

## WP N°2

Task N° 2.2

### D2.2: Guidance on the “Implementation of the case studies – A tool for the development of strategic foresight”



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# BlueGreen Governance

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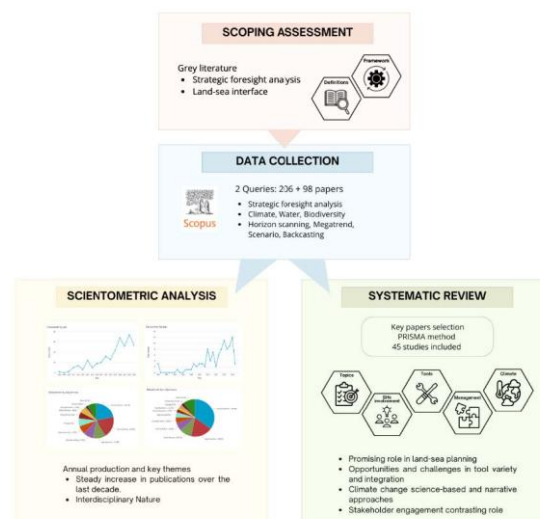
# Abstract

Strategic foresight analysis is emerging as a proactive approach to address complex challenges in environmental science, due to its characteristic in helping institutions and organizations to anticipate and prepare for future issues and opportunities. Especially in the context of climate change, this methodology becomes essential for understanding and managing the complexities of the land-sea interface (LSI), a dynamic zone where diverse and interconnected ecosystems interact, and where the land- and sea-based pressures converge.

This guidance provides fundamental concepts and theoretical frameworks for the implementation of strategic foresight as a tool to facilitate multi-scale and multi-actor deliberations. Thus, research trends and insights are explored, providing insights into the evolution and areas of interest of this approach in managing LSIs. Moreover, within the document, the current methodologies and tools used in strategic foresight analysis for the management of LSIs are analyzed and discussed.

The main benefits of strategic foresight analysis in LSI management include its interdisciplinarity and the possibility of facilitating transdisciplinary collaborative exercises, for a long-term view. It aims to support decision-making through scenario-based approaches and digital tools, this methodology enables the co-construction of capacities to assess cumulative impacts and opportunities, translating them into collective actions and adaptive management strategies at different governance levels.

However, significant gaps persist in the applications of this methodology to LSI management, in which the applications are still not widespread, such as a scarcity of science-based approaches can be noted, which impacts the accuracy of global understanding of land-sea dynamics and future projections, the lack of the use of a broad range of foresight tools, and the complexity related to stakeholders engagement.





# 1. Introduction

Climate change (CC) is a complex issue that intensifies existing environmental challenges, including water scarcity and quality, habitat loss, and biodiversity decline (Cramer et al., 2018). This is a systemic issue, as evolving development landscapes and related risks are increasingly dynamic and interconnected, shaped by multiple factors that interact through intricate feedback mechanisms (UNEP, 2022). This interconnectedness is highlighted in the climate-water-biodiversity nexus where CC, water resources, and biodiversity converge, emphasizing the necessity of integrated management approaches to address the multifaceted impacts of environmental changes (Jackson et al., 2022). Ecological complexity is reflected in the socio-political space where anticipatory planning and governance are affected by tensions in the inter-scalar and inter-sectoral relationships involved in environmental management (Ferraro et al., 2024).

This is particularly true within the LSI, where management is fragmented due to institutional obstacles and legacies from the past, and often fails to adequately respond to the material complexity of these natural connections, characterized by the impact of human activities (social and economic) both on land and at sea and their interaction with climate hazard phenomena (Schlüter et al., 2020). Coastal regions are economically and ecologically vital, providing essential ecosystem services such as nutrient cycling, habitat for biodiversity, and fisheries resources (Karp et al., 2015). However, the “openness” of marine ecosystems compared to terrestrial ones can complicate the design and implementation of management strategies, posing unique challenges that require innovative analytical approaches for their governance and planning (Innocenti & Musco, 2023).

Given the existing gaps and challenges in the study, governance and management of LSI, strategic foresight analysis has emerged as a powerful tool to address the current situation, explore potential scenarios, identify emerging trends, systematically consider future conditions and their implications, and inform decision-making (Störmer et al., 2020). This approach incorporates a multi-actor perspective and a co-creation approach, using deliberative planning to address future environmental challenges.

In light of this, scientists, decision-makers, managers, conservation practitioners, and stakeholders in general, have called for an integrated approach to managing terrestrial, freshwater, and marine socioecological systems (Alvarez Romero et al., 2011; Gordon 2007, Olsson et al., 2008; Stoms et al., 2005). In an evolving environment due to the threat of CC, this approach should be shaped not only in a more integrated way but also through the use of adequate tools to solve, at least partially, the gaps in knowledge deriving from concrete data, through the contribution of experts and interested parties (Ferraro et al., 2024).



Accordingly, the aim of this document is to raise awareness of stakeholders getting a general picture of the current state of the art of strategic foresight analysis for LSI management and planning, through an in-depth examination of the last sixteen years' publications.

The methodology behind the development of the present review is reported in the following box:

<b>Review methodology</b>	
A multi-phase literature review was conducted to provide a comprehensive overview of the current state-of-the-art concerning the application of strategic foresight analysis in the management of LSI. The methodological approach is structured in four key steps including: <i>i</i> ) scoping assessment, <b>the strategic foresight overview</b> (Section 2), <i>ii</i> ) data/publications collection <i>iii</i> ) scientometric analysis, <b>trend and disciplines</b> (Section 3), and <i>iv</i> ) systematic review, <b>insights from key papers</b> (Section 4). Finally, discussion (Section 5) and conclusion (Section 6) are reported.	
<b>Scoping assessment (i.e. narrative review)</b>	The scoping assessment serves as the foundational phase of the review, aiming to comprehensively frame and understand the current state of strategic foresight analysis, providing a <b>comprehensive description</b> of what is known about a topic, including insights from grey literature, and establishing the boundaries for the analysis and setting the stage for the subsequent research. This phase minimizes the risk of including irrelevant aspects or overlooking essential elements, thereby laying a solid groundwork for driving the entire study.
<b>Data/publications collection</b>	Based on the results obtained from the narrative approach, this phase involved systematically searching peer-reviewed literature on the application of strategic foresight analysis methodological approaches in managing LSIs, through the creation of a specific search query on Scopus across 2008-2024 (timeframe selected because before 2008 any study was found related with the specific topic) <b>SEARCH QUERY:</b> ("Strategic foresight analysis" OR "Foresight analysis") AND ("Climate" OR "Water" OR "Biodiversity") AND ("Ecosystem" OR "Land" OR "Sea" OR "Coast" OR "Marine"). <b>NUMBER OF EXTRACTED PAPERS:</b> 304
<b>Scientometric analysis</b>	The scientometric analysis was conducted to quantitatively assess the state of research examining the progression of research over time, focusing on identifying <b>key trends</b> in annual scientific production and highlighting the <b>thematic areas</b> of study of this methodology, to provide valuable insights, revealing gaps, and areas of growing interest.
<b>Systematic review</b>	A systematic review was implemented to answer defined research questions by collecting and summarizing relevant studies that met specific eligibility criteria (Oxman & Guyatt, 1993). Scientific articles were selected through a deep analysis and classification of the <b>key papers</b> selected was assessed, based on comparisons criteria, including the topic analysed, the geographical location, the methodological steps of the case studies, tools used, SHs involved, the types of data



used; whether the methodology applied took into account the effect of CC, whether management scenarios were created in the application of the foresight process, and finally if any policy was connected or directly related.

