of flood safety and nature development goals marked a shift in path dependencies, exemplified by a coordinated partnership between the Flemish Waterways Agency, responsible for hydraulic engineering and water management, and the Flemish Agency for Nature and Forests, tasked with nature development and nature conservation monitoring (Sigmaplan, n.d.-b).

The updated Sigma Plan raised complex questions regarding land use, particularly in areas designated for depoldering (goal dimension). Successful implementation of the Sigma Plan projects required cooperation between farmland owners and water managers, as some agricultural land was repurposed to create nature reserves. For example, the Hedwige-Prosper tidal area alone required 4,500 ha (Sigmaplan, n.d.-b). Collaboration between organizations such as the Boerenbond (the Flemish professional association of farmers) and the Flemish Waterways Agency was essential in facilitating the implementation of the Sigma Plan projects (interdependencies). To address landowner concerns, a series of flanking policies was introduced as part of negotiations to compensate farmers for land lost to flood control areas. These measures included phased implementation, allowing some projects to begin only when farmers became eligible for pensions; financial remuneration, offering competitive land prices with an additional "reinvestment fee"; land exchanges, where the Flemish Waterways Agency purchased land outside project areas to provide farmers with the option of compensation in either money or land; and damage compensation, ensuring that farmers who continued managing land within project areas received compensation for crop losses.

The implementation of the updated Sigma Plan also operates within a broader economic and international context. The management of the Scheldt has historically prioritized maintaining navigable channels to secure access to the Port of Antwerp, Europe's second-largest port, which received approximately 15,000 vessels in 2019 (Elias et al., 2023; Plancke et al., 2022). Given the economic significance of the port, the Scheldt basin remains densely populated and supports key industrial interests along the Sea Scheldt. As a result, policies must balance the estuary's ecological health with its economic and functional *interdependencies*.

4.2.3. Do the New Challenges Require a Continuation of the Coalition and/or New Partners? (2025–2030 and beyond)

By 2030, the updated Sigma Plan will be fully implemented, prompting the Flemish Waterways Agency and the Department of Mobility and Public Works to prepare for a third Sigma Plan. This next phase will focus on flood safety measures in response to climate change impacts. While policy development is ongoing, current discussions emphasize the importance of managing unnavigable waterways upstream, recognizing land management as a critical factor in ensuring flood safety in the Sea Scheldt (goal dimension). This focus extends to the broader management of watercourses in Flanders, closely linked to the implementation of integrated water policy.

Since the 1990s, water management in Flanders has undergone an ecological shift. Previously centered on stream regulation, the approach has evolved to encompass the entire water system, emphasizing area-specific, integrated water policy at the river basin scale (Crabbé, 2008). Despite the establishment of

informal river basin committees in the 1990s and their formalization in the 2000s, watercourse management remains fragmented, leading to inefficiencies. The following section outlines "integrated water policy" in Flanders and the complex governance network shaped by institutional dependencies resulting from the strict separation of powers in managing navigable and non-navigable waterways.

At the Flemish level, the Coordination Committee on Integrated Water Policy—established in 2004 and chaired by the Flemish Environment Agency (Vlaamse Milieumaatschappij)—oversees the coordination of integrated water policy (Coördinatiecommissie Integraal Waterbeleid, n.d.-a). The Decree on Integrated Water Policy (approved in 2003) serves as the legal framework for implementing the EU Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC; institutional dimension). This decree defines water systems in Flanders as a cohesive and functional network of surface water, groundwater, waterbeds, banks, living ecosystems, and related physical, chemical, and biological processes, along with associated technical infrastructure (Coördinatiecommissie Integraal Waterbeleid, n.d.-b). Flemish water systems are categorized into three levels: border-crossing river basin districts (e.g., Scheldt and Meuse), river basins (Scheldt, Meuse, IJzer, and Polders of Bruges), and sub-basins (11 across Flanders; Tröltzsch et al., 2016). The management of non-navigable waterways is distributed across multiple authorities, creating path dependencies. First-category non-navigable waterways are overseen by the Department of Environment and executed by the Flemish Environment Agency. Second-category non-navigable waterways fall under the jurisdiction of provincial authorities. Third-category non-navigable waterways are managed by municipalities. Polders and wateringen (district-based water boards) manage second- and third-category waterways at the local level. This fragmented management structure poses challenges to achieving a fully integrated water management approach in Flanders.

The challenges Flanders faces in designing its climate adaptation strategy post-2030 are primarily driven by meteorological unpredictability, which calls for more integration of land management with water managers upstream. With increasing average precipitation, Flanders is experiencing wetter winters and drier summers, often accompanied by frequent heavy rainfall and thunderstorms. These shifts introduce additional goal complexities into water system management, converging three key flood risks: pluvial, fluvial, and coastal flooding (Vlaamse Overheid, 2023). The summer 2021 "water bomb," which caused unprecedented flooding in Wallonia, served as a stark reminder of the potential for further human suffering and economic damage unless adaptation measures are taken. The *Weerbaar Waterland* report calls for a shift to a more holistic systems approach, emphasizing the need for clear flood safety objectives at the Flemish level for flood risk management (Ovink et al., 2022). Unlike the Netherlands, these flood safety standards have not yet been established in Flanders (goal dimension). A blend of nature-based solutions and hydraulic engineering requires a robust institutional framework capable of efficiently implementing blue-green measures at the sub-basin level. This includes utilizing river valleys for flood management and adopting strategies to retain more runoff rainwater upstream (material dimension). These adaptation efforts are aligned with Flanders' obligations under the EU Nature Restoration Regulation (EU2024/1991), which sets targets for restoring free-flowing rivers by 2030 and includes additional requirements for floodplain conditions (institutional dimension). The next Sigma Plan will need to find a way to reconcile the region's obligations at the basin level with its responsibilities for both flood risk management and nature restoration, as dictated by regional and EU requirements.

Table 2 summarises how flood management of the Sea Scheldt (Flanders) has changed over time.

Table 2. Evolution of flood governance of the Sea Scheldt (Flanders), from an evolutionary governance perspective.

Sea Scheldt (Belgium)			
EGT dimensions	**Phase 1**	**Phase 2**	**Phase 3**
Goal dimension: Governance objective	Flood safety	Goal complexity: flood safety and depoldering as nature compensation	Goal complexity: flood safety and nature. Outlook for upstream water management
Material dimension: Natural and human patterns	Dike heightening and dike enforcement, flood control areas, and a storm surge barrier	Further dike heightening measures combined with nature development in a large number of flood control areas, with occasional depoldering	Development of reserve flood control areas specified in the updated Sigma plan. Introducing more meanders
Discursive dimension: Narratives and impact on governance	Control over nature via hydraulic engineering, inspired by the Dutch	Ecological turn: water system perspective, working with nature, and Room for the River	Climate adaptation calls for more integration of land management with water managers upstream, tackling new challenges such as drought and water bombs
Institutional dimension: Formal and informal rules	Sigma Plan provides the programme framework for the corps of engineers	Co-evolution of European directives (nature compensation for deepening Scheldt, EU legislation, and Birds and Habitats Directive) Integrated Water Policy	Further EU requirements via the Nature Restoration Regulation: ensure the good condition of floodplains
Path dependencies: Historical developments	Development behind the dikes because of a (potentially false) feeling of safety	A coalition between hydraulic engineers and nature development agencies	Hindrances are associated with the strict separation of management between navigable and non-navigable waterways
Interdependencies: Mutual influence of governance elements	Stakeholder resistance led to the evolution from technocratic approaches towards economic solutions (land buying)	Balancing ecological demands with navigable waterways is important for the economy	Feasibility of flood control areas and urban land use

4.3. Alignment and Divergences

The results of our analysis, detailed in Tables 1 and 2, reveal distinct governance trajectories in the Netherlands and Flanders. While both countries share similar goal dimensions across the three periods, they differ in material, discursive, and institutional aspects, path dependencies, and interdependencies. In the discursive realm, both countries initially embraced a control-over-nature paradigm in phase 1, with Flanders being influenced by the Dutch approach. The ecological turn in phase 2 marks a moment of divergence, although both countries adopted nature compensation measures under EU obligations, outcomes varied. In the Netherlands, path dependencies rooted in a tradition of hydraulic control sparked resistance to

nature-based solutions such as depoldering. By contrast, Flanders' redesign of the Sigma Plan fostered collaboration between engineers and nature development agencies, enabling the implementation of nature-based interventions. Phase 3 underscores further divergence. The introduction of the Delta Act in the Netherlands institutionalized long-term budgeting for flood safety, a significant shift in the institutional dimension, but sidelined nature-based strategies. Meanwhile, Flanders' governance remains fragmented due to path dependencies; the administrative divide between navigable and non-navigable waterways impeded a fully integrated water management. Despite these differences, the Flemish-Dutch Scheldt Commission emerges as a key point of convergence on the perspectives of nature and flood risk management in the Scheldt. It anchors shared perspectives on nature and flood risk management, aligning institutional power and knowledge around a long-term vision for the Scheldt. The institutional dimension and interdependencies of power and knowledge coalesce around the Flemish-Dutch Scheldt Commission as an institution in which flood risk management and climate change scenarios remain central. As the EU Nature Restoration Regulation takes effect, the Flemish-Dutch Scheldt Commission will play a central role in integrating nature-based solutions into future flood governance for the estuary.

5. Discussion

The legacy of engineering-driven water management in the low-lying coastal regions of the Scheldt estuary has long shaped flood risk governance in the Netherlands and Flanders. Hydraulic infrastructure, grounded in command-and-control paradigms, has historically dominated governance strategies, prioritizing technological control and flood defense. However, as ecological consciousness grew and environmental concerns gained traction, a gradual transition toward integrated governance emerged—one that balances flood safety with ecological restoration. This shift aligns with the broader ecological turn in water management, offering opportunities to rethink flood resilience through nature-based solutions and climate adaptation. This shift also reflects the continuous evolution of governance systems, a key premise of EGT, where internal institutional dynamics and external regulatory pressures shape governance trajectories (Beunen et al., 2022; Van Assche et al., 2014).

The growing recognition of nature-based solutions as viable alternatives highlights the increasing role of ecological considerations in flood risk governance. However, deeply entrenched institutional and technical path dependencies, shaped by historical trajectories and actor coalitions, have continued to constrain their large-scale implementation (Hanger-Kopp et al., 2022; Pierson, 2000). In flood risk governance, technical and institutional lock-ins have favored traditional engineering solutions and limited transformative shifts (Seebauer et al., 2023; Vitale, 2023). These constraints illustrate the contingency of governance change. Where institutional transformation alone is insufficient, broader alignment of policy, discourses, and regulatory pressures is necessary to drive systemic reform (Lieberman, 2002; North, 1990).

The differences encountered in the Dutch and Flemish governance trajectories in the Scheldt estuary can be largely explained by material conditions and how these interact with discursive and institutional dynamics in shaping policy decisions. Initially, both regions prioritized large-scale hydraulic infrastructure, reinforcing the dominance of traditional engineering paradigms. However, as the ecological turn in water management gained momentum, governance strategies began to diverge. In the Netherlands, flood management remained heavily rooted in engineering-based approaches, exemplified by the Delta works. Two key material factors have influenced flood governance in the Dutch side of the estuary, namely the estuary's strategic

economic role for the port of Antwerp and the limited flood protection benefits of depoldering, making large-scale ecological restoration politically and financially challenging. For what concerns the first material factor, the Western Scheldt remains the only tidal branch in the southwestern Netherlands that has not been dammed, preserving its unique ecological value (M. W. Van Buuren et al., 2015). Regarding the second, unlike the Room for the River program, where floodplain expansion demonstrably reduced water levels, Dutch water managers struggled to justify depoldering in the wide Western Scheldt, where flood safety benefits were minimal. Financial constraints further entrenched this approach, as sunk costs in flood defense infrastructure limited the feasibility of alternative strategies (Avoyan & Meijerink, 2021). Moreover, deeply ingrained socio-political narratives continued to prioritize land reclamation and economic interests over ecological restoration, fueling resistance from landowners and policymakers. In contrast, Flanders embraced a more adaptive governance model, driven by European regulatory frameworks and a shifting policy discourse that framed nature-based solutions as legitimate flood management tools. Unlike in the Western Scheldt, where depoldering offered little direct flood protection, in the Sea Scheldt, floodplain expansion significantly reduced peak water levels, directly benefiting urban centers like Antwerp. This material advantage facilitated greater acceptance of nature-based solutions. Additionally, evolving societal discourses in Flanders increasingly framed nature as integral to water governance, strengthening the legitimacy of nature-based solutions, and this integrative approach was further institutionalized by giving a strong role in the coordination of the Integrated Water Policy to the Flemish Environmental Agency.

While material conditions influence flood risk management choices, the relationship between ecosystem restoration and flood protection is also shaped by evolving societal discourses on the role of nature. The differences between the two regions highlight the pivotal role of discourses in governance transformation—another core tenet of EGT. In Flanders, evolving narratives redefined nature as an integral component of flood management, strengthening the legitimacy of nature-based solutions and facilitating their uptake. In the Netherlands, by contrast, discursive change remained constrained by economic and political interests that continued to prioritize land reclamation and infrastructural resilience over ecological restoration. The Hedwige Polder case illustrates these tensions, where depoldering was implemented only under international legal obligations despite prolonged societal and political resistance.

While external shocks such as the 1953 and 1976 floods have historically shaped governance responses, they primarily reinforced existing infrastructural paradigms rather than catalyzing transformative change. As Meijerink (2005) observes, the Delta Plan—despite its groundbreaking scale—represented a continuation rather than a rupture with pre-existing governance traditions. This pattern exemplifies how governance evolution is shaped by historical dependencies, where crises often reinforce dominant paradigms rather than dismantling them (Boin et al., 2009). Applying an EGT lens to flood governance in the Scheldt estuary reveals that institutional reform or discursive shifts alone do not drive systemic change; instead, transformation requires the alignment of policy integration, regulatory frameworks, and shifting societal perspectives. Although the Room for the River program signals growing recognition of ecologically informed approaches in the Netherlands, tensions persist between traditional engineering solutions and the need for adaptive, nature-based strategies. The Dutch case illustrates the challenge of overcoming entrenched governance structures, whereas the Flemish trajectory suggests that governance adaptation is most successful when material, institutional, and discursive shifts converge.

6. Conclusion

The case studies show that the transition toward integrated flood risk governance is a non-linear and contingent process, shaped by historical legacies, stakeholder dynamics, and external pressures. While aligning flood risk management with ecological restoration enhances resilience and promotes sustainable estuarine ecosystems, the pace of change remains incremental in both the Belgian and Dutch parts of the Scheldt estuary. Traditional institutional analysis frameworks often fail to capture the complex interdependencies shaping flood risk management. EGT helps address these limitations by emphasizing that governance systems evolve continuously through internal and external pressures. EGT also stresses that change is contingent upon historical trajectories, stakeholder interactions, and contextual factors, with discourses playing a key role in governance transitions (Beunen et al., 2022; Van Assche et al., 2014). The governance of the Scheldt estuary exemplifies these dynamics. Unlike many other governance theories, EGT points explicitly to the relevance of materialities. The case studies convincingly show that differences in material conditions partly explain why nature-based solutions to flood risks were adopted more easily in the Belgian than in the Dutch part of the Scheldt estuary. However, as we have seen, institutional choices also matter, as integrated water policies, combining green and blue governance, are more embedded in organizational structures in Flanders, while in the Netherlands, flood risk governance by a sector-based approach is more dominant.

The application of EGT to other cases of flood risk governance will teach us more about similarities and differences in trajectories of flood risk governance and the relevance of material and other conditions for understanding these differences.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024-2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Funding

Publication of this article in open access was made possible through the institutional membership agreement between the Radboud University and Cogitatio Press.

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

Data supporting the findings of this study are available from the authors upon request.

References

Allan, J. A. (2003). Integrated water resources management is more a political than a technical challenge. *Developments in Water Science*, *50*, 9–23. https://doi.org/10.1016/S0167-5648(03)80004-7

Allan, J. A. (2006). IWRM: The new sanctioned discourse? In P. P. Mollinga, A. Dixit, & K. Athukorala (Eds.), *Integrated water resources management: Global theory, emerging practice and local needs* (pp. 38–63). Sage.

Aukes, E., Lulofs, K., & Bressers, H. (2020). (Mis-)matching framing foci: Understanding policy consensus among coastal governance frames. *Ocean & Coastal Management*, *197*, Article 105286. https://doi.org/10.1016/j.ocecoaman.2020.105319

Avoyan, E., & Meijerink, S. (2021). Cross-sector collaboration within Dutch flood risk governance: Historical analysis of external triggers. *International Journal of Water Resources Development*, *37*(1), 24–47. https://doi.org/10.1080/07900627.2019.1707070

Baeyens, W., van Eck, B., Lambert, C., Wollast, R., & Goeyens, L. (1997). General description of the Scheldt estuary. *Hydrobiologia*, *366*, 1–14. https://doi.org/10.1023/A:1003164009031

Beunen, R., & Patterson, J. J. (2019). Analysing institutional change in environmental governance: Exploring the concept of 'institutional work.' *Journal of Environmental Planning and Management*, *62*(1), 12–29. https://doi.org/10.1080/09640568.2016.1257423

Beunen, R., & Van Assche, K. (2021). Steering in governance: Evolutionary perspectives. *Politics and Governance*, *9*(2), 365–368. https://doi.org/10.17645/pag.v9i2.4310

Beunen, R., Van Assche, K., & Duineveld, M. (2015). *Evolutionary governance theory: Theory and applications*. Springer. https://doi.org/10.1007/978-3-319-12274-8

Beunen, R., Van Assche, K., & Gruezmacher, M. (2022). Evolutionary perspectives on environmental governance: Strategy and the co-construction of governance, community, and environment. *Sustainability*, *14*(16), Article 9912. https://doi.org/10.3390/su14169912

Boin, A., Hart, P., & McConnell, A. (2009). Crisis exploitation: Political and policy impacts of framing contests. *Journal of European Public Policy*, *16*(1), 81–106.

Broekx, S., Smets, S., Liekens, I., Bulckaen, D., & De Nocker, L. (2011). Designing a long-term flood risk management plan for the Scheldt estuary using a risk-based approach. *Natural Hazards*, *57*, 245–266. https://doi.org/10.1007/s11069-010-9610-x

Coördinatiecommissie Integraal Waterbeleid. (n.d.-a). *Integrated water policy in Flanders*. https://www.integraalwaterbeleid.be/en

Coördinatiecommissie Integraal Waterbeleid. (n.d.-b). *Decreet Integraal Waterbeleid*. https://www.integraalwaterbeleid.be/nl/regelgeving/decreet-integraal-waterbeleid

Crabbé, A. (2008). *Integraal waterbeleid in Vlaanderen: van fluïde naar solide*. University of Antwerp.

Dahdouh-Guebas, F., Hugé, J., Abuchahla, G. M., Cannicci, S., Jayatissa, L. P., Kairo, J. G., Arachchilage, S. K., Koedam, N., Nijamdeen, M. T. W. G. F., Mukherjee, N., Poti, M., Prabakaran, N., Ratsimbazafy, H., Satyanarayana, B., Thavanayagam, M., Velde, K. V., & Wodehouse, D. (2021). Reconciling nature, people and policy in the mangrove social-ecological system through the adaptive cycle heuristic. *Estuarine, Coastal and Shelf Science*, *248*, Article 106942. https://doi.org/10.1016/j.ecss.2020.106942

Disco, C. (2002). Remaking "nature": The ecological turn in Dutch water management. *Science, Technology, & Human Values*, *27*(2), 236–261. https://doi.org/10.1177/016224390202700203

Eger, S. L., De Loë, R. C., Pittman, J., Epstein, G., & Courtenay, S. C. (2021). A systematic review of integrated coastal and marine management progress reveals core governance characteristics for successful implementation. *Marine Policy*, *132*, Article 104688. https://doi.org/10.1016/j.marpol.2021.104688

Elias, E. P. L., Van der Spek, A. J. F., Wang, Z. B., Cleveringa, J., Jeuken, C. J. L., Taal, M., & Van der Werf, J. J. (2023). Large-scale morphological changes and sediment budget of the Western Scheldt estuary 1955–2020: The impact of large-scale sediment management. *Netherlands Journal of Geosciences*, *102*, Article e12. https://doi.org/10.1017/njg.2023.11

Faghih, N., & Samadi, A. H. (2021). An introduction to dynamics of institutional change in emerging markets: Theories, concepts, and mechanisms. In N. Faghih & A. H. Samadi (Eds.), *Dynamics of institutional change in emerging market economies: Theories, concepts and mechanisms* (pp. 1–8). Springer. https://doi.org/10.1007/978-3-030-56926-3_1

Francesch-Huidobro, M., Dabrowski, M., Tai, Y., Chan, F., & Stead, D. (2017). Governance challenges of flood-prone delta cities: Integrating flood risk management and climate change in spatial planning. *Progress in Planning*, 114, 1–27. https://doi.org/10.1016/j.progress.2015.11.001

Fürstenberg, K. (2016). Evolutionary institutionalism: New perspectives. *Politics and the Life Sciences*, *35*(1), 48–60. https://doi.org/10.1017/pls.2016.8

Hanger-Kopp, S., Thaler, T., Seebauer, S., Schinko, T., & Clar, C. (2022). Defining and operationalizing path dependency for the development and monitoring of adaptation pathways. *Global Environmental Change*, *72*, Article 102425. https://doi.org/10.1016/j.gloenvcha.2021.102425

Hardy, C., & Thomas, R. (2015). Discourse in a material world. *Journal of Management Studies*, *52*(5), 680–696. https://doi.org/10.1111/joms.12113

Heyse, I. (1997). Belgium. In C. Embleton & C. Embleton-Hamann (Eds.), *Developments in Earth surface processes* (Vol. 5, pp. 31–59). Elsevier.

Hodgson, G. M. (2004). *The evolution of institutional economics*. Routledge. https://www.routledge.com/The-Evolution-of-Institutional-Economics/Hodgson/p/book/9780415322539?srsltid=AfmBOop-r98OEjG9-D8a5eyt2-6Hq5eAjXBdISWKnlIeWgo_ct0eD9_i

Hoogwaterbeschermingsprogramma. (2021). *Stappenplan beoordeling sober en doelmatig ontwerp*. https://www.hwbp.nl/kennisbank/sober-en-doelmatig/documenten/handreikingen/2021/10/25/stappenplan-sober-en-doelmatig

Kellens, W., Vanneuville, W., Verfaillie, E., Meire, E., Deckers, P., & De Maeyer, P. (2013). Flood risk management in Flanders: Past developments and future challenges. *Water Resources Management*, *27*, 3585–3606. https://doi.org/10.1007/s11269-013-0366-4

Lewis, O. A., & Steinmo, S. (2012). How institutions evolve: Evolutionary theory and institutional change. *Polity*, *44*(3), 314–339. https://doi.org/10.1057/pol.2012.10

Lieberman, R. C. (2002). Ideas, institutions, and political order: Explaining political change. *American Political Science Review*, *96*(4), 697–712. https://doi.org/10.1017/S0003055402000394

Mees, H., Suykens, C., Beyers, J.-C., Crabbé, A., Delvaux, B., & Deketelaere, K. (2016). *Analysing and evaluating flood risk governance in Belgium: Dealing with flood risks in an urbanised and institutionally complex country* (Report No. D3.2). STAR-FLOOD Consortium. https://doi.org/10.13140/RG.2.1.4745.0007

Meijerink, S. (2005). Understanding policy stability and change. The interplay of advocacy coalitions and epistemic communities, windows of opportunity, and Dutch coastal flooding policy 1945–20031. *Journal of European Public Policy*, *12*(6), 1060–1077. https://doi.org/10.1080/13501760500270745

Meire, P., Ysebaert, T., Damme, S. V., Van den Bergh, E., Maris, T., & Struyf, E. (2005). The Scheldt estuary: A description of a changing ecosystem. *Hydrobiologia*, *540*, 1–11. https://doi.org/10.1007/s10750-005-0896-8

Micelotta, E., Lounsbury, M., & Greenwood, R. (2017). Pathways of institutional change: An integrative review and research agenda. *Journal of Management*, *43*(6), 1885–1910. https://doi.org/10.1177/0149206317699522

Ministerie van Infrastructuur en Waterstaat. (2018). *Overstromingsrisico's In Nederland: Voorlopige overstromingsrisicobeoordeling en aanwijzing van gebieden met potentieel significant overstromingsrisico in het kader van de Europese Richtlijn Overstromingsrisico's (ROR) 2e cyclus: 2016–2021*. https://www.helpdeskwater.nl/publish/pages/132174/overstromingsrisicos_in_nederland_2018_1.pdf

Molle, F., Mollinga, P. P., & Wester, P. (2009). Hydraulic bureaucracies and the hydraulic mission: Flows of water, flows of power. *Water Alternatives*, *2*(3), 328–349.

Nicolai, R., Gensen, M., Van de Moortel, I., Michielsen, S., Thant, S., Boudewijn, T., van der Jagt, H., de Jong, J., Middelveld, R. P., Van Echelpoel, W., Bruneel, S., Goethals, P., & Postma, R. (2023). *Beleidssamenvatting. T2021 Evaluatie Schelde-estuarium: De toestand van Veiligheid, Toegankelijkheid en Natuurlijkheid*. Universiteit Gent.

North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge University Press.

Ovink, H., Declerck, J., Dehenauw, D., De Nolf, S., De Potter, B., Dewelde, J., Gielen, H., Huysmans, M., Maeghe, K., & Nossent, J. (2022). *Weerbaar Waterland. Ons voorbereiden op wat al gebeurt. Advies van het expertenpanel hoogwaterbeveiliging aan de Vlaamse Regering*. Vlaanderen.

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., Hornidge, A. K., Le Tissier, M., Pittman, J. B., Song, A. M., Sousa, L. P., Văidianu, N., & Van Assche, K. (2020). Environmental governance theories: A review and application to coastal systems. *Ecology & Society*, *25*(4), Article 19. https://doi.org/10.5751/ES-12067-250419

Pierson, P. (2000). Increasing returns, path dependence, and the study of politics. *American Political Science Review*, *94*(2), 251–267.

Plancke, Y. M., Verleye, T., & Sandra, M. (2022). Scheldt estuary. In Dauwe, S. et al. (Eds), *Knowledge guide coast and sea 2022—Compendium for coast and sea* (pp. 225–236). Compendium Kust & Zee.

Rydin, Y. (2021). Discourse, knowledge and governmentality: The influence of Foucault. In *Theory in planning research* (pp. 149-169). Springer.

Saeijs, H., Smits, A. J. M., Overmars, W., & Willems, D. (2004). *Changing estuaries, changing views*. Worldwide Fund for Nature.

Samadi, A. H., & Alipourian, M. (2021). Institutions and institutional change: Concepts and theories. In N. Faghih & A. H. Samadi (Eds.), *Dynamics of institutional change in emerging market economies: Theories, concepts and mechanisms* (pp. 107–132). Springer.

Saurugger, S. (2017). *Sociological institutionalism and European integration*. Oxford Research Encyclopedia of Politics.

Sayers, P., Gersonius, B., den Heijer, F., Klerk, W. J., Fröhle, P., Jordan, P., Ciocan, U. R., Rijke, J., Vonk, B., & Ashley, R. (2021). Towards adaptive asset management in flood risk management: A policy framework. *Water Security*, *12*, Article 100085. https://doi.org/10.1016/j.wasec.2021.100085

Schlüter, A., Van Assche, K., Hornidge, A. K., & Văidianu, N. (2020). Land-sea interactions and coastal development: An evolutionary governance perspective. *Marine Policy*, *112*, Article 103801. https://doi.org/10.1016/j.marpol.2019.103801

Schlüter, A., Wise, S., SchwerdtnerMánez, K., Weber de Morais, G., & Glaser, M. (2013). Institutional change, sustainability and the sea. *Sustainability*, *5*(12), 5373–5390. https://doi.org/10.3390/su5125373

Schmidt, R. H., & Spindler, G. (2002). Path dependence, corporate governance and complementarity. *International Finance*, *5*(3), 311–333. https://doi.org/10.1111/1468-2362.00099

Seebauer, S., Thaler, T., Hanger-Kopp, S., & Schinko, T. (2023). How path dependency manifests in flood risk management: Observations from four decades in the Ennstal and Aist catchments in Austria. *Regional Environmental Change*, *23*, Article 31. https://doi.org/10.1007/s10113-023-02029-y

Sigmaplan. (n.d.-a). *Koning in de bres. Hoe Ruisbroek ons de ogen opende*. https://www.sigmaplan.be/nl/nieuws/koning-de-bres-hoe-ruisbroek-ons-de-ogen-opende

Sigmaplan. (n.d.-b). *What does the Sigma Plan do?* https://www.sigmaplan.be/en

Sistermans, P., & Nieuwenhuis, O. (2004). Western Scheldt Estuary (The Netherlands). *Eurosion Case Study*, *31*, 1–14.

Smits, A. J. M., Nienhuis, P. H., & Saeijs, H. L. F. (2006). Changing estuaries, changing views. *Hydrobiologia*, *565*, 339–355. https://doi.org/10.1007/s10750-005-1924-4

Sperber, D. (1996). *Explaining culture: A naturalistic approach*. Oxford.

Thelen, K. (1999). Historical institutionalism in comparative politics. *Annual Review of Political Science*, *2*, 369–404. https://doi.org/10.1146/annurev.polisci.2.1.369

Tröltzsch, J., Vidaurre, R., Bressers, H., Browne, A., La Jeunesse, I., Lordkipanidze, M., Defloor, W., Maetens, W., & Cauwenberghs, K. (2016). Flanders: Regional organization of water and drought and using data as driver for change. In H. Bressers, N. Bressers, & C. Larrue (Eds.), *Governance for drought resilience: Land and water drought management in Europe* (pp. 139–158). Springer. https://doi.org/10.1007/978-3-319-29671-5_7

Ubels, H., Bock, B., & Haartsen, T. (2019). An evolutionary perspective on experimental local governance arrangements with local governments and residents in Dutch rural areas of depopulation. *Environment and Planning C: Politics and Space*, *37*(7), 1277–1295. https://doi.org/10.1177/2399654419825637

Van Assche, K., Beunen, R., & Duineveld, M. (2013). *Evolutionary governance theory: An introduction*. Springer.

Van Assche, K., Beunen, R., & Duineveld, M. (2014). *Evolutionary governance theory: An introduction*. Springer. https://doi.org/10.1007/978-3-319-00984-1

Van Assche, K., Beunen, R., & Gruezmacher, M. (2024). *Strategy for sustainability transitions: Governance, community and environment*. Edward Elgar Publishing.

Van Assche, K., Beunen, R., Gruezmacher, M., & Duineveld, M. (2020). Rethinking strategy in environmental governance. *Journal of Environmental Policy & Planning*, *22*(5), 695–708. https://doi.org/10.1080/1523908X.2020.1768834

Van Buuren, A., Gerrits, L., & Teisman, G. R. (2010). Understanding and managing the Westerschelde—Synchronizing the physical system and the management system of a complex estuary. *Hydrology and Earth System Sciences*, *14*(11), 2243–2257. https://doi.org/10.5194/hess-14-2243-2010

Van Buuren, M. W., Ellen, G. J., van Leeuwen, C., & van Popering-Verkerk, J. (2015). *Die het water deert die het water keert. Overstromingsrisicobeheer als Maatschappelijke Gebiedsopgave. Opbrengsten en Lessen uit de Pilots Meerlaagsveiligheid*. Erasmus Universiteit Rotterdam; Deltares.

van Slobbe, E., de Vriend, H. J., Aarninkhof, S., Lulofs, K., de Vries, M., & Dircke, P. (2013). Building with nature: In search of resilient storm surge protection strategies. *Natural Hazards*, *65*, 947–966. https://doi.org/10.1007/s11069-012-0342-y

Vergne, J. P., & Durand, R. (2010). The missing link between the theory and empirics of path dependence: Conceptual clarification, testability issue, and methodological implications. *Journal of Management Studies*, *47*(4), 736–759. https://doi.org/10.1111/j.1467-6486.2009.00913.x

Vikolainen, V., van Buuren, A., Warner, J., Lulofs, K., & Bressers, H. (2015). Negotiated space for the river Scheldt in Flanders: A longitudinal reconstruction of the policy debate to realize multifunctional retention capacity. *International Journal of Water Governance*, *3*(3), 101–120.

Vitale, C. (2023). Understanding the shift toward a risk-based approach in flood risk management, a comparative case study of three Italian rivers. *Environmental Science & Policy*, *146*, 13–23.

Vlaamse Overheid. (2023). *Vlaams Klimaatadaptatieplan: Vlaanderen wapenen tegen de klimaatverandering*. Peter Cabus.

Vlaams-Nederlandse Scheldecommissie. (2019). *Systeemanalyse natuur Schelde-estuarium: Gezamenlijk feitenonderzoek van stakeholders, deskundigen en de Vlaams-Nederlandse Scheldecommissie*. https://northsearegion.eu/media/14997/ltp-n-systeemanalyse-natuur-schelde-estuarium.pdf

Vlaams-Nederlandse Scheldecommissie. (2025). *De Schelde: van bron tot monding*. https://vnsc.eu/de-schelde/de-schelde-van-bron-tot-monding

Weisscher, S. A., Baar, A. W., Van Belzen, J., Bouma, T. J., & Kleinhans, M. G. (2022). Transitional polders along estuaries: Driving land-level rise and reducing flood propagation. *Nature-Based Solutions*, *2*, Article 100022. https://doi.org/10.1016/j.nbsj.2022.100022

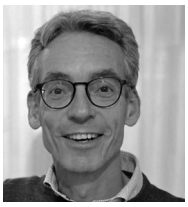
Zheng, J., Elmilady, H., Röbke, B. R., Taal, M., Wang, Z. B., van Prooijen, B. C., de Vet, P. L. M., & van der Wegen, M. (2021). The impact of wind-waves and sea level rise on the morphodynamics of a sandy estuarine shoal. *Earth Surface Processes and Landforms*, *46*(15), 3045–3062. https://doi.org/10.1002/esp.5207

Zurnić, M. (2014). Discursive institutionalism and institutional change. *Filozofija i društvo*, *25*(2), 217–234. https://doi.org/10.2298/FID1402217Z

About the Authors

Corinne Vitale is an assistant professor of spatial planning and water governance at Radboud University. Her research adopts a discursive-institutional lens to explore the interplay between discourse, institutional arrangements, and contextual factors in flood risk management. She is particularly interested in how power structures shape stakeholder dynamics in river basin management.

Ann Crabbé is a senior researcher at the Research Centre on Environmental and Social Change at the University of Antwerp, Department of Sociology. The introduction and evolution of new modes of governance, explaining institutional stability and change, and developing and implementing methods for policy evaluation are her main research topics.



Sander Meijerink is a full professor of water governance at Radboud University. His research focuses on water governance and climate change adaptation in an international comparative perspective. Research themes are flood risk management, the management of water scarcity and drought, water quality management, and climate-proof cities.

Cory Fletcher is a PhD candidate at the University of Antwerp as part of its Research Centre of Environmental and Social Change within the Department of Sociology. Her research interests include the governance of climate adaptation with a focus on the Sea Scheldt estuary in Flanders, Belgium.

Mafaziya Nijamdeen is a postdoctoral researcher at the Open University in the Netherlands. She holds a PhD in science from the Université Libre de Bruxelles in Belgium. Her research focuses on coastal social-ecological systems, with an interdisciplinary approach that integrates social and environmental perspectives. Her work particularly addresses issues related to coastal governance and management, aiming to enhance the resilience and sustainability of coastal regions.

Mark Wiering is a full professor of environmental institutional dynamics. He is part of the Environmental Governance and Politics group at Radboud University Nijmegen. He focuses on policy transformations towards a sustainable society, how policy and governance arrangements differ, and what the conditions are for accelerated change.

Ocean and Society
2025 • Volume 2 • Article 10452
https://doi.org/10.17645/oas.10452

cogitatio

ARTICLE

Open Access Journal

The Process and Procedures for the Preparation of Integrated Maritime Spatial Planning: The Case of Slovenia

Barbara Goličnik Marušić and Andrej Gulič

Urban Planning Institute of the Republic of Slovenia, Slovenia

Correspondence: Barbara Goličnik Marušić (barbara.golicnik-marusic@uirs.si)

Submitted: 31 March 2025 **Accepted:** 23 July 2025 **Published:** 17 September 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

This article explores the establishment of a maritime spatial planning (MSP) framework in Slovenia. Following revised spatial planning legislation and the Directive 2014/89/EU, Slovenia initiated the development of processes and procedures for integrated MSP. Drawing on a dedicated research project, the article presents a proposed methodology grounded in the ecosystem approach, forming a foundation for integrated land–sea interaction planning. The framework outlines a four-phase process: (1) preliminary MSPlan preparation, (2) MSPlan preparation, (3) MSPlan monitoring and evaluation of implementation, and (4) ongoing MSPlan monitoring and updating. Each phase consists of independent or sequential steps, which are also linked procedurally between the phases. A central feature linking the preliminary and main preparation phases is stakeholder involvement. While the MSPlan preparation phase ensures broad stakeholder participation, the preliminary phase engages those representing strategic development or conservation interests. Experts and other stakeholder groups may also be involved directly in the planning process. The article concludes by evaluating the adopted Slovenian MSPlan, highlighting deviations from the proposed process and assessing the extent of its implementation in relation to the original plan. It also emphasises the importance of developing the MSP process and its procedures in parallel to ensure strong alignment and facilitate a smoother preparation of the final MSPlan.

Keywords

coastal governance; coastal zone; Directive 2014/89/EU; maritime spatial planning; North Adriatic Sea; public participation; Slovenia

1. Introduction

The purpose of this article is to present the concept of maritime spatial planning (MSP) processes and procedures in Slovenia, as developed in the research project by Goličnik Marušić et al. (2018). The aim is to inform the broader professional community about Slovenia's approach to MSP. This discussion is particularly relevant in the context of the current MSP-related project (BlueGreen Governance, n.d.), which focuses on blue-green governance and includes the Northern Adriatic as one of its case study areas. For Slovenia, this area is addressed through the maritime spatial plan (MSPlan). A clear understanding of the process and procedures behind the MSPlan's preparation is essential for effective integration into cross-border MSP governance frameworks, one of the core objectives of the BlueGreen Governance project (BlueGreen Governance, n.d.).

The implementation of MSP in Europe has been extensively analysed in academic and policy literature, particularly following the adoption of Directive 2014/89/EU (2014), which established a common framework for MSP across member states. MSP is designed to coordinate the spatial and temporal distribution of maritime activities, promote sustainable development, and support marine environmental protection. However, implementation across Europe remains heterogeneous, shaped by differing legal, institutional, and socio-economic contexts (Jay et al., 2013; Jones et al., 2016). Accordingly, there are some key issues identified in the literature, spanning from governance complexity and institutional fragmentation, environmental considerations and ecosystem-based approach, data availability and integration, stakeholder participation and legitimacy, spatial conflicts and blue growth pressures, to actual MSPlan implementation, adaptability, and monitoring.

