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Beyond Ecology: Land–Sea Governance, Policy, and Research in Réunion Island (2000–2024)

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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.).

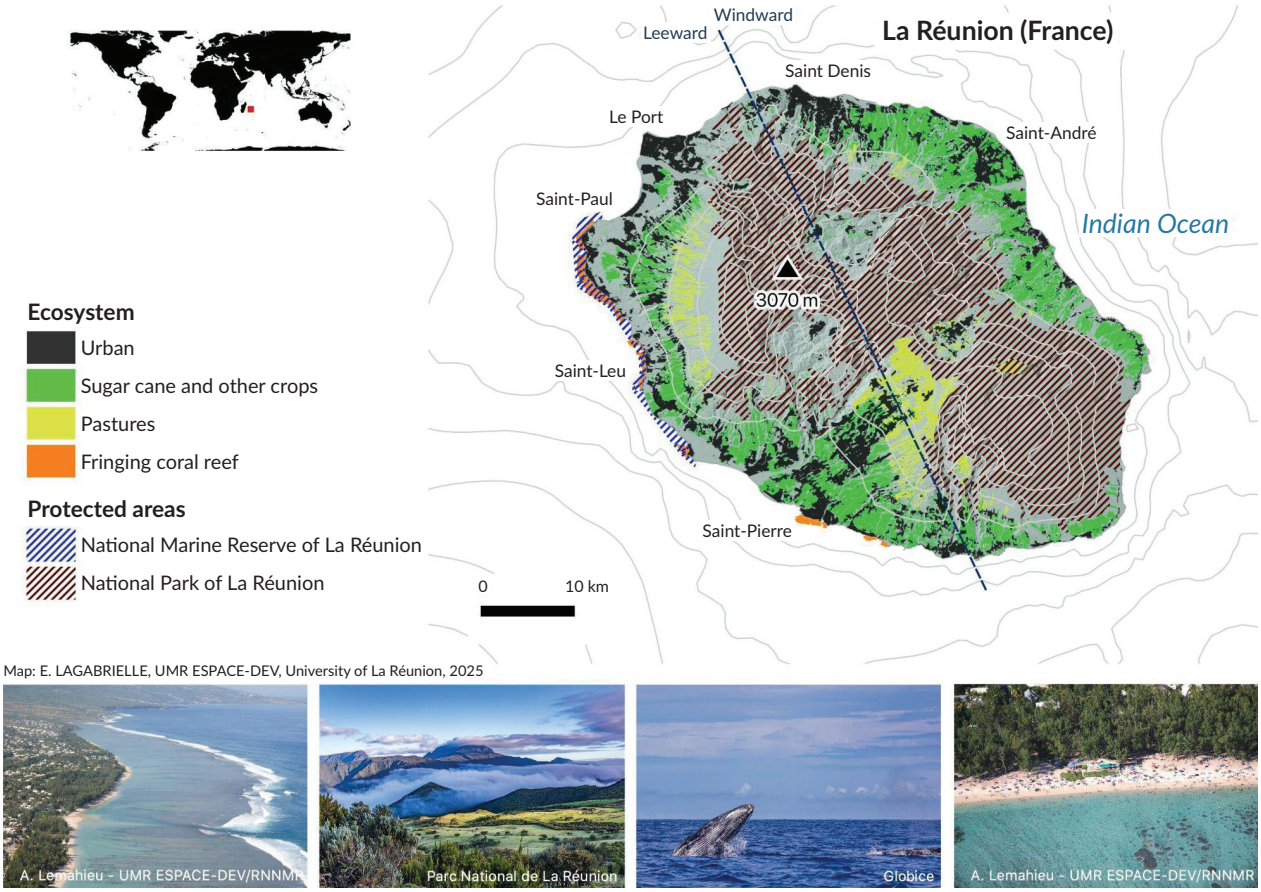

Figure 1. Map illustrating the location and spatial organization of La Réunion in the western Indian Ocean. Notes: The lower panel shows pictures (from left to right): fringing coral reef on the West coast, Piton des Neiges and pasture landscape in the uplands, jumping whale (Megaptera novaeangliae) 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