#### Discussion

Results are interpreted, compared in a **critical way**, and potential limitations and challenges are addressed, guiding readers from specific results to a broader understanding. This section also often suggests new research directions, highlighting unanswered questions or challenges.

#### Conclusion

Key outcomes and their implications are summarized, offering a clear **takeaway** for readers.

## 2 Strategic foresight overview

The philosophy behind strategic foresight has been established since the 1950s in the world of corporate strategy (Spaniol et al., 2022) and has grown into a multidisciplinary field, widely appreciated for generating speculative knowledge on plausible futures useful for the development of strategies (Ramírez and Selin, 2014; Rowland and Spaniol, 2015, 2017; Cook et al., 2014). Over the years, strategic foresight has been applied across multiple domains to anticipate risks and opportunities, guide decision-making, and enhance resilience in uncertain environments. Examples in the context of environmental security are detailed by Chad M. Briggs (2010), who explores the role of strategic foresight and its implications for military operations and national security planning. Meanwhile, in the corporate context, Vecchiato & Roveda (2010) focus on managing uncertainty in strategic foresight within corporate organizations, particularly addressing the uncertainties related to technological and social changes.

### 2.1 Exploring Diverse Definitions

Strategic foresight includes numerous definitions that share key elements. UNDP (2018) defines Foresight as the “generic term for those innovative methods of strategic planning, policy formulation and solution design that do not predict or foresee the future but work with alternative futures” and as “a systematic, participatory, process of information on the future and the construction of medium and long-term visions aimed at enabling current decisions and mobilizing joint action”. This definition emphasizes the exploration of a range of possibilities, rather than focusing on predicting a single future outcome, and highlights the collaborative and action-oriented nature of foresight.

Building upon the 2018 definition, UNDP (2022) emphasizes the resilience-building aspect of strategic foresight, defining it as “the discipline that explores the future to anticipate changes, develop possible transition paths, and resist shocks, to help us act in the present to shape the future we desire”.



In this context, it is crucial to underline the difference between forecasting and foresight (Table 1), in fact, foresight goes beyond merely exploring future possibilities, as it also involves the construction of shared visions and the definition of strategies and actions to address the opportunities identified to pursue the defined shared visions. For this reason, strategic foresight is considered an action-oriented tool in the domain of public policy, namely in the phase (or stage) of policy formulation (Amanatidou et al., 2017; Miles and Popper, 2008; Havas et al., 2005).

**Table 1.** *Foresight and Forecasting comparison.*

	<b>Forecasting</b>	<b>Foresight</b>
<b>Objective</b>	Focuses on predicting and planning what will happen in the future by estimating future outcomes and minimizing uncertainty (Rožanec et al., 2022; UNDP, 2022).	Aims to explore a range of alternative futures, not to predict the most probable one, but to identify plausible and preferable futures (Cornish et al., 2004; UNDP, 2022).
<b>Approach</b>	Relies on quantitative analysis of trends, using models like trend extrapolation and statistical forecasting (Rožanec et al., 2022; UNDP, 2022).	Provides a structured approach to gathering information, using advanced methods that account for weak signals, emerging trends, and potential evolution paths (Battistella et al., 2022).
<b>Outlook to Uncertainty</b>	Focuses on the most probable future scenarios. Seeks to minimize uncertainty in future outcomes by predicting and planning based on current trends (Rožanec et al., 2022; UNDP, 2022).	Constructs scenarios that explore a range of futures. Embraces uncertainty as a source of learning and awareness, helping to manage vulnerabilities and navigate multiple scenarios (Rožanec et al., 2022; UNDP, 2022).
<b>Decision-Making support</b>	Provides tools for specific predictions, helping to plan and foresee what is likely to happen (UNDP, 2022).	Offers tools to navigate uncertainties, make informed decisions for the future, and consider multiple scenarios and potential outcomes (UNDP, 2022; Hopkins and Zapata, 2007).

## 2.2 Methodologies and Theoretical Frameworks

In exploring Strategic Foresight Analysis, researchers and practitioners have developed a diverse array of methodologies and frameworks to enhance understanding and anticipation of the future (Table 2). These approaches aim to provide structured and systematic means of examining emerging trends, analyzing potential future conditions and their implications, and ultimately informing decision-making processes.



**Table 2.** Selected foresight methodology frameworks and relative steps.

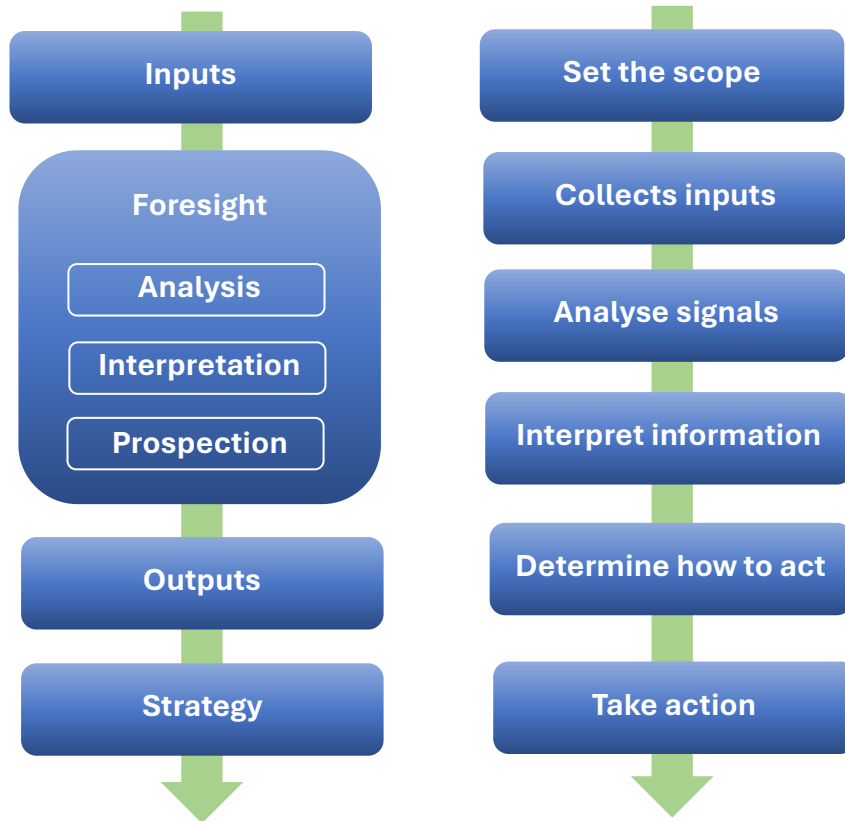
Foresight Frameworks	UNDP Foresight Manual (2018)	Voros et al. (2003)	Cook et al. (2014)	UNDO Adaptive foresight approach (2018)
<b>Method</b>	Outlines a Strategic Foresight Analysis framework composed of four phases, which was built on Voros's (2003) approach.	First detailed framework for the application of the Strategic foresight analysis, which explains in details the three steps that make up the foresight phase itself.	Alternative six-stage framework.	Defines a comprehensive adaptive foresight approach, involving different levels of participation, consisting of five stages.
<b>Steps</b>	Input: strategic Intelligence	Input	Define the scope	
		Analysis: create order in large quantities of data (using tools such as trend analysis, impact matrices, and other similar analytical techniques)	Collect inputs	Diagnosis: policymakers and experts reflect on the situation of the current system
	Foresight - Analysis - Interpretation - Prospecting	Interpretation: search for deeper intrinsic structures	Analyze the signals	Exploration: building scenarios of possible future evolutions of the system with wider participation of interested parties
		Prospecting: Creating and explicitly examining different visions of alternative futures	Interpret the information	Strategic orientation: policymakers discuss possible strategies (with varying degrees of stakeholder involvement, depending on the context)
	Results: broadening/new perspectives/perceptions or strategic options	Results	Determine how to act	Making choices: opening the public debate to reach the broadest possible consensus
	Strategy: strategic Planning	Strategy	Implement the findings	Implementation and coordination: Selected options are translated into policies