Regarding governance complexity and institutional fragmentation, it is evident that European MSP operates within complex governance systems involving multiple levels and actors, often resulting in fragmented responsibilities and weak cross-border coordination (Jay, 2010; Zaucha, 2014). These challenges are particularly acute in transboundary sea basins such as the Baltic Sea and North Sea (Schultz-Zehden & Gee, 2019) as well as the Adriatic Sea. Therefore, the North Adriatic Sea is taken as a cross-border case study in the BlueGreen Governance project (BlueGreen Governance, n.d.), where institutional capacities and readiness for a cross-border approach to the climate-water-biodiversity nexus are explored.

As one of the core principles of Directive 2014/89/EU (2014), the application of an ecosystem-based approach emphasises multi-disciplinary knowledge and cross-border cooperation through cross-sectoral planning that integrates shipping, fishing, renewable energy, conservation, and tourism. Nevertheless, environmental concerns remain frequently subordinate to economic growth agendas (e.g., Qiu & Jones, 2013). Cumulative impact assessments and protection of marine biodiversity are not consistently embedded in planning frameworks (Katsanevakis et al., 2020), although according to Directive 2014/89/EU (2014), monitoring, data-sharing, and stakeholder involvement are essential, especially as balancing economic development with ecological protection can create tensions.

Therefore, effective MSP depends on high-quality spatial data, but significant gaps persist in availability, standardisation, and cross-sectoral integration (Ehler & Douvere, 2009; Stelzenmüller et al., 2013). Integration of ecological, economic, and social dimensions remains a scientific and technical challenge (Kidd & Ellis, 2012). In this respect, data availability and integration, as well as stakeholder participation and

legitimacy, represent two key issues that need to be addressed in developing the process and procedures of MSP to ensure as smooth and efficient an MSPlan as possible. According to the literature review, the depth and quality of stakeholder engagement also vary. For example, Twomey and O'Mahony (2019) refer to a comparative study in the European Atlantic, stressing that government decision-makers and statutory stakeholders are usually well or even overrepresented. Civil society stakeholders such as NGOs, the science community, and local community groups also play an active role; however, stakeholders from industry are usually under-represented. However, the legitimacy of MSP processes hinges on more inclusive and deliberative participatory models (Katsanevakis et al., 2011). Therefore, considerable emphasis should already be placed on this when setting up the processes and procedures, including the timing and design of both engagement processes and participatory processes.

Although industry stakeholders usually do not participate in participatory processes, there are sectors that show increasing interest in marine space, which often leads to spatial conflicts (e.g, Schultz-Zehden et al., 2019). The MSP literature emphasises the need for tools to manage trade-offs and resolve multi-sectoral conflicts (e.g., Flannery et al., 2016, 2018).

Jones et al. (2016) emphasise the necessity of adaptability and monitoring in the revision of several European MSP approaches, and in doing so highlight several key issues that should be taken into account when setting up the processes and procedures for MSP. Their findings indicate that (a) MSP often prioritises specific sectoral objectives aligned with national strategic priorities, resulting in limited implementation of the integrated approach envisioned in the MSPlan; (b) MSP processes tend to be complex, fragmented, and ad hoc rather than adaptive and cynical; (c) top-down processes tend to dominate, rather than being undermined by the potentially conflicting priorities of other stakeholders, whose participation is usually somehow compelling at a conceptual level, however would their applicability in reality appear to be limited by the ad hoc, complex, sectoral fragmented and top-down characteristics of the structures and processes of actual MSP, which are more focused on strategic sectoral planning; and (d) blue growth is the overarching priority, often aligned with strategic sectoral priorities, despite growing indications that the 2020 Good Environmental Status target is unlikely to be met. It is concluded that the realities of MSP often contrast with widely recognised concepts and ideals. In practice, integrated-use MSP, driven by political expedience and blue growth priorities, diverges from—and may even compete with—ecosystem-based MSP, including marine protected area networks, guided by Good Environmental Status priorities (Jones et al., 2016).

A key message for the preparation of MSP processes and procedures is the need to pay critical attention to possible future gaps between an MSPlan and its implementation. This should include a mechanism for critically analysing whether the realities of the MSPlan are consistent with its concept and for supporting the development of processes and procedures that enable sustainable adaptability and monitoring of MSPlan implementation.

In the context of MSP in Europe, this article further presents a proposal for the process and the procedures for the preparation and implementation of the MSPlan for Slovenia. Directive 2014/89/EU (2014) requires every coastal member state of the EU to set up an MSP process and to prepare and adopt an MSPlan. Slovenia, as a Mediterranean country, must also implement the Protocol on Integrated Coastal Zone Management in the Mediterranean (Protocol on integrated coastal zone management in the Mediterranean, 2009). In this context, detailed knowledge of current and expected conflicting interests and situations, overlaps in actual land uses and regimes, and the water-economy-ecology-society nexus is of great importance.

This article is based on the research project, entitled Development of the Process and Procedures for the Preparation of Integrated Maritime Spatial Planning (2016–2018), which was co-financed by the Ministrstvo za naravne vire in prostor (in English, Ministry of Natural Resources and Spatial Planning [MNVP]) and the Slovenian Research and Innovation Agency. The article aims to present the process of establishing the procedures and mechanisms required to develop the MSPlan. This includes stakeholder engagement, the definition of the MSPlan's content and format, and a proposed approach for monitoring its implementation. It also highlights several key innovations, such as the identification of relationships and interactions within the process itself, as well as between the process and the supporting procedures, both of which are critical for ensuring the successful preparation of the MSPlan.

The structure of the article is as follows. Section 1 introduces the fundamental premises of MSP, offering a general overview of the European MSP literature in highlighting key issues and research questions. Section 2 presents the rationale for sustainable MSP and introduces the conceptual framework, emphasising the integration of ecosystem-based and collaborative approaches. Section 3 focuses on the development of processes and procedures for the MSPlan. It details the formal framework, outlines the preparation process, explores the relationships between its stages and steps, describes the implementation procedures, and reflects on the interactions between processes and procedures. Section 4 outlines the proposed contents and formats of the MSPlan. Section 5 discusses the implementation potential and challenges of the proposed MSP approach, reflects on the current MSPlan of Slovenia, and provides insights relevant to both the BlueGreen Governance project (BlueGreen Governance, n.d.) and the broader scientific community. Section 6 concludes with a summary of the key findings and messages.

2. Conceptual Framework

The definition of the conceptual framework is justified by Directive 2014/89/EU (2014), which establishes a framework for MSP, mandates the use of an ecosystem approach, and promotes the coexistence of relevant activities and uses. The integration of ecosystem and collaborative approaches represents the basic starting point for the development of the conceptual framework of MSP.

The ecosystem-based approach as a planning and management principle primarily refers to the balance of human activities regarding the ecosystem characteristics of the area and aims to maintain the structure and functioning of marine ecosystems while enabling sustainable economic activity (e.g., Douvere & Ehler, 2011; Katsanevakis et al., 2011). For this reason, in the context of spatial planning, it represents a sustainable approach and an integral starting point. It is important to understand that just as space is, ecosystems are. That ecosystems can be compatible differently with different activities and that activities do not necessarily have to be negatively correlated with the functioning of ecosystems.

The ecosystem approach is, therefore, also a tool that offers a framework for action and a principle for the management of land, water, and resources, supporting their conservation and sustainable use in an impartial and equitable way, aligning with the principles outlined by the Convention on Biological Diversity (2000). This approach calls for a comprehensive understanding of ecosystem structures, functions, and interactions, ensuring that planning decisions are grounded in ecological realities.

By considering the ecosystemic approach, MSP can become a tool for careful and rigorous control of human activities by positioning them spatially and temporally in the natural marine environment in such a way that they do not compromise its functioning and quality. The ecosystem approach establishes the scientific basis for reconciling the different economic, social, and environmental demands on the marine environment with its carrying capacity. In this context, planning serves as an effective tool and process for preventing conflicts among different users of marine space and its adjacent inland areas, enabling the sustainable management of activities and the enhanced protection and conservation of marine living resources (Maes, 2008).

Further, the implementation of the ecosystemic approach in MSP as a tool and framework of measures enables the integration or implementation of the concept of adaptive governance (e.g., Ansong et al., 2017). Adaptive governance in policy processes that address complex problems highlights the importance of experimentation, strengthening adaptability, long-term monitoring, continuous improvement, learning capacity, and stakeholder involvement. Flexible approaches can theoretically align policies and governance activities with new insights, changing circumstances, and emerging preferences. According to Giebels et al. (2013), adaptive governance can be understood as an attempt to increase the flexibility of management systems to adapt more successfully to constant change. This is based on the recognition that states of equilibrium in social and environmental systems are temporary and vulnerable. Thus, the dynamic, multidimensional, and multi-level nature of adaptive governance, which usually involves many different actors, contains specific characteristics and requirements concerning how knowledge is acquired and used in the decision-making process.

Incorporating adaptive governance into MSP ensures that planning processes remain responsive and resilient. It involves the regular monitoring and evaluation of both environmental and socio-economic outcomes, facilitating iterative improvements and informed decision-making. By fostering collaboration among diverse stakeholders and integrating scientific knowledge with local insights, adaptive governance enhances the legitimacy and effectiveness of spatial planning initiatives (e.g., Ansong et al., 2017; Frank-Kamenetsky et al., 2023).

In summary, the ecosystem-based approach provides a holistic framework for MSP that harmonises human activities with ecological systems. When coupled with adaptive governance, it enables planners to navigate the complexities of environmental management, ensuring that development is both sustainable and equitable. Together, these approaches support the creation of resilient socio-ecological systems capable of withstanding and adapting to future challenges. Such reasoning represents the basic underlying principle in further shaping and developing the process and procedures of MSP Goličnik Marušić et al. (2018) proposed for Slovenia.

3. Development of the Process and Procedures for the MSPlan

This section reflects on the conceptual basis of the MSPlan preparation process and presents the results in terms of the key process phases and their characteristics for achieving an integrated MSPlan. Firstly, it highlights the formal framework that must be understood before developing the MSP process and procedure. Secondly, the article presents the proposed process and procedures for MSP in Slovenia as developed by Goličnik Marušić et al. (2018). The proposal for the MSPlan preparation process was conceptualised on three interrelated premises:

1. The concept of MSPlan monitoring should be considered and known already in the preparation phase to ensure meaningful and effective monitoring of both the implementation of the MSPlan and the state of the environment.
2. Analyses of the obtained expert studies, other relevant sources, and the state of the environment constitute the first step in the MSP process and lead directly to a well-balanced spatial plan.
3. To identify the approaches and tools needed to support and implement the process from the outset, thereby enabling the effective implementation of the process.

Accordingly, we suggested the MSPlan preparation process to consist of four phases, as shown in Figure 1 (Phase 1: preliminary preparation of the MSPlan; Phase 2: preparation of the MSPlan; Phase 3: monitoring and evaluation of the implementation of the MSPlan; and Phase 4: modification and amendment of the MSPlan), and are commented in detail in Section 3.2.

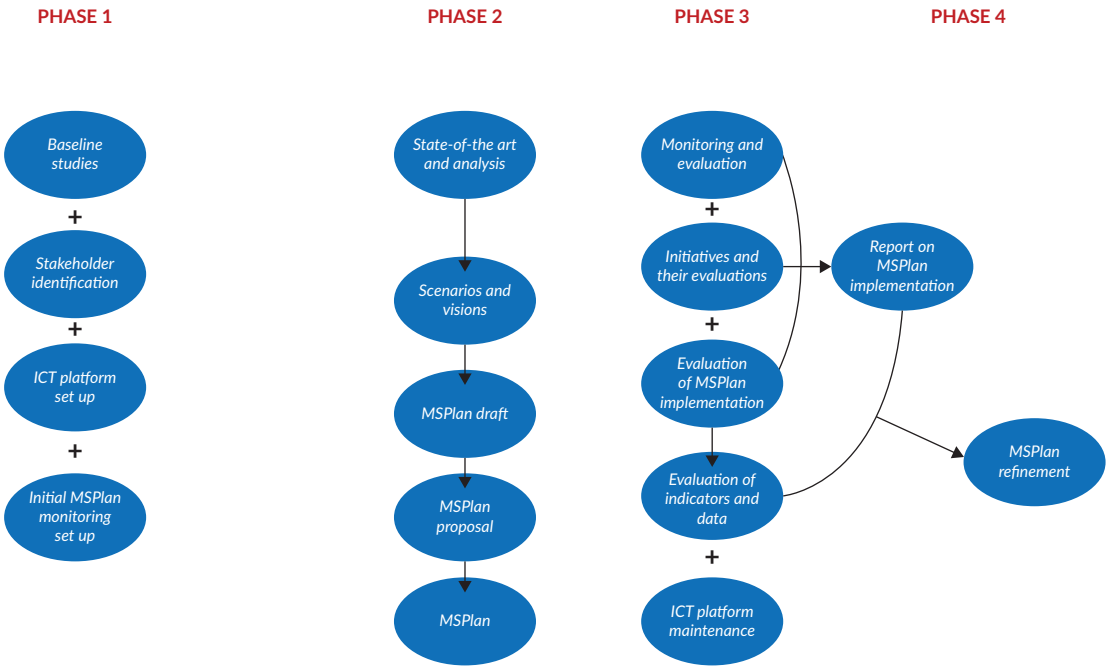


Figure 1. A flowchart of the MSPlan process structure. Source: Goličnik Marušić et al. (2018). Note: ICT stands for information-communication technology.

3.1. Formal Framework

This section presents an overview of the key supranational commitments/obligations and their implementation, and an overview of relevant national strategies and programmes, including the interpretation of current legislation (Zakon o urejanju prostora [ZUreP-3], including Zakon o varstvu okolja [ZVO]-2, Zakon o varstvu narave) for the implementation of MSP.

The key obligations to which Slovenia has committed are as follows:

- A requirement under Directive 2014/89/EU (2014) establishing a framework for MSP foresees the establishment of MSPlans by EU member states by 31 March 2021 at the latest. In 2021, Slovenia

adopted the first MSPlan of Slovenia, and in 2025, it carried out the first three-year assessment of its implementation as part of the *Slovenian Spatial Development Report* drafted in 2024.

- A requirement of Directive 2008/56/EC (2008) establishing a framework for action by the EU in the field of marine environmental policy (Marine Strategy Framework Directive) for each member state to draw up a marine strategy for its marine waters in respect of each marine region or subregion concerned. Slovenia fulfils this requirement with the current Marine Environment Management Plan for the period 2022–2027 (MNVP, 2022).
- A requirement under Directive 2000/60/EC (2000) for member states to ensure that a river basin management plan is drawn up for each river basin district lying entirely within their territory. Slovenia fulfils this requirement with the Decree on Water Management Plans in the water areas of the Danube and the Adriatic Sea for the period 2023–2027 (Government of the Republic of Slovenia, 2023).
- As a party to the Protocol on Integrated Coastal Zone Management in the Mediterranean (Protocol on integrated coastal zone management in the Mediterranean, 2009), Slovenia is required to prepare a national strategy for integrated coastal zone management, as well as plans and programmes for its implementation. There is currently no national strategy for integrated coastal zone management. The Decree on the Maritime Spatial Plan of Slovenia (Government of the Republic of Slovenia, 2021) about the Protocol on Integrated Coastal Zone Management in the Mediterranean highlights the need for the state to establish the coastal zone as a special management area and to set up a management structure for integrated coastal zone management.

The inclusion of maritime-related topics can be found in some Slovenian strategic documents.

At the national level, a Resolution of the Maritime Directorate of the Republic of Slovenia (National Assembly of the Republic of Slovenia, 1991) underscores the importance of pursuing a maritime-oriented economic and development policy, promoting the prudent use of the coastal area, preserving natural and cultural heritage, and ensuring maritime regulation in accordance with international law.

The Resolution on the National Maritime Development Programme of the Republic of Slovenia (Government of the Republic of Slovenia, 2010) provides guidelines for the development of maritime affairs and thus more efficient use of advantages such as access to the Adriatic Sea, a modern cargo and passenger port, and a maritime economy and education. Regulation is envisaged through state spatial plans. The document also discusses the possibility of developing a maritime cluster and protecting the marine environment.

The Development Strategy of Slovenia 2030 (Government of the Republic of Slovenia, 2017) mentions marine resources in the chapter on sustainable management of natural resources. It is committed to the effective management of coastal and marine resources and the achievement of their good status.

The valid Spatial Development Strategy of Slovenia 2050 (MNVP, 2023) provides strategic guidelines for the spatial development of offshore uses and the related spatial development of the coastal zone and other areas of influence, both at the national and supranational level. Within the framework of the guidelines for specific areas, it pays special attention to the development of activities at sea and in the coastal zone. The strategy aims to balance economic growth, environmental protection, and sustainability. The Port of Koper and its hinterland infrastructure play a crucial role in connecting Slovenia to key European corridors. The region promotes sustainable tourism, agriculture, and fisheries while striving for the protection of

natural and cultural assets. Marine-related industries are prioritised, while harmful coastal activities are restricted. Cross-border cooperation with Italy and Croatia enhances transport, tourism, and energy infrastructure. Climate adaptation measures address sea-level rise, droughts, and urban pressures. A protected coastal belt ensures ecological connectivity and quality of life, limiting construction with few exceptions.

The regional development programme of the coastal-Karst region for the period 2021–2027 (Regional Development Centre Koper, 2022.) places appropriate emphasis on the development of activities at sea and in the coastal zone. Within the framework of the topic of coastal zone management, the programme pursues the objectives of protecting the coastal zone from development and finding opportunities for implementing spatial arrangements that contribute to the quality of life, the development of recreation and tourism, the protection of nature, cultural heritage, and the landscape (such as the arrangement of a pedestrian promenade along the entire coast, green and recreational areas, swimming pools, and tourist infrastructure intended for the general public). The programme also pursues the objective of relieving the coastal zone of traffic pressures within the framework of a sustainable mobility scheme. In this context, the programme has also identified several strategic regional projects that can significantly impact the sustainable development of the coastal zone.

3.2. MSPlan Preparation Process

The first phase (the preliminary phase of MSPlan preparation) consists of four sets of activities that may be conducted independently, simultaneously, or sequentially: preparation of expert background studies; stakeholder identification and mapping, including the use or establishment of an online communication platform to facilitate active stakeholder participation; and the preliminary definition of the MSPlan's monitoring and evaluation system.

Preparation of background expert studies covers a wide range of activities, including the development of baseline studies that serve as starting points for the MSPlan preparation. This involves analysing guidelines and data from spatial planning authorities and other stakeholders, for example, assessing the state of the marine environment, interpreting environmental descriptors for planning marine uses and activities, and evaluating impacts on economic development and society. Stakeholder identification and mapping in the MSPlan process aims for a cross-sectoral approach. It begins by identifying the coordinator between MSPlan implementers and stakeholders, followed by defining the stakeholders and their respective roles. Where possible, an online platform is recommended to facilitate this process, bringing together spatial planning authorities and stakeholders to encourage active participation. This collaborative tool supports spatially coherent and complementary multifunctional use of marine spaces. Finally, the preliminary phase of defining the MSPlan's monitoring and evaluation system is essential. It ensures early integration with the spatial monitoring system and introduces the indicators that will later be used to assess the MSPlan. This makes the evaluation criteria clear from the outset and promotes consideration of the links between environmental indicators and descriptors.

The second phase (MSPlan preparation) comprises five interlinked stages, from initial analysis and scenario development to the final plan. The analytical phase presents and examines the current situation, processes, demand, planned activities, potential conflicts, synergies among human activities, and their interaction with

the marine environment, including the need for a comprehensive environmental impact assessment. Based on this analysis, stakeholders engage to develop and select suitable development scenarios and create a vision for the marine area and its hinterland. Using this foundation, a draft MSPlan is prepared in line with national strategic documents, Directive 2014/89/EU, and the Spatial Planning Act. Following public consultation and feedback, the initial draft is refined into the final MSPlan draft. Such an MSPlan draft must include both a textual description and a cartographic representation of planned activities and uses within the marine space. This includes details on spatial development, a programme for locating planned facilities and areas, a plan for public utility infrastructure and its capacities, and land-use plans for the coastal zone and hinterland. The draft should first establish priorities and measures to implement the planned maritime activities and align with long-term strategic documents. Second, it should provide guidelines for preparing subordinate spatial plans at the regional and municipal levels. Finally, such a draft MSPlan is shaped into a final MSPlan, which the Ministry of Spatial Planning prepares to be adopted by the government.

The third phase (MSPlan monitoring and evaluation) is crucial to achieving the desired development effects in the marine area and its hinterland. It consists of six interrelated steps (see column 3 in Figure 1). The MSPlan implementation report is the key product of the monitoring and evaluation phase, based on monitoring the marine environment and its hinterland, and on assessing proposed initiatives of the actors involved, together with their impacts on the marine environment against predefined indicators. With each evaluation, this phase also involves reviewing the relevance of indicators and suggesting adjustments if needed.

The MSPlan modification and amendment phase is the final stage of the preparation process, focused solely on updating the MSPlan. Updates are based on the findings of the implementation reports and evaluations of the indicator and data usefulness. According to ZUreP-3 (2021), updates are scheduled every 10 years; however, if justified by evaluation results, a new MSPlan may be prepared earlier.

3.3. The Relationships Between the Stages and Steps of the Process

When designing the process structure, special attention is given to the connections between phases, particularly the interrelations between individual steps, to highlight their reciprocal nature. The diagram structure of the MSPlan process and the relationships between its steps (Figure 2) illustrate these linkages. It emphasises both the importance of feedback loops between phases (see green lines in Figure 2) and the strong connections between the preliminary and main MSPlan preparation phases, particularly concerning stakeholder involvement (see orange lines in Figure 2).

Further, the MSPlan preparation process includes stakeholder involvement in two key phases: the preliminary phase (development of expert bases and baseline studies) and the main MSPlan preparation phase (all steps except the analytical phase, which builds on the expert bases from the previous phase of MSPlan preparation). Stakeholders representing governance, business and development, NGOs, the professional public, and others are identified and defined at the outset of the process.

In the preliminary MSPlan preparation phase, baseline studies are developed using key inputs from spatial planning policies, strategies, and programmes. Spatial planning authorities and other stakeholders are identified based on the territorial level of MSPlan preparation: Group 1 is based on transnational, cross-border, and national levels; Group 2 is the sub-national level; Group 3 is the regional level; and Group 4 is the local level.

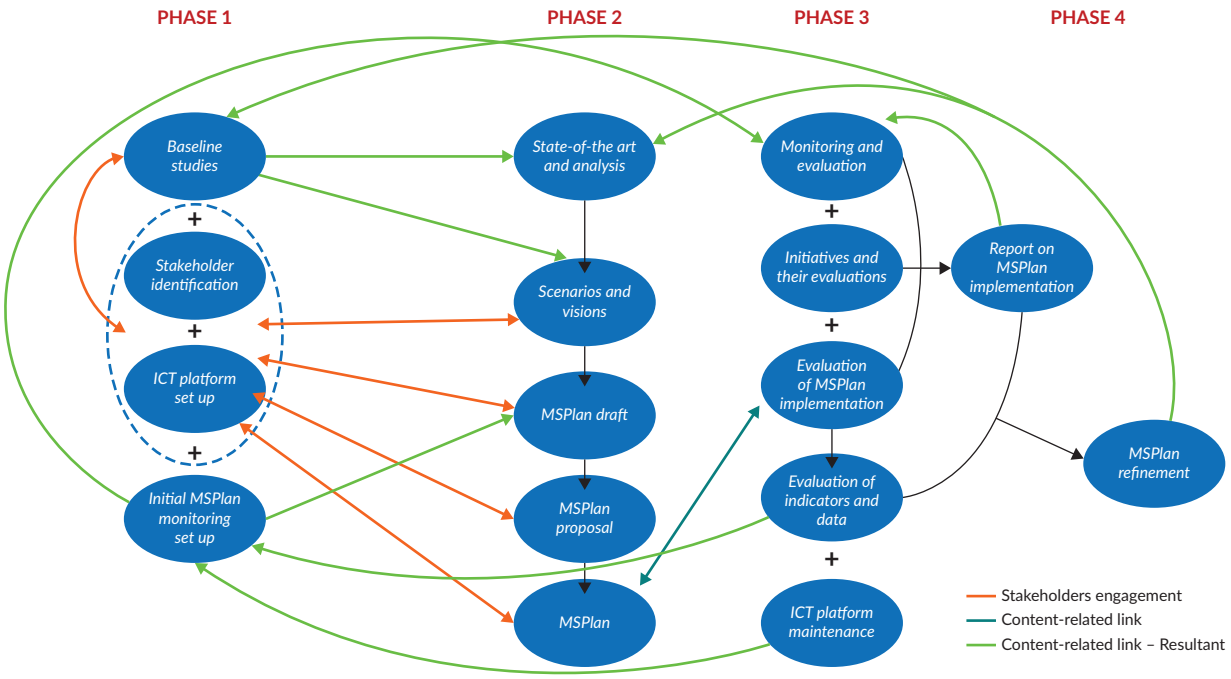


Figure 2. Structure of the MSPlan process and the relationships between its steps. Source: Goličnik Marušić et al. (2018).

Table 1 summarises the proposed preparation process and stakeholder involvement across various territorial and governance levels relevant to the MSPlan. It highlights how these contributions support the provision of development and protection guidelines, as well as other key information for the baseline studies in both the preliminary and main preparation phases.

In the second phase, stakeholders play a key role by constructively complementing the scientific baseline studies and contributing to the co-development of maritime and coastal activities, aiming to create synergies between sea uses and their land-based areas of influence.

The most crucial step in stakeholder involvement is the definition of development scenarios and a shared vision for the future. Public engagement methods may include information gathering, consultations, workshops, and social innovation labs. As a complementary tool for dialogue and consensus-building, an online interactive platform is proposed, serving as an information portal for sharing workshop materials, publishing outcomes, and facilitating ongoing communication during scenario and vision development. Subsequent steps in the MSPlan preparation phase are also vital, particularly when the draft MSPlan is circulated among spatial planners and stakeholders for review. Participation methods may vary and are defined by the MSPlan preparation team. These can range from collecting individual feedback to joint discussions between planners and stakeholders at different territorial levels, or broader workshops involving all stakeholders regardless of their territorial focus.

For illustration, all identified stakeholders can be actively involved in key steps of the second phase, such as defining development scenarios and visions and contributing to the draft MSPlan proposal. In contrast, active involvement in the preliminary phase is generally limited to stakeholders representing (strategic) development

or protection-related initiatives. The professional public and other stakeholders may also participate directly in the MSPlan preparation or specific parts of the process, depending on the discretion of the preparation team.

Table 1. Types and roles of stakeholders in the process of baseline studies preparation within the MSPlan preparation phase.

Territorial level	Stakeholders	Coordinator	Coordination media	Explanation/note
Transnational level, cross-border level, and national level	Ministry of Foreign Affairs Sectors Relevant economy and development actors	MNVP	Initial meeting with stakeholders, convened and coordinated by the MNVP Coordination meetings with stakeholders, convened and coordinated by the MNVP An online platform, if available	Defining and pursuing the national interest in global, international, and cross-border contexts
Sub-national level	Sectors Region Regionally important economy and development actors NGO	MNVP	Initial meeting with stakeholders, convened and coordinated by the MNVP Coordination meetings with stakeholders, convened and coordinated by the MNVP An online platform, if available	Prioritising national interests and balancing them with regional interests
Regional level	Sectors Region Regionally important economy and development actors NGO	MNVP	Initial meeting with stakeholders, convened and coordinated by the MNVP Coordination meetings with stakeholders, convened and coordinated by the MNVP An online platform, if available	Prioritising regional interests and aligning them with local interests
Local level	Municipality Locally important economy and development actors NGO	MNVP	Initial meeting with stakeholders, convened and coordinated by the MNVP An online platform, if available	Prioritising local interests

3.4. Procedure for the Implementation of the MSPlan

The MNVP, specifically the Directorate for Spatial Planning, Construction and Housing, is the national authority responsible for preparing the MSPlan. Under the Spatial Planning Act (ZUreP-3, 2021), the MSPlan serves as an action programme for implementing the Spatial Development Strategy of Slovenia. The preparation process will ensure the participation of neighbouring countries and relevant stakeholders involved. As part of the procedure, the Ministry issues guidelines for the preparation of the MSPlan to the designated MSPlan preparation team.

The process of drawing up an MSPlan procedure defines activities within three key temporal sequences: (a) before the start of the MSPlan preparation, (b) MSPlan preparation and adoption, and (c) MSPlan implementation, monitoring, and evaluation, and subsequent updates, as needed (see Figure 3).

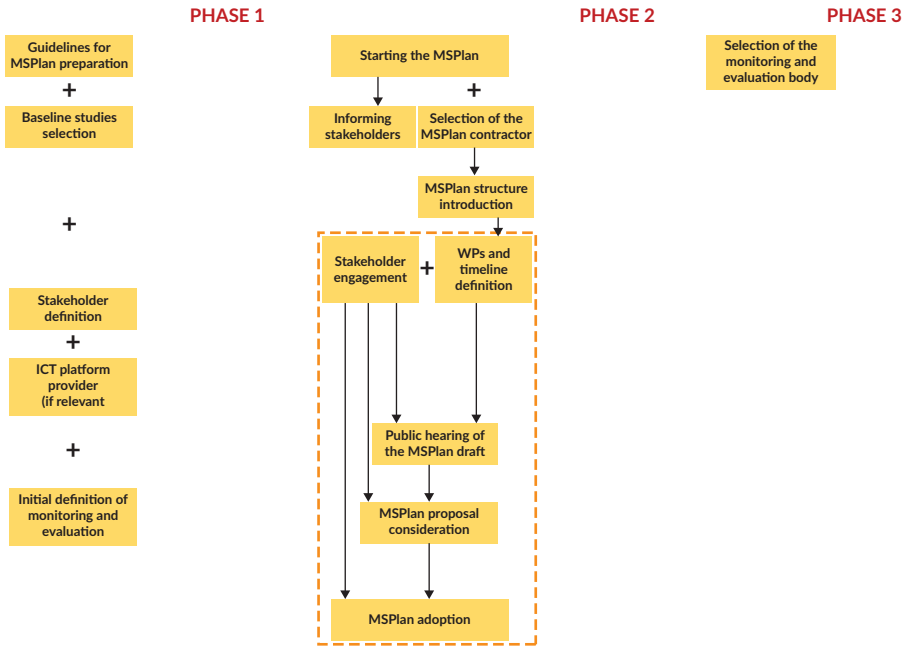


Figure 3. Structure of the MSPlan procedure. Source: Goličnik Marušić et al. (2018). Note: WP stands for work-package.

In the preliminary phase (Phase 1), the key procedures are recommended to ensure effective MSPlan preparation. These include issuing guidelines for MSPlan preparation, establishing a procedure for selecting baseline studies as mandatory starting points, designing and operationalising a communication platform, conducting the preliminary identification of stakeholders, and formulating the initial framework for monitoring and evaluation of the MSPlan. More specifically, for the selection of baseline studies, it is advisable to include a recommended timeframe—for instance, expert baseline studies should be completed within 12 months of the commencement of the process. Similarly, for the initial definition of the monitoring and evaluation system, the preliminary design of the monitoring framework should be established within six months of the start of the planning process.

Phase 2 (the preparation and adoption of the MSPlan) is typically the most procedurally demanding and fragmented stage of the planning process. It comprises a series of interdependent and iterative steps. Upon the official initiation of this phase, stakeholders are formally notified about the commencement of MSPlan preparation. Subsequently, the planning entity (a designated company or consortium) is selected and briefed on the proposed structure and scope of the MSPlan. This is followed by preparatory actions that lay the groundwork for the planning process (e.g., definition of work packages, estimation of timelines for each package, and coordination and engagement of stakeholders involved in plan development). This is followed by the detailed presentation of the individual phases of the MSPlan (e.g., MSPlan draft, amended MSPlan draft, and final MSPlan).

The methodological approach towards processes and procedures of the MSPlan, as well as its structure and the foreseen timeline for its preparation, have been outlined. For example, Goličnik Marušić et al. (2018) proposed the following segments for the MSPlan: (a) the legal and broader development framework of the MSPlan; (b) the MSPlan framework, including competences, responsibilities, key elements, and formats; (c) the process and procedure for preparing the MSPlan and its relationship with higher-level spatial planning

documents (MNVP, 2023), development planning (Government of the Republic of Slovenia, 2017), and the state's orientation at transnational and cross-border levels; (d) demonstration and analysis of the current situation, ongoing processes, demand, planned activities, and uses within the marine environment, particularly concerning the coastal zone and its hinterland; (e) definition of scenarios and visions for the future development of maritime space; (f) preparation of the MSPlan draft; (g) public consultation on the MSPlan draft; and (h) adoption of the MSPlan.

They also suggest an appropriate timeframe for completing these steps, estimating that the entire process should take about 18 months.

3.5. Process: Procedures Relations

One of the key innovations in the proposed concept for the MSPlan process and procedures is the identification of the relationships between them and how these relationships affect the MSPlan production. The structure of the MSPlan implementation procedure is designed to follow and support each phase of the MSPlan preparation process. Figure 4 illustrates these relationships, with the main connections highlighted by bold arrows. Recognising these connections is essential for ensuring a smooth preparation process. In the event of any bottlenecks, this clarity allows for swift and targeted interventions, as the links between procedures and the preparation process can be readily identified and addressed.

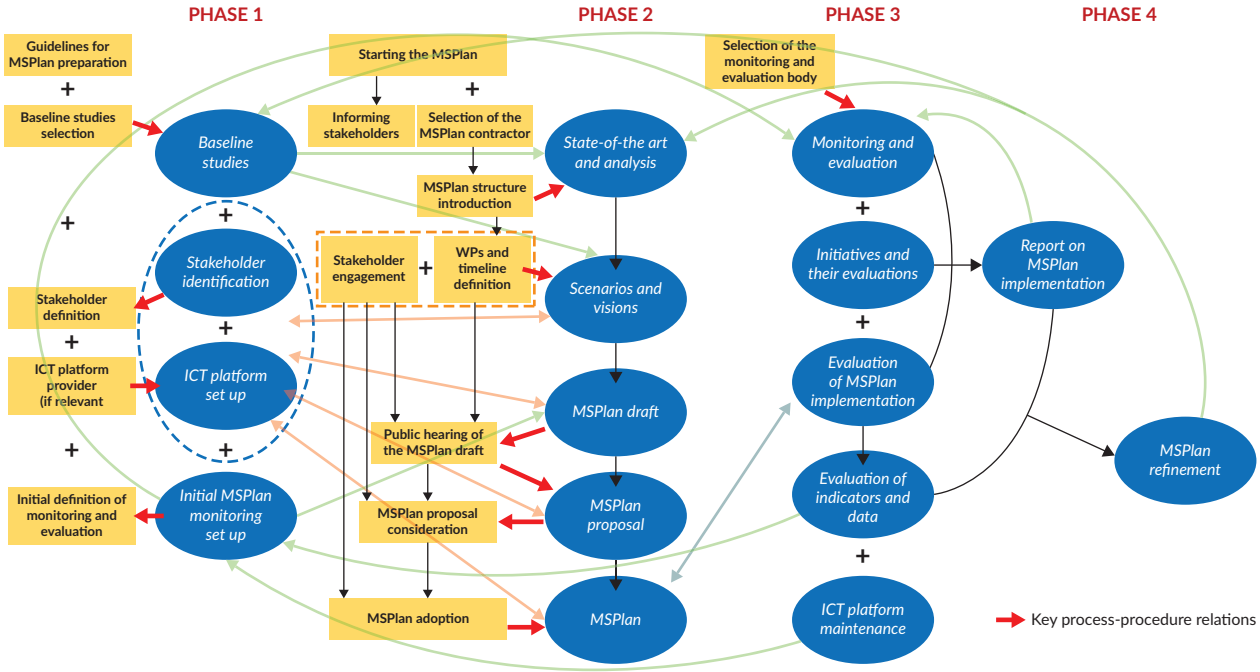


Figure 4. Relations between the process and the procedure in MSPlan preparation. Source: Goličnik Marušić et al. (2018).

4. MSPlan Contents and Form

The foundation for the content of the MSPlan is established by the EU Maritime Spatial Planning Directive 2014/89/EU, with particular emphasis on Articles 5, 6, 7, and 8. Given Slovenia's spatially limited marine area

and relatively short coastline, it is essential to provide detailed definitions of certain uses and activities, as the cumulative pressures exerted on the marine environment, coastline, and adjacent hinterland can be significant. The form of the MSPlan aligns with the requirements outlined in the Directive 2014/89/EU (2014), while also being harmonised with Slovenia's Spatial Planning Act and national spatial planning system. The MSPlan is composed of two main components: a strategic part and a detailed part. The strategic part presents the current state and planned activities, supported by cartographic representations at a scale of 1:250,000, offering a broad overview suitable for high-level decision-making. The detailed part provides finer spatial resolution at a scale of 1:50,000, where precise, up-to-date digital data on existing conditions and planned uses are depicted, enabling more granular analysis and implementation.

In line with the Spatial Planning Act (ZUreP-3, 2021), the MSPlan is developed as an action programme to implement the Spatial Development Strategy of Slovenia 2050 (MNVP, 2023). As such, the MSPlan serves as a strategic document guiding the development of activities in the marine area and its hinterland. To strengthen its connection with regional and local spatial planning documents, we propose a more detailed elaboration of the MSPlan in this context. Positioned appropriately within the hierarchy of planning documents, the MSPlan draws from higher-level national, cross-border, and supranational guidelines for maritime and coastal development. At the same time, it provides a foundation for subordinate planning documents at the regional and local levels.

Table 2 illustrates the relationship between the territorial levels relevant to maritime spatial planning and marine management. It emphasises the definition of the essential content required for maritime spatial planning, along with the corresponding scope and scale of the cartographic representations at each level.

Table 2. Territorial levels of MSPlan.

Territorial level	Document	Content	Territorial level of the cartographic representation in the document
Transnational level	Spatial Development Strategy of Slovenia 2050 (MNVP, 2023)	Creation of strategic spatial guidelines for Slovenia's participation in the implementation of the EU Strategy for the Adriatic and Ionian Region (EUSAIR; blue growth, regional integration, environmental quality, and sustainable tourism). Strategic spatial orientations are linked to the goals, orientations, and measures formulated in the Development Strategy of Slovenia 2030 (Služba Vlade Republike Slovenije za razvoj in evropsko kohezijsko politico, 2017)	A schematic representation (in digital form) of Slovenia's strategic spatial guidelines for activities within all four pillars of the EUSAIR is drawn on the prepared cartographic bases The display area covers the entire EUSAIR area

Table 2. (Cont.) Territorial levels of MSPlan.