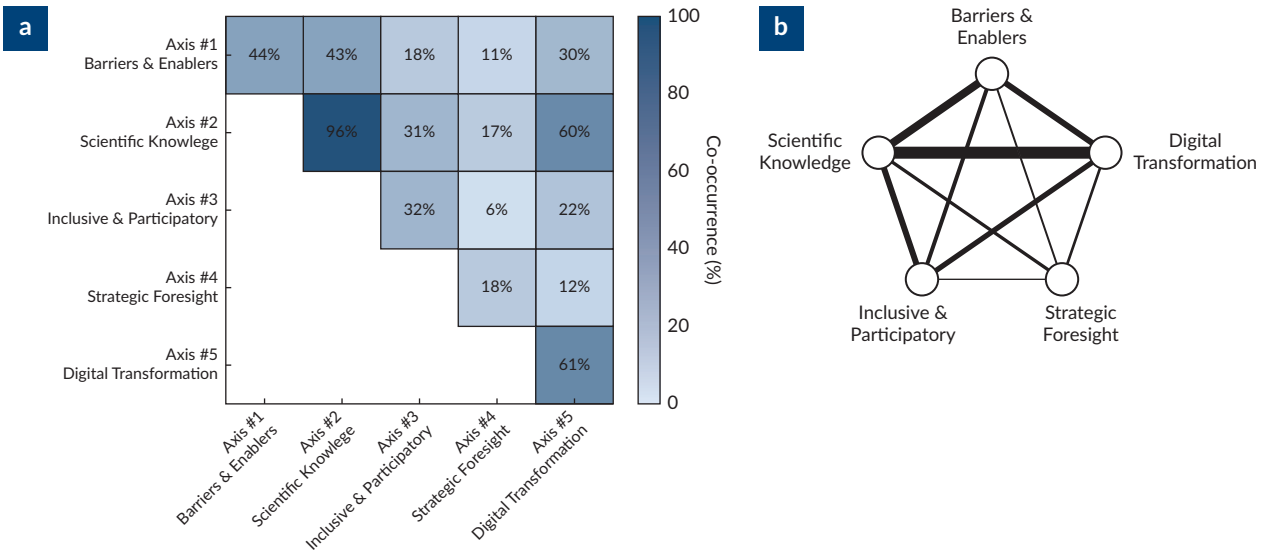

Figure 2. (a) Co-occurrence matrix (in %) of the five EGT axes within the corpus of 281 selected articles; (b) a network representation of the co-occurrences "linking" the five EGT axes (with line thickness proportional to the number of co-occurrences). Note: An axis is considered present in an article if at least one keyword associated with that axis appears in the article.

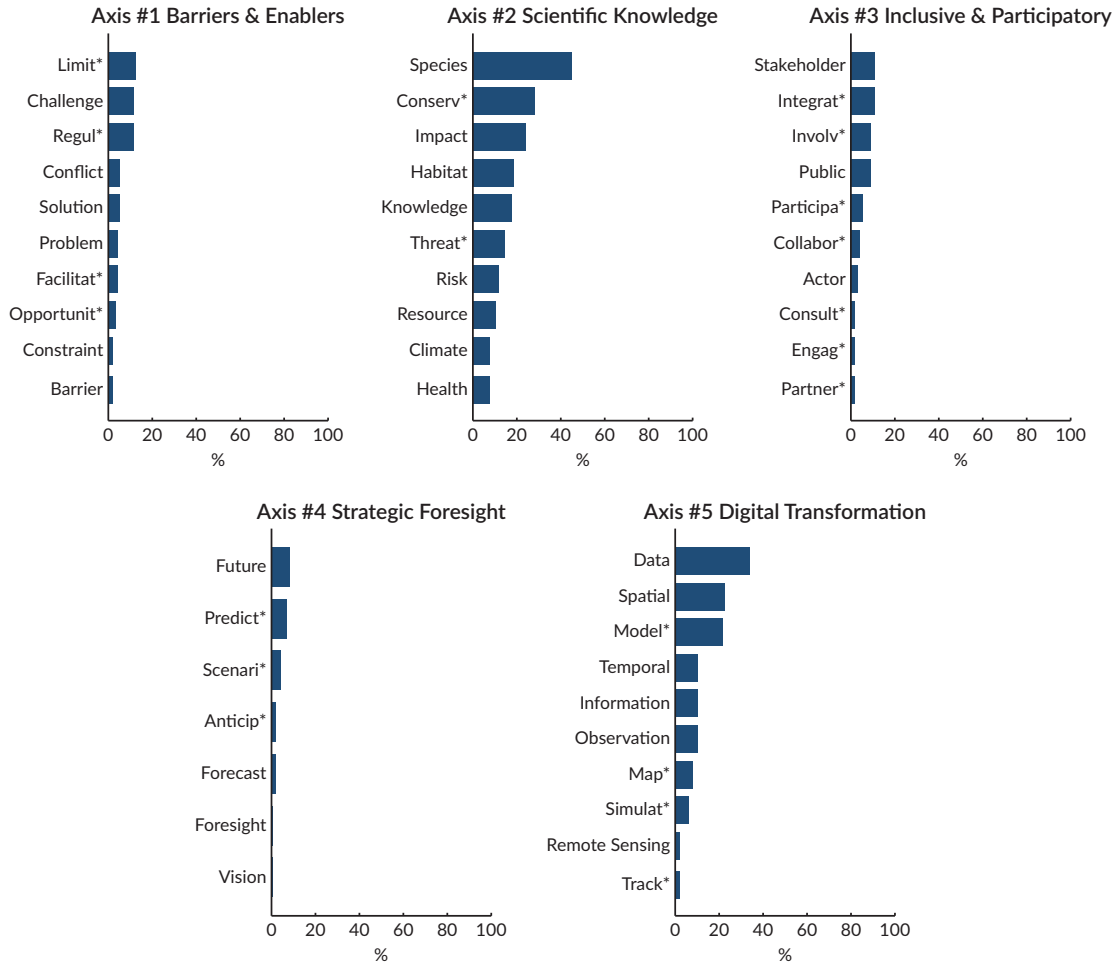

Figure 3. Proportion of corpus articles containing the 10 most frequent keywords relevant to each axis.

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.

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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.

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