The frameworks by Voros (2003) and Cook (2014) share many similarities but also exhibit differences. The one created by Voros (Figure 1 left) places greater emphasis on the fundamental phases that characterize foresight (analysis, interpretation, and prospection), focusing more on the search for insights and the creation of different possible futures. Differently, the framework by Cook (Figure 1 right) prioritizes the initial stages of scoping and gathering input. These early stages aim to determine the key questions and drivers relevant to



the system studied, emphasizing particular attention to understanding and identifying critical aspects at the beginning of the foresight process.

**Figure 1.** Adaptation of the Framework by Voros (2003) (left figure). Adaptation of the Framework by Cook (2014) (right figure).



UNDP (2018) highlights how, very often, the foresight is only partially designed or implemented, due to the lack of many elements that would be necessary within the generic model. The most incomplete approach, a "Shallow" foresight analysis framework, is also the most common. This is based only on trend analysis and can often turn out to be a simple prediction. Another incomplete approach is the "Narrow" foresight analysis framework. This includes two steps within the foresight phase, using this phase for both in-depth trend analysis and the strategic application of prospecting through scenario development (UNDP, 2018). Among the many foresight frameworks available, each with its strengths and limitations, the most suitable approach should be selected based on each means and objectives, allowing for the creation of original, reflective, and integrative foresight approach (van Asselt et al. 2010; Rulleau et al., 2020). These frameworks suggest a series of tools and actions to be implemented across the different stages, which are defined in the following Section (2.3).

## 2.3 Strategic foresight tools

Strategic foresight analysis encompasses a variety of techniques, differing in the type of data used, ranging from approaches relying on expert input to data-driven methods to develop future



visions. Applications also vary in their focus, with some exploring multiple future scenarios and others targeting specific outcomes. Approaches can be analytical, focusing on problem-solving, or social, aimed at enhancing group interaction (Rogut et al., 2021; Steyaert & Lisoir 2005; UNIDO, 2005).

What is most crucial is to select the tools that best align with the feasibility of implementation and the likelihood of adopting the insights. Several key strategic foresight tools and methods have been explored and the most relevant are summarized in Table 3, providing an overview of each tool's purpose and utility. It includes the category of the tool according to the (UNDP, 2022b, 2022a) classification; the tool's name, a concise definition, and the three key components: “Input” refers to the useful information gathered from other tools; “Output” is what is expected to be produced by using the tool; “Outcome” describes what is expected to be done with the produced outputs. These tools can be applied in isolation, rather than as part of a process of global strategic foresight. However, mixed methods approaches can be more effective and offer numerous benefits by providing a more complete understanding. Combining tools in a complementary manner, depending on the objectives and capacities allows them to reinforce and enhance one another (UNDP, 2022).

**Table 3.** Strategic Foresight tools based on the descriptions made by (Wilkinson & Kupers, 2014; Bengston, 2019; Bengston et al., 2012; Cook et al., 2014; Greenblott et al., 2019; UNDP, 2022a; Voros, 2003), logos from UNDP (2022a). “Input” refers to the useful information gathered from other tools; “Output” is what is expected to be produced by using the tool; “Outcome” describes what is expected to be done with the produced outputs.

Category	Tool	Definition	Input	Output	Outcome
Exploring the future	<b>Driver mapping</b>	Determining the most influential factors shaping system transformation recognizing the driver, the underlying forces that cause changes and generate trends.	STEEP-V (political, ecological, social, technical, economic) or PESTLE (political, environmental, social, technological, economic, legal) framework	A collection of significant drivers influential to the system or focal topic	An understanding of the drivers dividing the critical from the less influential ones and separating external and internal.
	<b>Horizon scanning</b>	Identifying and aggregating early indications of change, or emerging signals that may potentially exert significant impacts when they develop	A systematic search for signals of change	Emerging signals of change (e.g., weak signals, trends, emerging issues, wild cards)	<ul style="list-style-type: none"> <li>• Development of strategic plans and programmes resilient to future changes</li> <li>• Foster understanding of emerging development</li> <li>• Promote formulation of innovative solutions</li> </ul>
	<b>Trend analysis</b>	Analyze data (signals and events) to identify patterns that indicate the directions of change and understand connections (correlations and causations)	Driver mapping; Horizon scanning	Identification of trends and their potential impacts	Inform decision-making with data-driven insights and trend patterns
	<b>Futures wheel</b>	Systematically explore the direct and indirect implications of important trends and events, producing a visual map to better understand them.	Driver mapping; Trend analysis	Visual mapping of trends and events	Support in scenario planning and strategy development
Creating alternate futures	<b>Future triangle</b>	Quick tool to map plausible futures through the interaction of 3 dimensions: forces of change, current trends and drivers, and historical barriers to the change.	Driver Mapping; Horizon Scanning; Trends Analysis; Scenarios	A set of images depicting plausible desired futures, forces driving towards them, and barriers	<ul style="list-style-type: none"> <li>• Mapping of plausible future</li> <li>• Identification of forces driving change</li> <li>• Strategic planning to overcome barriers</li> </ul>
	<b>Scenarios</b>	Description of plausible future states (scenario narratives) based on assumptions about key relationships between drivers of change and trends.	Driver mapping; Trends analysis; Futures Wheel	Scenario narratives (descriptions of the future states)	<ul style="list-style-type: none"> <li>• Awareness of critical assumptions about the future and their alternatives</li> <li>• Understanding dynamics of a system’s evolution, and the options available to decision-makers and different SHs</li> </ul>