Territorial level	Document	Content	Territorial level of the cartographic representation in the document
Cross-border level	Spatial Development Strategy of Slovenia 2050 (MNVP, 2023)	The creation of strategic spatial guidelines for cross-border cooperation between Slovenia and the neighbouring Republic of Italy and Croatia is linked to the applicable mutual agreements and understandings and the EUSAIR. The strategic spatial guidelines are also linked to the objectives, orientations, and measures formulated in the Development Strategy of Slovenia 2030 (Služba Vlade Republike Slovenije za razvoj in evropsko kohezijsko politiko, 2017)	A schematic representation (in digital form) of Slovenia's strategic spatial guidelines for the implementation of cross-border activities within the North Adriatic region is drawn on the prepared cartographic bases The display area covers the entire area of the Northern Adriatic and its wider hinterland areas from the Gulf of Trieste to the virtual line between the cities of Zadar (Croatia) and Ancona (Italy)
National level	Spatial Development Strategy of Slovenia 2050 (MNVP, 2023)	Setting up strategic spatial orientations of Slovenia for the development of its marine waters and hinterland, taking into account the strategic spatial orientations of Slovenia at the transnational and cross-border level	A schematic representation (in digital form) of Slovenia's strategic spatial orientations is drawn on the prepared cartographic bases The display area covers the whole of Slovenia
Sub-national level	MSP as the Action Programme (strategic part)	Selection of the most appropriate scenario for the strategic spatial development of marine space in relation to its coastal areas and hinterland, based on the strategic content and orientations developed at the transnational, cross-border, and national levels, and the known long-term development initiatives of the sectors	The prepared cartographic bases shall illustrate the situation and key planned activities in the marine space The cartography covers the area of the Slovenian waters and the coastal hinterland across the Karst edge to the settlement triangle formed by the settlements of Kozina, Divača, and Sežana
Sub-national level	MSP as the Action Programme (detailed part)	The strategic part forms the basis for a further detailed MSP proposal	The prepared cartographic bases shall display real data on the state of the art and planned activities in the maritime space, based on available digital data, for each individual activity or groups of compatible activities or uses Display area coverage: (a) The Bay of Koper and the coastal zone (b) The Bay of Piran and the coastal zone

Table 2. (Cont.) Territorial levels of MSPlan.

Territorial level	Document	Content	Territorial level of the cartographic representation in the document
Regional level/ Sub-municipal level	Regional Spatial Plan	The contents of the MSP as an action programme are transferred to the regional spatial plan	The prepared cartographic bases shall display real data on the state of the art and planned activities in the marine space, based on available digital data, for each individual activity or use defined in the content of the MSP, or for groups of compatible activities or uses The display area covers the adequate region
Local level/ Municipal level	Municipal Spatial Plan	On the basis of the established goals, directions, and measures of spatial development in the marine space and its hinterland, and within the framework of the regional spatial plan, spatial arrangements of local importance are presented in detail	The prepared cartographic bases shall display real data on the state of the art and planned activities in the marine space, based on available digital data, for each individual activity or use defined in the MSP, or for groups of compatible activities or uses The display area covers the territory of the municipality and considers the prescribed cartographic representations for the preparation of the Municipal spatial plans

Source: Goličnik Marušić et al. (2018).

5. Discussion

The project aimed to establish a process and set of procedures for the MSPlan that would comply with national legislation and align with relevant EU Directives, while also being innovative and pragmatic to ensure the future feasibility of MSPlan preparation. To test the implementation potential of the proposed MSP, we conducted a simulation involving stakeholder engagement through a focused group workshop. We also gathered and reviewed all available data relevant to fulfilling the minimum content requirements of the MSPlan. During this process, several challenges emerged, primarily due to the absence of necessary data and the inadequate quality of existing data identified as relevant under Directive 2014/89/EU. As a response, we recommended that the missing data be included in the list of official databases maintained by the relevant ministries. Additionally, data currently falling short of MSPlan requirements should be systematically recorded and gradually improved—both in quality and scope—to meet the standards necessary for effective maritime spatial planning.

5.1. MSPlan of Slovenia

Slovenia's current MSPlan (MNVP, 2021) was developed for a ten-year period and is based on key recommendations proposed by Goličnik Marušić et al. (2018). The responsibility for its preparation, monitoring, and evaluation lies with the state. The plan addresses both individual uses and activities at sea

and coastal areas, as well as the interactions between them. Key issues and challenges are presented both in a textual part and through graphical maps at four different scales as summarised in Table 3. Slovenia's MSP also includes annexes such as an environmental report and the current state of space.

Table 3. The list of maps of the MSPlan of Slovenia.

Scale	Map content
1:100,000	Maritime spatial plan area
1:250,000	Cross-border impacts of the Slovenian sea
	Concept of development of the Slovenian sea and coastal area
1:50,000	Mariculture areas
	Fishing areas, legal regimes, and restrictions
	Areas of maritime affairs and maritime transport
	Activity areas for the needs of defence and protection from natural and other disasters
	Nature conservation areas
	Areas of extraction of raw material
	Scientific research areas
	Areas of tourism, sport, and recreation
	Immovable cultural heritage protection areas
	Coastal strip at sea and on land
1:25,000	Coastal strip division into spatial planning units, part 1
	Coastal strip division into spatial planning units, part 2

A recent ex-post assessment and analysis examined the implementation of Slovenia's MSPlan for the period from its adoption in 2021 to 2024 (Gulič & Goličnik Marušić, 2024). This assessment was prepared as part of the Spatial Development Report 2024, developed to support the work of the MNVP. The evaluation focused on individual activities and uses as defined in Directive 2014/89/EU, which establishes a framework for maritime spatial planning.

The ex-post assessment of Slovenia's MSPlan, adopted in 2021, highlights several areas for potential improvement. Key recommendations include strengthening the consideration of climate-change resilience, particularly in relation to mariculture, and adopting a more coordinated cross-border approach to fisheries management. Multifunctionality in marine environments presents notable challenges. Greater attention is needed to assess the socio-economic impacts of energy infrastructure on fisheries and local communities; to align maritime transport planning with environmental and infrastructure needs, including international cooperation; and to define clearer biodiversity goals and monitoring mechanisms. Enhanced stakeholder engagement is also recommended, particularly in connection with the preparation and implementation of climate adaptation plans. In the tourism sector, the assessment found an insufficient focus on sustainability, specifically in limiting mass tourism, reducing emissions, and addressing the impacts of climate change. A more robust environmental monitoring system is necessary. Regarding underwater cultural heritage, the MSPlan lacks detailed management strategies, long-term conservation measures, and the use of modern documentation tools such as 3D modelling. It also needs clearer guidance on integrating heritage protection into sustainable tourism development.

The implementation of Slovenia's MSPlan has involved varying levels of engagement across different sectors. State departments have been particularly active in the fields of mariculture and fisheries, concentrating on ongoing activities, regulatory preparations, and measures related to the European Maritime, Fisheries, and Aquaculture Fund. Departments responsible for defence, disaster protection, and nature conservation have also been proactive in carrying out planned MSPlan activities. Additionally, notable progress has been made in areas such as raw material extraction, scientific research, and underwater cultural heritage, where activities are generally aligned with the indicators set out in the MSPlan.

However, limited activity has been observed in several key sectors. State departments have not made significant progress in areas such as energy infrastructure, maritime transport, submarine cables and pipelines, or tourism. These gaps indicate shortcomings in the implementation of the MSPlan, particularly in sectors that are critical to sustainable economic development and environmental sustainability. Strengthening engagement in these areas could significantly improve the overall effectiveness of maritime spatial planning in Slovenia. Importantly, this ex-post analysis serves not only as a monitoring tool for the current MSPlan's implementation but also as a baseline for the next generation of the plan. It also highlights where gaps occurred in stakeholder involvement or where willingness to participate was lacking, offering valuable insights to guide and improve the preparation and implementation of future MSPlans.

5.2. Relevant Insights for the BlueGreen Governance Project and the Wider Scientific Community

This article reflects on the Slovenian MSP process, with particular focus on the pre-MSP activities. It details how the planning process and procedures were developed and later used as the key expert baseline for the current Slovenian MSP. The article presents evidence of the attention given to cross-border aspects, demonstrating how these were integrated throughout the planning process and considered in the final Slovenian MSPlan (MNVP, 2021). These insights contribute to a broader understanding of integrated governance in MSP, particularly within the North Adriatic case study of the BlueGreen Governance (BlueGreen Governance, n.d.) project, where adaptive cross-border governance solutions are currently being tested.

Alongside a brief commentary on the evaluation of the MSPlan, this article places Slovenia's MSP within the broader context of European MSP challenges. It highlights the need to address gaps and shortcomings in MSPlan implementation, particularly in sectors critical to both sustainable economic development and environmental protection. The article also emphasises the importance of strengthening engagement in these areas to significantly enhance the overall effectiveness of MSP across Europe, including increasing stakeholder willingness to actively participate. This overview of the preparation phase for the Slovenian MSPlan highlights the importance of developing both the MSP process and its procedures in parallel, while continuously reflecting on their interrelation. This parallel approach ensures strong connectivity between the two and, most importantly, facilitates a smoother preparation of the final MSPlan.

6. Conclusions

This article presents the results of the research project Development of the Process and Procedures for the Preparation of Integrated Maritime Spatial Planning (2016–2018), which aimed to define both the process and procedures for preparing MSPlans. As part of the project, we proposed a four-phase MSPlan process:

Preliminary MSPlan preparation, MSPlan preparation, MSPlan implementation monitoring and evaluation, and MSPlan monitoring and updating. Each phase includes independent or sequential steps, with procedural links between them. A key connection between the preliminary and main preparation phases is the stakeholder involvement process. The structure ensures that all identified stakeholders can participate actively in the MSPlan preparation phase. In contrast, involvement in the preliminary phase is limited to representatives of strategic development or conservation initiatives. Depending on the judgment of the MSPlan team, experts and other stakeholders may be involved either directly or in specific parts of the planning process. To ensure transparency, traceable stakeholder involvement, and effective monitoring and evaluation of MSPlan implementation and updates, we proposed a web-based interactive platform—where feasible—as a supporting tool.

In accordance with Slovenian legislation, we propose that the MSPlan be structured as an Action Programme for implementing the Slovenian Maritime Spatial Development Strategy. Cartographic materials should be prepared at two scales, corresponding to strategic and detailed levels of planning. At the strategic level, the current state and key planned activities should be presented at a scale of 1:250,000. At the detailed level, accurate representations of the current situation and planned activities, based on available digital data, should be provided at a scale of 1:50,000. The final Slovenian MSPlan followed these recommendations. In addition, it included a general map of the entire marine spatial planning area at a scale of 1:100,000, as well as two detailed maps of the coastal strip at sea and on land. These were titled Coastal Strip Division into Spatial Planning Units, part 1 and part 2, and were prepared at a scale of 1:25,000.

The current analysis of MSPlan implementation, together with a review of its process and procedures, provides a crucial foundation for enhancing future planning, implementation, and monitoring activities. These findings also serve as a baseline input for the BlueGreen Governance project (BlueGreen Governance, n.d.), which considers the North Adriatic region as a cross-border case study.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Funding

The authors acknowledge the financial support from the Slovenian Research and Innovation Agency (research core funding No. P5-0100); the financial support from the Republic of Slovenia, Ministry of the Environment and Spatial Planning within the project Development of the Process and Procedures for the Preparation of Integrated Maritime Spatial Planning. The authors also acknowledge funding from the EU's Horizon Europe programme Grant agreement ID: 101086091.

Conflict of Interests

The authors declare no conflict of interests.

References

Ansong, J., Gissi, E., & Calado, H. M. G. (2017). An approach to ecosystem-based management in maritime spatial planning process. *Ocean & Coastal Management*, *141*, 65–81. https://doi.org/10.1016/j.ocecoaman.2017.03.005

BlueGreen Governance. (n.d.). *Home*. https://bggovernance.eu

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. (2000). *Official Journal of the European Union*, L 327.

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (marine strategy framework directive). (2008). *Official Journal of the European Union*, L 164.

Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning. (2014). *Official Journal of the European Union*, L 257. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0089

Douvere, F., & Ehler, C. N. (2011). The importance of monitoring and evaluation in adaptive maritime spatial planning. *Journal of Coastal Conservation*, *15*, 305–311. https://doi.org/10.1007/s11852-010-0100-9

Ehler, C., & Douvere, F. (2009). *Marine spatial planning: A step-by-step approach toward ecosystem-based management*. Intergovernmental Oceanographic Commission. http://unesdoc.unesco.org/images/0018/001865/186559e.pdf

Flannery, W., Ellis, G., & Ellis, G., Nursey-Bray, M., van Tatenhove, P. M., Kelly, C., Coffen-Smout, S., Fairgrieve, R., Knol, M., Jentoft, S., Bacon, D., & O'Hagan, A. M. (2016). Exploring the winners and losers of marine environmental governance/Marine spatial planning: *Cui bono*?/"More than fishy business": Epistemology, integration and conflict in marine spatial planning/Marine spatial planning: Power and scaping/Surely not all planning is evil?/Marine spatial planning: a Canadian perspective/Maritime spatial planning—"*ad utilitatem omnium*"/Marine spatial planning: "it is better to be on the train than being hit by it"/Reflections from the perspective of recreational anglers and boats for hire/Maritime spatial planning and marine renewable energy. *Planning Theory & Practice*, *17*(1), 121–151. https://doi.org/10.1080/14649357.2015.1131482

Flannery, W., Healy, N., & Luna, M. (2018). Exclusion and non-participation in marine spatial planning. *Marine Policy*, *88*, 32–40. https://doi.org/10.1016/j.marpol.2017.11.001

Frank-Kamenetsky, D., Schmidtbauer Crona, J., & Lundqvist, H. (2023). *Policy brief: An ecosystem-based approach delivers future-proof maritime spatial planning*. Emerging Ecosystem-based Maritime Spatial Planning Topics in the North and Baltic Sea Regions. https://www.emspproject.eu/wp-content/uploads/2024/01/Ecosystem-based-Approach-Policy-Brief-eMSP-NBSR-January-2024.pdf

Giebels, D., van Buuren, A., & Edelenbos, J. (2013). Ecosystem-based management in the Wadden Sea: Principles for the governance of knowledge. *Journal of Sea Research*, *82*, 176–187.

Goličnik Marušić, B., Gulič, A., Radovan, D., Kovačič, B., & Bizjak, I. (2018). *Development of the process and procedures for the preparation of integrated maritime spatial planning (2016–2018): Final report*. Urban Planning Institute of the Republic of Slovenia.

Government of the Republic of Slovenia. (2010). *Resolucija o nacionalnem programu razvoja pomorstva Republike Slovenije (ReNPRP)*. https://pisrs.si/pregledPredpisa?id=NACP41

Government of the Republic of Slovenia. (2017). *Slovenia's development strategy 2030*. https://www.gov.si/assets/ministrstva/MKRR/Strategija-razvoja-Slovenije-2030/Slovenian-Development-Strategy-2030.pdf

Government of the Republic of Slovenia. (2021). *Decree on the maritime spatial plan of Slovenia*.

Government of the Republic of Slovenia. (2023). *Decree on water management plans in the water areas of the Danube and the Adriatic Sea for the period 2023–2027*.

Gulič, A., & Goličnik Marušić, B. (2024). Pomorski prostorski plan Slovenije—naknadna ocena in vrednotenje izvajanja. *Urbani izziv*, *19*, 5–23.

Jay, S. (2010). Built at sea: Marine management and the construction of marine spatial planning. *Town Planning Review*, *81*(2), 173–191. https://www.jstor.org/stable/40660676

Jay, S., Flannery, W., Vince, J., Liu, W., Xue, J. G., Matczak, M., Zaucha, J., Janssen, H., van Tatenhove, J., Toonen, H., Morf, A., Olsen, E., de Vivero, J. L. S., Rodríguez Mateos, J. C., Calado, H., Duff, J., & Dean, H. (2013). International progress in marine spatial planning. *Ocean Yearbook Online*, *27*, 171–212. https://doi.org/10.1163/22116001-90000159

Jones, P. J. S., Lieberknecht, L. M., & Qiu, W. (2016). Marine spatial planning in reality: Introduction to case studies and discussion of findings. *Marine Policy*, *71*, 256–264. https://doi.org/10.1016/j.marpol.2016.04.026

Katsanevakis, S., Coll, M., Fraschetti, S., Giakoumi, S., Goldsborough, D., Mačić, V., Mackelworth, P., Rilov, G., Stelzenmüller, V., Albano, P. G., Bates, A. E., Bevilacqua, S., Gissi, E., Hermoso, V., Mazaris, A. D., Pita, C., Rossi, V., Teff-Seker, Y., & Yates, K. L. (2020). Twelve recommendations for advancing marine conservation in European and contiguous seas. *Frontiers in Marine Science*, *7*, Article 565968. https://doi.org/10.3389/fmars.2020.565968

Katsanevakis, S., Stelzenmüller, V., South, A., Sørensen, T. K., Jones, P. J. S., Kerr, S., Badalamenti, F., Anagnostou, C., Breen, P., Chust, G., D'Anna, G., Duijn, M., Filatova, T., Fiorentino, F., Hulsman, H., Johnson, K., Karageorgis, A. P., Kröncke, I., Mirto, S., . . . Hofstede, R. (2011). Ecosystem-based marine spatial management: Review of concepts, policies, tools, and critical issues. *Ocean & Coastal Management*, *54*(11), 807–820. https://doi.org/10.1016/j.ocecoaman.2011.09.002

Kidd, S., & Ellis, G. (2012). From the land to sea and back again? Using terrestrial planning to understand the process of marine spatial planning. *Journal of Environmental Policy & Planning*, *14*(1), 49–66. https://doi.org/10.1080/1523908X.2012.662382

Maes, F. (2008). The international legal framework for marine spatial planning. *Marine Policy*, *32*(5), 797–810.

Ministrstvo za naravne vire in prostor. (2022). *Načrt upravljanja z morskim okoljem 2022–2027*. https://www.gov.si/assets/ministrstva/MOP/Dokumenti/Voda/NUMO/NUMO_2022_2027.pdf

Ministrstvo za naravne vire in prostor. (2023). *Strategija prostorskega razvoja Slovenije 2050*. https://www.gov.si/assets/ministrstva/MNVP/Dokumenti/Prostorski-razvoj/SPRS/Strategija_prostorskega_razvoja_2050.pdf

Ministrstvo za naravne vire in prostor. (2021). *Pomorski prostorski plan Slovenije*. https://dokumenti-pis.mop.gov.si/javno/veljavni/PPP2192/index.html

National Assembly of the Republic of Slovenia. (1991). *Resolution on the maritime orientation of the Republic of Slovenia*.

Protocol on integrated coastal zone management in the Mediterranean. (2009). *Official Journal of the European Union*, L 34/19. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22009A0204%2801%29

Qiu, W., & Jones, P. J. S. (2013). The emerging policy landscape for marine spatial planning in Europe. *Marine Policy*, *39*, 182–190. https://doi.org/10.1016/j.marpol.2012.10.010

Regional Development Centre Koper. (2022.). *Regionalni razvojni program Obalno-Kraške regije za obdobje 2022–2027* https://www.gov.si/assets/ministrstva/MKRR/DRR/RRP-2021_2027/RRP-Obalno-kraske-razvojne-regije.pdf

Schultz-Zehden, A., & Gee, K. (2019). *Maritime spatial planning: Past, present and future*. Springer. https://doi.org/10.1007/978-3-319-98696-8

Schultz-Zehden, A., Gee, K., & Lukic, I. (2019). Marine spatial planning and the EU's blue growth policy: Past, present and future perspectives. In A. Schultz-Zehden & K. Gee (Eds.) *Maritime spatial planning: Past, present and future* (pp. 121–149). https://link.springer.com/book/10.1007/978-3-319-98696-8

Služba Vlade Republike Slovenije za razvoj in evropsko kohezijsko politiko. (2017). *Strategija razvoja Slovenije 2030*. https://www.gov.si/assets/ministrstva/MKRR/Strategija-razvoja-Slovenije-2030/Strategija_razvoja_Slovenije_2030.pdf

Stelzenmüller, V., Lee, J., South, A., Foden, J., & Rogers, S. I. (2013). Practical tools to support marine spatial planning: A review and some prototype tools. *Marine Policy*, *38*, 214–227. https://doi.org/10.1016/j.marpol.2012.05.038

Twomey, S., & O'Mahony, C. (2019). Stakeholder processes in marine spatial planning: Ambitions and realities from the European Atlantic experience. In J. Zaucha & K. Gee (Eds.), *Maritime spatial planning* (pp. 295–325). Palgrave Macmillan. https://doi.org/10.1007/978-3-319-98696-8_13

Zakon o urejanju prostora. (2021). *Zakon o urejanju prostora (ZUreP-3)*. https://pisrs.si/pregledPredpisa?id=ZAKO8249

Zakon o varstvu narave. (2023). *Zakon o ohranjanju narave (ZON)*. https://pisrs.si/pregledPredpisa?id=ZAKO1600

Zakon o varstvu okolja (2022). Zakon o varstvu okolja (ZVO-2). https://pisrs.si/pregledPredpisa?id=ZAKO8286

Zaucha, J. (2014). Sea basin maritime spatial planning: A case study of the Baltic Sea region and Poland. *Marine Policy*, *50*, 34–45. https://doi.org/10.1016/j.marpol.2014.05.003

About the Authors

Barbara Goličnik Marušić is a senior researcher and Head of Research at the Urban Planning Institute of the Republic of Slovenia (UIRS). Her expertise includes spatial planning, urban design, and marine spatial planning, with a focus on developing innovative, research-based approaches that integrate nature-based solutions, circular economy principles, and behavioural mapping.

Andrej Gulič is a senior researcher at the Urban Planning Institute of the Republic of Slovenia (UIRS), specialising in spatial planning, regional development, climate change adaptation, and marine spatial planning. His work primarily focuses on integrated coastal and marine planning and governance, with an emphasis on strategic approaches.

Ocean and Society
2025 • Volume 2 • Article 10505
https://doi.org/10.17645/oas.10505

cogitatio

ARTICLE

Open Access Journal

Governance Challenges for the Adaptation to Sea-Level Rise in the Canary Islands: A Multilevel Approach

Aridane G. González [1], Carolina Peña-Alonso [1], Melchor González-Dávila [1], J. Magdalena Santana-Casiano [1], David González-Santana [1], Gianluca Ferraro [2], Lorena Naranjo-Almeida [1], and Leví García-Romero [1]

[1] Instituto de Oceanografía y Cambio Global (IOCAG), Universidad de Las Palmas de Gran Canaria, Spain
[2] Centre for Blue Governance, University of Portsmouth, UK

Correspondence: Aridane G. González (aridane.gonzalez@ulpgc.es)

Submitted: 10 April 2025 **Accepted:** 10 July 2025 **Published:** 2 September 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Island territories are particularly vulnerable to climate change due to their geographical isolation and environmental characteristics, as highlighted in the Intergovernmental Panel on Climate Change *Sixth Assessment Report*. In the Canary Islands, sea-level rise is a critical impact of climate change, affecting several coastal ecosystems, including beaches, dunes, and wetlands, as well as infrastructure and residential areas, which in turn significantly impacts tourism and housing. This study examines the existing climate change legislation and norms, focusing particularly on the islands' adaptation to sea-level rise as a socio-ecological system. It also analyses the intentionality and substantiality of these measures within a multilevel governance framework. Accordingly, this research provides an initial approach to constructing and studying the main governance network concerning sea-level rise in the Canary Islands through a combination of experiences, events, and mechanisms. Conflicts were identified between legislation and the implementation of adaptation measures, where the timescale for the latter is not aligned with the climate emergency. The study highlights coordination gaps that hinder effective adaptive management in the face of climate change. The findings emphasize the need for enhanced inter-institutional collaboration and propose mechanisms to harmonise policies, mitigate conflicts, and improve governance. Strengthening governance capacities in the Canary Islands could provide a model for other island territories facing similar challenges and contribute to global efforts to address the climate emergency and ensure sustainable development in vulnerable coastal regions. This is the first study to focus on the coastal governance in the Canary Islands in relation to sea-level rise.

cogitatio

Keywords
Canary Islands; climate change adaptation; coastal management; multilevel governance; ocean governance; sea-level rise

1. Introduction

Climate change represents one of the most important crises of the present century, with impacts on the environment, society, and economy. The Intergovernmental Panel on Climate Change (IPCC) has reported an increase in impacts such as global warming, extreme weather, ocean acidification, and rising sea-levels. These are all affecting ecosystems and human society (IPCC, 2023). These impacts are becoming more severe in island ecosystems, which are more vulnerable than continental ecosystems (Nurse et al., 2014), making adaptation essential (Betzold, 2015). This is due to their geographic isolation, limited territory size, dependence on external resources, and vulnerability to extreme weather events (Correa et al., 2025; Kelman & West, 2009; Mycoo et al., 2022). Rising sea-levels pose an especially serious threat to islands due to the increased risk of coastal flooding, saltwater intrusion into aquifers, and the loss of important ecosystems such as mangroves, wetlands, and beaches (Church et al., 2013; van den Hurk et al., 2024). However, other impacts are also considered to be of anthropogenic origin, such as reduced sediment supplies due to streamflow obstructions, urbanisation and habitat loss in exposed coastal areas, a lack of sustainable groundwater strategies, and ageing coastal infrastructure (van den Hurk et al., 2024). This is a common challenge for the entire EU, given the importance of its coasts for its growth (Tocco et al., 2024).

In this sense, the governance of coastal adaptation in the Canary Islands (the study area of the current research) poses a significant challenge due to the territory's unique characteristics. Located in the northeastern Atlantic, the Canary Islands are an outermost region of the EU and comprise eight islands with an area of around 515 km from east to west (Figure 1). The region covers an area of around 7,447 km^2, making it the largest in the Macaronesia region (Fernández-Palacios & Dias, 2001; Pérez-Chacón Espino et al., 2019), with around 52% of the territory under some form of protection. The trend of the impacts of

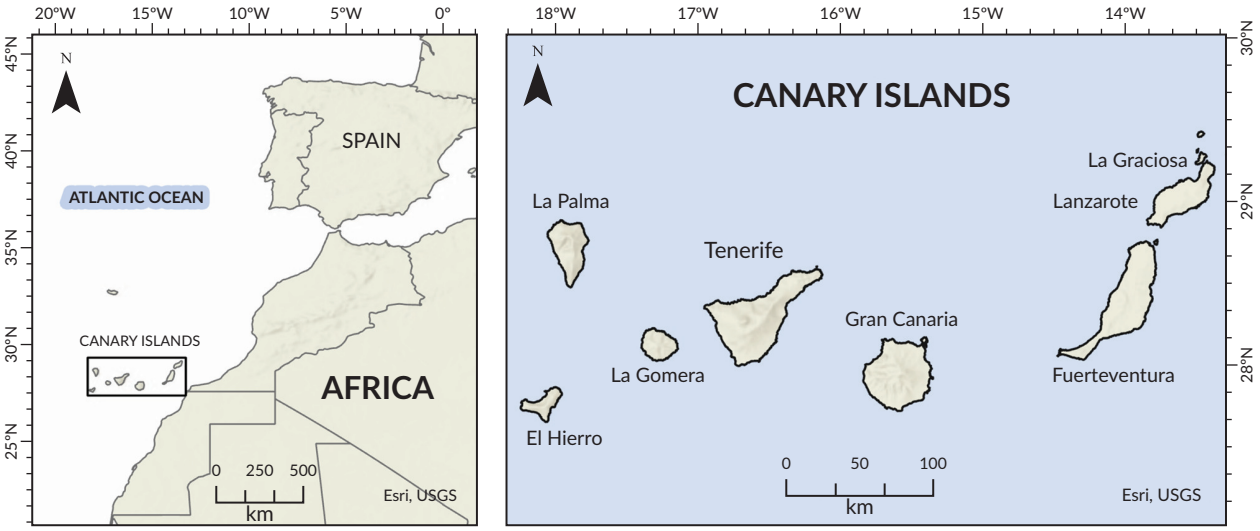


Figure 1. Study area: Location of the Canary Islands.

climate change has been studied there. Primary effects such as temperature (Correa et al., 2025) and ocean warming and acidification (González-Dávila & Santana-Casiano, 2023), for example, have been analysed for over 25 years, and there is clear evidence of these effects in the region. Other related impacts, such as tropical storms near the islands, precipitation, and tropical nights, have also been studied (Antequera et al., 2018; Correa et al., 2025; López-Díez et al., 2019). In fact, a climatic atlas (Söllheim et al., 2024) and projections (Carrillo et al., 2022; Expósito et al., 2015) under different scenarios have been developed to enhance understanding of potential future impacts in the Canary Islands.

Focusing on the sea-level rise in the Canary Islands, Vargas-Yáñez et al. (2023) reported an increase of 1.09 ± 0.14 mm yr^{-1} for the period between 1948 and 2019 using tide-gauge data and an increase of 2.7 ± 0.4 mm yr^{-1} from 1993 to 2019 using altimetry data. Additionally, Marrero-Betancort et al. (2022) reported the sea-level anomaly from 1993 to 2019 using satellite estimation, finding a total rise of approximately 8 cm during this period. This suggests that the increase will reach 18 cm by 2050, which will affect the islands' coastal environment and economy. The impacts also include dune systems, wetlands, and marine habitats (Peña-Alonso et al., 2018), as well as economic infrastructure such as ports, hotels, and residential developments. These are increasingly vulnerable to flooding, which could have severe economic consequences for the tourism industry and local livelihoods (García-Romero et al., 2023). Accordingly, projections of sea-level rise in the Canary Islands have been carried out (Gobierno de Canarias, 2022) to identify critical areas and infrastructures, the economic impact, and the number of people affected by the coastal flooding. The proposed solutions to mitigate this impact mainly focus on hard infrastructure (engineering) and nature-based solutions as proposed by Lise et al. (2025), which imply a transformation of the land–sea interface or a change in the maritime competencies. This is particularly pertinent in the context of the Canary Islands, where urban areas are highly affected (Gobierno de Canarias, 2022).

According to Tocco et al. (2024), the governance of coastal adaptation should include environmental, economic, social, and scientific information in order to address the challenges posed by sea-level rise, a global hazard. They proposed three recommendations to this end: "1) the effective implementation of EU marine and coastal legislation's fundamental principles related to an integrated approach; 2) the development of new governance mechanisms to enhance policy coordination, and 3) the development of collaborative governance processes" (Tocco et al., 2024). Moreover, multiple stakeholders must be involved in decision-making processes (Ferraro & Failler, 2024a). If coastal governance is considered the framework for compromising institutional, structural, and legal arrangements (Stephenson et al., 2019), then the confluence of heterogeneous management is mandatory when considering conflicts and difficult policy integration (Van Assche et al., 2020). This is particularly evident in the Canary Islands in relation to mainland Spain due to the confluence of legal competencies related to the decentralised structure between different administrations (from local to national level). Even though climate change governance has been in place for over 30 years, it is still in the process of being developed. Most efforts have focused on mitigation, but this is particularly true of adaptation, where political prioritisation and scientific development are needed because greenhouse gases remain in the atmosphere for a long time and their impacts will be felt for years. In addition, the science–policy interface for adaptation is still evolving, and governance structures are mainly reactive rather than anticipatory, although the impacts of climate change are well understood in many regions, including the Canary Islands. This global problem requires governments to reach credible agreements (Jordan et al., 2018), and, in terms of administrative systems, poses a significant challenge (Meadowcroft, 2009), primarily due to the inertia that hinders effective and timely responses.

When the focus is on a case like the Canary Islands, the coastal adaptation has to take into account the governments of European, national, regional, and island (cabildos, seven in total) levels, as well as the municipalities (88, of which 77 have coastal zones). The Regional Law on Climate Change and Energy Transition (2022) establishes a framework for climate mitigation and adaptation, addressing areas such as land use planning, infrastructure design standards, and risk assessment. Additionally, this law allocates certain responsibilities to cabildos and municipalities with regard to adaptation plans. Other sectoral laws are clearly related to adaptation strategies, such as those concerning coastal protection, urban development, and water management. Despite the importance of coastal areas to the Canary Islands' economy, there are no specific policies in place to integrate coastal and maritime management (García-Sanabria et al., 2011). This complexity highlights the need for analysis and recommendations to be implemented. To this end, the objectives of this article are:

- To examine existing laws, policies, and regulations in the Canary Islands that address climate change adaptation to sea-level rise.
- To analyse the intentionality and substantiality of legal policy and instruments at the multi-scale level (from European to municipal) associated with climate change adaptation in the context of sea-level rise.
- To identify governance challenges, including conflicts between legislation and the implementation of adaptation measures.
- To assess coordination gaps that hinder effective adaptive management, and to propose mechanisms for improved inter-institutional collaboration.

This research aims to enhance climate governance by shedding light on the unique challenges faced by highly vulnerable insular regions such as the Canary Islands.

2. Methodology

This study employs a multilevel policy analysis framework to assess governance structures responding to sea-level rise adaptation in the Canary Islands. For this purpose, we undertook a review of institutional instruments (e.g., policies, legislation, and plans) that are focused on climate change and sea-level rise. Our methods span content analysis of various policy documents with a structured evaluation framework developed using intentionality and substantiality based on the research of Elrick-Barr and Smith (2021) and built on the conceptualisation of Dupuis and Biesbroek (2013). This is the first study of this nature in the region.

2.1. Policy and Instruments Selection

We consider intentionality as the level to which the policy explicitly incorporates climate change adaptation, especially concerning sea-level rise, as a primary objective. In this case, intentionality demonstrates the design of a policy as a response to climate threats for coastal areas. We consider substantiality as the extent to which the policy includes solid, actionable, and enforceable measures to assist with adaptation efforts. This comprises the various implementation tools, measures of success, legally binding structures or enforceability, and operationalized plans.

The manuscript is organized as follows: (a) the current state of sea-level impacts in the region and their impacts on different sectors; (b) the description of the multilevel legal framework to attend the risk of sea-level rise, and the importance of the Law of Climate Change and Energy Transition (Comunidad Autónoma de Canarias, 2022) in the Canary Islands; (c) analysis the intentionality and substantiality of legal policy and instruments at the multi-scale level associated with climate change adaptation to sea-level rise; (d) the normative conflicts, institutional fragmentation, and barriers to effective adaptation in the Canary Islands; and eventually, (e) the recommendations for coastal adaptation governance in this case study. The study was conducted at four different scales, each of which has competence in the Canary Islands: national, regional, insular, and local.

2.2. Analysis

The current research has attempted to critically evaluate information in order to improve our understanding of public policy and make it better (Dunn, 2015; Vogel & Henstra, 2015). However, there is no universally accepted methodology for conducting policy analysis. Instead, the choice of method largely depends on the analysis's specific objectives, for example, whether the focus is on policy content or the policymaking process (Dunn, 2015). This analysis draws on the conceptual framework established by Dupuis and Biesbroek (2013) to help policy analysts assess the scope and intent of climate change adaptation policies. We have refined this framework by transitioning it from a purely conceptual model to an analytical tool. This has been achieved by introducing a rating system that evaluates policy instruments based on their degree of intentionality and substantiality, as defined by Elrick-Barr and Smith (2021), but adapted to three categories: low, moderate, and high (see Table 1). Intentionality, defined as the presence of a deliberate aim or plan, has its origins in psychological theory as an extension of causal models of behaviour (Turner, 2017). In a policy context, intentionality reflects the extent to which a policy deliberately targets a specific issue. Accordingly, instruments were considered intentional if coastal management constituted their primary objective. Integrated Coastal Zone Management, for instance, aims to sustain, restore, or enhance coastal ecosystems and the benefits that humans derive from them (Olsen, 2003). Therefore, a policy instrument was classified as intentional if it explicitly addressed coastal zone management and the preservation of coastal values.

To analyze both intentionality and substantiality, we applied a three-tier rating scale (Table 1): Low (1) = no or limited reference to adaptation in the context of sea-level rise; moderate (3) = partial or indirect reference to adaptation in the context of sea-level rise by including some relevant provisions; and high (5) = clearly and directly focused on adaptation in the context of sea-level rise with mechanisms or mandates for implementation. In this evaluation, we emphasize the climate adaptation component of each policy, regardless of whether adaptation was the initial or dominant objective. We recognize that some documents were meant to serve as strategic frameworks rather than operational plans; this distinction is considered in their substantiality ratings. In total, we reviewed 28 policies and plans at the five governance levels: International and EU—EU Strategy on Adaptation to Climate Change; national (Spain)—Law 7/2021, of 22 April, on Climate Change and Energy Transition; regional (Canary Islands)—Law 6/2022, of 2 November, on Climate Change and Energy Transition in the Canary Islands; island (Cabildos)—Island Spatial Plans (PIOs); and municipal—General Urban Development Plans (PGOUs).

For each policy we have documented, we recorded: legal and institutional coverage, intended objectives, types and strength of adaptation instruments, territorial coverage, and stage of operationalisation. In addition to scoring individual policies, we also considered barriers to effective adaptation by assessing the

Table 1. Intentionality and substantiality rating scale.

Rating	Intentionality	Substantiality
Low (1)	No intent to address coastal issues or values	Does not address values, threats, or actions
	Coastal issues and values are incidental to the focus of the instrument	Addresses one of three in part
Moderate (3)	Coastal issues are noted, values are not reported, and other issues (beyond coastal) are of greater focus	Addresses two of three in part; or one comprehensively
	Coastal issues are a partial focus; values are partially (e.g., indirectly addressed) or not addressed	Addresses three in part; or one comprehensively and one in part
High (5)	Coastal issues are a key focus, values are considered (perhaps indirectly), and the coast receives equal or greater attention than other issues	Addresses one comprehensively, two in part; or two comprehensively
	Coastal issues and values are a major (but not sole) focus of the instrument	Addresses two comprehensively, one in part
	The absolute intent of the instrument is on coastal issues and values	Addresses values, threats, and actions comprehensively

degree of fragmentation, failure in coordination, and time-lag between impacts of climate change and planning cycles. The types of barriers were determined from a grounded approach and literature (e.g., Ferraro & Failler, 2024a; Meadowcroft, 2009) and then analysed in the context of the multilevel governance system of the Canary Islands.

3. Results and Discussion

3.1. High-Level Risk in the Canary Islands due to the Sea-Level Rise

Before presenting results, we provide a contextual summary of the biophysical and socio-economic exposure of the Canary Islands to sea-level rise. To the Plan de Impulso al Medio Ambiente (PIMA), specifically the PIMA Adapta Costas in the Canary Islands (Gobierno de Canarias, 2022). This study is one of the most effective ways of highlighting the socio-economic areas that will be affected by rising sea-levels. Understanding the potential impacts of different climate scenarios enables the development of targeted public policies and the analysis of the regulatory framework, thereby enhancing governance in coastal adaptation in the Canary Islands.

These studies, which were carried out throughout Spain, form part of the National Plan for Adaptation to Climate Change (PNACC) and aim to provide a more precise regional analysis of the impact of rising sea-levels on coastal areas. The risk of sea-level rise was studied in relation to the population, infrastructure, productive sectors, tourist beaches, cultural and natural heritage, and coastal ecosystems. The number of people affected could range from 558 people (representative concentration pathways [RCP] 4.5, the most favourable scenario) to over 46,000 (RCP 4.5 and a return period of 500 years). Of these people, 55% would be directly affected, and the remaining 45% indirectly. In terms of critical infrastructure, hospitals, airports,

motorways, water treatment, and supply stand out as particularly affected. A total of 127 infrastructures will be affected, of which 23 show the least favourable scenario (Figure 2a, high critical level) and 104 present the most favourable scenario (Figure 2a, critical level), mainly on the island of Gran Canaria. Beach erosion is another major consequence of sea-level rise in a region where sun and beach tourism dominate.