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Reimagining the future	<b>Casual layered analysis (CLA)</b>	Deconstruct a preferred future and uncover underlying assumptions to develop novel narratives about the future and guide new policies and strategies.	Scans; Trends; Scenarios	Dominant worldviews, myths and narratives; Reimagined scenarios; New narratives and stories	<ul style="list-style-type: none"> <li>• Deeper understanding of the shaping issues</li> <li>• Insight into designing processes, strategies, policies to deliver sustainable outcomes</li> <li>• Ability to look beyond the surface, address issues and redesign systems from the base</li> </ul>
	<b>Three horizon framework</b>	Tool to challenge current assumptions about the future and explore emerging changes, transition processes and potential timing.	Horizon Scanning, Trends Analysis	Unpacking and challenging assumptions	<ul style="list-style-type: none"> <li>• Identifying the most promising strategies, policies, programmes or innovations in terms of impact</li> </ul>
	<b>Inclusive imaginaries</b>	A collective reflection and imagination process to develop equitable and inclusive future policies that reflect local culture and people's lived experiences.	Community engagement processes; Participatory workshops; Stakeholder interviews	<ul style="list-style-type: none"> <li>• A vision of the future</li> <li>• Reflections on knowledge sources and influences</li> <li>• A map documenting the stages, capacities, and emerging threats</li> </ul>	<ul style="list-style-type: none"> <li>• Acquire diverse perspectives for policy design</li> <li>• Verify trends research or horizon scanning efforts with community perspectives</li> <li>• Identify priority areas for intervention</li> <li>• Chart out strategies and actions towards a program vision</li> </ul>
Transforming the future	<b>Visioning</b>	Process of collaboratively developing a shared vision for the future and focusing on what a successful outcome looks like.	Scenarios; Backcasting	A shared vision	<ul style="list-style-type: none"> <li>• A collective and discussed vision of the future that can guide action and engage all relevant stakeholder</li> </ul>
	<b>Backcasting</b>	Imagining a future where our goals have already been achieved, then working back to identify the key steps and actions that lead to that outcome.	Scenarios; Visioning	<ul style="list-style-type: none"> <li>• The new policies, institutions, main actors and their roles required to realize the vision</li> </ul>	<ul style="list-style-type: none"> <li>• The initial steps of an action plan or roadmap towards the preferred future</li> </ul>
Future-testing strategies	<b>Wind tunnelling</b>	Method to stress-test strategies against a range of alternative future scenarios, to identify the most robust ones and reveal how different contexts can impact the needs of our various SHs	Scenarios; Strategies and current strategic options, frameworks, or plans	A set of ranked strategies based on their suitability across diverse scenarios	<ul style="list-style-type: none"> <li>• Improved flexibility in the design and implementation of policies and projects</li> <li>• Adaptability to pivot when contexts change</li> <li>• More resilient programs, policies and plans</li> </ul>
	<b>Road mapping</b>	Method to chart the combination of steps, actions, strategies, policies, programs, interventions, and resources required to achieve a preferred future vision.	Visioning; Backcasting; Wind tunnelling; 3 Horizons framework	Easy-to-use, comprehensive report incorporating texts, animations, simulations and visuals	<ul style="list-style-type: none"> <li>• Development of a comprehensive action plan</li> <li>• Steps and resources needed identification</li> <li>• Clear understanding of interconnections and gaps</li> </ul>

# 3 Scientometric results: trend and disciplines

To understand the progressive relevance and trend of the application of strategic foresight analysis in the field of coastal environmental sciences, annual scientific production was surveyed.

As shown in Figure 2, the query revealed 304 studies published between 2008 and 2024. No studies related to this specific topic were found before 2008. The number of publications has increased steadily over the last 9 years, reaching a peak in 2023. This trend is also reflected in Google Trends 1data, where a gradual increase in interest for the term “strategic foresight” can be observed from 2008 onwards (Figure 3). This trend highlights the growing interest of the community's scientific expertise in the application of foresight analysis methods to this area of research.

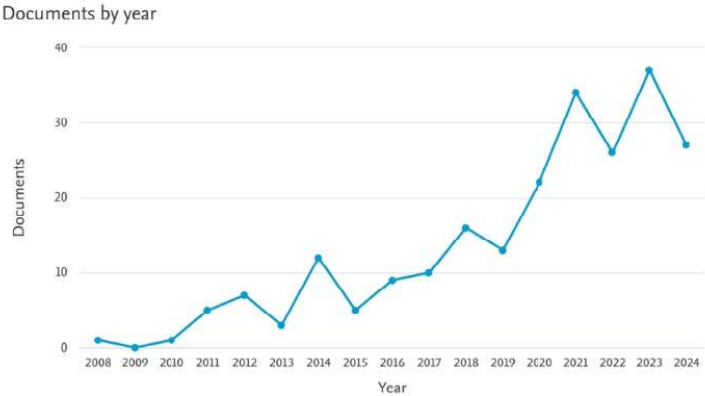


Figure 2. Number of articles coming from the query.

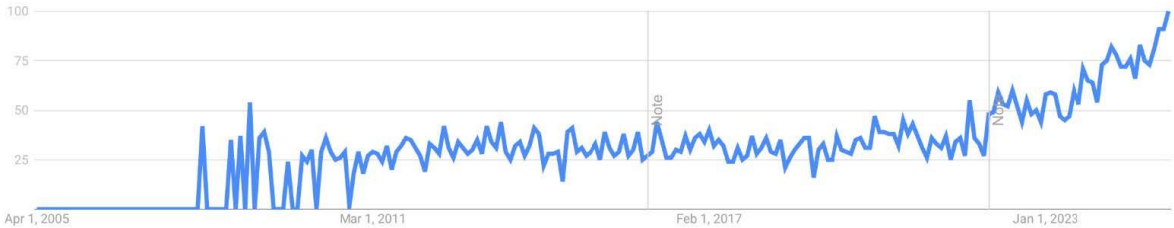
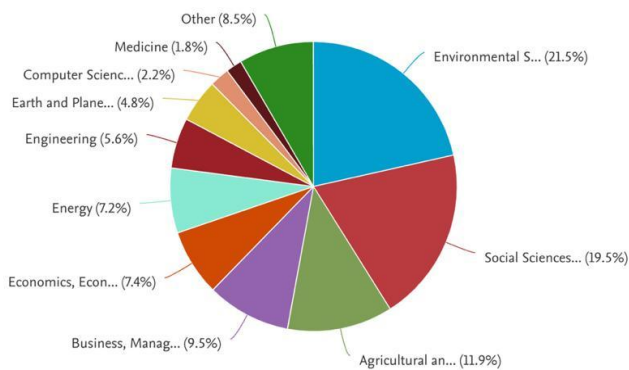


Figure 3. Global interest over time for the term ‘Strategic Foresight’ based on Google Trends data.

The analysis of the most relevant disciplines for these studies on strategic foresight analysis shows a strong interdisciplinarity. As reported in Figure 4, the main disciplinary areas involved are Environmental Sciences, Social science, Agricultural and biological science, and Business Management and Accounting.



Documents by subject area



**Figure 4.** Subject area graph indicating the number of papers published across each discipline in the query.

## 4 Systematic results: insights from key papers

### 4.1 Overview of selected 'key papers'

In Table 4 an extract of the main results of the systematic review is shown. Each row represents an identified key paper, among the 45 selected for their pertinence in the study, detailing the specific topic it addresses. Broad macro-categories (i.e. "Alien Species", "Territorial planning and management", "Climate Change Adaptation", "Socio-ecological Interactions", "Economic and development", "Conservation", "Fish and fisheries") are categorized, and the tools utilized, and the citation are reported. Each macro-category was designed to be aligned with a specific target from the United Nations Sustainable Development Goals (**SDGs**) reported in Agenda 2030 (Nations, 2018), reinforcing the connection between research outcomes and global sustainability objectives. By design, each of these macro-categories is based on relevant SDG targets meaning the review underscores the **importance of integrating strategic foresight into global sustainability efforts**, ensuring that research outcomes are directly applicable to the achievement of these critical international objectives.

From the table it can be underlined that the topics cover a broad spectrum of themes, nevertheless, the **analysis of invasive alien species is the topic most frequently addressed using foresight analysis tools**, as evidenced by a total of 12 articles. These studies explore different segments of the broad topic, from the specific category of freshwater invasive alien species (Caffrey et al. 2014), to more broad categories, taking into account invasive marine and freshwater species, terrestrial invertebrates, vertebrates and plants to calculate their impacts (Roy et al. 2014).



After the category of invasive species, the most addressed topic concerns Territorial planning and management, indicating a proactive approach to ensuring the sustainable use and protection of resources. Then, Climate change adaptation is the theme reflecting the urgent need to address the impacts of climate change on ecosystems. The economic dimensions of coastal management are addressed under the theme of Economics and Development. There's a growing interest in the concept of the "blue economy," which emphasizes the sustainable use of ocean resources for economic growth, as explored by Pace, Borch, et al. (2023) and Pace, Saritas, et al. (2023). The less present categories are Conservation and Fish and Fisheries, with a total of 4 papers each.


**Table 4.** Study areas macro-categories with percentage of key papers and applied strategic foresight tools.

Macro - category in SDGs targets	Topic	Tool	Paper
Alien species SDG Target 15.8 “Reduce the impact of invasive species”  26,7%	Invasive alien species (Freshwater)	Horizon scanning	(Caffrey et al., 2014)
	Invasive alien species (Marine)	Horizon scanning	(Oficialdegui et al., 2023)
		Horizon scanning	(Tsiamis et al., 2020)
	Invasive alien species (Marine, freshwater, terrestrial)	Horizon scanning	(Lucy et al., 2020)
	Invasive alien species (Marine, freshwater, terrestrial, and plants)	Horizon scanning	(Cano-Barbacil et al., 2023)
		Horizon scanning	(Peyton et al., 2020)
	Invasive alien species (Marine, freshwater invertebrates, terrestrial invertebrates, vertebrates and plants) impact	Horizon scanning	(Roy et al., 2014)
	Invasive non-native marine and brackish water species	Horizon scanning	(Clarke et al., 2020)
	Invasive non-native species likely to threaten biodiversity	Horizon scanning	(Hughes et al., 2020)
	Artic aquatic non-indigenous species risk	Horizon scanning	(Goldsmid et al., 2021)
Potential threats from marine invasive alien species	Horizon scanning	(Cottier-Cook et al., 2024)	
Territorial planning and management SDG Target 11.3 “Sustainable urbanization”  17,8%	Potentially invasive non-native marine species	Horizon scanning	(O’shaughnessy et al, 2023)
	Artic marine infrastructures	Horizon scanning	(Gormley et al., 2023)
	Coastal flooding and inundation on the local economy	Scenario planning	(Eaves et al., 2023)
	Landscape planning	Visioning Backcasting Scenario planning	(Roggema, Tillie & Hollanders, 2021)
	Management of the Pacific Crown-of-Thorns Sea Star <i>Acanthaster</i> sp.	Horizon scanning	(Pratchett et al, 2021)
Management for coral reef ecosystem services	Scenario planning	(Rogers et al., 2015)	



	Sustainable land and sea planning	Scenario planning	(Bohnet et al., 2010)
	Water infrastructure planning for nitrogen management	Scenario planning	(Harris-Lovett, Lienert & Sedlak, 2019)
	Wetland governance	The World Café method Scenario planning	(Polajnar Horvat et al., 2022)
Climate change adaptation SDG Target 13.1 “Resilience to climate hazards” 13,3%	Agricultural and water management (use of groundwater, aquifers risk and overexploitation) on climate change adaptation)	Drivers mapping Scenario planning	(Faysse et al., 2014a)
	Climate adaptation in coastal areas	Scenarios planning (in some Drivers mapping and Trend analysis)	(Faysse et al., 2014b)
	Climate change adaptation in coastal areas	Drivers mapping Scenario planning	(Nagy & Gutiérrez, 2018)
	Climate change adaptation for natural resource	Horizon scanning Scenario planning	(Serrao-Neumann et al., 2019)
	Sea level rise	Horizon scanning Visioning Scenario planning	(Wedin & Wikman-Svahn, 2021)
	Arctic Shipping	Scenario planning	(Brigham, 2008)
Socio-ecological interactions SDG Target 15.9 “Integrate ecosystems and social development” 13,3%	Cumulative effects for sustainable seas	Scenario planning	(Davies et al., 2018)
	Ecotourism	Drivers mapping Scenario planning	(Bohensky et al., 2009)
	Regional cumulative effects of future development	Horizon scanning Trend analysis Scenario planning	(Tulloch et al., 2024)
	Ocean science-policy interface	Horizon scanning	(Rudd, 2015)
	Oceans and societies interaction	Horizon scanning	(Lacroix et al., 2016)
Economics and development SDG Target 8.4 “Decouple growth from environmental degradation” 11,1%	Arctic development	Horizon scanning	(Petrov et al., 2021)
	Blue economy	Trend analysis Futures wheel Scenario planning Horizon scanning Trend analysis (narrative)	(Pace, Borch & Deidun, 2023a) (Pace, Saritas & Deidun, 2023b)
	Ocean Sustainable Development	Horizon scanning Drivers mapping Scenario planning Backcasting	(Nash et al., 2022)
	Sustainable development planning	Scenarios planning Trend analysis	(Wyatt et al., 2021)
	Conservation and natural resource management	Horizon scanning	(Weeks & Adams, 2018)
Conservation SDG Target 15.5 “Protecting Biodiversity” 8,9%	Conservation of global biological diversity	Horizon scanning	(Southerland et al., 2009)
	Marine conservation	Horizon scanning	(Parson et al., 2014)
	Marine biodiversity conservation	Drivers mapping Scenario planning Wind tunnelling	(Haward et al., 2013)



Fish and fisheries SDG Target 14.4 “End overfishing and restore stocks” 	Fish and fisheries	Horizon scanning	(Williams, Tibbetts, & Holmes, 2023)
	Fisheries management	Horizon scanning	(Gammage & Jarre, 2021a)
		Scenario planning	
	Migratory fish research	Horizon scanning	(Gammage & Jarre, 2021b)
Scenario planning			
		Drivers mapping	(Lambert et al., 2019)
		Scenario planning	

The studies reviewed used a range of foresight tools, sometimes in combination. It is interesting to note that some tools described previously and in turn described by UNDP (2022b), do not leave the review, showing a great predominance in the use of some of them. The results are presented in Figure 5, where the lines show the frequency of tool usage across the selected key papers. As can be seen, the two most used methodologies were: Horizon Scanning, with a total of 28 applications, and Scenario Planning, with a total of 24.