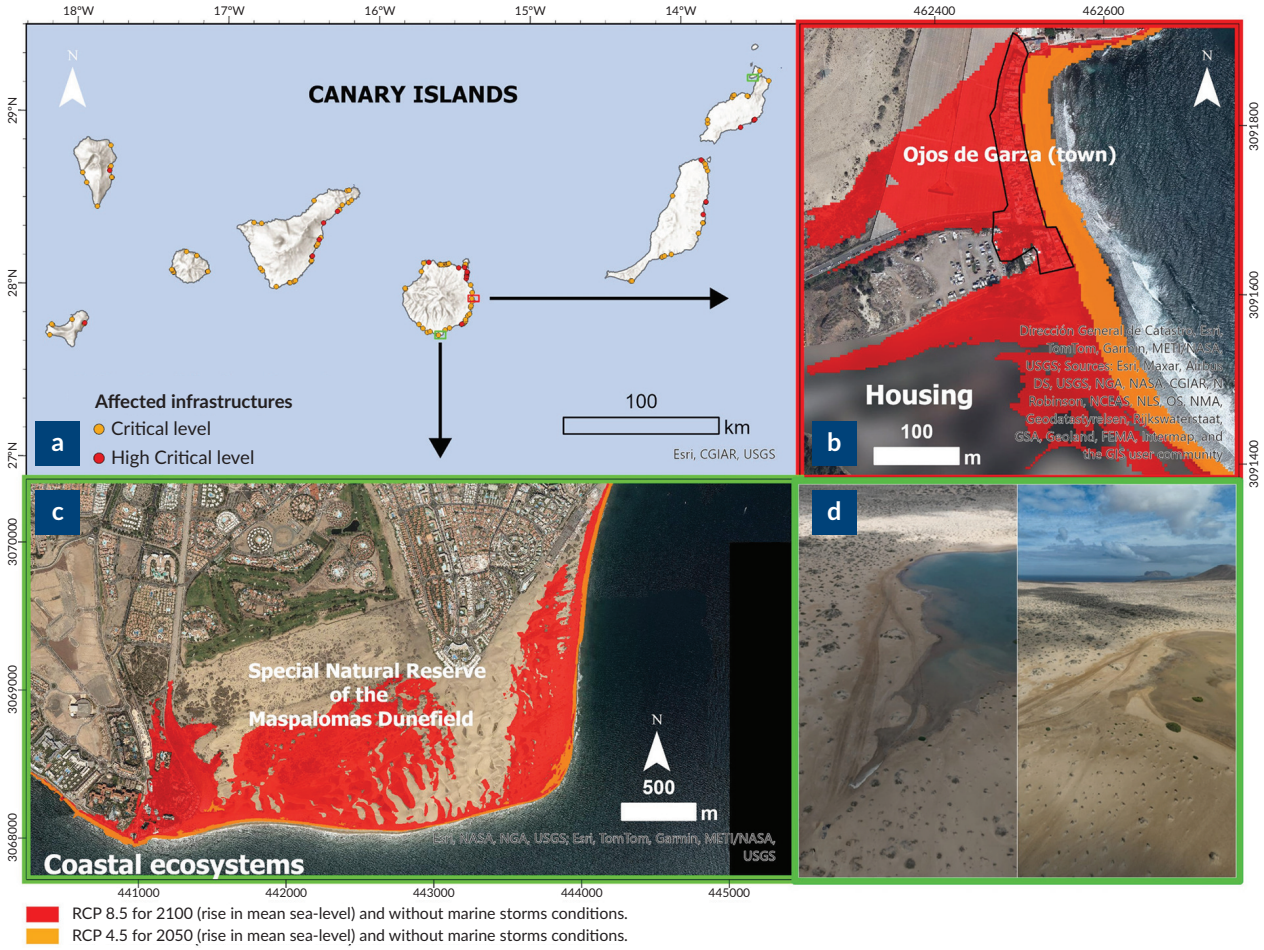


Figure 2. Results obtained through PIMA Adapta Costas in the Canary Islands Project: (a) location of the infrastructures affected by sea-level rise; (b) example of a residential area (housing) affected by sea-level rise with RCP 4.5 and 8.5 projections; (c) example of a coastal ecosystem that will be flooded and eroded by sea-level rise; (d) coastal ecosystem flooded currently when marine storms and equinoctial tides are produced in La Graciosa Island.

According to this study, the global surface area of tourist beaches could shrink by between 29.5% and 45.2%, which equates to the loss of up to 150 beaches in the RCP 4.5 scenario and 153 beaches in the RCP 8.5 scenario. This equates to an annual loss of capital related to beaches ranging from 2,940,324,000 euros per year in RCP 4.5 to 4,520,910,000 euros per year in RCP 8.5. This equates to approximately 10% of the islands' GDP. Within the framework of PIMA Adapta Costa in the Canary Islands (Gobierno de Canarias, 2022), 47 areas of high accumulated risk have also been identified that require urgent attention. This vulnerability is exacerbated by a dense, tourism-driven urban footprint, limited available land for retreat, and complex jurisdictional arrangements across five levels of government.

3.2. Multilevel Legal Framework for Sea-Level Rise Risk Management in the Canary Islands

The legal framework for adapting to sea-level rise in the Canary Islands is organised as a complex, multilevel governance system that defines the powers of the state, regions, islands, and local authorities. This legal system underpins the planning, administration, and decision-making processes intended to reduce the territories' susceptibility to coastal hazards. For example, the Canary Islands' climate change and energy transition law clearly identifies the role of the other administrations, such as cabildos and municipalities, which also have their own plans and regulations that interact with the legal framework in terms of climate adaptation, as shown above. This cascading legal influence affects planning decisions and infrastructure, as well as shaping how local risks are assessed and managed. Figure 3 illustrates the multilevel governance structure concerning sea-level rise adaptation in the Canary Islands. It schematically identifies the different administrative levels and their roles; however, it does not reflect the intensity, quality, or effectiveness of coordination mechanisms between these levels. These dimensions are further analysed in Section 3.5 on institutional fragmentation and coordination gaps. This current research examines several important legal tools pertinent to climate change and sea-level rise in the Canary Islands, ranging from national to insular levels. One of the primary obstacles to climate management in remote areas such as the Canary Islands is the overlapping powers of different administrative entities, which can result in divided government, implementation delays, and difficulties in achieving horizontal and vertical coordination. Table 2 shows the different laws and plans, and the administration responsible for them. Regarding climate adaptation and risks in the Canary Islands, the table shows the legal tools and the need for integration across scales to ensure adaptive, responsive, and effective multilevel governance.

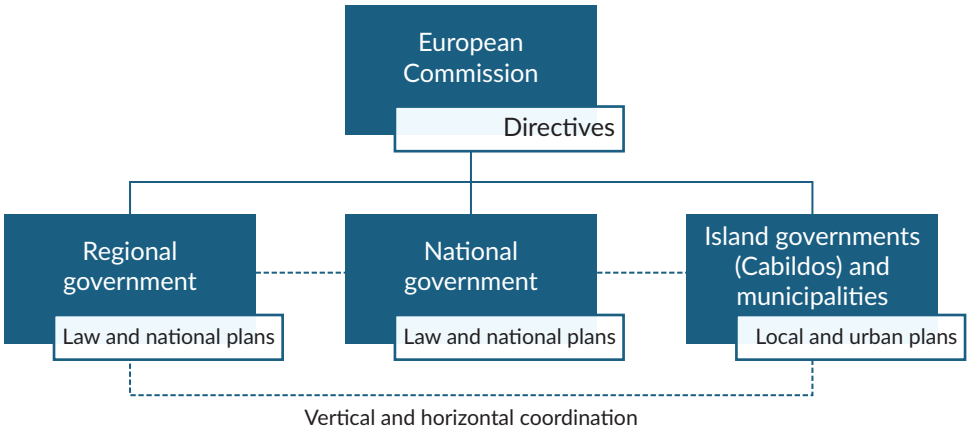


Figure 3. Schematic governance structure for the sea-level rise in the Canary Islands.

At the international level, the EU has worked towards a comprehensive framework for coastal action, recognising the importance of coasts in the different countries. Examples include the UN 2030 Agenda for Sustainable Development, the UNCLOS, and the Integrated Coastal Zone Management. The European Commission's Cabildo maritime spatial planning and 2008 Maritime Strategy Framework Directives are also important as they affect the reorganisation of coastal zones in relation to climate change. In direct relation to climate change, the EU adopted the EU Strategy on Adaptation to Climate Change in 2021, which recognises the urgent need for member countries to take action on rising sea-levels.

At a national level (Table 2), Spain's Coastal Law (Law 22/1988 of 28 July) plays a central role in controlling, protecting, and planning the use of the public maritime-terrestrial domain. Given the identified impacts in the Canary Islands, it is sensible for the organization of coastal uses to be addressed. In addition, the implementation of adaptation policies is required, such as restricting construction or urban planning in regions vulnerable to sea-level rise. This law actually defines servitudes and coastal protection zones. In terms of climate change, some articles must be highlighted. Management of the public maritime-terrestrial domain must guarantee climate change adaptation measures (Article 2). Article 44 requires project planning to include assessments of the effects of climate change. Regarding concessions, Article 66 stipulates that project durations must reflect authorised government initiatives for beach regeneration and erosion control. According to Article 76, concessions must take steps dictated by the government to adapt to sea-level rise and other environmental impacts. Article 116 clarifies inter-administrative connections by requiring data sharing, cooperation, and coordination at all levels of government.

Table 2. Summary of legal instruments analysed in the current investigation.

Policy/Instrument	Level of governance
UN 2030 Agenda for Sustainable Development	European
UNCLOS	
The Maritime Spatial Planning Directive (2014/89/EU)	
The Maritime Strategy Framework Directive (2008/56/EC)	
EU strategy on Adaptation to Climate Change 2021	
Law 22/1988, of 28 July 1988, on Coasts	National
Law 2/2013, of 29 May, on the protection and sustainable use of the coast and modification of Law 22/1988, of 28 July, on Coasts	
Law 26/2007, of 23 October 2007, on Environmental Liability	
Law 21/2013 of 9 December 2013 on environmental assessment	
Organic Law 1/2018, of 5 November, on the reform of the Statute of Autonomy of the Canary Islands	
Law 7/2021 of 20 May on climate change and energy transition	
PNACC 2021–2030	
Law 14/2014 of 26 December 2014 on Harmonisation and Simplification in the Protection of the Territory and Natural Resources	Regional
Law 4/2017, of 13 July, on the Land and Protected Natural Spaces of the Canaries	
Law 6/2022, of 27 December, on climate change and energy transition in the Canary Islands	
Decree-Law 5/2024 (Amendment of Law 6/2022)	
Canary Islands Climate Action Strategy 2030	
Canary Islands Climate Action Plan	
PIOs	Island
PGOUs	Municipalities

Following the introduction of Law 2/2013 on 29 May regarding the protection and sustainable use of the coastline, this legislation was revised to impose stricter limits on urban development in areas susceptible to coastal erosion. Another significant piece of national legislation is the Environmental Liability Law

(Law 26/2007 of 23 October), which establishes the groundwork for preventing and restoring environmental damage. Although it does not explicitly mention climate change, the increasing sea-levels that contribute to ecosystem destruction must be considered, along with the related obligations of public officials and commercial enterprises.

The Environmental Assessment Law (Law 21/2013 of 9 December) is essential for adaptation measures. This law requires impact evaluations for developments likely to cause significant damage to coastal areas prone to sea-level rise. The significance of incorporating climate change into tactical and technical reports is emphasized in Articles 18 and 24. Article 3 of the law also emphasises cooperation between the national administration and independent communities, thereby underlining the need for vertical coordination in its opening remarks and Article 2.

The regional government (Table 2) has certain responsibilities relating to coastal management, environmental protection, and land use planning under the Statute of Autonomy of the Canary Islands (Organic Law 1/2018). This provides the regional government with the legislative and administrative capacity to develop environmental adaptation measures. The Canary Islands Land and Protected Natural Areas Law (Law 4/2017) provides tools that enable sustainability and climate adaptation requirements to be integrated into spatial planning. This enables territorial planning to encourage risk management and impose land use limitations in susceptible regions. Article 102 assigns the island councils, cabildos, the task of creating and ratifying PIOs, provided that they can consider possible environmental effects, including those related to climate change. Although the Territorial Planning Law (Law 9/1999) does not explicitly refer to climate change, it governs land usage in the Canary Islands and includes clauses for planning in coastal areas subject to risk. This law also addresses sea-level rise and flooding.

At the island level (cabildos, see Table 2), the PIOs have become strategic instruments for long-term territorial management. Some cabildos have started to include environmental risk evaluations, flood modelling, and projections of coastal retreat for 2050 and 2100. Several coastal municipalities are adding land-use regulations based on exposure to coastal risk to their local urban development plans. Such updates support the precautionary principle and align with local legislation aimed at ensuring regional safety and preserving natural and cultural heritage. Using Gran Canaria as an example, the PIO must account for local hazards, including sea-level rise. It is a vital tool for managing regions prone to flooding. The Flood Risk Management Plan for Gran Canaria also identifies sensitive areas and proposes measures to minimise damage, which is highly relevant for planning coastal housing developments.

This picture of laws and norms could be improved if the impact of rising sea-levels on essential infrastructure were taken into account, as reported by the PIMA Adapta Costas (Gobierno de Canarias, 2022). This includes airports, water infrastructure, and transportation networks, for example:

- Particularly under Articles 92–104 of the Water Law (Royal Legislative Decree 1/2001, of 20 July), the safeguarding of water infrastructure is governed.
- Hydrological plans based on the EU Water Framework Directive (2000/60/EC) must include measures for water security and climate adaptation.
- The Critical Infrastructure Protection Law (April 28, 2011) provides strategic responses to natural hazards.

- Many of the roads affected by extreme weather events linked to climate change are covered by the National Roads Act (Law 37/2015) and the Canary Islands Roads Act (Law 9/2003), which govern road planning, construction, and management.

The Canary Islands have a sophisticated legal framework for managing coastal risks and adapting to climate change. However, the multiple levels of administrative complexity make it challenging. Efficient coordination and rapid response are hampered by overlapping duties and legal dispersion. Creating a robust governance system capable of handling the growing threat of sea-level rise requires institutional collaboration at all levels, from vertical to horizontal.

3.3. Climate Change Laws and Sea-Level Rise in Spain and the Canary Islands

In addition to the various legal frameworks relating to the impact of climate change on coastal areas, recent climate change legislation must be considered and analysed at the national and regional levels to find solutions for coastal management governance.

At the national level, Law 7/2021 on Climate Change and Energy Transition is the main legal framework for tackling climate-related issues in Spain. It includes guidelines for adapting to the impacts of climate change, such as sea-level rise, and requires all levels of government (national, regional, and local) to incorporate these risks into their policy frameworks. Regarding coastal planning, Law 7/2021 supplements Spain's Coastal Law by introducing the concept of "non-regression in environmental protection" and encouraging nature-based solutions for coastal defence. It particularly supports the restoration of coastal ecosystems, such as dunes, wetlands, and marshes, as a key strategy to enhance resilience and safeguard people and property from sea-level rise. However, its failure to provide for island territories, including the Canary Islands, makes enforcement of this law difficult. Here, aggressive coastal urbanisation, high tourism pressure, and geomorphological vulnerability require more targeted adjustment policies with committed and sustained financial resources.

The National Climate Change Adaptation Plan 2021–2030 is one of the most important tools for tackling sea-level rise. It is legally binding and is explicitly mentioned in Article 17 of Law 7/2021. According to the Plan, coastal regions are among the most sensitive sectors to climate change due to threats such as shoreline erosion, saltwater intrusion, permanent or occasional flooding, and loss of ecosystem products and services. The first priority is to improve early warning systems for marine risks, followed by incorporating sea-level projections into urban and territorial planning, and creating local adaptation plans for sensitive coastal areas. However, effective implementation in small regions such as the Canary Islands still requires locally appropriate strategies, including guaranteed funding and improved technical and administrative capabilities. Despite the national plan's recognition of increased sea-level hazards, its effectiveness will depend heavily on the adoption of regulations at the local, island, and municipal levels. Furthermore, pertinent for successful policy translation will be the creation of operational metrics and instruments tailored to extreme regional circumstances will be pertinent for successful policy translation. Due to the cross-cutting nature of climate change policy, the law also requires institutional coordination, emphasising inter-administrative cooperation as set out in Articles 2 and 17, among others.

At the regional level, Law 6/2022, on Climate Change and Energy Transition in the Canary Islands, which was developed by the government of the Canary Islands, is the archipelago's first comprehensive legal

framework aimed at establishing a structured governance system to address climate change. Partially amended and extended by Decree-Law 5/2024, the legislation incorporates mitigation and adaptation measures that take into account the unique territorial, social, and economic characteristics of the islands. Its main objectives include defending coastal areas and marine-coastal ecosystems against the effects of climate change, particularly rising sea-levels, which the Law identifies as one of the main long-term risks to territorial security. The Law incorporates the principles of ecosystem-based adaptation and precaution in the face of climate change. It requires all levels of Canary Islands administration and each Cabildo to incorporate climate change projections into spatial, environmental, and infrastructure planning processes. The Law will be implemented through two tools: the Climate Action Strategy and the Climate Action Plan. The Climate Action Strategy encourages collaborative planning at many levels, bringing together the government, cabildos, and municipalities, and inviting people to contribute, particularly in relation to areas of the coastline at risk of change or relocation. The Climate Action Plan will serve as the operational framework for implementing sectoral adaptation measures. It is expected to explicitly identify the coastal zones that are most vulnerable to sea-level rise, including: risk maps, projections of the impact on critical infrastructure (e.g., roads, ports, and sewage systems), and island-specific strategies. Decree-Law 5/2024 reinforces the obligation for island and municipal administrations to incorporate climate vulnerability assessments into spatial and sectoral planning instruments. This addition strengthens the legal mandate for evidence-based territorial governance in response to climate threats. However, funding from Spain and Europe is required for this to work. Additionally, local stakeholders are required to ensure the preservation of traditions and heritage. This is why the Climate Action Strategy states that islands and municipalities must be prepared with training courses, risk and vulnerability maps, and coastal adaptation measures. However, one of the key challenges is integrating the current climate governance into the existing interdisciplinary legislation, such as that relating to biodiversity and infrastructures. Climate change impacts must be considered holistically and in isolation.

3.4. Analysis of the Intentionality and Substantiality of Legal Policy and Instruments at the Multi-Scale Level

Table 3 provides a comparative assessment of five international and EU-level governance instruments, based on their level of intention and substance with regard to adapting to sea-level rise. The UN 2030 Agenda and UNCLOS demonstrate limited direct action, with moderate and low intentionality, respectively, reflecting their broad or outdated scope. In this sense, they include climate goals without obligations or implementation pathways for sea-level rise, resulting in a moderate or low intentionality and low substantiality. The Maritime Spatial Planning Directive and the Marine Strategy Framework Directive demonstrate moderate levels of both criteria, explicitly incorporating climate change considerations, albeit not as central mandates. The EU Strategy on Adaptation to Climate Change (2021) stands out due to its high level of intentionality, as it explicitly prioritises resilience and sectoral adaptation. However, its level of substantiality remains moderate due to implementation challenges.

Table 4 analyses the intentionality and substantiality of key Spanish national and regional governance instruments concerning sea-level rise adaptation. Although laws such as Law 22/1988 and Law 2/2013 demonstrate a high level of intentionality with regard to coastal protection, their substantiality is moderate due to outdated frameworks or uneven implementation. Instruments such as the Environmental Liability Law and the Environmental Assessment Law have moderate relevance and limited direct application to

Table 3. Analysis of intentionality and substantiality of the legal policy and instruments at the European level in current research.

Policy/Instrument	Intentionality	Substantiality	Analysis
UN 2030 Agenda for Sustainable Development	Moderate	Low	While it sets broad goals like SDG 13 ("climate action"), it lacks specific mandates for sea-level rise adaptation
UNCLOS	Low	Low	UNCLOS does not explicitly address sea-level rise, leading to legal ambiguities regarding maritime boundaries
Maritime Spatial Planning Directive (2014/89/EU)	Moderate	Moderate	Encourages consideration of climate change impacts, including sea-level rise, in maritime spatial plans. Needed for the zonification of coastal areas and industrial uses
Marine Strategy Framework Directive (2008/56/EC)	Moderate	Moderate	Aims for a good environmental status of marine waters, indirectly supporting adaptation through ecosystem-based approaches
EU Strategy on Adaptation to Climate Change (2021)	High	Moderate	Sets out a comprehensive framework for climate resilience, emphasizing adaptation across sectors, including coastal areas. It is the basis for the climate change laws at the national level

Table 4. Analysis of intentionality and substantiality of the legal policy and instruments at the Spanish (national) level in current research.

Policy/Instrument	Intentionality	Substantiality	Analysis
Law 22/1988, of 28 July 1988, on Coasts	High	Moderate	Establishes coastal protection zones but predates current climate change challenges. Actions at the coastal level have to be in agreement with this law
Law 2/2013, of 29 May, on the protection and sustainable use of the coast and modification of Law 22/1988, of 28 July, on Coasts	High	Moderate	Updates the 1988 Law, incorporating sustainable use principles, yet vertically coordinated implementation
Law 26/2007, of 23 October 2007, on Environmental Liability	Moderate	Low	Focuses on environmental damage prevention and remediation, with limited direct application to sea-level rise
Law 21/2013 of 9 December 2013 on environmental assessment	Moderate	Moderate	Requires environmental assessments for plans and projects, potentially integrating sea-level rise considerations
Law 7/2021 of 20 May on climate change and energy transition	High	Moderate	Establishes a framework for climate action, including adaptation measures relevant to coastal areas. It highlights the necessity of horizontal and vertical coordination
PNACC 2021–2030	High	High	Provides a strategic approach to adaptation, identifying coastal zones as priority areas. The national base product is later applied to local regions

Table 4. (Cont.) Analysis of intentionality and substantiality of the legal policy and instruments at the Spanish (national) level in current research.

Policy/Instrument	Intentionality	Substantiality	Analysis
Organic Law 1/2018, of 5 November, on the reform of the Statute of Autonomy of the Canary Islands	Moderate	Moderate	Provides the Canary Islands with the legal and institutional framework to design and implement adaptive policies to vulnerabilities of the region's coastal zones

sea-level rise. While Law 7/2021 and PNACC 2021–2030 have relatively high intentionality scores because they specifically mention climate change adaptation and identify sea-level rise as a national priority, there are only moderate substantiality scores due to implementation relying heavily on subnational entities and especially weak enforcement mechanisms in outermost regions, including the Canary Islands. While the Coastal Law (22/1988) recognizes high intentionality in protecting the littoral, its age and partial updates mean it does not apply adaptation tools evenly, hence moderate substantiality. The Organic Law 1/2018 strengthens the Canary Islands' regional autonomy, enabling them to develop localised adaptation strategies.

Table 5 presents a systematic evaluation of regional legislative and strategic instruments in the Canary Islands concerning their intentionality and substantiality in addressing sea-level rise adaptation. Organic Law 1/2018 and other legislation, such as Law 14/2014 and Law 4/2017, while not particular to climate issues, grant the Canary Islands autonomy to legislate on environmental issues, show moderate levels in both elements, and provide institutional competencies and regulatory frameworks to indirectly assist in adaptation processes. In contrast, Law 6/2022 and this policy's amendment through Decree-Law 5/2024 provide high levels of policy intentionality and substantiality as they specifically include climate change adaptation, especially for coastal impacts, into the regional legal framework and require the inclusion of climate projections in spatial planning. These features explain its high intentionality and substantiality. Additionally, both the Canary Islands Climate Action Strategy 2030 and the Climate Action Plan operationalise long-term resilience objectives through actionable, evidence-based measures, including ecosystem-based adaptation and infrastructure planning. Collectively, show an evolutionary shift towards a more integrated and adaptive model of governance in the subnational and local context. They excel in both dimensions of the score due to their implementation orientation and being multilevel instruments.

Finally, Table 6 evaluates the effectiveness of local-level planning instruments in Gran Canaria in adapting to sea-level rise. PIOs exhibit moderate intentionality and substantiality, offering a structural framework for land use that can incorporate adaptive strategies. Similarly, PGOUs are also moderately intentional and substantial, though their effectiveness varies based on local governance capacity and commitment. Overall, while these instruments provide entry points for adaptation, their implementation remains context-dependent and uneven.

A comparative analysis of international, national, regional, and local governance instruments reveals an evolving yet fragmented framework for adapting to sea-level rise. At the international and EU levels (Table 3 and Figure 4), instruments such as the UN 2030 Agenda and UNCLOS demonstrate limited direct action, reflecting either broad developmental scope or outdated priorities. In contrast, while the EU Strategy on Adaptation to Climate Change (2021) demonstrates high intentionality, it faces moderate substantiality due to implementation challenges. This is consistent with the observations of Elrick-Barr and Smith (2021) that "policy is rarely intentional or substantial for coastal issues."

Table 5. Analysis of intentionality and substantiality of the legal policy and instruments at the Canary Islands (regional) level in current research.

Policy/Instrument	Intentionality	Substantiality	Analysis
Organic Law 1/2018 on the Statute of Autonomy of the Canary Islands	Moderate	Moderate	Grants the region competencies that can be leveraged for climate adaptation policies
Law 14/2014 of 26 December 2014 on Harmonisation and Simplification in the Protection of the Territory and Natural Resources	Moderate	Moderate	Aims to streamline environmental protection, offering tools for coastal adaptation. The Canary Islands are highly protected, and it has to be considered for climate action
Law 4/2017, of 13 July, on the Land and Protected Natural Spaces of the Canaries	Moderate	Moderate	Regulates land use, including coastal zones, facilitating adaptation measures. The Canary Islands are highly protected, and it has to be considered for climate action
Law 6/2022, of 27 December, on climate change and energy transition in the Canary Islands	High	High	Specifically addresses climate adaptation, including sea-level rise, with actionable measures. It has a high grade of coordination (horizontal and vertical)
Decree-Law 5/2024 (Amendment of Law 6/2022)	High	High	Strengthens the regional climate framework, enhancing adaptation strategies. It is a modification of the law of climate change and energy in the Canary Islands
Canary Islands Climate Action Strategy 2030	High	High	Sets long-term goals for climate resilience, emphasizing coastal adaptation. The strategy is focused on adaptation and reflects the need for harmonization between different legal tools
Canary Islands Climate Action Plan	High	High	Details specific actions for adaptation, including infrastructure and ecosystem-based approaches

Table 6. Analysis of intentionality and substantiality of the legal policy and instruments at the island and municipal level in current research.

Scale	Policy/Instrument	Intentionality	Substantiality	Analysis
Island	PIOs	Moderate	Moderate	Provide a framework for land use, with potential to integrate sea-level rise adaptation
Municipal	PGOUs	Moderate	Moderate	Implementation of adaptation measures varies across municipalities, depending on local priorities and resources

Figure 4 shows the distributions of intentionality and substantiality ratings (the total number of assessments rated) for each level of governance. The figure shows that at the regional level (Canary Islands), there have been more instances of high ratings than nationally (EU, member state) or locally (municipal, city, etc.). This

suggests that the regional level, in this case, seems more in line with adaptation objectives. It is important to note that the figure does not represent functional linkages or coordination mechanisms between these policies; this aspect is discussed in the subsequent section. According to Figure 4, older frameworks such as Law 22/1988 are still limited by outdated mechanisms or inconsistent implementation. At the regional scale of the Canary Islands (Table 5), recent legislation, such as Law 6/2022 and the Canary Islands Climate Action Plan, reflects a shift toward comprehensive and strategic responses, integrating ecosystem-based and infrastructural measures. Local instruments (Table 6), including PIOs and PGOUs, provide planning frameworks, though these lack uniformity in application due to variability in municipal resources and priorities.

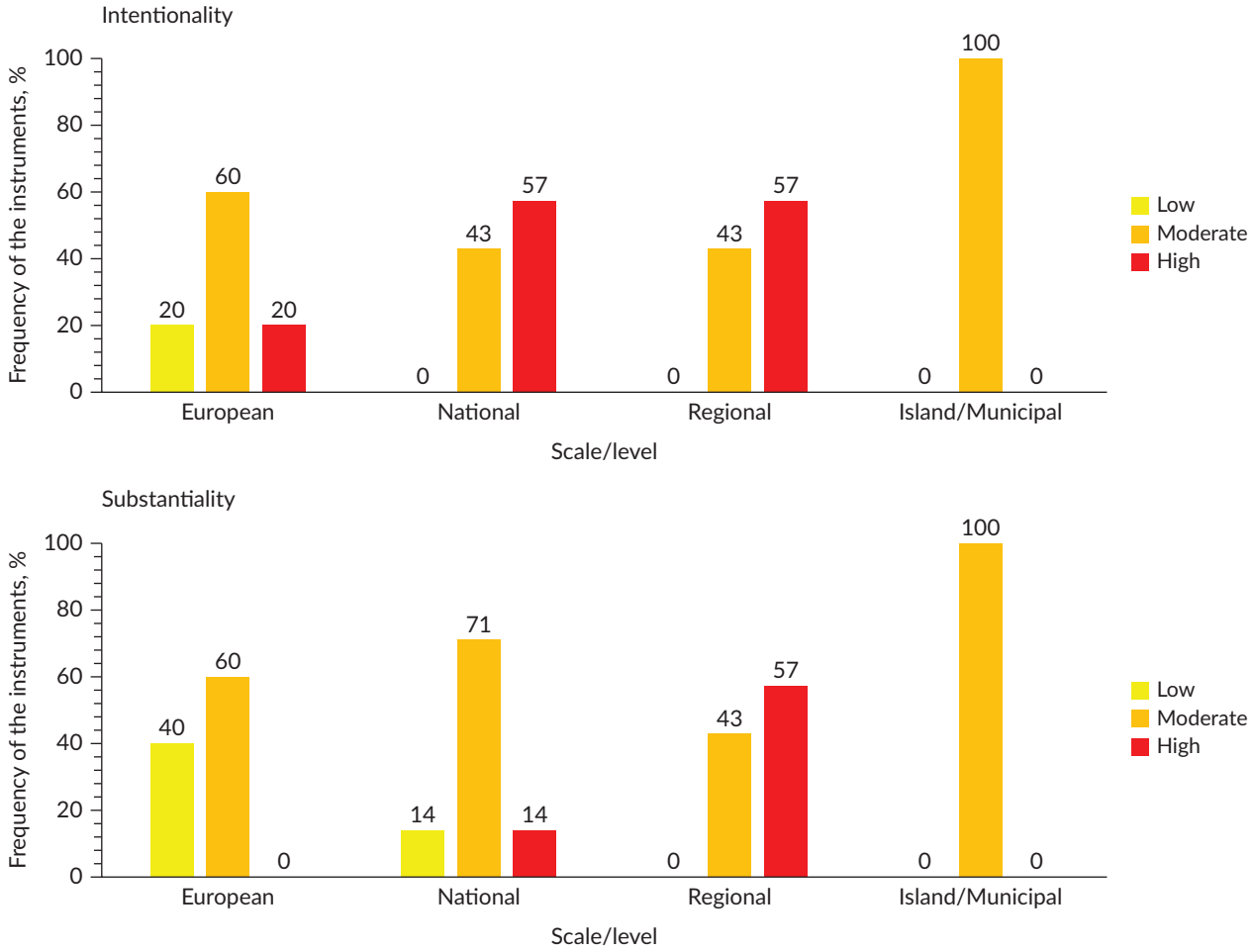


Figure 4. Distribution (frequency, %) of the intentionality and substantiality rating scale of the legal policy/instruments at the multilevel (from European to municipal) for the case of the Canary Islands.

At the island/municipal level (Figure 4), it shows that all instruments are rated as moderate in both intentionality and substantiality, reflecting a uniform but limited commitment likely due to constrained local capacities. At the regional level, over half of the instruments exhibit high intentionality (57.14%), alongside a balanced presence of moderate and high substantiality. This aligns with the discussion on Canary Islands legislation, such as Law 6/2022 and the Climate Action Plan. At the national level, the distribution is more mixed: intentionality is split between moderate (57.14%) and high (42.86%), while substantiality leans towards moderate (71.43%). This supports the finding that, although intentions are strong (e.g., the PNACC), implementation remains uneven. European-level instruments are largely moderate in intent (60%) and

substance (60%); they still lack high-substantiality policies, which reaffirms the claim that "broad or outdated scopes" limit direct action (e.g., UNCLOS and UN Agenda). Thus, the figure confirms that, while intentionality improves from the international to the regional scales, substantiality lags behind. This echoes the observations of Elrick-Barr and Smith (2021) that policy is rarely both intentional and substantial in coastal contexts.

This multilevel governance analysis underscores that while adaptation intent is increasingly embedded in policy frameworks, substantial, enforceable measures are uneven and are often hindered by institutional fragmentation or limited local capacity (see Supplementary File, for information related to the aims of the policy and instruments used in this analysis, the governance tools, and the expected outcomes).

3.5. Normative Conflicts, Institutional Fragmentation, and Barriers to Effective Adaptation in the Canary Islands

Although Figures 3 and 4 illustrate the existence of multiple governance levels and variable policy strength, they do not visualise specific forms of coordination or non-coordination, across levels. Our analysis suggests that although there are legal opportunities for multilevel coordination (e.g., Climate Action Network), coordination remains largely procedural and fragmented. In practice, we found that horizontal coordination (e.g., between cabildos and municipalities) is often weak or unspecified, while vertical linkages are shaped predominantly by the individual capacity of administration and political will.

According to Van Den Hurk et al. (2024), the coastal adaptation decision-making is complex, involving many stakeholders. It requires long-term implications, flexibility to adopt new decision processes, and monitoring the progress to achieve the established goals. However, the legal framework previously detailed demonstrated that there are no solutions from a single administration. This means that the presence of coordination instruments must be implemented and maintained in the long term (Ferraro & Failler, 2024b). Conversely, the complexity of the legal framework also shows that solutions must be found to address the timescale of the climate emergency (Bazant-Fabre et al., 2022). In the Canary Islands, the legal framework indicates a solid commitment to coastal governance, despite the absence of a defined strategy. However, this does not necessarily guarantee effective coastal adaptation governance. It is urgent that we consider the timescale of climate action. Although many laws, regulations, and plans include actions relating to emergency or general interest, unfortunately, this is not applied in the case of climate adaptation. Such solutions would improve the timescale of responses. In the case of the Canary Islands, the response to sea-level rise is hindered by a complex and fragmented legal framework. The mismatch between the timeframes of policies and the immediacy of climate risks creates a structural barrier to effective adaptation. The current legal framework includes the National Climate Change Law (Law 7/2021), coastal legislation (Coastal Law 22/1988 and the 2013 amendment), and regional and municipal competencies regarding spatial planning. This is complemented by the Canary Islands' Law 14/2014 on Harmonisation and Simplification of Territorial and Natural Resource Protection, which is a key instrument in land-use and environmental planning. Jurisdictional clashes, overlapping and conflicting competences, and procedural constraints in planning instruments hinder the effective implementation of environmental law.

Coordination is another major issue that needs to be addressed. In the Canary Islands, Law 6/2022 will introduce governance tools such as the Canary Islands Climate Action Network, a permanent multilevel

governance platform, and the Canary Islands Climate Action Office. The latter will provide technical advice on adaptation planning to all administrative levels, including cabildos and municipalities. These tools aim to promote coordination among institutions and to integrate climate action within the archipelago. However, they are still in the process of formation. Although Law 7/2021 mandates the development of sectoral adaptation plans, their implementation in the Canary Islands is hindered by institutional coordination gaps and limited integration into spatial and urban planning frameworks. Thus, while this national legislation provides an advanced legal framework, its effectiveness in insular contexts depends on its articulation with regional and local regulations, as well as governance mechanisms that ensure compliance in the face of escalating climate risks. Additionally, coordinating climate actions across different administrations requires more human resources to address all areas of responsibility. This issue could be resolved through the digitalisation of public administration.

The recent processing and approval by the City Council of Las Palmas de Gran Canaria of a climate action project promoted by the Regional Ministry of Ecological Transition and Energy of the Government of the Canary Islands is a representative example of the gaps in competencies and the lack of inter-administrative coordination in climate governance in the Canary Islands. According to the local newspaper *La Provincia*, the project was approved during a City Council plenary session due to a mistake by one of the council members (Villullas, 2025). The article contains statements from several city government members, who describe the proposal by the Regional Ministry as nonsensical and assert that they were neither sent the technical project nor officially invited to collaborate on the document.

This situation has arisen despite the regional legal framework being reinforced through Decree Law 5/2024, which actively promotes governance mechanisms and explicitly states that the proposed objectives cannot be achieved through unilateral public management. In the draft document of the Canary Islands Climate Action Plan, the governance mechanisms section states that an inter-administrative technical working group must be established to support administrative cooperation and accelerate joint efforts across the different levels of government involved in implementing action. Moreover, this information should be made public to encourage citizens, organisations, and social movements to participate in developing the planned measures.

This case study highlights that governance mechanisms rely not only on legal design and regulatory effectiveness, but also on the capacity of public administrations to execute, coordinate, and allocate resources. It reveals an operational gap in multilevel coordination: while the legal framework anticipates collaboration, participation, and policy coherence, however, fragmentation and the corresponding change in institutional levels create ambiguities in political agendas and coastal competences, particularly in strategic areas such as the urban coastline of the capital, the Canary Islands.

One of the key conflicts identified is the asymmetry between the pace of spatial and urban planning and the urgent need for adaptive decisions, especially in highly exposed coastal areas. Many PGOUs, for example, have not been updated to reflect new sea-level rise projections, despite available scientific evidence (e.g., PIMA Adapta Costas) and existing legal obligations to incorporate climate risk. Without this integration, the implementation of structural measures such as planned retreat or the prohibition of new development in high-risk zones is blocked.

Another critical issue is the lack of effective coordination between different levels of government. As highlighted throughout this paper, several laws emphasize the urgent need for horizontal and vertical

administrative cooperation in climate governance. Although cabildos hold key competencies in spatial planning through the PIOs, their alignment with regional strategies—such as the Canary Islands Climate Action Strategy 2030—remains incipient. At the same time, municipalities are burdened with many responsibilities but often lack the technical and financial capacity to implement recommendations stemming from vulnerability assessments, such as PIMA Adapta Costas. This results in territorial disparities in the application of adaptation measures across territories, revealing a structural weakness in adaptive governance where planning rarely translates into action.

In this sense, a key point of contention in the environmental governance of the Maspalomas Dunes Special Natural Reserve (Figure 2) is the differing roles and actions of the Cabildo of Gran Canaria and the San Bartolomé de Tirajana City Council, particularly with regard to rising sea-levels. As the managing authority, the Cabildo has initiated science-driven restoration projects such as MASDUNAS, which have successfully reintroduced over 60,000 m^3 of sand and increased native vegetation by 75% in order to stabilise the dunes (Cabildo de Gran Canaria, n.d.). In contrast, the City Council has been criticised for using tractors and scrapers to smooth the sand for tourism purposes. This practice harms dune vegetation and accelerates erosion by smoothing the dunes and removing a small amount of sand every day (Pinardo-Barco et al., 2023). The conflicting actions of the Cabildo, which pushes for ecological recovery, and the municipality, which enables tourism-driven maintenance, underscore a serious governance rift over who holds responsibility, how urgently action should be taken, and which should prevail: environmental integrity or tourist infrastructure.

4. Conclusions and Recommendations

This is the first study to address the legal framework for mitigating and adapting to sea-level rise in the Canary Islands, as well as the conflicts and barriers to improving coastal adaptation governance, and possible recommendations for doing so. Sea-level rise is one of the most pressing impacts of climate change in this region. Despite the existence of a relatively comprehensive legal framework, significant challenges persist due to the fragmentation of responsibilities among different levels of government (e.g., state, regional, island, and municipal). Furthermore, there is a significant discrepancy between the urgency of adaptation measures and the timeframes for implementing various laws.