Another aspect to analyze is how the majority of the articles, for a total of 28, apply only one tool within their methodology, then there are 13 cases in which 2 tools are used, 4 cases with 3 tools, and finally, only 1 case in which 4 different tools are used in succession

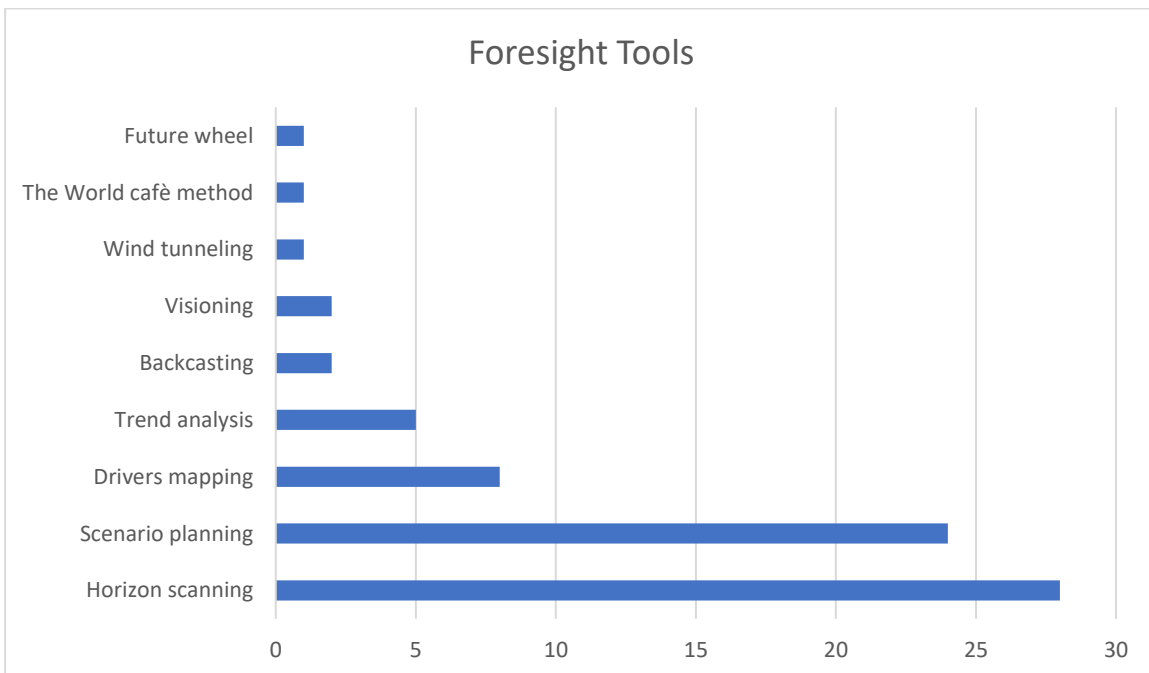
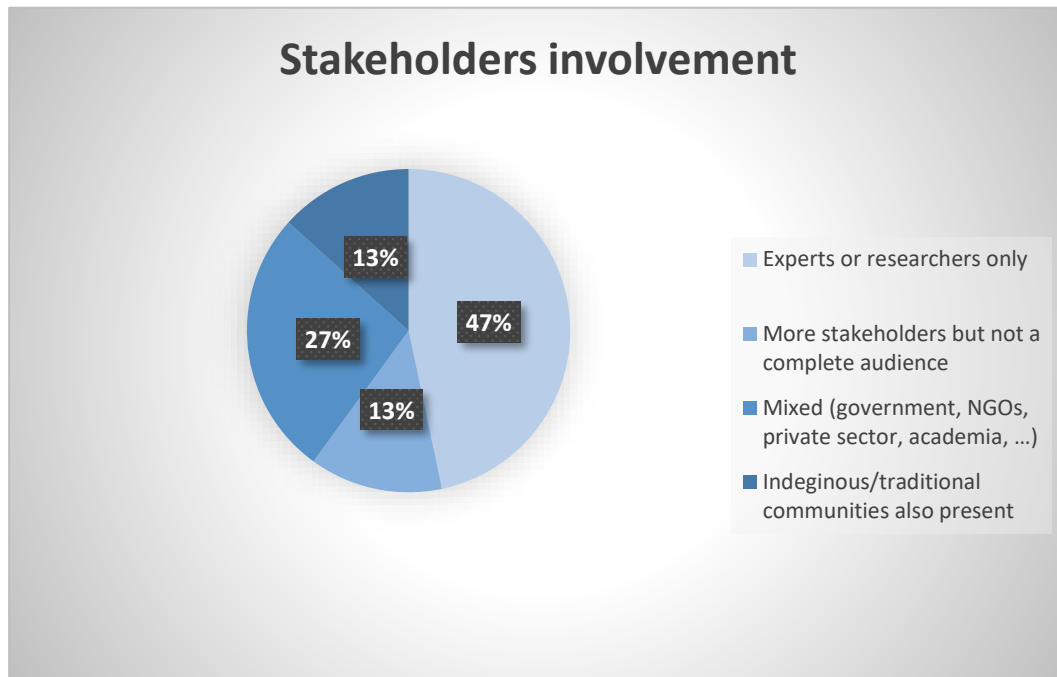


Figure 5. Foresight tools utilized within the selected 45 key papers.

The selected studies involve collaborative processes, aiming to capture and integrate different perspectives and forms of knowledge to inform decision-making and adaptation strategies for coastal environments. However, as represented in Figure 6, within our set of publications, most of the studies analyzed feature only the participation of experts or researchers (21 studies, about 47%). Subsequently, a smaller portion of publications includes a bigger range of SHs, as in the case of (Bohensky et al., 2009) which involves industry representatives, eco-tourism operators, NGOs, thus eliminating the portion of experts or researchers; or in the case of



(Polajnar Horvat et al., 2022) which creates an audience of representatives of interest groups, private businesses, training centres and schools, landowners, higher education and research, and business support organizations, but not involving governance representatives within its strategic foresight processes. It can be noted that the studies involving a mixed audience of SHs (including representatives of government, NGOs, private sector, academia, etc.) amount to a total of 12 and that another 6 case studies also manage to integrate traditional or indigenous communities within the dialogue.



**Figure 6.** Stakeholders involved (n°; %) within the selected 45 key papers.

## 4.2 Relationships between thematic areas, applied tools and stakeholder involvement

The relationships between the topics and the chosen tools are crucial for understanding the main interactions. To investigate this, a Sankey chart was designed, as illustrated in Figure 7. The chart provides a clear representation of the interconnections between topic categories, foresight tools, and audiences, highlighting the most prevalent applications and strongest relationships.