Against this backdrop, there is an urgent need for prompt and effective multilevel coordination mechanisms to enhance climate governance in the Canary Islands. A key recommendation is to establish the Climate Action Office and the Climate Action Network in the Canary Islands immediately, so that they can encourage the formation of climate adaptation committees at the island level. These committees should involve participants from national, regional, island, and local governments, and should be complemented by the establishment of a Coastal Observatory for the Canary Islands, whose remit would be to provide advice on integrating climate scenarios into planning instruments and on biodiversity. In terms of human resources, building institutional capacity is also fundamental. To this end, it is recommended that the technical expertise of local staff be enhanced. The timescale of climate actions must be addressed by implementing projects of general interest, thereby reducing the time for action, mainly in terms of adaptation. Furthermore, the link between climate adaptation and administrative effectiveness can be strengthened via digitalisation, bearing in mind that the public administrations must invest in human resources to be able to achieve the goals established in the various climate laws.

It is essential to strengthen public engagement further so that it becomes a key factor in co-governance in climate planning processes, especially for adaptation measures. Such participation must formalise the citizens' involvement in decision-making through participatory structures that further embed strategic planning tools. Also, regulatory harmonisation is necessary to keep the mechanisms agile and functional. Legal policy and instruments must be aligned and adapted to the current climate emergency in order to prevent slowdowns, jurisdictional disputes, and operational inefficiencies.

For all these reasons, there is a need to generate methodologies for monitoring the health of the sea and coastal areas within the identified management objectives. We propose adaptive management through tools that evolve periodically to incorporate new processes into the monitoring model via multidisciplinary work networks. This generates a living model that can adapt to systemic variations resulting from social and environmental changes in highly dynamic coastal and open ocean environments.

Improving climate governance in the Canary Islands is essential not only for the archipelago's resilience but also as a replicable model for other island territories, particularly those with high population density and economic dependence on coastal areas. The Canary Islands' experience can meaningfully contribute to designing differentiated climate policies for island contexts that align with the Paris Agreement and the Sustainable Development Goals commitments.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024-2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Funding

Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603).

Conflict of Interests

In this article, editorial decisions were undertaken by Raoul Beunen (Open University of the Netherlands, The Netherlands).

Conflict of Interests

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Antequera, P. D., Díez, A. L., & Pacheco, J. S. D. (2018). El calentamiento global en el Atlántico Norte Suroriental. El caso de Canarias. Estado de la cuestión y perspectivas de futuro. *Cuadernos Geográficos*, *57*(2), 27–52.

Bazant-Fabre, O., Bonilla-Moheno, M., Martínez, M. L., Lithgow, D., & Muñoz-Piña, C. (2022). Land planning and protected areas in the coastal zone of Mexico: Do spatial policies promote fragmented governance? *Land Use Policy*, *121*, Article 106325.

Betzold, C. (2015). Adapting to climate change in small island developing states. *Climatic Change*, *133*(3), 481–489.

Cabildo de Gran Canaria. (n.d.). *Masdunas*. https://masdunas.es

Carrillo, J., González, A., Pérez, J. C., Expósito, F. J., & Díaz, J. P. (2022). Projected impacts of climate change on tourism in the Canary Islands. *Regional Environmental Change*, *22*(2), 61.

Church, J. A., Clark, P. U., Cazenave, A., Gregory, J. M., Jevrejeva, S., Levermann, A., Merrifield, M. A., Milne, G. A., Nerem, R. S., Nunn, P. D., Payne, A. J., Pfeffer, W. T., Stammer, D., & Unnikrishnan, A. S. (2013). Sea-level rise by 2100. *Science*, *342*(6165), Article 1445. https://doi.org/10.1126/science.342.6165.1445-a

Comunidad Autónoma de Canarias. (2022). *Ley 6/2022, de 27 de diciembre, de cambio climático y transición energética de Canarias*. https://www.boe.es/eli/es-cn/l/2022/12/27/6

Correa, J., López-Díez, A., Dorta, P., & Díaz-Pacheco, J. (2025). Evolution of warm nights in the Canary Islands (1950–2023): Evidence for climate change in the Southeastern North Atlantic. *Theoretical and Applied Climatology*, *156*, Article 87. https://doi.org/10.1007/s00704-024-05290-1

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive). (2008). *Official Journal of the European Union*, L 164/19. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056

Directive 2014/89/EU of the European Parliament and of the Council of 23 July 2014 establishing a framework for maritime spatial planning. (2014). *Official Journal of the European Union*, L 257/135. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0089

Dunn, W. N. (2015). *Public policy analysis*. Routledge.

Dupuis, J., & Biesbroek, R. (2013). Comparing apples and oranges: The dependent variable problem in comparing and evaluating climate change adaptation policies. *Global Environmental Change*, *23*(6), 1476–1487.

Elrick-Barr, C. E., & Smith, T. F. (2021). Policy is rarely intentional or substantial for coastal issues in Australia. *Ocean & Coastal Management*, 207, Article 105609. https://doi.org/10.1016/j.ocecoaman.2021.105609

Expósito, F. J., González, A., Pérez, J. C., Díaz, J. P., & Taima, D. (2015). High-resolution future projections of temperature and precipitation in the Canary Islands. *Journal of Climate*, *28*(19), 7846–7856.

Fernández-Palacios, J. M., & Dias, E. (2001). Marco biogeográfico macaronésico. In J. M. Fernández-Palacios & J. L. Martín (Eds.), *Naturaleza de las Islas Canarias* (pp. 45–52). Publicaciones Turquesa.

Ferraro, G., & Failler, P. (2024a). Biodiversity, multi-level governance, and policy implementation in Europe: A comparative analysis at the subnational level. *Journal of Public Policy*, *44*(3), 546–572.

Ferraro, G., & Failler, P. (2024b). Understanding the "implementation gap" to improve biodiversity governance: An interdisciplinary literature review. *Journal of Sustainability Research*, *6*(2), Article e240009.

García-Romero, L., Carreira-Galbán, T., Rodríguez-Báez, J. Á., Máyer-Suárez, P., Hernández-Calvento, L., & Yánes-Luque, A. (2023). Mapping environmental impacts on coastal tourist areas of oceanic islands (Gran Canaria, Canary Islands): A current and future scenarios assessment. *Remote Sensing*, *15*(6), Article 1586.

García-Sanabria, J., García Onetti, J., & Barragán, J. M. (2011). *Las Comunidades Autónomas y la gestión integrada de las áreas litorales de España*. Fundación Biodiversidad; Universidad de Cádiz.

Gobierno de Canarias. (2022). *PIMA Adapta Costas: Evaluación del riesgo frente al cambio climático en las costas de Canarias*. https://opendata.sitcan.es/upload/medio-ambiente/pima/20220531IP_ResumenPIMA.pdf

González-Dávila, M., & Santana-Casiano, J. M. (2023). Long-term trends of pH and inorganic carbon in the Eastern North Atlantic: The ESTOC site. *Frontiers in Marine Science*, *10*. https://doi.org/10.3389/fmars.2023.1236214

Intergovernmental Panel on Climate Change. (2023). *Climate change 2023: Synthesis report*.. https://doi.org/10.59327/IPCC/AR6-9789291691647

Jordan, A., Huitema, D., Van Asselt, H., & Forster, J. (2018). *Governing climate change: Polycentricity in action?* Cambridge University Press.

Kelman, I., & West, J. J. (2009). Climate change and small island developing states: A critical review. *Ecological and Environmental Anthropology*, *5*(1), 1–16.

Villullas, A. (2025, Febraury 28). Luz verde al plan de transición ecológica para San Cristóbal por el error de un edil de Darias. *La Provincia*. https://www.laprovincia.es/las-palmas/2025/02/28/luz-verde-plan-transicion-ecologica-114806933.html

Lise, F., Gianluca, F., & Pierre, F. (2025). Blue nature-based solutions in marine and coastal EU policies: Challenges, recommendations and policy opportunities throughout the policy cycle. *Marine Policy*, *177*, Article 106687.

López-Díez, A., Máyer Suárez, P., Díaz Pacheco, J., & Dorta Antequera, P. (2019). Rainfall and flooding in coastal tourist areas of the Canary Islands (Spain). *Atmosphere*, *10*(12), Article 809.

Marrero-Betancort, N., Marcello, J., Rodríguez-Esparragón, D., & Hernández-León, S. (2022). Sea level change in the Canary current system during the satellite era. *Journal of Marine Science and Engineering*, *10*(7), Article 936.

Meadowcroft, J. (2009). *Climate change governance* (Working Paper No. 4941). World Bank.

Mycoo, M., Wairiu, M., Campbell, D., Duvat, V. K., Golbuu, Y., Maharaj, S., Nalau, J., Nunn, P., Pinnegar, J., & Warrick, O. (2022). Small islands. In *Climate change 2022: Impacts, adaptation and vulnerability* (pp. 1–107). Cambridge University Press

Nurse, L. A., McLean, R. F., Agard, J., Briguglio, L. P., Duvat, V. K., Pelesikoti, N., Tompkins, E., & Webb, A. (2014). Small islands. In *Climate change 2014: Impacts, adaptation, and vulnerability* (pp. 1613–1654). Cambridge University Press.

Olsen, S. B. (2003). Frameworks and indicators for assessing progress in integrated coastal management initiatives. *Ocean and Coastal Management*, *46*(3/4), 347–361.

Peña-Alonso, C., Gallego-Fernández, J. B., Hernández-Calvento, L., Hernández-Cordero, A. I., & Ariza, E. (2018). Assessing the geomorphological vulnerability of arid beach-dune systems. *Science of the Total Environment*, *635*, 512–525.

Pérez-Chacón Espino, E., Peña-Alonso, C., Santana-Cordero, A. M., & Hernández-Calvento, L. (2019). The integrated coastal zone management in the Canary Islands. In J. A. Morales (Ed.), *The Spanish coastal systems: Dynamic processes, sediments and management* (pp. 789–814). Springer.

Pinardo-Barco, S., Sanromualdo-Collado, A., & García-Romero, L. (2023). Can the long-term effects of beach cleaning heavy duty machinery on aeolian sedimentary dynamics be detected by monitoring of vehicle tracks? An applied and methodological approach. *Journal of Environmental Management*, *325*, Article 116645.

Söllheim, Á. L. L., Suárez, P. M., & Hernández, F. G. (2024). The digital climate atlas of the Canary Islands: A tool to improve knowledge of climate and temperature and precipitation trends in the Atlantic islands. *Climate Services*, *34*, Article 100487.

Stephenson, R. L., Hobday, A. J., Cvitanovic, C., Alexander, K. A., Begg, G. A., Bustamante, R. H., Dunstan, P. K., Frusher, S., Fudge, M., Fulton, E. A., Haward, M., Macleod, C., McDonald, J., Nash, K. L., Ogier, E., Pecl, G., Plagányi, E. E., van Putten, I., Smith, T., & Ward, T. M. (2019). A practical framework for implementing and evaluating integrated management of marine activities. *Ocean & Coastal Management*, *177*, 127–138.

Tocco, C. L., Frehen, L., Forse, A., Ferraro, G., & Failler, P. (2024). Land-sea interactions in European marine

governance: State of the art, challenges and recommendations. *Environmental Science & Policy*, *158*, Article 103763.

Turner, C. K. (2017). A principle of intentionality. *Frontiers in Psychology*, *8*, Article 137.

Van Assche, K., Hornidge, A. K., Schlüter, A., & Vaidianu, N. (2020). Governance and the coastal condition: Towards new modes of observation, adaptation and integration. *Marine Policy*, *112*, Article 103413.

van den Hurk, B., Pinardi, N., Bisaro, A., Galluccio, G., Jimenez, J., Larkin, K., Melet, A., Pomarico, L. G., Richter, K., Singh, K., van de Wal, R., & Winter, G. (2024). Sea level rise in Europe: Summary for policy makers. *State of the Planet Discussions*, *1*. https://doi.org/10.5194/sp-3-slre1-1-2024

Vargas-Yáñez, M., Tel, E., Marcos, M., Moya, F., Ballesteros, E., Alonso, C., & García-Martínez, M. C. (2023). Factors contributing to the long-term sea level trends in the Iberian Peninsula and the Balearic and Canary Islands. *Geosciences*, *13*(6), Article 160.

Vogel, B., & Henstra, D. (2015). Studying local climate adaptation: A heuristic research framework for comparative policy analysis. *Global Environmental Change*, *31*, 110–120.

About the Authors

Aridane G. González is a Dr. in marine sciences from the University of Las Palmas de Gran Canaria. He is a senior lecturer at the Department of Chemistry and a researcher in the QUIMA group at the Institute of Oceanography and Global Change. His background is in marine chemistry, biogeochemical cycles, and climate change, among others. He is a scientist of the Horizon Europe project BlueGreen Governance.

Carolina Peña-Alonso is a lecturer at the University of Las Palmas de Gran Canaria, and most of her teaching is focused on the Faculty of Geography. She is a researcher at the Institute of Oceanography and Global Change at the same university. Her background is in different topics related to global change, environment, and society. She is a scientist of the Horizon Europe project BlueGreen Governance.

Melchor González-Dávila is a full professor at the University of Las Palmas de Gran Canaria and the coordinator of the QUIMA group at the Institute of Oceanography and Global Change. He is the coordinator of the network of CO_2 observations in the Canary Islands and the lead of the marine section of ICOS-ERIC in Spain. His background is in the CO_2 system in the ocean and the physicochemistry of trace metals. He is a scientist of the Horizon Europe project BlueGreen Governance.

J. Magdalena Santana-Casiano is a full professor at the University of Las Palmas de Gran Canaria and the coordinator of the research line of physicochemistry of trace metals in the QUIMA group, at the Institute of Oceanography and Global Change. Her background is in CO_2 systems and the physicochemistry of trace metals in the ocean. She is a scientist of the Horizon Europe project BlueGreen Governance.

David González-Santana is a postdoctoral researcher at the QUIMA group (Institute of Oceanography and Global Change at the University of Las Palmas de Gran Canaria). His background is focused on iron biogeochemistry and climate change. He is a scientist of the Horizon Europe project BlueGreen Governance.

Gianluca Ferraro is an associate professor in environmental governance at the University of Portsmouth (Centre for Blue Governance) and visiting professor at the University of Valencia. His research examines policy implementation, public participation, institutional change, and subnational governance. He is the scientific coordinator of the Horizon Europe project BlueGreen Governance.

Lorena Naranjo-Almeida is a predoctoral scientist in the PhD program DOYCAG at the Institute of Oceanography and Global Change, University of Las Palmas de Gran Canaria. She is studying the governance of climate change in the land–sea interface and public participation. She is a scientist of the Horizon Europe project BlueGreen Governance.

Leví García-Romero is currently hired as a postdoctoral fellow at ULPGC, and he holds a PhD in oceanography and global change. The main projects in which he has participated are related to the multiscale analysis (spatiotemporal) of eco-anthropogenic processes associated with the dynamics of coastal ecosystems, and how these are adapting to climate change. In recent years, he has also been interested in developing innovative land–sea governance schemes for sustainable environmental policy to help reduce socio-environmental conflicts that occur in coastal ecosystems, and thus strengthen them and keep them healthy in the face of climate change. He is a scientist of the Horizon Europe project BlueGreen Governance.

Ocean and Society
2025 • Volume 2 • Article 10341
https://doi.org/10.17645/oas.10341

cogitatio

ARTICLE

Open Access Journal

Beyond Ecology: Land–Sea Governance, Policy, and Research in Réunion Island (2000–2024)

Barbara Losen, Erwann Lagabrielle, and Salwa Aabid

UMR Espace Dev, University of Reunion Island, France

Correspondence: Barbara Losen (barbara.losen@univ-reunion.fr)

Submitted: 15 March 2025 **Accepted:** 28 May 2025 **Published:** 13 August 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Coastal areas are increasingly exposed and vulnerable to environmental degradation and climate change, requiring adaptive governance approaches that integrate the climate–environment–health nexus. In Réunion Island, a French overseas department and EU region, two decades of science-policy initiatives have aimed to improve coastal governance through stakeholder engagement, scientific knowledge integration, and deliberative processes. Building on the evolutionary governance theory framework, this study analyzes a body of 281 scientific research articles (2000–2024), 4 participatory projects (2005–2020), and 12 expert insights to identify land–sea governance challenges and opportunities. Scientific articles remain focused on diagnosing environmental problems rather than elaborating systemic solutions, with a predominance of ecological and conservation science. Participatory governance and long-term strategic foresight are underdeveloped, and while digital tools are widely used for environmental monitoring, their integration into decision-making remains insufficient. Key barriers include administrative fragmentation, weak institutional coordination, and difficulties in integrating scientific knowledge into policy processes. Four enablers emerge: strong political leadership, long-term institutional support, a shared strategic vision, and regional cooperation aligned with European and international frameworks. Additionally, Réunion's hybrid sociability, shaped by its colonial history, presents both challenges and opportunities for governance. While it may foster exclusivity, it can also facilitate trust-based collaboration. A dedicated land–sea governance structure could enhance multi-scale and multi-level coordination among stakeholders.

Keywords

environmental risk; evolutionary governance theory; marine and coastal research; muti-scale governance; participatory decision-making; social-ecological systems; trust relationships

1. Introduction

Marine and coastal social-ecological systems are rapidly changing and degrading; their sustainability is threatened and requires innovative governance schemes that address the climate–environment–health nexus. Global efforts to enhance international ocean governance have intensified, particularly with the adoption of the 2030 Sustainable Development Goals in 2015, including SDG 14, which focuses on the protection of aquatic ecosystems. In 2017, the EU launched the International Ocean Governance Programme to enhance cooperation and coordination among EU member states and international organizations, ensuring the sustainable management of marine resources and contributing to the achievement of the 2030 Sustainable Development Goals (European Parliament, 2018). Faced with fragmented expertise, dispersed information, and a disjointed decision system, the EU is seeking to develop more coherent maritime governance schemes to respond to growing environmental and socio-economic challenges.

The EU has developed an integrated coastal zone management (ICZM) strategy since the 2000s (Recommendation of the European Parliament and of the Council of 30 May 2002, 2002). ICZM has been conceptualized and applied in different ways internationally, most notably in Australia and Southeast Asia, reflecting varied governance contexts and coastal management traditions (Kay & Alder, 2005). Referring to the EU's interpretation, as formalized in the EU Recommendation (2002/413/EC) and subsequent policy instruments, ICZM is understood as a "management framework" that promotes a coordinated, ecosystem-based, and participatory approach to managing coastal zones, addressing issues such as biodiversity loss, habitat degradation, urbanization, and climate change impacts. Those issues were further addressed within the Marine Strategy Framework Directive, adopted in 2008, establishing a framework for achieving good environmental status of EU marine waters by 2020 and promoting the sustainable use of marine resources. These actions now fall within the scope of Directive 2014/89/EU, establishing an explicit legal framework for maritime spatial planning. EU maritime spatial planning strategy integrates ecological, social, and economic sustainability objectives and aims to promote coordinated, transparent, and proof-based planning for the management of maritime and coastal activities while taking into account regional specificities. This approach emphasizes the participation of local actors and coordination between different levels of governance (Lozachmeur, 2009). In the European context, the term "maritime spatial planning" is commonly used, notably in the EU legal framework. By enabling the concrete implementation of the ecosystem-based approach through the analysis and allocation of human activities in the marine space, marine spatial planning (MSP) is now applied in around 70 countries facing various challenges (Santos et al., 2019). MSP aims to bring together the various ocean users to facilitate coordinated and informed decisions on the sustainable use of marine resources (Ehler & Douvere, 2009). Its principles and mechanisms have been incorporated into the legal frameworks of several nations, including EU member states (Shabtay et al., 2020).

Stemming from the observation-conceptualization effort to develop ocean governance, the evolutionary governance theory (EGT) proposes to understand governance as a co-evolving process over time (Van Assche et al., 2014). The co-evolution of formal and informal institutions governing marine and coastal areas, as well as mechanisms and bodies responsible for their implementation, is part of the broader framework of ocean governance (Van Assche et al., 2017). EGT articulates diverse conceptual frameworks such as social systems theory, post-structuralism, institutional economics, but also the roles of materiality, the co-evolutions of social and ecological systems (Van Assche et al., 2020). According to EGT, the elements

of governance and their interdependencies evolve together. The co-evolution process of these elements results in the governance itself (Van Assche et al., 2014). EGT focuses particularly on the roles of knowledge and narrative in governance and the links between the formation of discursive objects (such as the coast) and the evolution of organizational forms (Van Assche et al., 2020). The observation of the evolving configurations of actors/institutions, power/knowledge, remains an issue for policy adaptation and integration (Schlüter et al., 2020). Apprehending policy integration (Schlüter et al., 2020) requires pointing out the enablers and barriers within a multi-level governance system. EGT as an analytical framework is motivated by its capacity to grasp the complexity, non-linearity, and historically embedded nature of governance processes, features that are particularly pronounced in insular and peripheral territories. Islands often concentrate layered institutions, overlapping jurisdictional scales, and historically contingent governance trajectories, making them fertile ground for the study of co-evolutionary dynamics between actors, knowledge, discourses, and institutions. In this regard, EGT offers a relevant and flexible conceptual lens for exploring the tensions, adaptations, and strategic shifts that characterize coastal and marine governance in such contexts. Despite its potential, the application of EGT to insular coastal governance remains limited in the academic literature. This study addresses that gap by mobilizing EGT to analyze the governance of land–sea interactions in Réunion Island, an EU outermost region, where complex actor configurations, colonial legacies, and institutional fragmentation present a unique case for examining how governance evolves across scales. It contributes to expanding the empirical reach of EGT and offers new insights into the challenges and opportunities of integrated coastal planning in island territories.

Using the EGT framework, this article explores the co-evolutionary relationships between researchers, stakeholders, and decision-makers in managing the land–sea interface in Réunion Island, a French overseas department and EU outermost region in the Indian Ocean. It addresses five research questions related to: (a) barriers and enablers of land–sea integration, (b) the role and limitations of scientific knowledge, (c) stakeholder perceptions of participatory governance, (d) the use of strategic foresight, and (e) the relevance of digital tools for coastal and marine planning in Réunion. The study draws on material from 2000 to 2024, combining a review of the scientific literature, analysis of relevant research projects, and semi-structured interviews with researchers and institutional actors.

1.1. Study Site

Réunion Island (France; Figure 1) is a volcanic island in the southwest Indian Ocean, with steep terrain rising to 3,059 m. Its 870,000 residents are mostly concentrated in urban lowlands below 1,000 m, which occupy 10% of the territory. Since becoming a French department in 1946, the island's population has doubled from 250,000 in 1950 to 500,000 in 1980, amid rapid development (Shabtay et al., 2020). Agriculture covers 15% of the island, mainly for sugarcane, while tourism accounts for 3% of the GDP. Despite a service-based economy, unemployment and poverty remain high, with 38% of people living below the poverty line. A National Park now protects 43% of the island, alongside a marine reserve and a UNESCO World Heritage designation (Lagabrielle et al., 2010). As an EU outermost region, Réunion receives significant support: €1.795 billion was allocated under the 2021–2027 FEDER-FSE+ program, of which €1.409 billion came from the EU, equivalent to roughly 1% of the island's annual GDP (€20.4 billion in 2021), according to the Europe en France portal (Agence nationale de la cohésion des territoires, n.d.).

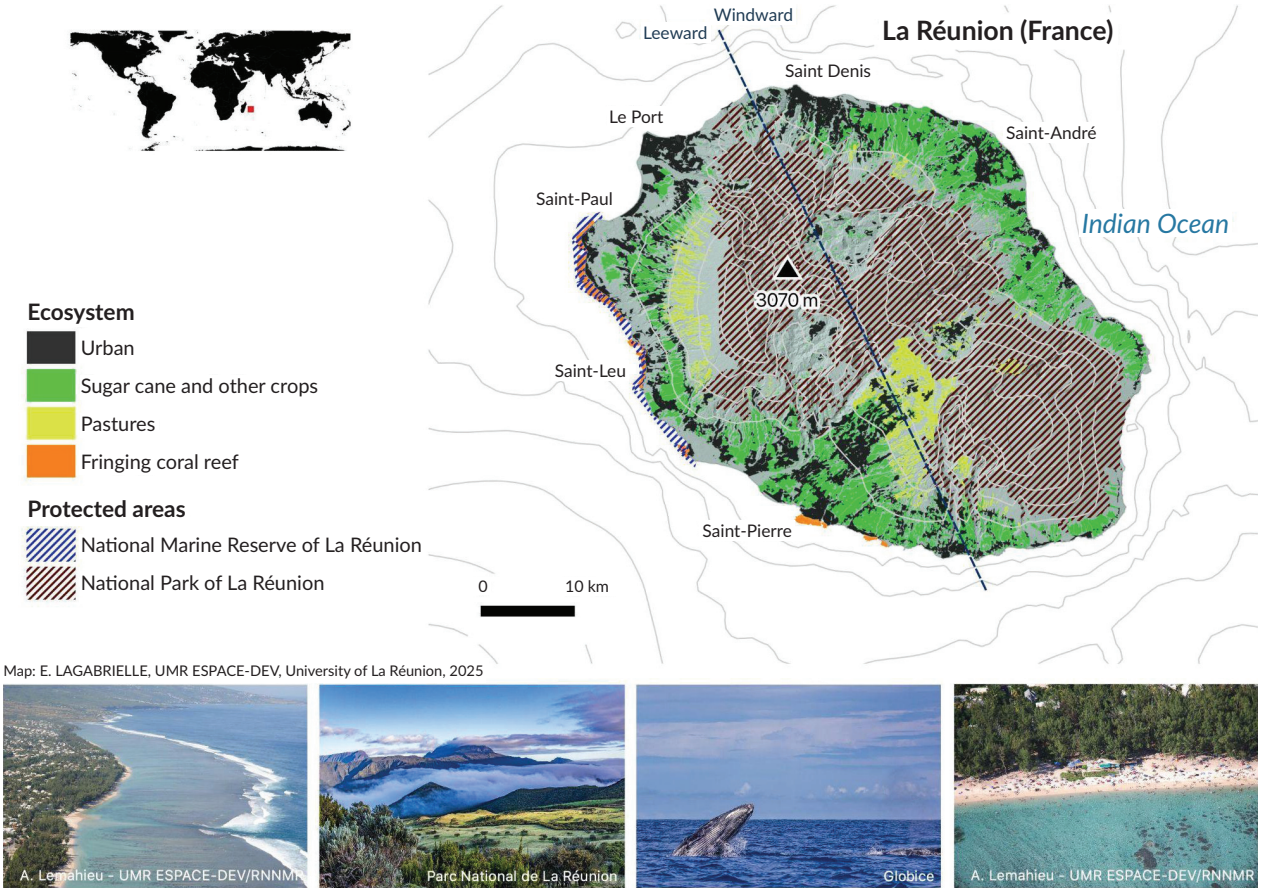


Figure 1. Map illustrating the location and spatial organization of La Réunion in the western Indian Ocean. Notes: The lower panel shows pictures (from left to right): fringing coral reef on the West coast, Piton des Neiges and pasture landscape in the uplands, jumping whale (Megaptera novaeangliae) on the West coast, and beach users in the back reef depression on the West coast coral reef; altitude contour lines (per 500 m) and terrestrial shaded relief were generated using publicly available geographic data from the General Bathymetric Charts of the Oceans (The GEBCO_08 Grid, version 20100927); data on land-use, benthic cover, and administrative units were extracted from OpenStreetMap.

Spatial planning in Réunion relies on several French regulatory instruments that aim to align development with environmental protection (Ferraro et al., 2023). The Schéma d'Aménagement Régional (SAR) defines regional land-use priorities and ensures coherence with local planning tools like the Schémas de Cohérence Territoriale and Plans Locaux d'Urbanisme. The SAR includes a maritime component through the Schéma de Mise en Valeur de la Mer (SMVM), which sets zoning rules for coastal areas. Nationally, the Document Stratégique de Bassin Maritime (DSBM) for the southern Indian Ocean defines maritime priorities, while the Stratégie Réunionnaise pour la Biodiversité integrates biodiversity into territorial policies. These frameworks are supported by natural hazard plans and invasive species strategies. Territorial development is also linked to a local research ecosystem of about 500 full-time researchers, including 340 permanent academics at the University of La Réunion and partner institutions such as the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), Institut de Recherche pour le Développement, Bureau de Recherches Géologiques et Minières, and Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER; based upon data collected from research institutions).

The DSBM is a strategic plan for the sustainable management of maritime and coastal areas in the southern Indian Ocean, including Réunion, Mayotte, and the French Southern and Antarctic Lands. Developed by the Conseil Maritime Ultramarin du bassin Sud océan Indien (CMUB) under the Direction Mer Sud Océan Indien, it localizes France's National Strategy for the Sea and Coastline. Covering 13 key themes, it focuses on protecting marine ecosystems, supporting the maritime economy, managing coastal development, addressing climate risks, and promoting scientific research. The plan involves public and private stakeholders through consultations and is updated every six years. At the local level, the SAR-SMVM (Schéma d'Aménagement Régional-Schéma de Mise en Valeur de la Mer) guides land and maritime planning in Réunion. Overseen by the Regional Council, it aims to balance development with environmental preservation. With a population projected to reach one million by 2030, key priorities include managing urban growth, protecting ecosystems, supporting the maritime economy, enhancing climate resilience, and promoting sustainable mobility. The SAR-SMVM is revised every 10 years to adapt to evolving challenges.

Current coastal management policies prioritize short-term protection through a strategy known as "holding the line," a recognized approach in shoreline management that involves maintaining the existing coastline position using hard infrastructure such as seawalls and dikes (Lorion & Villeneuve, 2007; Magnan & Duvat, 2018). However, ongoing urbanization and the proliferation of coastal infrastructure increase the vulnerability of shorelines, notably by heightening exposure to marine submersion. Climate change and sea level rise are likely to intensify these existing pressures. Although regulatory tools (e.g., the coastal law) exist, they are underused and face challenges in effective enforcement (Cazes-Duvat, 2004; Mirault, 2004). Both decision-makers and the public remain largely unprepared for transformative adaptation measures, such as the relocation of at-risk populations, despite growing consensus on the need to rethink land use planning. Awareness of climate risks remains low: over 80% of residents are unaware of existing risk prevention plans (Magnan & Duvat, 2018).

2. Materials and Methods

2.1. Conceptual Framework and Thematic Axis

The methodological approach is based on the five analytical dimensions of EGT as defined by Fobé et al. (2024). EGT frames governance as a dynamic, co-evolutionary process shaped by the interactions between actors, institutions, and socio-ecological systems. The research design, data collection, and analysis were structured following the five EGT axes (Table 1, adapted from Fobé et al., 2024):

1. Barriers and enablers to effective management: This axis examines how coastal and marine governance systems address the challenges of fragmented responsibilities, overlapping mandates, and weak coordination across land–sea interfaces. It explores both institutional barriers and enabling mechanisms such as inter-agency collaboration and stakeholder engagement.

2. Scientific knowledge in marine and coastal governance: This dimension analyzes the use of scientific evidence in governance processes, focusing on the alignment (or lack thereof) between research outputs and policy needs, and the conditions under which scientific advice is accepted or resisted.

3. Inclusive and participatory approaches: This axis investigates the design, implementation, and perceived effectiveness of participatory processes in coastal governance, highlighting both their normative value and the practical challenges of engaging diverse stakeholders.

4. Strategic foresight for long-term policy-making: This dimension focuses on the extent to which scenario planning, anticipatory tools, and long-term visioning are used to inform policy development, and how these practices are perceived by local actors.

5. Digital transformation in marine and coastal governance: This axis explores how digital tools, such as spatial platforms, data-sharing systems, and decision-support technologies, are used in coastal governance, including their accessibility, perceived usefulness, and adaptability to the Réunion Island context.

Table 1. Thematic axis of investigation and related key questions and keywords.

Axis	Short title	Description	Key question	Keywords (``," = OR)
Scope	Land–sea governance (scope)	A governance approach that seeks to coordinate the management of terrestrial and marine environments in a holistic and interconnected manner	How can governance frameworks effectively integrate land–sea planning to ensure policy coherence and sustainable management?	Scope 1: Reunion, Réunion A–ND Scope 2: Ecosystem AND Scope 3: Sea, ocean, marine, maritime, coast, shore*, water*, coral AND Scope 4: Manage*, monitor*, planning, control*, strateg*, govern*, policy*, politic*, decision, conserv*, develop*, econom*, socio-econom*, human, social
Axis #1	Barriers and enablers to effective management	Explores barriers and enablers to effective land–sea management, including coordination, data sharing, and stakeholder engagement	What are the key barriers and enablers to effective land–sea management and planning in Réunion?	Challenge, regul*, constraint, limit*, barrier, facilitat*, opportunit*, solution, lesson, issue, problem, enabler, agreement, conflict
Axis #2	Scientific knowledge in marine and coastal governance	Assesses how scientific knowledge is used in governance and identifies barriers such as mismatches between data and policy needs	How is scientific knowledge used in marine and coastal governance, and what are the barriers to its application?	Fishing, agriculture, farming, livestock, aquaculture, forestry, urban, conservation, ecosystem service, protected area, transport, energy, industr*, species, habitat, land-use, risk, hazard, resource, touris*, threat, pressure, impact, pollution, waste, erosion, climate, health, resilien*, adapt*, evidence, expert*, knowledge, disciplin*

Table 1. (Cont.) Thematic axis of investigation and related key questions and keywords.

Axis	Short title	Description	Key question	Keywords (``," = OR)
Axis #3	Inclusive and participatory approaches	Examines stakeholder perceptions of participatory governance approaches and the challenges of integrating diverse perspectives	How do stakeholders perceive the effectiveness of participatory governance approaches in marine and coastal management?	Participa*, public, stakeholder, consult*, involv*, engag*, collabor*, partner, actor, integrat*
Axis #4	Strategic foresight for long-term policy-making	Investigates the perception of strategic foresight as a tool for long-term policy-making in marine and coastal governance	How is strategic foresight perceived by stakeholders in the governance of Réunion's marine and coastal areas?	Foresight, forecast, scenari*, future, vision, anticip*, predict*
Axis #5	Digital transformation in marine and coastal governance	Analyzes stakeholder perceptions of digital tools for governance, focusing on accessibility, effectiveness, and adaptability to Réunion's context	How do stakeholders perceive digital tools for marine and coastal governance in terms of accessibility, effectiveness, and adaptability to Réunion's context?	Data, observation, information, model*, spatial, temporal, simulation, map*, track*, remote sensing

2.2. Thematic Trends of Scientific Literature (2000–2024)

To conduct a keyword-based review of scientific literature on land–sea governance in Réunion Island, we adopted a structured methodology based on the first two steps of the preferred reporting items for systematic reviews and meta-analyses guidelines (Mejia et al., 2021; Page et al., 2021). The research corpus consisted of peer-reviewed journal articles published in English or French between 2000 and 2024. For French-language articles, it was assumed that an English version of the title, abstract, and keywords was available. The initial inclusion criterion was based on the presence of the following keyword combination in the text: ("Reunion" OR "Réunion") AND "Ecosystem." Literature searches were conducted across multiple academic platforms, including Google Scholar, BASE, JSTOR, Frontiers, Open Science, Springer Nature, ScienceDirect, Taylor & Francis, and PubMed.

To identify dominant thematic trends over time, we conducted a keyword frequency analysis using truncated root forms. Words marked with an asterisk (e.g., maritim*, govern*, etc.) indicate lexical stems used in the database queries. This sampling method allowed us to include multiple lexical variations of the same concept (e.g., governance, government, and governing) in the corpus.

An article database was compiled, including the year, authors, title, abstract, and journal of each article. When necessary, English translations of these elements from French were subsequently produced using ChatGPT 4.0. This database was then manually screened to check the selected articles and exclude duplicate entries. In a second step, articles that didn't contain at least one keyword in each of the 4 groups of keywords composing the "Scope" (Table 1) were excluded, ending with a list of 281 articles that fit the inclusion criteria.

The investigation framework of the selected corpus of 281 research articles was structured around the five EGT-based research axes (Table 1), ensuring relevance to land–sea governance. Each of the five axes is associated with a list of keywords relevant to the theme. A quantitative content analysis was conducted by screening the 281 selected articles, assessing keyword presence/absence in titles and abstracts. Keywords were fine-tuned to avoid polysemic or ambiguous terms. The resulting database enabled graphical visualization of keyword frequency and co-occurrence linkages, aligning with previous studies that have employed semantic network analysis for scientific literature, providing insights into thematic trends in land–sea governance research.

Two software programs were used: Zotero (version 7.0.11) open-source reference manager, and Microsoft Excel (version 16.94). Zotero facilitated reference management, while Excel was used to track the presence or absence of keywords.

2.3. Thematic Analysis of Selected Projects (2005–2020)

We selected four scientific projects on land–sea governance in Réunion Island that, through temporal overlap, aimed to cover the period from 2005 to 2020 (Table 2). The inclusion criteria for project selection were as follows: the project had to focus on the entire territory or a sub-region of Réunion Island, demonstrate an interdisciplinary approach, actively engage stakeholders and public decision-makers,

Table 2. Participatory research projects analyzed.

Project	Objectives	Project leader	Funding	Description
Ocean Metiss (2017–2020)	Develop a sustainable, integrated, long-term maritime development strategy and implement it through a marine spatial plan	University of Reunion	€963,211 from the EU, the French state, and the Reunion Island Regional Council	Pilot project aiming to investigate innovative MSP processes, tools, and methods for the European MSP Directive (Directive 2014/89/CE)
GIML (2013–2015)	Improve land–sea continuum management in an experimental territory to ensure harmonious coexistence of maritime and coastal uses	IFREMER	€600,000 from the EU, General Council, and Territoire de la Côte Ouest	Focus on managing the relationship between human activities and the marine/terrestrial environment, particularly upstream-downstream flows
Descartes (2012–2015)	Build a partnership framework using a landscape dynamics simulation tool for territorial foresight exercises	CIRAD	€443,552 from the National Research Agency	Exploration of land–use evolution scenarios with a focus on urban sprawl and its impacts, through a participatory approach
ATP Domino (2005–2007)	Develop forward-looking modeling tools that integrate political processes into land–use management simulations	CIRAD	Funded by the National Research Agency, with other local contributions	Creation of tools to facilitate political decision-making regarding land–use planning, especially in the context of SAR

incorporate the use of spatial models or geospatial data, and implement a territorial foresight process. Each collected project report was examined through the lens of the five dimensions of EGT (Table 1). The selected projects (Ocean Metiss, GIML, Descartes, and ATP Domino) provide critical case studies on participatory research, decision-support tools, and the integration of scientific knowledge into policy frameworks. These projects span different periods and thematic areas within governance of land, sea, or land–sea interface, allowing for a comprehensive assessment of governance evolution over time.

2.4. Semi-Structured Interviews of Researchers and Institutional Stakeholders

In addition to the literature review and project analysis, semi-structured interviews were conducted with 12 scientists and institutional stakeholders. The interview guide was structured around five dimensions inspired by EGT, each addressing key challenges in the governance of coastal and marine areas: (a) integrated land–sea planning and management, (b) the role of scientific knowledge in governance, (c) inclusive and participatory approaches, (d) the use of strategic foresight, and (e) digital transformation. Each axis was explored through targeted questions about barriers, enablers, tools, and practices. Interviewees were invited, for instance, to reflect on institutional fragmentation and coordination (Dimension 1), the use and limitations of scientific evidence in policy-making (Dimension 2), or the effectiveness of participatory initiatives (Dimension 3). For Dimension 4, questions addressed the use of foresight tools like scenario planning or expert panels, and their relevance in long-term governance. Dimension 5 focused on stakeholders' perceptions of digital platforms, including their accessibility, integration, and adaptability to Réunion's specific challenges. These thematic axes also structured the subsequent analysis of interview material.

Rather than applying a deductive coding framework, the analysis focused on comparing and contrasting the representations expressed across the five dimensions in order to identify tensions, evolutions, and recurring patterns. This approach ensured fidelity to EGT's emphasis on the co-evolution of institutions, knowledge, actors, and discourses, while remaining grounded in the specific context of Réunion. The interviews enabled in-depth exploration of current and potential governance models by eliciting detailed accounts of challenges, strategies, and tools. Given the complexity of coastal governance and the diversity of actors involved, the sample included both scientists and institutional actors with expertise in land–sea management, environmental governance, and decision-making. Although some individuals directly involved in planning projects were unavailable, the inclusion of experts experienced in participatory research and collaborative governance ensured critical insights.

To ensure the trustworthiness of the data, particular attention was paid to selecting a diverse and complementary sample (Table 3), mitigating the risk of one-sided narratives. Potential biases—such as institutional affiliation, past involvement in governance processes, or professional positioning—were considered during both collection and analysis. The interviews were conducted using open-ended, non-leading questions to encourage critical reflection. Triangulation with project documentation and literature allowed for contextualizing and validating the responses. While no qualitative interview is entirely free from bias, the consistency of the responses and thematic saturation reached during analysis strengthen the reliability of the findings presented.

Table 3. Classification of interviewees.

Actors	Administrative structure(s)	Type(s) of actor	Expertise field	Implications in participatory projects studied and/or SAR-SMVM
A1	Regional Council of Reunion Island	Institutional	European affairs officer	Ocean Metiss
A2	Regional Council of Reunion Island	Institutional	SAR-SMVM officer	SAR-SMVM
A3	Regional Council of Reunion Island Land Planning and Housing Public Land Establishment of Réunion Reunion Island Aquaculture Association	Scientist/institutional	Entomologist Ex-vice-president of the Regional Council responsible for spatial planning Ex-vice-president of the Land Planning and Housing Ex-vice-president of the Public Land Establishment of Réunion Ex-president of the Reunion Island Aquaculture Association	SAR-SMVM
A4	National Park of Reunion	Scientist/institutional	Ex-responsible and mission manager Restoration of native habitats, Ecology, and Biological invasions	—
A5	University of Reunion Island Regional Council of Reunion Island	Scientist/institutional	Lecturer in geography Ex-vice-president of the Regional Council responsible for spatial planning Ex-member of the National Assembly	SAR-SMVM
A6	University of Reunion Island National Park of Reunion Island	Scientist	Professor Island biology, tropical forest ecology, and conservation biology	—
A7	University of Reunion Island Shark Security Center Natural Marine Reserve of Reunion	Scientist	Lecturer Ecology, public policy, remote sensing, geoinformatics, and geography	Ocean Metiss GIML Descartes ATP Domino
A8	Research Institute for Development Natural Marine Reserve of Reunion	Scientist	Researcher Ecology and marine biology	—

Table 3. (Cont.) Classification of interviewees.

Actors	Administrative structure(s)	Type(s) of actor	Expertise field	Implications in participatory projects studied and/or SAR-SMVM
A9	University of Reunion Island Coastal Observatory of Reunion	Scientist	Professor Geomorphology, coastal environment, remote sensing, and geoinformatics	—
A10	IFREMER Reunion Island Aquaculture Association Natural Marine Reserve of Reunion	Scientist	Researcher in fisheries sciences Ex-director of the Reunion Island Aquaculture Association.	—
A11	Research Institute for Development Natural Marine Reserve of Reunion	Scientist	Research director ICZM and the design and implementation of marine protected areas	GIML
A12	Regional agency for development, investment, and innovation	Scientist/institutional	In charge of territorial intelligence Ecological economics (island economies) and research and innovation systems	—

3. Results

The presentation of results is structured following the five axis of the EGT framework and includes a preliminary interpretation.

3.1. Enablers and Barriers to Effective Management (Axis #1)

Based on the four groups of keywords forming the inclusion criteria of the scope (Table 1), the research article corpus of 281 papers uses the keyword ocean (cited in 63% of articles), sea (54%), coastal (30%), and marine (27%) environments. The keyword coral is present in 22% of articles, while maritime only reaches 1%.

However, socio-economic and governance-related terms such as socio-econom*, politic*, and govern* are cited in fewer than 10% of articles, pointing to a gap in studies integrating human dimensions, institutional frameworks, and political processes into marine governance research. This imbalance suggests that governance discussions remain largely focused on environmental management rather than broader socio-political and economic contexts.

Despite 44% of articles addressing, with at least one key-word, barriers and enablers to effective management (Axis #1; (Figures 2a and 2b), the actual citation of specific obstacles (constraint, barrier, and problem) and solutions (solution, opportunity, and facilitators) remains low, at under 5% (Figure 3). This indicates that while

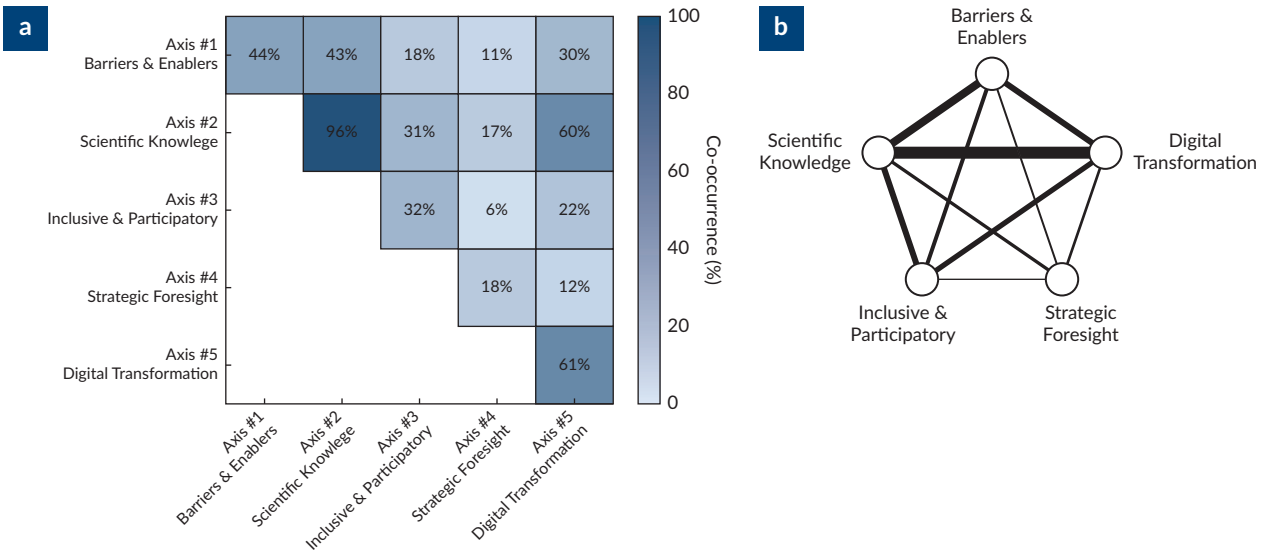


Figure 2. (a) Co-occurrence matrix (in %) of the five EGT axes within the corpus of 281 selected articles; (b) a network representation of the co-occurrences "linking" the five EGT axes (with line thickness proportional to the number of co-occurrences). Note: An axis is considered present in an article if at least one keyword associated with that axis appears in the article.

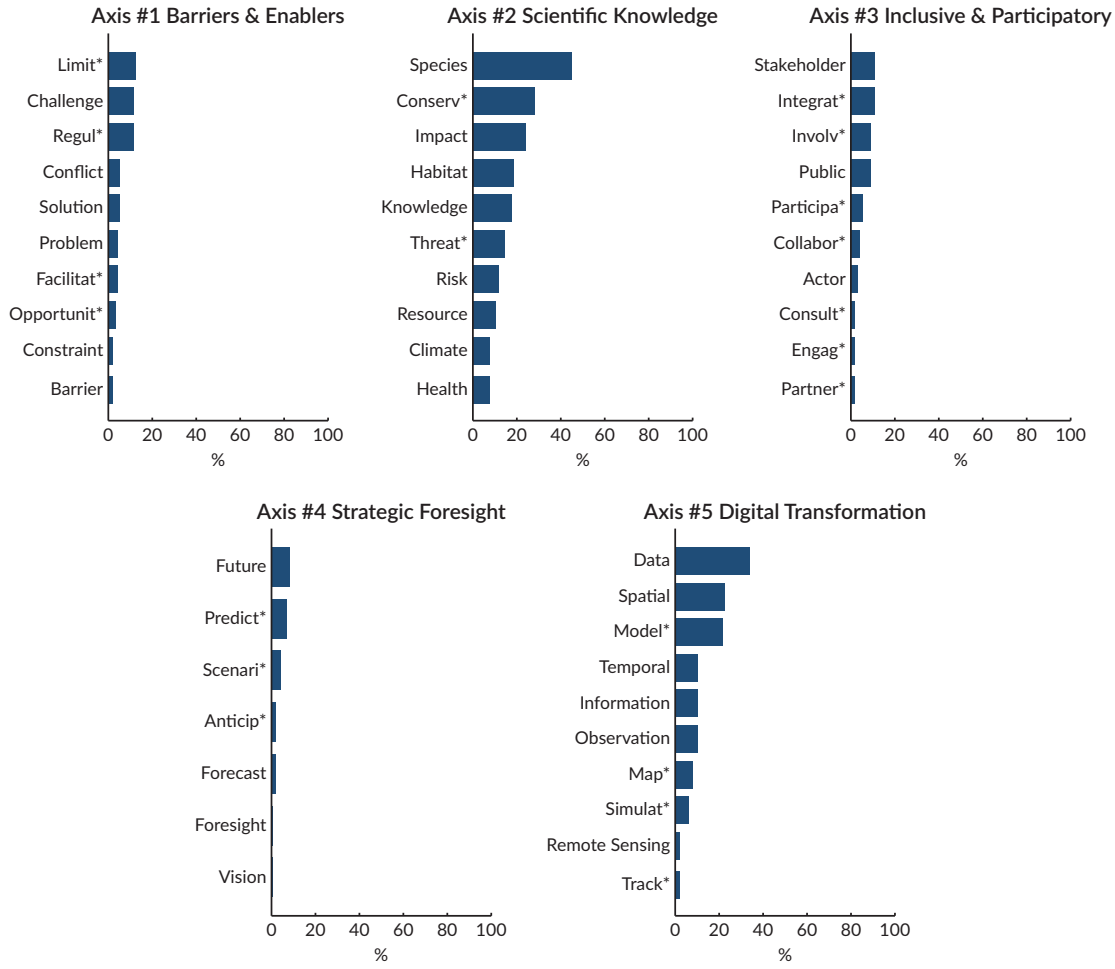


Figure 3. Proportion of corpus articles containing the 10 most frequent keywords relevant to each axis.

governance challenges are recognized, research may not sufficiently delve into detailed analyses of systemic constraints or the practical mechanisms that facilitate effective management.

A majority of interviewees suggested that the fragmentation of responsibilities across different spatial domains and governance levels, between marine, coastal, lowland, and upland territories, is a barrier that severely undermines the coherence of public action. The resulting sectoralized governance structures are perceived as limiting the coordination necessary for holistic and integrated coastal management. Participatory projects analysis, such as ATP Domino (2005–2007; Table 2), emphasized how new actors, such as NGOs and supranational institutions, contribute to governance complexity. Polycentric and project-based decision-making are described as addressing issues as isolated crises rather than interconnected problems requiring coordinated, long-term strategies.

Another barrier to integrated land–sea management, underlined by the interviews insights, is the funding constraint for research in Réunion. For example, interviewees involved in the Ocean Metiss project (Table 2 and Table 3) highlighted that as an EU outermost region, La Réunion is ineligible for European MSP funds, which are reserved for coastal states sharing maritime borders with other countries. This limitation hinders the development of a spatial vision for its exclusive economic zone (EEZ). To bypass this, the interviewees indicated that the Regional Council, the University of La Réunion, and the Prefecture secured funding through the Executive Agency for Small and Medium-sized Enterprises, supported by cooperation frameworks such as the OACPS-EU partnership, which includes Indian Ocean states. While the Indian Ocean Commission did not implement MSP directly, it was perceived as playing a regional coordination role under the broader Nairobi Convention. The Océan Métiss project is apprehended as having marked a pioneering step, aligning regional coordination with emerging legal responsibilities for the Réunion Regional Council within future MSP protocols. Meanwhile, the French state launched the Strategic Document for the Southwestern Indian Ocean Maritime Basin (DSBM), covering Réunion's EEZ and guiding regional investment priorities. However, this document is perceived as not yet having been translated into an operational MSP.

Insights from interviews with institutional actors, particularly those involved in planning documents, reveal that one of the key challenges faced by public authorities is the coordination between the DSBM and the SMVM. The DSBM falls under state jurisdiction, covering the area from internal waters to the outer limit of the EEZ. In contrast, the SMVM is under the authority of the Regional Council, extending from internal waters to 3 km offshore. The coordination between the DSBM and the SMVM for coastal planning is perceived by those interviewees as a major challenge, particularly due to differences in the scale of planning documents. The SMVM, designed at a 1/50,000 scale, imposes specific constraints, limiting flexibility for the implementation of coastal development projects. One interviewed institutional actor underlined that the way elected officials perceive the sea and the coastline, through their use of planning documents such as the SMVM, can indirectly influence how these documents are developed by policy-related actors:

> The SMVM is a coastal space planning seen from the sea, not from the land. What this means is that when you approach by boat and see the coastline, the focus is on how to plan based on what's visible from the sea: what is already developed, urbanized, protected…It's about deciding where to place facilities in a way that doesn't further degrade the coastal space we see from the sea. (Interview A2, 2024)

The SMVM institutional approach, as perceived by this interviewee, adopts an exclusive conservation-oriented perspective that confines coastal planning to conservation activities versus so-called "threats" (i.e., human activities). By emphasizing natural capital and visual aesthetics, this approach risks overlooking critical dimensions such as infrastructure, economic imperatives, and functional uses of coastal areas, including fishing, industry, and transportation. It is perceived as potentially generating tensions with land-based development objectives and neglecting broader environmental and social concerns, such as resource management. While it may contribute to the preservation of coastal identity and visual heritage, its limitations become apparent when striving for a more integrated and multidimensional planning framework.

Institutional stakeholders emphasized that the Réunion Region—responsible for the SAR-SMVM—must play a more proactive role in DSBM-related discussions, which have direct implications for the planning of maritime services, infrastructure, and logistics. However, regional elected officials are not perceived as fully grasping the strategic importance of the EEZ and the DSBM. Several interviewees pointed out that the SAR-SMVM lacks political momentum, being viewed more as a restrictive regulatory instrument than as a platform for articulating a shared territorial vision. Its binding provisions—such as the Coastal Law and the Zero Net Land Take objective—are seen as limiting the capacity for innovation and adaptive strategies. Rather than stimulating political debate or long-term strategic thinking, the SAR is often reduced to a tool for regulatory compliance. Institutional respondents stressed the need for a unified political vision, particularly as regulatory requirements grow more stringent, including obligations for environmental impact assessments. Some highlighted that maritime planning is emerging as a crucial governance issue, requiring greater political commitment and leadership from elected officials.

> Should all port development be concentrated at the Western port, or should new port infrastructure be planned elsewhere? If extensions are considered, they must be identified within the framework of the SMVM. This highlights the need for ongoing dialogue between the SAR-SMVM working groups and the CMUB. (Interview A2, 2024)

To address current governance limitations, a majority of interviewees recommended establishing a dedicated administrative structure for coastal management. This entity would centralize coordination, ensure project continuity, and integrate diverse stakeholders, bridging interpersonal trust networks within public administration. Civil servants were unanimously seen as key to ensuring stability and expertise, particularly in contrast to elected officials, whose turnover often leads to policy inconsistency. Their accumulated knowledge is perceived as allowing a better adaptation to local contexts and evolving challenges. However, all the interviewees also highlighted a lack of training among municipal staff on land and coastal planning in the face of climate change, limiting their capacity to contribute meaningfully. Effective governance is expected to strike a balance between timely decision-making and the capacity for in-depth evaluation; however, this balance is perceived as insufficiently developed when addressing complex territorial challenges. Strong political leadership is considered crucial for sustaining long-term planning efforts and securing stakeholder engagement, yet its effectiveness is seen as contingent upon the stability and continuity of the public service.

These findings on limiters and enablers further confirm how fragmented institutional responsibilities, scale mismatches, and the lack of a shared political vision shape coastal and maritime governance as a complex, evolving process marked by competing interests, regulatory constraints, and uneven capacities for coordination and adaptation in Réunion Island.

3.2. Scientific Knowledge in Marine and Coastal Governance (Axis #2)

The research article corpus strongly emphasizes the scientific knowledge in marine and coastal governance (Axis #2; Figures 2a and 2b), with 96% of articles containing at least one keyword relevant to this axis: the remaining 4% of articles contain either ambiguous language or highly technical content that did not match the Axis #2. Interdisciplinary terms such as health, resilien*, pollution, and evidence are either rare or absent, suggesting that cross-sectoral approaches integrating public health, socio-economics, and resilience planning remain underexplored. The frequent citation of species (45% of articles), impact (24%), and conserv* (28%) confirms a strong ecological research focus (Figure 3).

All the interviewees attribute the emergence of environmental studies in La Réunion since the 2000s to a combination of scientific, ecological, and political factors. According to most of them, this shift was supported by global trends, like the Kyoto Protocol, and driven locally by the political leadership of Paul Vergès and the Parti Communiste Réunionnais. All the interviewees emphasized that when political support for research is strong, scientific knowledge can influence environmental policy. However, that long-term integration is perceived as depending on institutional continuity.

Projects such as GIML, ATP Domino, and Descartes (Table 2) illustrated how scientific research, participatory processes, and political dynamics interact, revealing both the potential and the limitations of using scientific approaches to inform governance in the context of changing political and environmental landscapes. The GIML project (2013–2015) developed an urban simulation model with territorial stakeholders, but the turnover of elected officials hindered its integration into decision-making, highlighting the importance of long-term civil servants. The ATP Domino project (2005–2007) showed that territorial maps attracted partner interest but sparked debates over their level of complexity. Descartes and ATP Domino projects emphasized that participatory projects facilitate relationships between scientists and decision-makers when they align with political agendas and commit to supporting them.

A majority of interviewees emphasized that scientific research and political decision-making operate on misaligned timelines. Research is perceived as progressing over the long term, whereas political decisions are often made quickly due to electoral cycles and clientelism, or urgent social demands. This discrepancy is perceived as limiting the integration of scientific knowledge into decision-making. Some interviewees, particularly scientists, stressed the need to better sensitize decision-makers to environmental challenges. Scientific knowledge is regarded as a necessary foundation for informed decision-making in areas such as climate change adaptation, natural resource management, and biodiversity conservation. Interviewees emphasized that evidence-based policies serve as a critical counterbalance to misinformation and populist narratives.

All the interviewees emphasized the need to reinforce dialogue between decision-makers, stakeholders, and researchers. However, some institutional interviewees expressed concerns that some research institutes maintain close ties with lobbying groups (e.g., the sugarcane industry and CIRAD, for instance), potentially influencing public policy under the guise of scientific credentials. Martignac (2006) provides key insights on the issue of interactions among research institutions and lobby interactions.

Interviewees with both institutional and scientific backgrounds associated the lack of dialogue between academics and decision-makers with an "administrative culture" that favors technical expertise over academic research. In their view, consulting firms are perceived as more pragmatic, responsive, and grounded in field experience, offering concrete and actionable outputs that are often integrated directly into decision-making. Conversely, the academic knowledge production process is seen as slower and less aligned with immediate governance needs, which is perceived as deterring decision-makers from preferring technical over scientific input. However, since consultants operate with their logics, institutional interviewees underlined that decision-makers must often adapt their technical outputs to the procedural and regulatory constraints of public decision-making. For these interviewees, strengthening collaboration between researchers and policymakers is essential to better integrate diverse forms of knowledge into decision-making, especially under conditions of uncertainty.

Finally, a minority of interviewees expressed a perceived disconnection between scientific agendas and local societal needs, highlighting a broader issue: the insufficient collaboration between the social and human sciences and the experimental sciences. Rather than fostering interdisciplinary synergies, current academic practices are perceived by these interviewees as marked by an academic compartmentalization that limits both horizontal (between disciplines) and vertical (between institutions) collaboration. This siloed approach is seen as a barrier to producing integrated and policy-relevant knowledge. Finally, these interviewees expressed concerns about the existence of what was referred to as "scientific clientelism" in the allocation of research funding in Réunion. This refers to the perception that financial and institutional resources can instead be influenced by informal networks, personal affiliations, or political alliances. This situation is seen as a barrier to scientific excellence, interdisciplinary collaboration, and the inclusion of emerging or critical voices. It is perceived as standing in contrast to the transparency and rigor promoted by national and European agencies such as the National Research Agency or Horizon Europe. To address this, these interviewees call for aligning local research governance with these standards by strengthening transparency, collegiality, and accountability.

These findings reflect the dynamics described by the EGT, highlighting how perceived interactions between scientific research and politics in Réunion unfold through an adaptive, non-linear process shaped by institutional contexts, misaligned temporalities, and power relationships.

3.3. Inclusive and Participatory Approaches for Effective Policies (Axis #3)

The analysis of the research article corpus highlights a limited integration of participatory and long-term foresight approaches in marine governance research. Only 32% of selected articles reference keywords related to Inclusive and Participatory Approaches (Axis #3; Figures 2a and 2b), with terms such as participation, consultation, and collaboration appearing in just 2% to 9% of papers (Figure 3). This suggests that while participation is acknowledged, it is not yet a dominant theme in the literature.

The Ocean Metiss project analysis reveals that the participatory approach through MSP allowed hundreds of local stakeholders to actively engage in defining the direction for maritime activities within La Réunion's EEZ. The use of the SeaSketch platform, enhanced with cartographic data and an integrated discussion forum, facilitated this inclusive consultation, allowing local actors to propose management scenarios tailored to the region's specific challenges. The Ocean Metiss project approach demonstrated the importance of inclusivity

for informed management, based on local realities and the concerns of different maritime users. However, interviewees within the project (Table 3) revealed that the initiative was suspended due to concerns related to national security, particularly because the data on the SeaSketch platform passed through the US, which was seen as a conflict with French strategic interests. This highlights the need to balance participatory approaches with broader strategic imperatives, raising the question of how to reconcile transparency, participation, and security in large-scale projects.

Insights from the panel of institutional interviewees revealed that EPCIs (Établissements Publics de Coopération Intercommunale) are perceived as playing a key role in managing coastal projects on a larger scale. These intermunicipal structures, which bring together multiple municipalities, promote a coordinated and shared approach to projects, helping to overcome administrative boundaries. EPCIs are perceived as promoting integrated planning, preventing fragmented municipal decisions, and enabling resource pooling to tackle complex challenges. Intermunicipal coordination supports unified responses to climate risks and harmonizes coastal strategies, while also balancing economic uses, like tourism and fishing, with environmental goals. These perceptions suggest that EPCI mechanisms, along with participatory approaches like Ocean Metiss, are seen as complementary tools for building more robust, inclusive, and coherent coastal governance. Together, they would help align local interests with unified policies capable of addressing environmental challenges at multiple scales. Additionally, institutional interviewees revealed that initiatives involving participatory mechanisms were developed by the Regional Council, particularly through the SAR Caravan. This initiative was designed to engage with the citizens by gathering their opinions and suggestions on projects and territorial development. The goal of this initiative is to ensure better citizen involvement in decisions regarding their environment and to foster direct dialogue between regional authorities and the population.

These findings reflect how the participation approach in Réunion's coastal governance is not a fixed model but an evolving process, shaped by institutional choices, technical tools, and political priorities. From the perspective of the EGT, participation is not only a normative ideal but a governance mechanism that co-evolves with the discourses, actor roles, and structures of decision-making, making its emergence, limits, and transformations particularly relevant to analyze.

3.4. Strategic Foresight for Long-Term Policy-Making (Axis #4) and Digital Transformation (Axis #5)

Strategic foresight for long-term policy-making (Axis #4; Figures 2a and 2b) is addressed in only 18% of articles, with foresight-related keywords (scenario, vision, or foresight) appearing in fewer than 4% of papers (Figure 3). This weak representation of long-term planning and strategic visioning suggests that governance research may be more reactive than proactive in addressing future coastal and marine challenges. One emerging trend is the growing role of digital technologies in marine and coastal governance. A significant proportion (61%) of articles cite keywords related to Digital Transformation (Axis #5; Figures 2a and 2b), with data (34%), spatial (23%), and model (22%) among the most frequently cited terms (Figure 3). This reflects the increasing reliance on spatial analysis and modeling tools in coastal-marine research. However, the relatively low citation of remote sensing, tracking, mapping, and particularly web (less than 1%) suggests that digital approaches are still primarily used for environmental monitoring rather than for interactive governance or decision-support systems.

The development of strategic foresight in land–sea planning is widely regarded by interviewees as a key enabler, particularly in light of the necessary coordination between the SMVM and the DSBM. The use of

territorial foresight is perceived by all interviewees as a key asset for the governance of the land–sea continuum, as it allows for anticipating future territorial developments and planning accordingly. This approach not only helps identify future challenges but also enables the development of strategies that address environmental, social, and economic issues.

In this regard, institutional interviewees considered that digital tools that allow for the visualization of various future scenarios are underdeveloped in Réunion, where the integration of such technologies remains limited. The simulation tools allow for visualizing and anticipating the evolution of urban and demographic challenges in relation to natural risks. It highlights the need for tailored land-use policies to reduce exposure to risks. These tools are perceived by these interviewees as essential for simulating the impact of decisions on the territory, but their effectiveness depends on the quality of data that feeds them. One of the main obstacles to their use would be the lack of human and financial resources necessary to collect, update, and integrate these data on an ongoing basis. Therefore, establishing these resources is perceived by these interviewees as crucial for strengthening governance and enabling more proactive and sustainable territorial management.

According to several institutional interviewees, although the European Commission has promoted numerous e-tools to support marine and coastal governance, these tools are primarily designed for European basin strategies and fail to account for the specificities of the Indian Ocean region. For instance, these interviewees reported that certain tools developed for projects such as the Atlantic MSP are not applicable in Réunion Island, as their configuration overlooks local particularities. They also pointed out that other platforms, such as WestMed, do not address these region-specific challenges. While acknowledging the European Commission's efforts to develop digital platforms, these interviewees expressed concern that their current design reflects the priorities and contexts of continental Europe, leaving overseas regions like Réunion Island insufficiently supported. From their perspective, this lack of tailored tools limits the platforms' applicability and weakens their effectiveness in addressing local governance needs. They emphasized the need for e-tools that are better adapted to the realities of outermost regions, in order to foster more inclusive and context-relevant decision-making for coastal and maritime issues.

These insights show how strategic foresight and digital tools are perceived as not only technical supports but active components of governance that evolve alongside institutions, actor practices, and territorial priorities. With the EGT conceptual framework, such instruments shape, and are shaped by, the co-evolving configurations of knowledge, policy goals, and governance capacities, making their design and appropriation key to understanding the dynamics of adaptive land–sea governance.

4. Discussion

The concerns raised by interviewees reflect and deepen the findings from the literature review: while scientific research on marine and coastal governance in Réunion Island predominantly focuses on ecological and technical dimensions, it largely overlooks political, institutional, and social issues. The island's endemic biodiversity, combined with rapid urbanization and growing awareness of climate change, has prompted researchers and institutions to intensify their efforts in environmental governance (Lagabrielle et al., 2010). Paul Vergès promoted sustainable development, energy and food autonomy, and launched initiatives such as the GERRI program (Morand-Deviller, 2005; Vergès, 1993). Research on marine and coastal issues in Réunion remains largely driven by ecological and conservation sciences, with a strong reliance on scientific

assessments and spatial data (Figure 3). Governance, socio-economic, and institutional analyses are clearly underrepresented, and there is limited integration of participatory governance and long-term strategic foresight (Figures 2a and 2b). Moreover, while digital tools are increasingly used for environmental monitoring, their application in decision-making is still underdeveloped. This imbalance illustrates how governance and knowledge production co-evolve and how scientific research can reinforce a governance model that marginalizes critical reflections on power, participation, and long-term strategic planning. According to the EGT conceptual framework, this mutual shaping process explains the persistence of fragmented and reactive approaches to coastal and marine governance in Réunion Island.

Institutional fragmentation in Réunion Island leads to policy silos and weak coordination, limiting holistic responses to complex issues like coastal management (David et al., 2006; Cazes-Duvat, 1999). Overlapping responsibilities among the state, the Regional Council, the Department, and agencies such as Direction de l'Environnement, de l'Aménagement et du Logement and Office Français de la Biodiversité hinder governance efforts (Ferraro et al., 2023). Some progress has been made toward island-wide coordination through initiatives like the Stratégie Réunionnaise pour la Biodiversité, the Regional Biodiversity Agency, and the Groupe d'experts interinstitutionnel de La Réunion (Ferraro et al., 2023). Supported by frameworks such as Natura 2000 and EU maritime strategies, these bodies foster collaboration among scientists, managers, and stakeholders to monitor ecosystems and design management strategies (Ferraro et al., 2023). Still, economic growth remains the dominant political priority, often at the expense of ecosystem protection (Ferraro et al., 2023). Fragmented planning authorities impede integrated coastal-urban strategies, resulting in disconnected agendas and isolated responses (Ferraro et al., 2023). However, competing interests among diverse authorities impede the development of integrated policies (Cinner & David, 2011).

Coastal management presents numerous challenges, especially when it comes to defining suitable governance indicators (David et al., 2010). These challenges can be addressed through participatory approaches, particularly through co-construction with experts, which allows for better adaptation to local realities (David et al., 2010). However, implementing such solutions often faces obstacles, including a lack of coordination among actors, insufficient funding, and the absence of project follow-up (David et al., 2010). These difficulties demonstrate that truly effective management cannot rely solely on external experts (Poti et al., 2022). Strengthening local capacities is essential to reduce dependence on outside actors and improve adaptability to rapid environmental changes (Poti et al., 2022). Involving local communities also enhances resilience in the face of ecological crises (Poti et al., 2022). Regional cooperation should be reinforced to facilitate the exchange of knowledge and experiences applicable to similar environmental challenges in neighboring areas (Poti et al., 2022). Integrating local knowledge into decision-making processes is crucial for crafting context-specific and sustainable solutions (Poti et al., 2022). Furthermore, ensuring sustainable funding is critical to avoid the shortcomings of short-term, ineffective solutions that fail to address underlying challenges (Poti et al., 2022).

In Réunion Island, governance relies heavily on interpersonal trust, shaping interactions and ensuring project continuity (Losen, 2023; Luhmann, 2001). This form of governance reflects a complex societal model, evolving between tradition and modernity and influenced by the island's colonial past (Watin & Wolff, 1995). Réunion displays the characteristics of a traditional society undergoing transformation, affecting all areas of social life (Simonin, 2000).

Since 1946, when the island shifted from French colony to French department, Réunion has evolved from one social model to another: traditional Creole sociability coexists with modern European sociability (Simonin, 2000). The island thus operates in a "community-societal" dynamic, shaped by both internal (endogenous) and external (exogenous) influences. On the one hand, traditional dynamics of mutual acquaintance, derived from community ties and informal relationships, help maintain strong local cooperation (Watin, 2007). On the other hand, modern structures and contemporary administrative mechanisms are increasingly influencing and organizing these relationships to address broader institutional challenges. While personal connections remain key for local project management, they are no longer sufficient to ensure sustainable governance on a larger scale. Moreover, these interactions, between informal interactions and formal procedures, can lead to conflicts between stakeholders on their perception of scientific practices in Réunion Island for political and societal concerns. The Chikungunya epidemic and the "Shark Crisis" illustrate the difficulty of maintaining scientific legitimacy during periods of social tension (Idelson, 2011; Losen, 2023, 2024). The issue of "scientific clientelism" was particularly evident during the management of the Shark Crisis in Réunion Island, where the Prefecture directly commissioned marine ecologists to conduct research, bypassing formal procedures usually required for public expertise, such as official institutional requests or competitive calls (Losen, 2022). In overseas territories like Réunion, where the Prefecture holds extensive discretionary power, such informal practices raise concerns about transparency, institutional balance, and the conditions under which scientific expertise is mobilized.

Integration of scientific knowledge into policy often faces major challenges. Effective decision-making relies on accurate data on ecosystem conditions and human activities. In Réunion, however, biodiversity research remains limited, and local expertise is insufficient to conduct in-depth environmental assessments (Ferraro et al., 2023). The lack of centralized and up-to-date environmental data further hinders effective implementation of conservation policies (Ferraro et al., 2023). Despite these obstacles, regional research initiatives are emerging, such as Réunion's participation in IFRECOR, which focuses on coral reef conservation. Access to European funding and international research networks provides opportunities to strengthen local scientific capacity. Additionally, increased use of geographic information systems could enhance habitat monitoring and improve the planning of conservation actions (Lagabrielle et al., 2010). Geographic information systems tools are key instruments for visualizing usage conflicts and organizing decision-making (David et al., 2006).

Yet, participatory mechanisms remain weak in Réunion Island (Ferraro et al., 2023). ICZM can only be effective if it is grounded in consultation, ownership, and the engagement of local stakeholders (David et al., 2006). A culture of public consultation and engagement with local actors is still underdeveloped, and environmental decisions are often made by the state or the Regional Council without substantial community consultation (Ferraro et al., 2023). Conflicts between local and national interests contribute to public distrust in government institutions and hinder the acceptance of conservation initiatives (Ferraro et al., 2023). Nonetheless, there are signs of gradual improvement, such as the revision of the Stratégie Réunionnaise pour la Biodiversité and the development of the Regional Biodiversity Agency, both of which increasingly involve local stakeholders.

Participatory projects can foster relationships between scientists and decision-makers when they align with political agendas and commit to supporting them (Augusseau et al., 2018; Daré et al., 2008; Lagabrielle et al., 2010). In such cases, researchers directly contribute to public policy by providing data, analysis, and

recommendations, thereby enhancing policy credibility. Conversely, research conducted independently of political priorities risks rejection or distrust from political leaders (Losen et al., 2025).

Involving decision-makers and planners in adjusting model parameters and refining forecasts is crucial for navigating complex and uncertain environmental futures (Rousseaux & Judge, 2017). Strategic foresight allows governance actors to anticipate and prepare for evolving risks rather than merely reacting to crises. In this regard, recent research emphasizes that adopting advanced technologies, such as remote sensing, AI, and automated ecosystem monitoring, can significantly improve tracking capacities and decision-making effectiveness, thereby informing long-term planning strategies (Ferraro et al., 2023).

The concept of "risk culture" is central to understanding governance dynamics, as risks constitute a "total social fact" that shapes societies (Giddens, 1991; Mauss, 2022). These risks often lie at the boundaries of knowledge and predictability, where conventional planning tools and linear forecasting prove inadequate (Seligman, 2001). It is precisely at these boundaries that strategic foresight becomes essential: to make sense of uncertainties, navigate knowledge gaps, and support adaptive, resilient planning frameworks. When systems reach their cognitive and institutional limits, the legitimacy of administrative structures and their representatives may be called into question by actors exposed to risks (Seligman, 2001). In this context, the translation of uncertainties becomes a critical challenge.

Actor-network theory's concept of "translation" or "chains of translation" refers to the successive transformations that actors make as they move an idea or object across different registers (Callon et al., 2001). This includes both discursive and practical activities through which collectives align, coordinate, confront, and arrive at innovation or knowledge. This process is particularly valuable in managing uncertainty, as it enables stakeholders to negotiate and adapt their understandings and actions. In this regard, strategic foresight can thus contribute to fostering trust among actors and institutions by promoting transparency, cooperation, and mutual adaptation, ultimately supporting more flexible and informed decision-making in complex and evolving contexts.

5. Conclusion

This study examines land–sea governance in Réunion Island, highlighting persistent challenges such as administrative fragmentation, weak institutional coordination, and limited integration of scientific and digital tools. Despite two decades of efforts, governance remains constrained by limiting factors such as spatio-temporal scale mismatches, insufficient skills and capacities, and a lack of awareness of land–sea issues. However, key enablers, strong political leadership, long-term institutional support, a shared political vision, and regional cooperation aligned with EU frameworks, offer paths forward. The coexistence of modern and traditional social practices creates both barriers and opportunities, particularly for trust-building and collaboration. Establishing dedicated land–sea governance coordination structures appears to be a promising means of enhancing stakeholder engagement and inclusivity in response to escalating environmental and socio-economic pressures. However, the proliferation of such bodies over time highlights a paradoxical trend: Rather than empowering stakeholders, the multiplication of overlapping governance interfaces may contribute to their disempowerment and dilute institutional effectiveness. The EGT analytical framework proves particularly relevant in the context of Réunion Island, as it can allow the analysis of the fast co-evolution of institutions, discourses, actors, and knowledge in a governance system shaped by

colonial legacies and institutional layering. The combination of French and European administrative structures with local political logics produces overlapping and sometimes conflicting governance logics. EGT can help to trace how these evolve over time, particularly concerning actor logics, community-based sociability, and the circulation of dominant narratives. However, in post-colonial settings like Réunion, EGT may understate historical power asymmetries and the legacies of domination. As such, it can benefit from being complemented by approaches from political ecology or postcolonial studies to better account for identity dynamics, center–periphery dependencies, and struggles over knowledge recognition.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024-2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (Project number 10108603). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them. The authors thank all the participants in the study, and also wish to express their gratitude to Dr. Lammy Kelsey Maria, Director of International Student & Scholar Services from the National Louis University, for reading this manuscript.

Funding

Projects Blue Green Governance (Grant agreement 101086091) and SELINA (Grant agreement 101060415).

Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

Agence nationale de la cohésion des territoires. (n.d.). *Accueil*. Europe en France. https://www.europe-en-france.gouv.fr

Augusseau, X., Bourgoin, J., David, D., Degenne, P., Lagabrielle, E., Lestrelin, G., & Lo Seen, D. (2018). Chapitre 9—Modèles et simulations spatio-temporels comme objets intermédiaires: Le cas de l'étalement urbain à la Réunion. In R.Plant, P.Maurel, E.Barbe, & J.Brennan (Eds.), *Les terres agricoles face à l'urbanisation. De la donnée à l'action, quels rôles pour l'information?* (pp. 177–196). Editions Quae.

Callon, M., Lascoumes, P., & Barthe, Y. (2001). *Acting in an uncertain world*. MIT Press.

Cazes-Duvat, V. (1999). *La gestion des zones côtières en milieu tropical insulaire: l'exemple d'un département d'Outre-Mer français, l'île de la Réunion*. *Cahiers Nantais*, *52*, 193–212. https://www.persee.fr/doc/canan_0767-8436_1999_num_52_1_964

Cazes-Duvat, V. (2004). L'évolution des littoraux de l'île de La Réunion (océan Indien): Bilan et perspectives. *Travaux & documents*, *22*, 31–49.