Figure 7 shows that the study of invasive alien species is exclusively addressed using the horizon scanning method, underlying the dominance of this tool. Most of these case studies are implemented following a similar scheme which is organized into 3 main steps: i) Production of preliminary lists of the most important drivers; ii) Prioritization of drivers made by stakeholders, usually through a questionnaire; iii) Consensus approach to validate the results of the previous horizon scanning phase. Sometimes additional steps such as impact assessment are added to



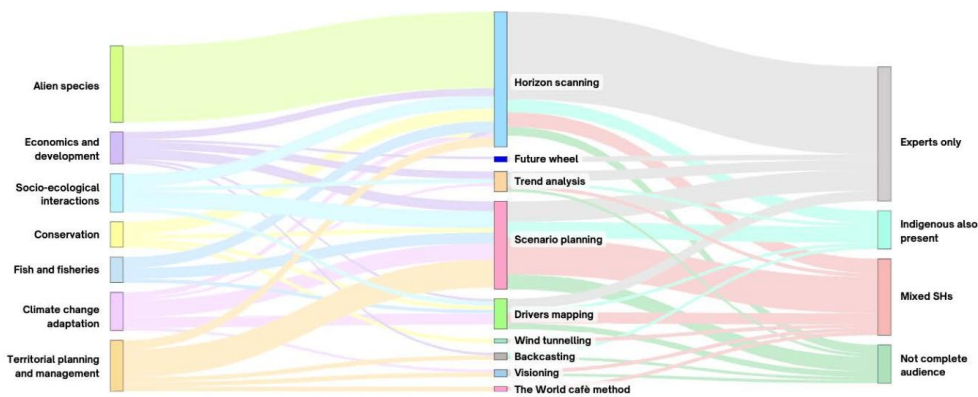
these steps, or a final phase of statistical analysis, which can also include consequent insight analysis.

In this type of case study, the focus is on the monitoring and early warning aspects, so Horizon Scanning lends itself perfectly to quickly emerging threats, while the focus does not appear to be on the actual management of these.

A further example of the correlation between tool and scope of application is the use of the Scenario Planning tool. This tool, as has already been highlighted, is one of the most used within our pool of articles. It is a versatile tool used in all categories, demonstrating its importance in long-term planning, with a strong representation in CC adaptation, Economics and development, and Socio-ecological interactions, and a lack only in the study of Alien species. In particular, the articles that adopt Scenario Planning focus more on two aspects: 1) the analysis of possible futures linked to customer change adaptation and 2) the evaluation of developments regarding planning, management, and the creation of infrastructures. The scenario planning tool is frequently used with a wide range of stakeholders, including indigenous communities.

As regards the analysis of possible futures linked to CC adaptation, this process is often combined with driver mapping to search for the drivers that will shape possible futures. For instance, in Nagy et al. (2018) a mainly narrative work of Vulnerability Reduction Assessment is conducted based on the perception of threats, impacts, vulnerability, uncertainties and scenarios through a Climate drivers' matrix and a Management drivers' matrix, utilizing quantitative data. Driver mapping is also a tool that from the perspective of SHs engagement, has a high representation with Mixed SHs, indicating a common use in contexts that require input from different stakeholders.

A final interesting correlation between the topic covered and the tool used is shown by the fact that the trend analysis tool is not particularly used within the selected key papers, with a balanced presence among the audiences, showing that it is a versatile tool for trend analysis. As regards the macro categories of application, it shows a greater representation among "Economics and development" studies. An example of integrating quantitative trend analysis with other tools in an integrated approach is shown for example in the article by Wyatt et al. (2021) where following phases of participatory mapping and narrative scenario creation, two modelling phases are carried out, first focusing on the habitat risk assessment, for each scenario, and then on the consequent ecosystem services modelling, to give quantitative values to possible futures.



**Figure 7.** Sankey chart connecting the macro categories, utilized tools, and SH involved of the 45 key paper.

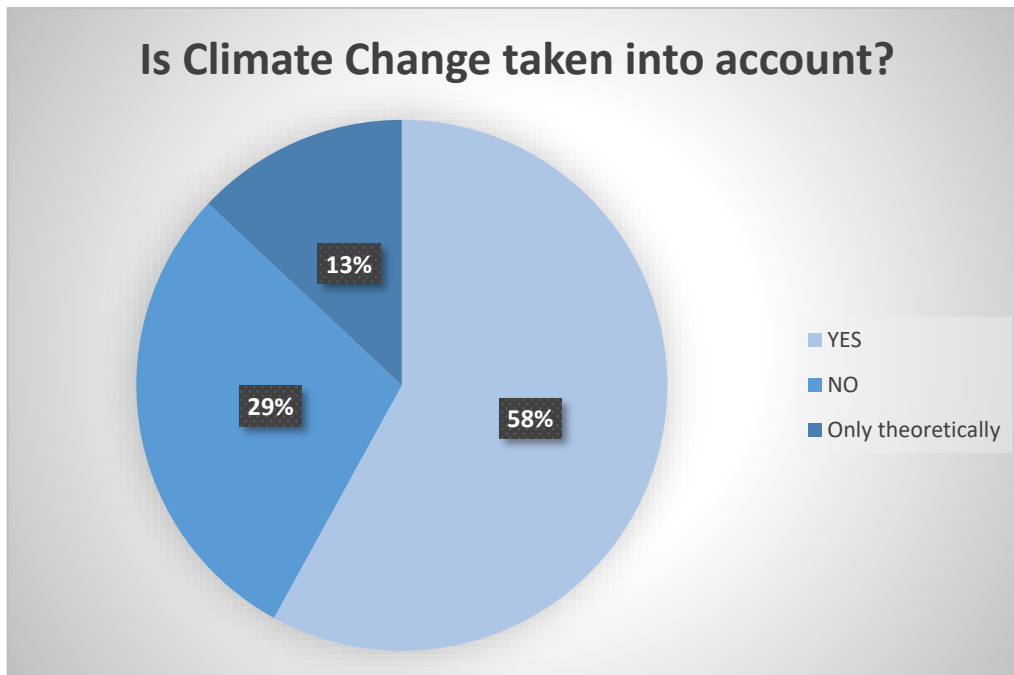
### 4.3 Climate change and management scenarios

The integration of CC considerations within strategic foresight analysis is examined to quantify the inclusion of this aspect into the field of LSI management. Results presented in Figure 8.A, show how this topic is taken into consideration in 58% of the reviewed case studies (for a total of 26 times). It is important to underline how this was done mostly through a narrative representation, while just a couple of examples present an integration of quantitative data and climate models within the assessments and scenario development. An example of an approach to the integration of quantitative CC can be found in Nagy et al. (2018), where the scenarios are based on the integration of stakeholder opinion and data from IPCC AR-5 RCP 4.5 and 8.5 midterm projections. Examples of integration from the qualitative point of CC can be found in Prason et al. (2014), Rudd (2015), Sutherland et al. (2009), and Weeks & Adams (2018). These are four examples of horizon scanning through surveys to identify potentially important research questions (in the context of the ocean science-policy interface as regards Rudd (2015) and conservation as regards the other three). In these cases, the CC is taken into consideration by creating in all cases a separate section within the survey on possible research questions, but no quantitative approach is applied.