Cinner, J. E., & David, G. (2011). The human dimensions of coastal and marine ecosystems in the Western Indian Ocean. *Coastal Management*, *39*(4), 351–357. https://doi.org/10.1080/08920753.2011.589207

Daré, W., Aubert, S., Bah, A., Botta, A., Diop-Gaye, I., Fourage, C., Lajoie, G., & Leclerc, G. (2008). Difficultés de

la participation en recherche-action: Retour d'expériences de modélisation d'accompagnement en appui à l'aménagement du territoire au Sénégal et à la Réunion. *VertigO*, *8*(2). https://journals.openedition.org/vertigo/5012

David, G., Cazalet, B., Barnay, A. S., Charbonnel, E., Couture, E., Ferraris, J., Fleury, P.-G., Malterre, P., Pascal, N., & Pelletier, D. (2010, September 20–24). *Participatory approach to identify governance indicators for integrated coastal zone management, the case of marine protected areas* [Paper presentation]. ICES 2010 Annual Science Conference, Nantes, France. http://archimer.ifremer.fr/doc/00450/56138

David, G., Mirault, E., Quod, J. P., & Thomassin, A. (2006, October 17–20). *Les concordances territoriales au cœur de la gestion intégrée des zones côtières: L'exemple de la Réunion* [Paper presentation]. Colloque Interactions Nature-Société, analyse et modèles, La Baule, France.

European Parliament. (2018). *International ocean governance: An agenda for the future of our oceans in the context of the 2030 Sustainable Development Goals* (2017/2055(INI)). https://www.europarl.europa.eu/doceo/document/TA-8-2018-0004_EN.html

Ehler, C., & Douvere, F. (2009). *Marine spatial planning: A step-by-step approach*. Unesco. http://doi.org/10.25607/OBP-43

Ferraro, G., Failler, P., & Touron-Gardic, G. (2023). Biodiversity policy and subnational implementation in the remote regions of France. *Environment, Development and Sustainability*, *25*, 12033–12050. https://doi.org/10.1007/s10668-022-02502-4

Fobé, E., Blatrix, C., Douguet, J.-M., Salès, K., Dinh, L., Trubbach, S., Froukje, M. P., Johannesen, E., Aase, J. K., Beunen, R., & Nijamdeen, M. (2024). *Policy report on institutional barriers and enablers blue green governance project deliverable 1.1*. EU; UK Research and Innovation.

Giddens, A. (1991). *Modernity and self-identity: Self and society in the late modern age*. Stanford university press.

Idelson, B. (2011). Traitement médiatique et crise sanitaire. L'épidémie du chikungunya à La Réunion. In I. Gavillet (Ed.), *Déviance et risque en dispositifs: Expertise et médiatisation* (pp. 157–172). Presses Universitaires de Nancy.

Kay, R., & Alder, J. (2005). *Coastal planning and management*. Taylor & Francis.

Lagabrielle, E., Botta, A., Daré, W., David, D., Aubert, S., & Fabricius, C. (2010). Modelling with stakeholders to integrate biodiversity into land-use planning—Lessons learned in Réunion Island (Western Indian Ocean). *Environmental Modelling & Software*, *25*(11), 1413–1427.

Lorion, D., & Villeneuve, N. (2007). Les risques littoraux à l'île de la Réunion. *Travaux & documents*, *32*, 169–191.

Losen, B. (2022). *La légitimité d'une expertise scientifique à l'épreuve de sa médiatisation. Le cas de la controverse sur la gestion du risque d'attaques de requins à La Réunion* (2011–2015). Université de La Réunion.

Losen, B. (2023). Shark attack risk on Reunion Island: Emphasis on local media construction. *Marine Policy*, *157*, Article 105851. https://doi.org/10.1016/j.marpol.2023.105851

Losen, B. (2024). Uses of scientific discourses and markers in shark risk management on Reunion Island. *Marine Policy*, *161*, Article 106011. https://doi.org/10.1016/j.marpol.2024.106011

Losen, B., Do Huu, C., & Lagabrielle, E. (2025). Construction et (dé)légitimation des savoirs et représentations dans la gouvernance évolutive du «risque requin» (La Réunion). *Études de communication, langages, information, médiations*, *64*, 153–172. https://doi.org/10.4000/14b5l

Lozachmeur, O. (2009). Rappel des principes de la «gestion intégrée des zones côtières» et des axes de la Recommandation du 30 Mai 2002. *VertigO*, *5*. https://journals.openedition.org/vertigo/8222?lang=pt&utm_source=chatgpt.com

Luhmann, N. (2001). Confiance et familiarité: Problèmes et alternatives. *Réseaux*, *108*(4), 15–35. https://doi.org/10.3917/res.108.0015

Magnan, A. K., & Duvat, V. K. E. (2018). Unavoidable solutions for coastal adaptation in Reunion Island (Indian Ocean). *Environmental Science & Policy*, *89*, 393–400. https://doi.org/10.1016/j.envsci.2018.09.002

Martignac, C. (2006). *Maintien d'une filière dominante ou projet de territoire: le cas du sucre à la Réunion*. Université Paul Valéry—Montpellier III.

Mauss, M. (2022). *Essai sur le don: Forme et raison de l'échange dans les sociétés archaïques*. Books on Demand.

Mejia, C., Wu, M., Zhang, Y., & Kajikawa, Y. (2021). Exploring topics in bibliometric research through citation networks and semantic analysis. *Frontiers in Research Metrics and Analytics*, *6*, Article 742311.

Mirault, E. (2004). Approche socio-économique du territoire littoral récifal de l'île de la Réunion: Une contribution à sa gestion intégrée. In B. Chérubini (Ed.), *Le Territoire littoral, tourisme, pêche et environnement dans l'océan Indien* (pp. 57–73). L'Harmattan.

Morand-Deviller, J. (2005). La Charte de l'environnement et le débat idéologique. *Revue juridique de l'Environnement*, 97–106. https://doi.org/10.3406/rjenv.2005.4364

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., & Brennan, S. E. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *71*, Article 372. https://www.bmj.com/content/372/bmj.n71.short

Poti, M., Hugé, J., Shanker, K., Koedam, N., & Dahdouh-Guebas, F. (2022). Learning from small islands in the Western Indian Ocean (WIO): A systematic review of responses to environmental change. *Ocean & Coastal Management*, *227*, Article 106268. https://doi.org/10.1016/j.ocecoaman.2022.106268

Recommendation of the European Parliament and of the Council of 30 May 2002 concerning the implementation of Integrated Coastal Zone Management in Europe. (2002). Official Journal of the European Communities, L 148/24.

Rousseaux, F., & Judge, V. (2017). *Simulating the evolution of stakes on Réunion Island in a context of coastal risk*. Hal open science. https://hal.science/hal-01604596

Santos, C. F., Ehler, C. N., Agardy, T., Andrade, F., Orbach, M. K., & Crowder, L. B. (2019). Chapter 30—Marine spatial planning. In C. Sheppard (Ed.), *World seas: An environmental evaluation* (pp. 571-592). Elsevier.

Schlüter, A., Van Assche, K., Hornidge, A.-K., & Văidianu, N. (2020). Land-sea interactions and coastal development: An evolutionary governance perspective. *Marine Policy*, *112*, Article 103801.

Seligman, A. B. (2001). Complexite du role, risque et emergence de la confiance. *Réseaux*, *108*(4), 37–61. https://doi.org/10.3917/res.108.0037

Shabtay, A., Lagabrielle, E., Plot, V., Potin, G., & Guyomard, D. (2020). Marine spatial planning provides a comprehensive framework for building evidence-based shark risk management policies with sea-users. *Environmental Science & Policy*, *111*, 18–26. https://doi.org/10.1016/j.envsci.2020.05.014

Simonin, J. (2000). Médias locaux et citoyenneté. *Hermès*, *26*(27), Article 295.

Van Assche, K., Beunen, R., & Duineveld, M. (2014). Evolutionary governance theory: An introduction. Springer. https://doi.org/10.1007/978-3-319-00984-1

Van Assche, K., Beunen, R., Duineveld, M., & Gruezmacher, M. (2017). Power/knowledge and natural resource management: Foucaultian foundations in the analysis of adaptive governance. *Journal of Environmental Policy & Planning*, *19*(3), 308–322. https://doi.org/10.1080/1523908X.2017.1338560

Van Assche, K., Hornidge, A.-K., Schlüter, A., & Vaidianu, N. (2020). Governance and the coastal condition: Towards new modes of observation, adaptation and integration. *Marine Policy*, *112*, Article 103413.

Vergès, P. (1993). *D'une île au monde: Entretiens avec Brigitte Croisier*. L'Harmattan.

Watin, M. (2007). Du Kartié au quartier : Quel développement urbain à La Réunion? [Paper presentation]. In *Alizés : Revue angliciste de La Réunion* (pp. 87–100). HAL open science.

Watin, M., & Wolff, E. (1995). L'émergence de l'espace public à la Réunion. Un contexte socio-historique singulier. *Études de communication*, *17*, 19–39. https://doi.org/10.4000/edc.2480

About the Authors

Barbara Losen is a PhD in communication sciences and a postdoctoral researcher at the University of Réunion. Her research focuses on risk communication, environmental controversies, social crises, and land–sea governance. In Réunion, she has published on shark risk mediatization and investigates prison sociology. She collaborates with public institutions and European projects.

Erwann Lagabrielle is an associate professor at the University of Réunion and leads interdisciplinary research bridging geography, ecology, and political science. His work integrates spatial data, critical analysis, and normative approaches to sustainability, governance, and ecosystem services. He contributes to European and international projects in the EU overseas territories and the Western Indian Ocean region.

Salwa Aabid is a postdoctoral researcher at the University of La Réunion. With training in biology and geography, she studies tropical terrestrial ecosystems and maps ecosystem services, emphasizing rigorous and holistic spatial analysis and environmental data valorization. As a forest ecology and human–nature interaction specialist, her research informs evidence-based conservation.

Ocean and Society
2025 • Volume 2 • Article 10338
https://doi.org/10.17645/oas.10338

cogitatio

ARTICLE

Open Access Journal

Strategies for Transforming Coastal Governance: Addressing Interdependent Dimensions

Mafaziya Nijamdeen [1], Ansje Löhr [1], Kristof Van Assche [2], and Raoul Beunen [1]

[1] Department of Environmental Sciences, Open University, The Netherlands
[2] Department of Earth and Atmospheric Science, University of Alberta, Canada

Correspondence: Mafaziya Nijamdeen (fathima.mafaziyanijamdeen@ou.nl)

Submitted: 15 March 2025 **Accepted:** 28 May 2025 **Published:** 4 September 2025

Issue: This article is part of the issue "Transforming Coastal Governance: Challenges, Experiences, and Ways Forward" edited by Raoul Beunen (Open University of the Netherlands) and Gianluca Ferraro (University of Portsmouth), fully open access at https://doi.org/10.17645/oas.i470

Abstract

Coastal areas are places where land and sea meet. These places offer many socio-economic opportunities but also face profound social and environmental challenges that are often exacerbated by limitations in current governance systems. These limitations include a lack of coordination, unclear mandates and roles, fragmented knowledge, power dynamics, and insufficient stakeholder involvement. Transforming coastal governance is therefore needed to enhance the effectiveness and legitimacy of governance systems and their institutions, but current practices and past experiences have shown that changing governance is anything but easy. In this article, we analyse how three critical governance dimensions: (1) forms of integration of land and sea management; (2) forms of knowledge mobilized; and (3) forms of democracy in their interplay, shape possibilities and limits for transforming governance. Drawing on insights from the literature and three case studies from Spain, the UK, and Norway, we highlight how these different governance dimensions are strongly interrelated and should be addressed in coherent ways to make governance more effective and legitimate.

Keywords

environmental governance; institutional change; knowledge integration; policy adaptation; sustainability transitions

1. Introduction

Coastal areas are increasingly under pressure from rapid urbanization, population growth, and expanding economic activities. Combined with escalating environmental challenges such as climate-induced flooding

and pollution (including plastic waste), these pressures pose significant risks to both ecosystems and human well-being (Jouffray et al., 2020; MacAfee & Löhr, 2024; Neumann et al., 2015). Together, they present complex governance challenges that require a careful balance between conservation efforts and sustainable use of coastal resources (Wu & Wan, 2024). Coastal governance encompasses the policies, institutions, and decision-making processes that regulate and manage coastal zones. It seeks to integrate diverse regulatory frameworks, encourage stakeholder participation, and support sustainable development. Given that many coastal challenges cannot be addressed through purely technical solutions, governance must navigate political complexities while aligning with scientific knowledge as well as national or international regulations (Vega-Muñoz et al., 2021). One of the primary challenges in coastal governance is managing the intricate interactions between land and sea while striving for sustainable coastal social-ecological systems (Dahdouh-Guebas et al., 2021). Sustainable coastal social-ecological systems management is often hindered by persistent challenges such as fragmented management structures, weak institutional capacities, and resistance to change within governance systems (Kelly et al., 2019). These issues reflect broader patterns identified in recent research, showing that transformation in coastal governance is constrained by institutional inertia and conflicting priorities across governance levels (Rölfer et al., 2022). Addressing these issues calls for integrated management approaches that foster coordination across governance levels, both vertically and horizontally.

Transformation in coastal governance requires reflexivity, inclusivity, and the integration of diverse forms of knowledge (Evans et al., 2023). It necessitates addressing the interrelations between the different dimensions of governance, such as participatory governance and scientific expertise. A governance dimension refers to a specific aspect or area of governance that can be distinguished in a governance system. Well-known examples include the legal or economic dimension, but other aspects, such as forms of democracy or types of knowledge, can also be considered distinct governance dimensions (Van Assche et al., 2024). These different dimensions are strongly interwoven. This article aims to explore how analysing the interplay between different governance dimensions can deepen our understanding of the transformation options in coastal governance. More specifically, it analyses the interplay between three dimensions that are particularly relevant for transforming coastal governance: (1) forms of integrating the management of land and sea (Van Assche et al., 2020), (2) forms of knowledge mobilized (Muhl et al., 2023), and (3) forms of democracy (Paramita et al., 2023; Partelow et al., 2020; Schlüter et al., 2020). These dimensions reflect foundational aspects of governance that shape both the processes and outcomes of environmental decision-making. The integration of land and sea governance addresses the ecological interconnectedness of coastal systems, helping to overcome fragmented policies and institutional silos. Mobilizing diverse forms of knowledge, scientific, local, and experiential, ensures that governance strategies are both robust and grounded in context. The form that democracy takes determines who participates in decisions, how power is distributed, and how legitimacy and trust are built. The following section introduces the theoretical perspective and the concept of governance dimensions in more detail, after which the method and results are presented. The article concludes with a discussion of key insights for transforming coastal governance.

2. Governance and Its Dimensions

Coastal governance concerns the planning, use, and management of coastal areas. It encompasses a range of public and private actors, as well as various formal and informal institutions. Although most governance systems tend to be fairly stable, there are always sources of change, including the ongoing dynamics in the

configurations of power/knowledge and actor/institution configurations that are self-transformative (Partelow et al., 2020; Schlüter et al., 2020; Van Assche et al., 2013). Some governance transformations are initiated through deliberate reform efforts; however, the outcomes of these interventions often diverge significantly from their original intentions and expectations (Evans et al., 2023). Every outcome, either in the form of specific elements of governance or in the overall structure, recurrently shapes what happens in the future.

The purposive attempts for change in coastal governance systems, including different forms of planning, coordination, steering, and strategy, are made possible because of the stabilizing effects of governance (Van Assche et al., 2013). Governance systems assign roles to certain actors, shaping and limiting their options for planning and policy-making, as well as facilitating certain attempts for changes while delimiting other options. Governance systems also describe the action procedures that need to be followed in order to change the formal procedures of decision-making, such as the adoption or revision of legal rules. The options for sustainability transformations in coastal governance, therefore, depend on the current organization and functioning of the system of coastal governance. In order to better understand the possibilities and limits for sustainable strategies and transformation, it is important to grasp the characteristics of a certain governance system and the paths through which these characteristics evolved (Van Assche et al., 2024).

Each governance system evolves through a sequence of past decisions and developments, which simultaneously shape the conditions for future change (Garud et al., 2010). A particular governance path emerges in a series of decision-making processes, which partly focus on the specific dimensions of governance. As previously described in this article, the governance dimension refers to a specific aspect or area of governance that has an important role in the overall organisation and functioning of a governance system (Van Assche et al., 2013). These governance dimensions reflect the internal distinctions that a given community makes within its governance structures, and over time, they can become increasingly important as organising principles. This process of making distinctions is linked to the structure of policy domains and the topics considered relevant in these domains. The process of making distinctions further depends on the dominant values and ideals in the community and on the specific issues and needs the governance system addresses. Different dimensions can be distinguished, such as, for example, forms of democracy or forms of knowledge. These dimensions are often interconnected and overlapping. The positions on those dimensions are the result of choices made, whereby different positions are possible. Certain positions can stabilize through their embedding in institutions. Both the dimensions that are considered important, as well as the alternative positions on these specific dimensions, tend to show recurring patterns in a specific governance path. Analysing these patterns is therefore useful for strategizing in governance (Van Assche et al., 2024). Certain dimensions and clusters of dimensions will be more common than others. This can depend on the presence of certain ideas and ideologies about democracy and market mechanisms, but also on dominant narratives about particular governance issues or shared conceptual perspectives for thinking of self and community (Partelow et al., 2020). In communities where coastal governance is mostly understood as a local issue, it reflects the ideas and ideologies of local communities. This understanding will trigger different discussions and decision-making processes. As a result, attention is given to distinct governance dimensions and the various positions taken within them. This stands in contrast to approaches that treat coastal areas merely as extensions of either land or sea, where governance is largely shaped by objectives and rules set out in national or international policies. Such differences will also impact attempts to change coastal governance. An analysis of different governance dimensions and the positions on these dimensions can thus

enrich the understanding of the processes of change in governance and the factors that enable and delimit the options for transformation.

2.1. Key Dimensions in Coastal Governance

The literature on coastal governance identifies several such governance dimensions, some of which are specific to coastal governance, such as the integration of land and sea, while others are more universal and also relevant to many other governance contexts, such as forms of democracy. The overarching ambition to work towards more sustainable and inclusive forms of coastal governance concerns the following dimensions: (1) forms of integrating the management of land and sea, (2) forms of knowledge mobilized, and (3) forms of democracy.

2.1.1. Forms of Integrating the Management of Land and Sea

The integration of land and sea management is one of the key challenges of coastal governance (Schlüter et al., 2020). This integration can be organized at different levels and in various ways. It can be facilitated by developing integrated frameworks in policies and plans, as well as by bringing together different sectoral strategies through projects and dedicated practices (Ansong et al., 2021; Eger et al., 2021). The need for land–sea integration is especially pronounced in coastal regions where multiple institutions operate across overlapping jurisdictions (Nijamdeen et al., 2023). Coastal governance often suffers from fragmented frameworks, including international agreements, national policies, and regional or local decision-making processes. Such fragmentation often leads to misaligned objectives, policy conflicts, and inefficiencies, ultimately undermining sustainable coastal management. Effective planning in this context involves aligning goals and strategies across different levels of governance and policy sectors to ensure coordinated action (Fobé et al., 2024). In the end, land–sea connectivity supports the sustainability and resilience of both ecosystems and the communities that depend on them (Barcelo et al., 2023).

2.1.2. The Forms of Knowledge Mobilized

Different forms of knowledge are mobilized in governance. On one hand, expert knowledge, including scientific research and technical expertise, plays a critical role in informing evidence-based policies and management strategies. Scientific knowledge, systematically gathered through research and empirical analysis, serves as a cornerstone for effective coastal and marine governance (Connor et al., 2009). It provides essential insights into social-ecological interactions, identifies potential risks, and develops strategies for mitigation and adaptation. Scientific knowledge also enables long-term monitoring and predictive modelling, allowing policymakers to respond proactively to environmental changes while continuously evaluating the effectiveness of governance interventions. However, despite its significance, integrating scientific knowledge into governance is often hindered by communication gaps, institutional silos, and the limited accessibility of research findings to local/relevant practitioners (Turnhout et al., 2016). Furthermore, different forms of expertise might compete over prominence in decision-making processes, depending on power/knowledge dynamics. On the other hand, various forms of other knowledge, including co-produced knowledge, local ecological knowledge (LEK), traditional ecological knowledge (TEK), and experiential knowledge, are equally important in governance (Muhl et al., 2023). For example, LEK is deeply embedded in the lived experiences of coastal communities and provides valuable insights into environmental changes, species behaviours, and ecosystem dynamics that may not be captured through formal scientific

methods (Berkes, 2012). This knowledge is often place-based, accumulated over generations, and reflects adaptive strategies that communities have developed in response to environmental fluctuations (Jasanoff, 2004). While scientific and local knowledge systems can sometimes complement each other, they may also conflict due to differences in epistemological frameworks, power dynamics, and institutional recognition. In some cases, integrating these diverse knowledge systems can enhance governance by fostering co-production of knowledge, where scientists, policymakers, and local communities collaborate to develop shared understandings and more holistic management approaches (Pahl-Wostl, 2009). Mobilizing LEK, TEK, as well as experiential knowledge effectively may require inclusive governance structures that recognize and validate non-scientific forms of expertise. Participatory approaches, such as community-based monitoring, citizen science, and co-management frameworks, can facilitate the integration of local insights into policy and decision-making. For instance, co-management initiatives, where local communities share governance responsibilities with state institutions, have been successful in improving resource management outcomes by bridging scientific and experiential knowledge (Ostrom, 2009). Additionally, boundary organizations and knowledge brokers can help translate and mediate between different knowledge systems, fostering trust and mutual learning among stakeholders (Nijamdeen et al., 2023). By embracing multiple ways of knowing, governance systems can become more adaptive, resilient, and responsive to the complex challenges of coastal management. Which types of knowledge are mobilized and how these relate to each other depend on different institutions, as well as the actors and their positions in governance. In some cases, these forms of knowledge can be effectively integrated, while in others, they may conflict.

2.1.3. Forms of Democracy

Governance always combines forms of representative and participatory democracy, each of which comes with different structures for decision-making and with varying expectations regarding the roles and influence of different actors (Held, 2006; Young, 2002). The balance between these forms of democracy shapes governance processes and determines the extent to which different stakeholders can contribute to decision-making. In the context of coastal governance, this balance becomes particularly significant due to the complexity of managing interconnected ecosystems and diverse stakeholder interests. Representative democracy, typically exercised through elected officials and government agencies, plays a crucial role in setting legal frameworks, allocating resources, and enforcing policies (Jentoft, 2007). However, participatory democracy is increasingly emphasized, as it enables local communities, resource users, and non-state actors to engage in decision-making processes, ensuring that policies reflect local needs and knowledge (Pomeroy & Berkes, 1997). Participatory approaches, such as co-management, deliberative forums, and stakeholder advisory councils, foster social learning and adaptive governance, allowing coastal communities and other local stakeholders to respond more effectively to environmental changes (Paramita et al., 2023). Nevertheless, challenges such as power imbalances, conflicts of interest, and institutional constraints often hinder the meaningful participation of marginalized groups (Berkes, 2012). Bridging the gap between representative and participatory democracy in coastal governance requires inclusive institutional arrangements, capacity-building initiatives, and transparent decision-making mechanisms that foster trust among stakeholders (Quimby & Levine, 2018; Shipman & Stojanovic, 2007).

The dimensions discussed in the previous sections can be organized in many ways, with various stakeholders taking diverse views on these aspects and very different positions on the dimensions. The positions and organizational forms that become institutionalized depend on historical developments, power dynamics,

institutional structures, and the broader socio-political context. Integration of land and sea management can, for example, range from fully integrated, ecosystem-based governance (where land and marine policies are aligned) to fragmented governance (where separate institutions govern land and sea with little coordination). For example, in some coastal regions, marine spatial planning is closely linked with terrestrial land-use planning, whereas in others, they remain separate, creating governance gaps (Duck, 2012; Tocco et al., 2024). The forms of knowledge mobilized vary between technocratic, expert-driven governance (where scientific knowledge dominates) and inclusive, co-produced knowledge systems (where local knowledge is integrated into decision-making; Nijamdeen et al., 2023). This reflects the ongoing debate between the role, representation, as well as the opportunities for expertise and community participation in governance (Jasanoff, 2004; Turnhout et al., 2016). Forms of democracy can range from highly centralised, top-down governance (where decisions are made by state authorities with limited public participation) to bottom-up, participatory governance (where local actors have a strong voice in decision-making). Different governance systems strike different balances between representation and participation. Across these dimensions, a range of hybrid approaches to integration, knowledge mobilization, and decision-making coexist.

2.2. Interrelations Between Dimensions

The interdependence of governance dimensions is well established in the literature on institutional interactions and co-evolution (Van Assche et al., 2024). For example, if we consider land–sea integration and knowledge mobilization, a more integrated land–sea governance system may necessitate the use of diverse knowledge forms as marine and terrestrial ecosystems are governed by different epistemic traditions. For example, in small-scale fisheries governance that integrates land and sea management requires combining LEK with scientific expertise to manage coastal resources effectively (Berkes, 2012). For knowledge mobilization and forms of democracy, the type of knowledge that is privileged in governance can shape who participates in decision-making. If governance relies heavily on expert-driven knowledge, this may limit (or maybe sometimes also give opportunities if this comes from sectoral experts that already work with "a coastal lens") opportunities for participatory democracy, whereas governance systems that emphasize deliberative democracy often seek to incorporate local and indigenous knowledge (Fischer, 2000). When we consider democracy and land–sea integration, the degree of participatory governance can affect how successfully land and sea policies are integrated. Top-down governance may prioritize efficiency, yet struggle to achieve legitimacy (Nijamdeen et al., 2023), while participatory approaches may slow down decision-making but foster greater acceptance and compliance with integrated policies (Pahl-Wostl, 2009).

When analysing governance dimensions, it is essential to recognize that actual decision-making practices often diverge from their formal representations, particularly under conditions of uncertainty and dynamic contexts. As highlighted in studies on knowledge co-production in human-natural systems, decision-making is shaped by complex interactions, power dynamics, and the need for inclusive, adaptive approaches that respond to evolving realities (Moallemi et al., 2023). The position on each dimension is an emergent outcome of a history of interactions between different actors and the rules of coordination these actors adopted. The governance dimensions that are considered relevant and the dominant positions on these dimensions co-evolve (Van Assche et al., 2024). This renders a certain governance configuration more cohesive and characteristic of a particular governance path (Fobé et al., 2024; Van Assche et al., 2013). The choices made tend to reinforce the relevance of a certain dimension and the positions taken. The interdependence between the different dimensions and positions taken creates an important path

dependence in governance evolution. The resulting governance path is shaped by, and specific to, particular coastal conditions (Van Assche et al., 2020). Once things are organized and understood in a certain manner, it becomes harder to change them. Such reflections on dimensions and positions can, for example, help explain why policy integration is often promoted, but also often difficult to achieve, and it can enrich the understanding of the discrepancies between the rhetoric and realities of participation.

Various internal and external drivers and events can shift the position on one governance dimension. Such changes often influence positions on other dimensions, potentially triggering broader transformations in the governance system or, conversely, reinforcing stability and contributing to institutional lock-ins. Together, these dimensions and their relative positions form the foundation for understanding and adapting coastal governance processes to the challenges posed by environmental changes, societal needs, and political dynamics.

3. Methodology

In the study, we apply the insights presented in the introduction to three different cases exploring how the interaction between three critical governance dimensions, that is, the integration of land and sea management, knowledge mobilization, and forms of democracy, plays out in the context of coastal governance.

3.1. Case Selection

The three case studies, Valencia (Spain), the Isle of Wight (UK), and the Oslofjord (Norway; Figure 1), were selected to reflect a diversity of coastal governance contexts across Europe. These cases are part of the Blue Green Governance project (https://bggovernance.eu), which focuses on transformations in coastal and marine governance. Each case highlights different challenges and trajectories related to the integration of land and sea management, the mobilization of various forms of knowledge, and the role of democratic structures in governance. The Valencia case exemplifies a context of long-standing tension between environmental conservation and economic development (e.g., port expansion and tourism). The Isle of Wight was selected for its status as a UNESCO Biosphere Reserve and its evolving community participation landscape. Whereas, the Oslofjord case showcases a multi-level governance context where land-based pollution and ecosystem degradation intersect with governance complexity.

3.2. Data Collection

Between May and September 2024, we conducted a qualitative study combining a targeted literature review and semi-structured interviews. The literature review focused on governance pathways, coastal transformation, along with institutional barriers and enablers in Europe, including the three cases. Interview participants included academic stakeholders (key experts) actively involved in the Blue Green Governance project who are also experts in their respective case study regions. The key experts interviewed were primarily academics and researchers, some of whom had ongoing collaborative relationships with policymakers and practitioners in their regions. Their insights provided both empirical knowledge of local governance systems and reflective assessments on governance transformations.

Figure 1. Case study locations: Valencia (Spain), the Isle of Wight (UK), and the Oslofjord (Norway).

3.3. Approach to Analysis

Rather than employing formal coding techniques, we used a theory-informed thematic reading of all interview transcripts and relevant documents. Guided by the evolutionary governance theory (Van Assche et al., 2013), we focused on identifying patterns and examples that related to the three key governance dimensions. We looked for illustrative dynamics and interactions, drawing comparisons across the cases to highlight how each governance system evolves through its specific institutional, discursive, and actor configurations. To construct the governance pathways for each case, we examined various aspects, including key events, relevant policies, organizational forms, material aspects, and important discourses, to further develop the governance pathways. These governance pathways were constructed based on the literature and input from key experts representing each case study.

4. Results

4.1. Case Study Reflections

We provide a brief overview of each case, followed by an analysis of how the three governance dimensions manifest in the specific context. We then examine the interactions between these dimensions and conclude each case with a figure illustrating its governance path.

4.2. The Valencian Case

The Valencian coastal region in eastern Spain presents a compelling case for examining the challenges of integrated coastal governance in a densely populated and economically dynamic area. Characterized by a long history of tourism, urban development, and environmental policy reforms, the region faces persistent tensions between ecological preservation and economic growth. As pressures on coastal ecosystems intensify, Valencia's experience highlights the importance of coordinating land and sea management, effectively mobilizing diverse forms of knowledge, and balancing representative and participatory democratic practices. This case shows how the interaction of these governance dimensions shapes both policy outcomes and public trust in coastal decision-making (Figure 2).

4.2.1. Integration of Land and Sea Management

In the Valencian case, the integration of land and sea management takes on particular urgency due to the region's long-standing policy complexity and competing coastal interests. The region's approach involves multiple policy layers, from the historical Ley de Costas (Coastal Law of 1969) to more recent plans like Pativel (Territorial Action Plan for the Green Infrastructure of the Coastal Region) in 2018 (Vergés & Larruga, 2023). This integration, however, is not seamless. Conflicting interests between tourism development, private property rights, environmental protection, and urban expansion often create tensions between land–based and marine policy objectives. For instance, while the expansion of the port of Valencia emphasizes economic growth and logistical capacity, it simultaneously encroaches on sensitive coastal ecosystems, creating a governance challenge in balancing these priorities.

4.2.2. Forms of Knowledge Mobilized

Knowledge mobilization in Valencian coastal governance reveals the complexities of scientific, local, and political knowledge in decision-making. Technical knowledge, such as data on coastal erosion and biodiversity, plays a critical role in informing governance decisions (Gonzalez-Alonso et al., 1997). However, as highlighted by the interviewed experts, there are significant barriers to the effective use of this knowledge. For instance, there is a lack of coordination in sharing scientific data between institutions, and political agendas often influence the interpretation and application of scientific findings. The frustration of local stakeholders is also evident in the limited use of participatory knowledge in policymaking, as most decisions are driven by top-down frameworks with insufficient integration of local community perspectives (Miró Pérez & Olcina, 2020). This resonates with other studies where the results are often a gap between available scientific information and its practical application in managing coastal resources (Enguix, 2023).

4.2.3. Forms of Democracy in Coastal Governance

The forms of democracy in Valencian coastal governance blend both representative and participatory elements, yet their interaction often leads to challenges in stakeholder engagement and decision-making. Representative democracy, embodied by government agencies and elected officials, has traditionally dominated decision-making processes, particularly through frameworks such as the Ley de Costas (Alfosea, 2010; Verges & Larruga, 2024). However, the increasing emphasis on participatory democracy is evident in initiatives (i.e., Pativel) and various stakeholder advisory councils. Despite these efforts, participation is often

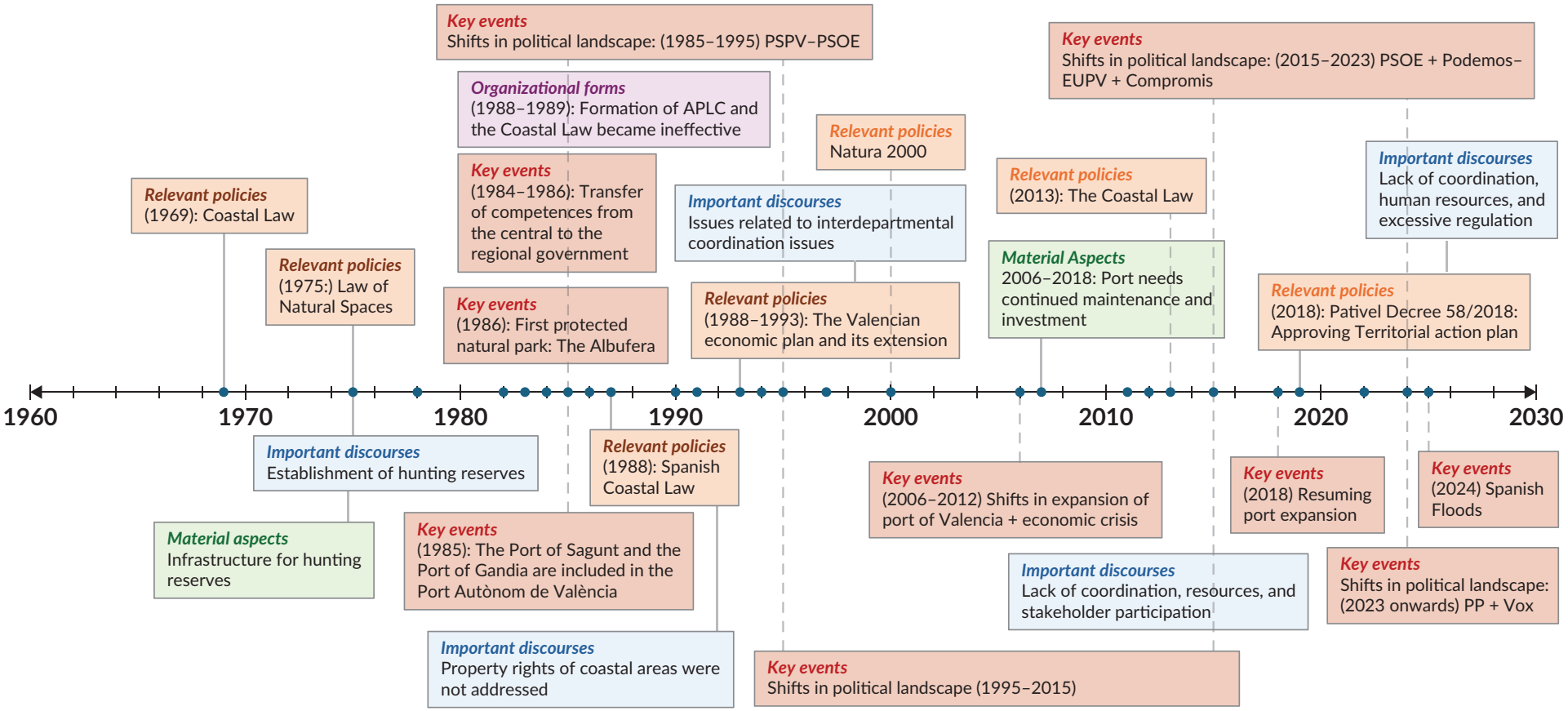


Figure 2. Governance path related to coastal and marine governance in Valencia, Spain, from 1970 to 2025. Notes: PSPV stands for Partido Socialista del País Valencià; PSOE for Partido Socialista Obrero Español; EUPV for Esquerra Unida del País Valencià; and PATIVEL for Plan de Acción Territorial de la Infraestructura Verde del Litoral.

limited to actors with vested interests only, while marginalized groups or those without clear economic stakes in coastal management face barriers to involvement. Stakeholder fatigue and a lack of institutional mechanisms for meaningful participation further exacerbate the situation in Valencia. Bridging the gap between these democratic forms requires a careful balance, ensuring that decision-making processes are both inclusive and effective while addressing the power imbalances that often skew participation (Enguix, 2023).

4.2.4. Interaction Between Governance Dimensions

The interaction between the three governance dimensions—the integration of land and sea management, the mobilization of knowledge, and the forms of democracy—shapes the broader governance process in Valencian coastal management. The tension between land and sea-based policies often complicates the application of scientific knowledge, as the priorities of stakeholders involved in land management may not always align with those in marine management (Miró Pérez & Olcina, 2020). Similarly, the forms of democracy at play influence how knowledge is mobilized and who gets to decide which knowledge is valid. Representative democracy tends to prioritize economic or development-driven knowledge, whereas participatory forms of democracy call for the inclusion of local and scientific knowledge, fostering a more holistic approach to governance (Gonzalez-Alonso et al., 1997). The interaction between these dimensions also reveals governance challenges. For example, while the integration of land and sea management in Valencia may promote more cohesive decision-making, the barriers to knowledge sharing and participatory fatigue hinder its effectiveness. This creates a need for governance structures that can simultaneously address the technical complexities of coastal management, incorporate diverse forms of knowledge, and foster meaningful democratic participation at all levels (Enguix, 2023). Thus, the interviewed experts emphasized that achieving a balance between these dimensions is essential for creating adaptive, resilient governance systems capable of responding to the multifaceted challenges faced by coastal communities.

4.3. The Isle of Wight Biosphere Case

Situated off the southern coast of England, the Isle of Wight is renowned for its rich ecological diversity, notable coastal landscapes, and cultural heritage. As a designated UNESCO Biosphere Reserve, it represents a living laboratory for sustainable development, where environmental protection, economic resilience, and social well-being must be carefully balanced. Its position at the interface of land and sea makes it particularly vulnerable to climate change impacts such as coastal erosion, sea-level rise, and habitat degradation. At the same time, the island's tightly knit communities, reliance on tourism, and proximity to the busy Solent maritime corridor create a unique set of governance challenges. These conditions make the Isle of Wight an ideal case for exploring how different dimensions of governance and their interactions (Figure 3).

4.3.1. Integration of Land and Sea Management

Integrating land and sea management on the Isle of Wight involves navigating a complex landscape of diverse stakeholders, including policymakers, conservationists, local businesses, and residents. Community scepticism, often rooted in a historical mistrust of local authorities, further complicates efforts to establish cohesive governance frameworks. Policies aimed at integrating coastal and terrestrial management are frequently seen as top-down impositions. This perception of exclusion alienates coastal communities,

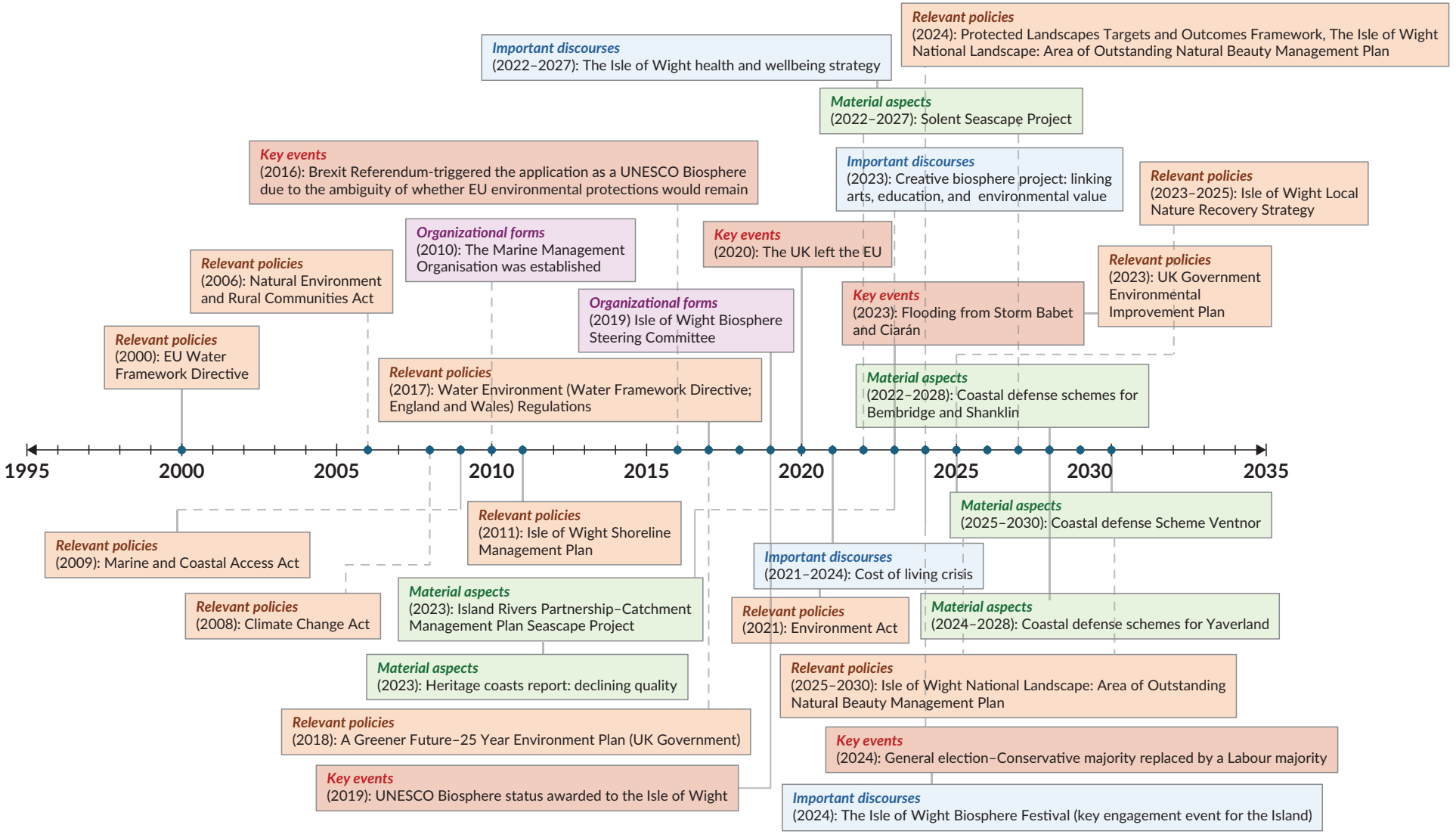


Figure 3. Governance path related to coastal and marine governance in the Isle of Wight, UK, from 2000 to 2025.

making it harder to gain widespread support for such initiatives. Decision-making linked to these policies is often shaped by sentimental connections to the past, resulting in hesitancy to adopt plans that deviate from historical environmental baselines or long-standing perceptions of the local landscape. Efforts to develop a cohesive conservation framework face difficulties due to fragmented policies and competing stakeholder interests (McInnes et al., 2003).

4.3.2. Forms of Knowledge Mobilized

The challenge of integrating land and sea management on the Isle of Wight is deeply tied to knowledge production. Scientific expertise plays a crucial role in identifying environmental risks to the island, such as coastal erosion and sea level rise. Scientific research on the Isle of Wight has provided vital insights into coastal ecosystem services, biodiversity threats, and climate adaptation strategies. However, these expert-driven initiatives often struggle to gain traction when they do not incorporate the lived experiences and concerns of local communities. Although local communities possess valuable ecological knowledge about marine ecosystems, such as seagrasses and kelp forests, it proves difficult to integrate this knowledge into a more comprehensive understanding of land–sea interactions. The disconnect between scientific and local knowledge is particularly evident in the post-Brexit landscape, where governance uncertainty has exacerbated mistrust in regulatory frameworks. For example, while conservationists advocate for stricter environmental protections under the Biosphere framework, some residents fear that such measures could limit economic opportunities or impose restrictions on coastal land-use. The tension between scientific expertise and local priorities highlights the need for governance structures that actively engage communities in knowledge production, ensuring that policies are informed by both technical research and local knowledge and experiences.

4.3.3. Forms of Democracy in Coastal Governance

On the Isle of Wight, decision-making power is largely concentrated in formal institutions, while grassroots organizations and community groups are playing an increasingly active role in advocating for alternative governance approaches. A key challenge lies not simply in the use of expert knowledge but in the dominance of certain sectors, particularly those tied to traditional investment priorities, in shaping which knowledge is mobilized. This sectoral bias can influence how policies supporting land–sea integration are framed and whose interests they reflect. The Isle of Wight case illustrates the importance of structured, inclusive engagement mechanisms that allow diverse stakeholders to contribute to governance processes. For instance, uncertainties around the understanding of what the biosphere designation means to the island have highlighted the role of participatory forums where local communities and experts engage in dialogue. These forums have helped to build public trust and ensure that governance strategies reflect both scientific insights and the experiences and perspectives of local communities. An example of how they are bridging different perspectives includes the Biosphere Festival, which effectively brought together a diverse audience that fostered a sense of community, highlighted the role of the biosphere, and provided free/low-cost nature education events. In practice, opportunities for co-management have enabled local actors to play a direct role in shaping and implementing policies, contributing to governance structures that are more responsive and adaptive to changing environmental and social conditions.

4.3.4. Interaction Between Governance Dimensions

The interviews illustrate that coastal governance in the Isle of Wight is making progress toward integrating land and sea management, but challenges remain. The interviewees explained that local communities possess valuable ecological knowledge about marine ecosystems, but it is not always easy to integrate this form of knowledge with the findings of scientific studies. Despite ongoing collaborations between local knowledge holders and academic institutions to bridge this gap, integration at a systemic level is still evolving. Governance structures combine both participatory and representative democratic elements, with active community involvement through grassroots events and formal engagement with government agencies and NGOs. Overall, the case highlights the importance of co-production of knowledge and adaptive governance, suggesting a promising yet complex trajectory toward a more integrated and inclusive coastal governance model. This case study highlights the deep interconnections between the different governance dimensions. Land–sea integration cannot be achieved without effective knowledge mobilization, and knowledge alone is insufficient unless supported by democratic governance structures that foster trust and participation. Conversely, participatory governance is most effective when it draws on both expert and local knowledge to inform decision-making. The Isle of Wight's journey underscores the importance of integrating expertise, community knowledge, and democratic participation to build sustainable governance models that are both effective and equitable. At the same time, governance structures shape how knowledge is valued and mobilized. When decision-making remains centralized, scientific expertise often takes precedence over local insights. By contrast, more participatory governance structures can facilitate the integration of diverse knowledge systems, creating more socially accepted and effective policies. The Isle of Wight's governance evolution demonstrates that sustainable coastal management cannot rely on expertise alone; it must also incorporate democratic legitimacy and community buy-in.

4.4. The Oslofjord Case

The Oslofjord, located in southeastern Norway, is recognized for both its ecological value and socio-economic significance. Home to diverse marine habitats, the fjord supports a wide range of activities, including fisheries, recreation, tourism, and maritime transport, that make it central to the livelihoods and well-being of surrounding communities. In recent decades, however, the Oslofjord has experienced growing environmental stress due to pollution, habitat degradation, and intensified human activity. These pressures have triggered rising public concern and spurred renewed policy focus, making the area a compelling case for examining the challenges and opportunities of integrated coastal governance and to explore the interaction between different governance dimensions, in a densely used yet ecologically sensitive marine environment (Figure 4).

4.4.1. Integration of Land and Sea Management

The degradation of the Oslofjord ecosystem is largely driven by land-based pollution sources, such as agricultural runoff and wastewater discharge. The Oslofjord action plan has been developed to tackle these challenges; although it has contributed to a reduction in nitrogen inputs, its limited long-term vision underscores a persistent challenge in land–sea governance: aligning environmental objectives with infrastructure development and broader economic priorities.

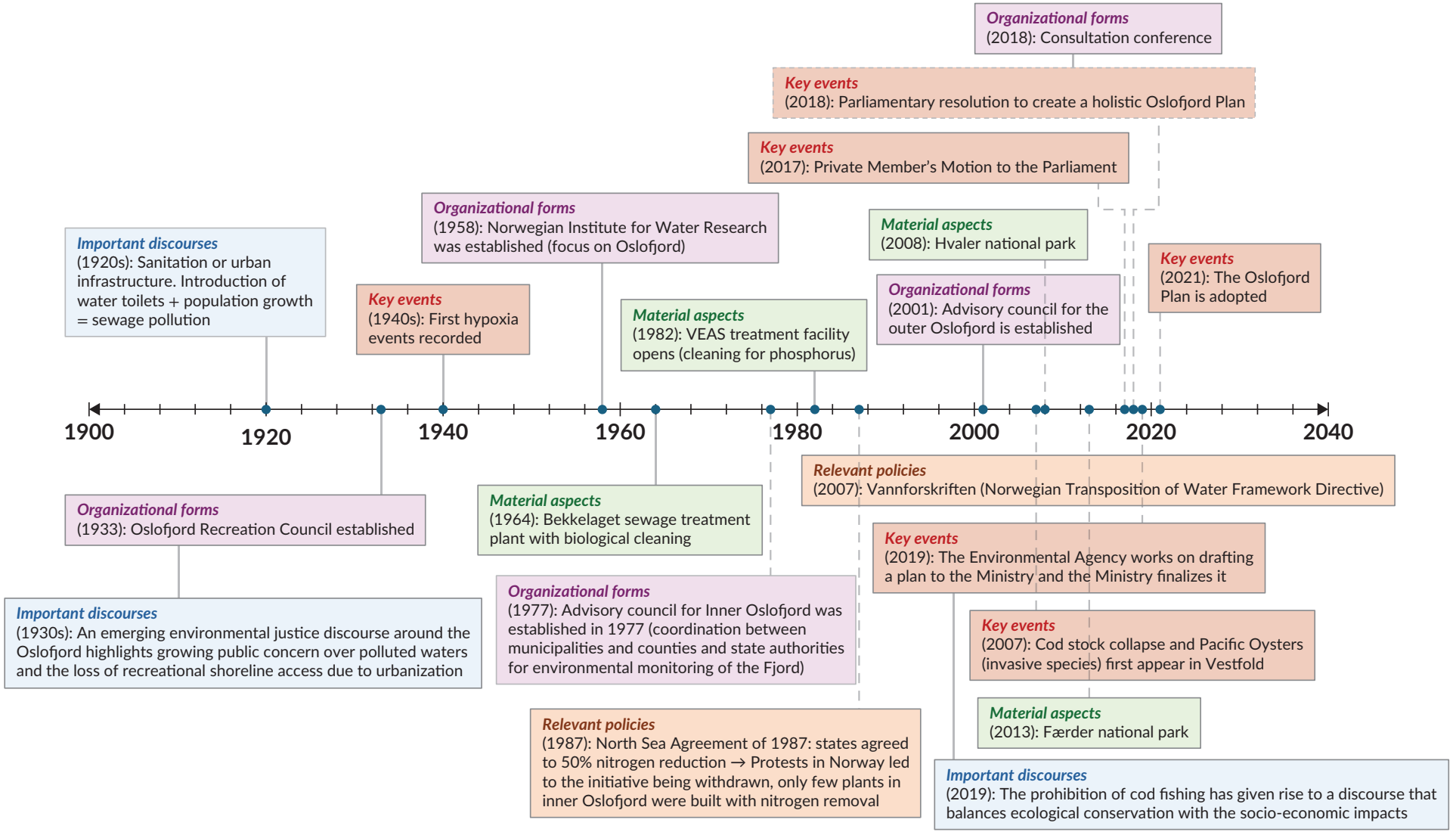


Figure 4. Governance path related to coastal and marine governance in the Oslofjord, Norway, from the 1920s to 2021.

To support coordination across governance levels, the Oslofjord Council was established. However, its effectiveness has been constrained by a focus on reporting actions rather than assessing their ecological impacts. According to interviewees, this lack of functional integration reflects deeper institutional shortcomings, where governance frameworks often struggle to connect policy implementation with the ecological requirements of complex systems. Without a more dynamic and adaptive approach, one that incorporates climate change considerations, continuous monitoring, and iterative learning of land–sea governance efforts, may continue to fall short in reversing the fjord's ongoing environmental decline.

4.4.2. Forms of Knowledge Mobilized

The role of knowledge production in Oslofjord governance is crucial, as scientific research informs management decisions regarding pollution control, habitat restoration, and biodiversity conservation. However, the governance framework has historically struggled to incorporate ecological knowledge effectively. The initial action plan relied heavily on traditional mitigation measures such as reducing nutrient inputs without fully considering the broader ecological dynamics at play. Furthermore, the absence of clear ecological indicators has hindered the ability to measure the effectiveness of conservation efforts. While scientific assessments have identified ongoing environmental decline, governance institutions have been slow to integrate new knowledge into policy adjustments. This misalignment highlights the challenge of bridging the gap between scientific expertise and decision-making processes. Recent developments, such as the introduction of marine gardens and technological solutions, indicate a shift towards a more innovative approach. However, these measures have not yet been fully embedded within the governance framework. The integration of industry perspectives and local knowledge remains critical for improving the alignment between management strategies and ecosystem functions. The interviewed experts indicated that without a stronger emphasis on knowledge co-production, governance risks continuing a cycle of reactive rather than proactive environmental management.

4.4.3. Forms of Democracy in Coastal Governance

The forms of democracy in the Oslofjord rely on a combination of representative and participatory mechanisms. The Oslofjord Council, composed of municipalities, county governors, and sector agencies, plays a central role in coordinating environmental actions. However, its approach has been criticized for focusing on administrative processes rather than fostering deeper stakeholder engagement. A major challenge in participatory governance is ensuring that diverse stakeholders, ranging from local communities and environmental groups to industries and policymakers, have meaningful influence in decision-making. The historical lack of industry engagement has limited the ability to develop more holistic management strategies that align environmental goals with economic realities. Moreover, the absence of clear ecological indicators weakens accountability and transparency in governance processes, reducing public trust in management efforts. According to interviewed experts, to improve governance legitimacy and effectiveness of the fjord, stronger participatory mechanisms are needed to bridge the divide between expert knowledge and local concerns.

4.4.4. Interaction Between Governance Dimensions

Reflecting on the Oslofjord case, it becomes clear that integrating land and sea management is a complex process shaped by local governance and broader environmental policies. The Oslofjord Plan demonstrates an attempt to move beyond a municipality-focused approach to a more holistic perspective that considers the entire catchment area. However, this shift is not without challenges, as municipalities often resist interference from higher levels of government, while also needing state support to address issues like sewage treatment and water quality management. Scientific expertise plays a key role in understanding the issues at hand, but municipalities struggle to fully access and utilize this knowledge, especially when it comes to technical solutions. Despite this, local stakeholders remain heavily involved in decision-making, and there is growing recognition of the need for collaboration across various levels of governance. Ultimately, the case shows that effective environmental management requires a balance between local autonomy, state intervention, and scientific input, all while ensuring that political support at the municipal level drives meaningful action.

5. Discussion

The three cases clearly demonstrate how each governance system is shaped by a particular way of organizing the planning and use of coastal areas. The cases also show how the options for transforming coastal governance systems are shaped by existing governance structures and choices made concerning the three dimensions this article focuses on. The distribution of different tasks and responsibilities over different authorities, the hierarchical and sectoral division of particular responsibilities, the strong reliance on scientific knowledge in the formulation of policies, and the dominance of certain sectors, types of land use, and vested interests strongly influence the social-environmental challenges and how governance responds to them. These aspects also influence the implementation of policies as well as the attempt to reform governance in all three cases—the three dimensions are strongly interwoven. By examining these cases, we can identify some of the key challenges and opportunities for transforming coastal governance.

5.1. Land–Sea Integration

The cases confirm the general insight that the integration of land and sea management remains one of the most persistent governance challenges, as land-based activities, such as urbanization, agriculture, and industrial development, have profound impacts on marine ecosystems. The Valencian case illustrates how fragmented policies create tensions between conservation efforts and economic development. For example, while Pativel seeks to preserve coastal ecosystems, the expansion of the Port of Valencia continues to place pressure on these fragile environments (Miró Pérez & Olcina, 2020). Similarly, in the Oslofjord, land-based pollution from agriculture and wastewater significantly contributes to marine degradation. Yet, actors struggle to align land-use planning with marine conservation, as municipal spatial plans often inadequately regulate fjord usage, and existing marine management frameworks frequently overlook coastal areas, leading to fragmented and ineffective governance. On the Isle of Wight, the challenge of land–sea integration is further complicated by deep-rooted community scepticism toward authorities and governance processes. While scientific expertise is essential in identifying threats such as sea-level rise and erosion, this knowledge must be effectively communicated and aligned with local perspectives to avoid resistance. Across all three cases, the difficulty of coordinating across governance levels and departments, each with

distinct mandates, interests, and institutional cultures, limits the capacity to address land–sea interdependencies. Furthermore, they regularly seem to promote different and competing interests. Integrating land and sea thus either requires new overarching structures that bring these different ways of organizing together, or a profound reorganization of these different ways of organizing and their position in the overarching governance system. Both options may face resistance due to institutional inertia, actor familiarity with established practices, and vested interests embedded in current governance systems.

5.2. Knowledge Mobilization

The integration of different forms of scientific expertise, local knowledge, and policy insights (Berkes, 2012; Turnhout et al., 2016) is another key challenge that plays a role in the three cases. Across all three case studies, governance structures have struggled to translate knowledge into action due to fragmented information sharing and political constraints. In Valencia, scientific data on coastal erosion and biodiversity loss are widely available but underutilized due to bureaucratic inefficiencies and political inertia. In the Isle of Wight, the failure to integrate community knowledge into decision-making has led to resistance from local stakeholders, particularly in conservation initiatives. The Oslofjord case highlights the importance of ecological indicators in guiding policy; however, governance institutions have been slow to incorporate new scientific findings into regulatory frameworks. The cases thus show that existing forms of organizing are strongly interwoven with specific types of knowledge that are not easily exchanged. The challenges are greater if other types of knowledge, either different types of expertise or forms of local knowledge, conflict with dominant discourses. These other types of knowledge may either be seen as irrelevant or even conflicting or threatening. The cases also draw attention to the limits of knowledge integration by demonstrating that there will always be different perspectives and views, and different ideas about how knowledge should be mobilized and used in decision-making processes. These are power/knowledge dynamics that play out in every community and governance system but may be even more complex in coastal governance because of the enormous diversity in topics, views, and interests, and because the ecological, economic, and political stakes are often vast.

5.3. Democratic Structures

The three case studies show that there are significant barriers to inclusive participation and that outcomes and decisions from participatory processes are not always integrated into decisions made by authorities. In Valencia, representative forms of decision-making have historically favoured economic interests, limiting the influence of civil society and local environmental groups in decision-making (Miró Pérez & Olcina, 2020). On the Isle of Wight, governance legitimacy has been undermined by community scepticism toward local authorities, particularly in post-Brexit environmental governance. Similarly, in the Oslofjord, participatory structures such as the Oslofjord Council have struggled to engage industries in governance discussions, leading to weakened public trust in management strategies. The cases highlight the difficulties of introducing participatory approaches, particularly if these go beyond decision-making concerning a specific plan or vision. Such participatory approaches may not always align with other forms of decision-making and the more dominant representative forms of decision-making that are institutionalized. The cases also show that participatory processes are always embedded in larger structures of decision-making and subject to dominant (prevailing or mainstream) views and interests. Different decision-making approaches can yield conflicting outcomes, and ignoring these may erode trust in governance and hinder participatory coastal transformation.

5.4. Interactions Between Governance Dimensions: A Path Towards Transformation

The cases highlight how the three governance dimensions—land–sea integration, knowledge mobilization, and democratic forms—are interrelated, shaping both current coastal governance and its potential for transformation. The cases show that a change in one dimension (e.g., using scientific knowledge or increasing local participation) is difficult and that efforts to transform coastal governance are often undermined by the interplay between all three dimensions. Current forms of organizing related to the three key dimensions and their interdependencies thus create a strong path dependency. The cases show that failure to bring change in one dimension might also weaken attempts to make changes in the other dimensions. For example, in Valencia, the fragmented integration of land and sea policies has undermined knowledge-sharing mechanisms and restricted stakeholder participation. In contrast, the Isle of Wight biosphere initiative demonstrates that enhanced participatory structures can improve the mobilization of diverse knowledge sources, ultimately strengthening land–sea governance. A better understanding of the different ways governance is structured concerning each dimension helps to enrich our understanding of the co-evolution in coastal governance and distinguish realistic transformation options from normative ideals. The focus on dimensions and ways of organizing can thus enrich existing theories of coastal transformation and the attempts to transform coastal governance.

As shown in Table 1, the three case studies reveal how land–sea integration, knowledge mobilization, and democratic forms vary across contexts. Each case presents a unique configuration of how these dimensions interact and evolve, highlighting both distinct paths and shared challenges. Beyond clarifying these dimensions, we identified recurring patterns and dynamics that show how each governance system adapts to context-specific pressures, including events, policies, organizational forms, material conditions, and discourses. This enabled a nuanced understanding of governance functions and transformations across

Table 1. Comparative analysis of the three critical governance dimensions of Valencia (Spain), the Isle of Wight (UK), the Oslofjord (Norway), and the main lessons learned.

Governance dimension	Valencia, Spain	Isle of Wight, UK	Oslofjord, Norway	Lessons learned
Land–sea integration	Fragmented governance and tensions between urban expansion and ecosystem protection	Progressing toward integration through biosphere efforts, hindered by mistrust	Partially integrated and policy misalignment with ecological priorities	Institutional fragmentation hampers integration, and it requires a long-term vision and stakeholder trust
Knowledge mobilization	Dominated by technical expertise and limited incorporation of local knowledge	Weak connection between scientific insight and community experience	Strong reliance on scientific data and insufficient co-production and ecological metrics	Bridging scientific and local knowledge is essential for socially accepted and adaptive governance
Forms of democracy	Predominantly representative and minimal participatory engagement	Formal governance structures with increasing grassroots activism	Combination of representative councils and limited participatory mechanisms	Participatory governance must be meaningfully institutionalized to strengthen legitimacy and inclusiveness

cases. Figures 2, 3, and 4 illustrate integrative governance pathways, showing how challenges emerge and are addressed. The comparative analysis deepens understanding of the three dimensions and suggests entry points for improving coastal governance.

6. Conclusions and recommendations

The analysis highlights the importance of past choices on the three key governance dimensions—land–sea integration, knowledge mobilization, and forms of democracy—their interdependencies, and the structural challenges involved in adapting governance systems. A more comprehensive understanding of these governance dimensions helps identify both constraints and opportunities for transformation. Once dimensions crystallize, and once positions are taken, these features and categories can entrench themselves, while their transformation is limited by what happens in the other dimensions. The case studies illustrate that such interdependence not only constrains but also guides change. How this influence plays out depends heavily on the specific governance path and institutional configuration.

What can be said in general is that attempts at transformation towards integration of land and sea governance and towards enhanced observation and adaptation ought to be informed by a localized analysis of governance dimensions and the nature of their interdependence. What further transpires from the cases is that a fixed set of normative principles for good coastal governance must be regarded as no more than a convenient fiction. Indeed, our cases all indicated issues with participation, knowledge, and policy integration and differentiation, yet they also demonstrated that correct forms and degrees, as well as participation, cannot be defined in the abstract. Moreover, the analyses suggest that our distinction between participation and representation was useful, and that forms of democracy make all the difference in delineating transformation options, yet also that we might have to broaden our definition of that dimension to include other aspects, including centralization/decentralization and individualist/collectivist. If we rethink the forms of democracy as a more synthetic concept in this manner, recognizing a wider variety of forms, different intensities, and functions of participation becomes possible, while the dimension can be more easily used as a strong first indicator in future analyses.

Future research can expand beyond these insights to explore their interactions with additional factors such as economic incentives, legal frameworks, and institutional path dependencies. Examining how existing institutional structures, power dynamics, and decision-making processes influence transformation efforts will provide valuable insights into the barriers and enablers of governance change. To support effective governance interventions, practical conceptual tools should be developed, enabling policymakers, practitioners, and stakeholders to analyze their governance contexts and identify adaptive strategies tailored to their specific needs. Additionally, a balanced perspective is necessary when approaching governance change, recognizing both its possibilities and limitations. Moving away from overly normative approaches and grounding strategies in empirical realities will enhance their feasibility, ensuring that governance reforms remain actionable, politically viable, and sustainable over time.

Acknowledgments

The research leading to this work was conducted in the framework of the Project BlueGreen Governance (2024–2027). The project is co-funded by the European Union (EU) under the Horizon Europe Programme (Project number 101086091) and by UK Research and Innovation (UKRI) under the UK government's Horizon

Europe funding guarantee (Project number 10108603). Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the EU or UKRI. Neither the EU nor UKRI can be held responsible for them.

Conflict of Interests

In this article, editorial decisions were undertaken by Gianluca Ferraro (University of Portsmouth).

Data Availability

Data supporting the findings of this study are available from the authors upon request.

References

Alfosea, F. J. T. (2010). Cuarenta años de leyes de costas en España (1969–2009). *Investigaciones Geográficas*, *52*, 167–200.

Ansong, J. O., McElduff, L., & Ritchie, H. (2021). Institutional integration in transboundary marine spatial planning: A theory-based evaluative framework for practice. *Ocean & Coastal Management*, *202*, Article 105430. https://doi.org/10.1016/j.ocecoaman.2020.105430

Barcelo, M., Vargas, C. A., & Gelcich, S. (2023). Land–sea interactions and ecosystem services: Research gaps and future challenges. *Sustainability*, *15*(10), Article 8068. https://doi.org/10.3390/su15108068

Berkes, F. (2012). *Sacred ecology* (3rd ed.). Routledge. https://doi.org/10.4324/9780203123843

Connor, M. O., Cooper, J. A. G., & McKenna, J. (2009). Integrating science into shoreline management practice and policy: An Irish perspective. *Journal of Coastal Research*, *50*,1267–1270.

Dahdouh-Guebas, F., Hugé, J., Abuchahla, G. M. O., Cannicci, S., Jayatissa, L. P., Kairo, J. G., Arachchilage, S. K., Koedam, N., Nijamdeen, M. T. W. G. F., & Mukherjee, N. (2021). Reconciling nature, people and policy in the mangrove social-ecological system through the adaptive cycle heuristic. *Estuarine, Coastal and Shelf Science*, *248*, Article 106942. https://doi.org/10.1016/j.ecss.2020.106942

Duck, R. W. (2012). Marine spatial planning: Managing a dynamic environment. *Journal of Environmental Policy & Planning*, *14*(1), 67–79. https://doi.org/10.1080/1523908X.2012.664406

Eger, S. L., De Loë, R. C., Pittman, J., Epstein, G., & Courtenay, S. C. (2021). A systematic review of integrated coastal and marine management progress reveals core governance characteristics for successful implementation. *Marine Policy*, *132*, Article 104688. https://doi.org/10.1016/j.marpol.2021.104688

Enguix, J. (2023). Coastal governance challenges in Spain: Insights from the Valencian community. *Marine Policy*, *37*(3), 112–125.

Evans, T., Fletcher, S., Failler, P., & Potts, J. (2023). Untangling theories of transformation: Reflections for ocean governance. *Marine Policy*, *155*, Article 105710. https://doi.org/10.1016/j.marpol.2023.105710

Fischer, F. (2000). *Citizens, experts, and the environment: The politics of local knowledge*. Duke University Press.

Fobé, E., Blatrix, C., Douguet, J.-M., Salès, K., Đinh, L., Trubbach, S., Platjouw, F. M., Johannesen, E., Kvanneid, A. J., Beunen, R., & Nijamdeen, M. T. W. G. F. (2024). *Policy report on institutional barriers and enablers*. B. G. Project.

Garud, R., Kumaraswamy, A., & Karnøe, P. (2010). Path dependence or path creation? *Journal of Management Studies*, *47*(4), 760–774. https://doi.org/10.1111/j.1467-6486.2009.00914.x

Gonzalez-Alonso, P., Cantos, F., & Miró, M. (1997). Climate change and its impact on the Valencian agricultural sector: Challenges and adaptation strategies. *Regional Environmental Studies*, *22*(3), 112–125.

Held, D. (2006). *Models of democracy* (3rd ed.). Polity Press.

Jasanoff, S. (2004). *States of knowledge: The co-production of science and social order*. Routledge. https://doi.org/10.4324/9780203413845

Jentoft, S. (2007). Limits of governability: Institutional implications for fisheries and coastal governance. *Marine Policy*, *31*(4), 360–370. https://doi.org/10.1016/j.marpol.2006.11.003

Jouffray, J.-B., Blasiak, R., Norström, A. V., Österblom, H., & Nyström, M. (2020). The blue acceleration: The trajectory of human expansion into the ocean. *One Earth*, *2*(1), 43–54. https://doi.org/10.1016/j.oneear.2019.12.016

Kelly, C., Ellis, G., & Flannery, W. (2019). Unravelling persistent problems to transformative marine governance. *Frontiers in Marine Science*, *6*, Article 213. https://doi.org/10.3389/fmars.2019.00213

MacAfee, E. A., & Löhr, A. J. (2024). Multi-scalar interactions between mismanaged plastic waste and urban flooding in an era of climate change and rapid urbanization. *WIREs: Water*, *11*(2), Article e1708. https://doi.org/10.1002/wat2.1708

McInnes, R. G., Jakeways, J., Marriott, C., Street, C., & Houghton, H. (2003). *Making coastal zone management work—Experience from the implementation process on the Isle of Wight, UK*. TRID. https://trid.trb.org/View/798547

Miró Pérez, J. J., & Olcina, J. (2020). Cambio climático y confort térmico. Efectos en el turismo de la Comunidad Valenciana. *Investigaciones Turísticas*, *20*, 1–30. https://doi.org/10.14198/INTURI2020.20.01

Moallemi, E. A., Zare, F., Hebinck, A., Szetey, K., Molina-Perez, E., Zyngier, R. L., Hadjikakou, M., Kwakkel, J., Haasnoot, M., & Miller, K. K. (2023). Knowledge co-production for decision-making in human-natural systems under uncertainty. *Global Environmental Change*, *82*, Article 102727. https://doi.org/10.1016/j.gloenvcha.2023.102727

Muhl, E.-K., Armitage, D., Anderson, K., Boyko, C., Busilacchi, S., Butler, J., Cvitanovic, C., Faulkner, L. A., Hall, J. A., & Martynuik, G. (2023). Transitioning toward "deep" knowledge co-production in coastal and marine systems: Examining the interplay among governance, power, and knowledge. *Ecology and Society*, *28*(4), Article 17. https://doi.org/10.5751/ES-14443-280417

Neumann, B., Vafeidis, A. T., Zimmermann, J., & Nicholls, R. J. (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding-a global assessment. *PloS One*, *10*(6), Article e0131375. https://doi.org/10.1371/journal.pone.0118571

Nijamdeen, M. T. W. G. F., Ratsimbazafy, H. A., Kodikara, K. A. S., Thahira, T., Peruzzo, S., Dahdouh-Guebas, F., & Hugé, J. (2023). Mangrove management in Sri Lanka and stakeholder collaboration: A social network perspective. *Journal of Environmental Management*, *330*, Article 117116. https://doi.org/10.1016/j.jenvman.2022.117116

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419–422. https://doi.org/10.1126/science.1172133

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, *19*(3), 354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Paramita, A. O., Partelow, S., & Fujitani, M. (2023). A systematic review of deliberation research in marine and coastal case studies. *Frontiers in Marine Science*, *10*, Article 1178453. https://doi.org/10.3389/fmars.2023.1178453

Partelow, S., Schlüter, A., Armitage, D., Bavinck, M., Carlisle, K., Gruby, R. L., Hornidge, A.-K., Le Tissier, M., Pittman, J., & Song, A. M. (2020). Environmental governance theories: A review and application to coastal systems. *Ecology and Society*, *25*(4), Article 19. https://doi.org/10.5751/ES-12067-250419

Pomeroy, R. S., & Berkes, F. (1997). Two to tango: The role of government in fisheries co-management. *Marine Policy*, *21*(5), 465–480. https://doi.org/10.1016/S0308-597X(97)00017-1

Quimby, B., & Levine, A. (2018). Participation, power, and equity: Examining three key social dimensions of fisheries comanagement. *Sustainability*, *10*(9), Article 3324. https://doi.org/10.3390/su10093324

Rölfer, L., Celliers, L., & Abson, D. (2022). Resilience and coastal governance: Knowledge and navigation between stability and transformation. *Ecology and Society*, *27*(2), Article 40. https://doi.org/10.5751/ES-13244-270240

Schlüter, A., Van Assche, K., Hornidge, A.-K., & Văidianu, N. (2020). Land-sea interactions and coastal development: An evolutionary governance perspective. *Marine Policy*, *112*, Article 103801. https://doi.org/10.1016/j.marpol.2019.103801

Shipman, B., & Stojanovic, T. (2007). Facts, fictions, and failures of integrated coastal zone management in Europe. *Coastal Management*, *35*(2/3), 375–398. https://doi.org/10.1080/08920750601169659

Tocco, C. L., Frehen, L., Forse, A., Ferraro, G., & Failler, P. (2024). Land-sea interactions in European marine governance: State of the art, challenges and recommendations. *Environmental Science & Policy*, *158*, Article 103763. https://doi.org/10.1016/j.envsci.2024.103763

Turnhout, E., Dewulf, A., & Hulme, M. (2016). What does policy-relevant global environmental knowledge do? The cases of climate and biodiversity. *Current Opinion in Environmental Sustainability*, *18*, 65–72. https://doi.org/10.1016/j.cosust.2015.09.004

Van Assche, K., Beunen, R., & Duineveld, M. (2013). *Evolutionary governance theory: An introduction*. Springer. https://doi.org/10.1007/978-3-319-00984-1

Van Assche, K., Beunen, R., & Gruezmacher, M. (2024). *Strategy for sustainability transitions: Governance, community and environment*. Edward Elgar Publishing. https://doi.org/10.4337/9781035324002

Van Assche, K., Hornidge, A.-K., Schlüter, A., & Vaidianu, N. (2020). Governance and the coastal condition: Towards new modes of observation, adaptation and integration. *Marine Policy*, *112*, Article 103413. https://doi.org/10.1016/j.marpol.2019.01.002

Vega-Muñoz, A., Salazar-Sepúlveda, G., & Contreras-Barraza, N. (2021). Identifying the blue economy global epistemic community. *Water*, *13*(22), Article 3234. https://doi.org/10.3390/w13223234

Vergés, F. A. R., & Larruga, F. J. S. (2023). Experiencias sobre la legislación de costas y su aplicación en España: posible contribución al caso mexicano. *Revista Costas*, *5*(1), 135–158. https://doi.org/10.25267/Costas.2023.v5.i1.0603

Verges, F. A. R., & Larruga, F. J. S. (2024). Coastal Laws evolution in Spain: An analysis from the public policy cycle. *Marine Policy*, *162*, Article 106052. https://doi.org/10.1016/j.marpol.2024.106052

Wu, W., & Wan, L. (2024). 13—Coastal ecological and environmental management under multiple anthropogenic pressures: A review of theory and evaluation methods. *Current Trends in Estuarine and Coastal Dynamics*, *4*, 385–415. https://doi.org/10.1016/B978-0-443-21728-9.00013-2

Young, I. M. (2002). *Inclusion and democracy*. Oxford University Press. https://doi.org/10.1093/0198297556.001.0001

About the Authors

Mafaziya Nijamdeen is a postdoctoral researcher at the Open University in the Netherlands. She holds a PhD in science from the Université Libre de Bruxelles in Belgium. Her research focuses on coastal social-ecological systems, with an interdisciplinary approach that integrates social and environmental perspectives. Her work particularly addresses issues related to coastal governance and management, aiming to enhance the resilience and sustainability of coastal regions.

Ansje Löhr has a Master's degree in Marine biology and a PhD degree in ecotoxicology. She is an associate professor at the Department of Environmental Sciences at the Open University of the Netherlands and a visiting lecturer at the Soegijapranata Catholic University (Semarang, Indonesia). She is involved in varying (international) projects related to marine and riverine plastic pollution and waste management, and has been working since 2014 in close cooperation with the United Nations Environment Programme (UNEP) and the Global Partnership on Plastic Pollution and Marine Litter (GPML). She is one of the main researchers in the RISE (Resilient Indonesian Slums Envisioned) project (NWO-WOTRO/RISTEK-BRIN) that seeks to develop inclusive governance approaches for strengthening social-ecological resilience in urban settlements vulnerable to water-related hazards. Moreover, she is involved in the Horizon Europe project BlueGreen Governance, aiming to develop innovative land–sea governance schemes based on scientific evidence and societal choices.

Kristof Van Assche is a professor of governance, planning, and development at the University of Alberta, Canada. He is interested in evolution and innovation in governance, with focus areas in spatial planning and design, development, and environmental policy. He worked in various countries and often combines fieldwork with theoretical reflection, mainly on system theories, interpretive policy analysis, institutional economics, and post-structuralism. He held visiting positions at McGill University, Krakov Agricultural University, Wageningen University, and Bonn University. Geographically, his work spans Europe, the Americas, Central Asia, and the Caucasus.

Raoul Beunen is a professor of environmental governance at the Open University, the Netherlands. His research explores the potential and limitations of environmental policy and planning from the perspective of adaptive governance and sustainability. It focuses on innovation and evolution in governance, paying attention to the dynamics of policy implementation and integration, multi-level governance, stakeholder involvement, and the performance of institutional structures.

OCEAN AND SOCIETY
ISSN: 2976-0925

Ocean and Society is an innovative peer-reviewed open access journal focused on the societal interactions with marine and coastal environments.

As an interdisciplinary journal, Ocean and Society brings together relevant studies in the multiple areas of marine and maritime social sciences, promoting both theoretical and empirical studies whether these studies are done on a global, regional, or local level.

As an interdisciplinary journal, Ocean and Society brings together relevant studies in the multiple areas of marine and maritime social sciences, promoting both theoretical and empirical studies whether these studies are done on a global, regional, or local level.

cogitatio

www.cogitatiopress.com/oceanandsociety