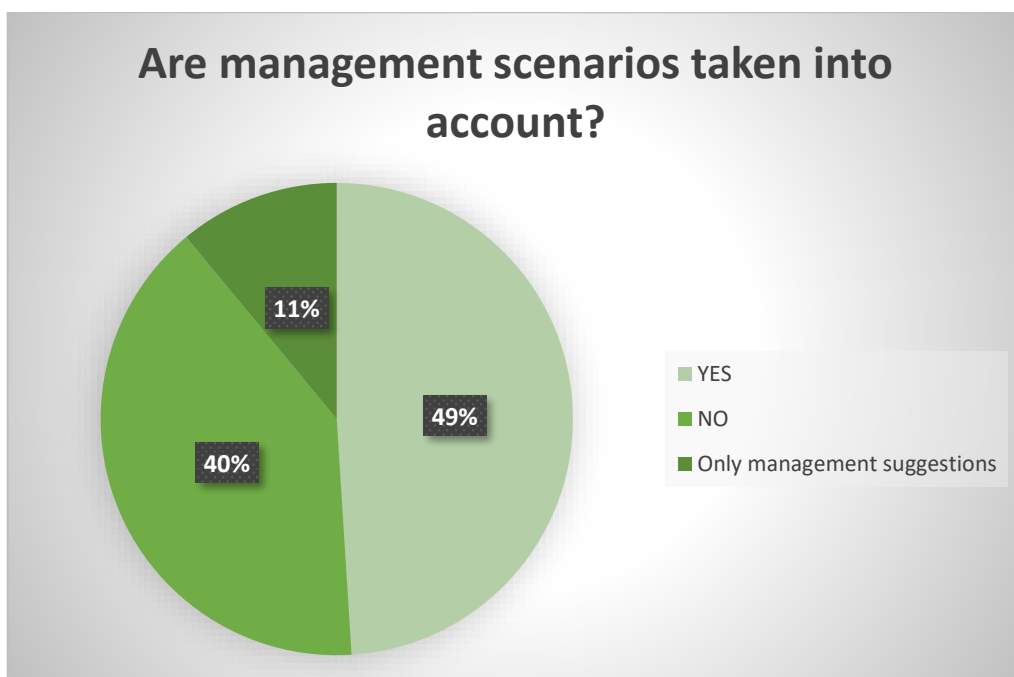
As a final analysis, the presence of management scenarios is also considered (Figure 8.B), highlighting how these are developed, and strategies are evaluated to address environmental challenges. In this case, it was observed that 49% of the publications examined consider management scenarios. The remaining 51% deals with case studies in which the issues analyzed are not explored in their possible variations based on the types of management that could be done. Among these, 11% present management suggestions or underline some problems of the current governance system but without analyzing what the evolutions of a change in the current system could be.



A



B

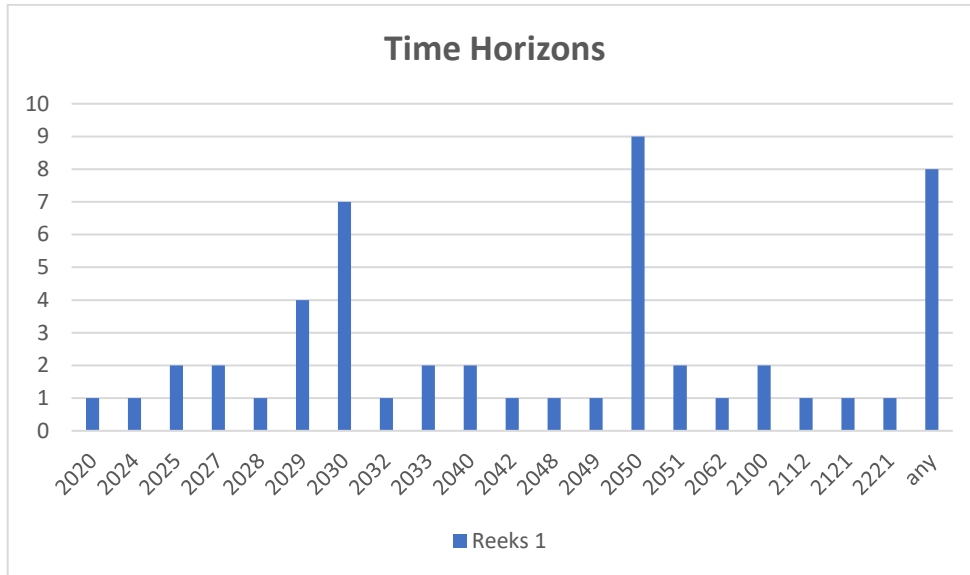


**Figure 8.** Percentage of studies integrating Climate change (8.A) and management scenarios (8.B) within the selected 45 key papers.

The papers analyzed are distinguished by the adoption of different time horizons (Figure 9), highlighting a wide variety of approaches in considering the future. The different time horizons analyzed show a significant heterogeneity, also taking into account that some research focuses on more than one time horizon such as in Eaves et al. (2023). Two main peaks are identified in 2030 and 2050. The first peak is linked to the deadline set for the achievement of the Sustainable



Development Goals of the 2030 Agenda, while the second is frequently used as a temporal reference for medium-term climate analyses. Furthermore, a significant number of articles emerged that do not report any precise temporal reference, this was reported mainly between the horizon scanning approaches, which often privilege the identification of emerging trends and potential future changes without specifying a defined reference period, such as Parson et al. (2014) and Sutherland et al. (2009).



*Figure 9. Percentage of studies for each time horizon within the selected 45 key papers.*

## 5 Discussion

In line with the literature review presented, several key points emerge for reflection on the use of foresight analysis methods in research and planning projects addressing environmental issues, particularly with a focus on coastal ecosystems. These reflections encompass key benefits, innovations, gaps, and challenges in the management of the LSI.

### 5.1 The promising strategic foresight role in land-sea planning

The results of the literature review show that while strategic foresight analysis has long been established in the economic and political domains (Bathke et al., 2022; Kelly et al., 2022) its application in environmental and territorial planning has recently gained traction. The overall trend indicates a growing interest in strategic foresight, while more in detail, publication trends indicate growing interest within the scientific community in using foresight methods to tackle environmental challenges, particularly for their potential to integrate insights from various scientific and social disciplines. Moreover, it is essential to highlight the increasing interest from decision-makers and international institutions in adopting strategic foresight tools for policy-making and governance. This growing trend is particularly evident in multi-stakeholder initiatives



and projects aimed at addressing complex challenges such as climate change, biodiversity loss, and sustainable development.

However, the studies included in this systematic review showcase a gap in the application of strategic foresight to explore in detail the inherent complexity of the LSI and of the interconnected dynamics between land and marine ecosystems.

This gap may stem from challenges in determining the boundaries of these critical areas, and the possible conflicts induced by the multiple social and economic sectors at stake (Faysse, Errahj, et al., 2014; Gammage & Jarre, 2021).

While some land-sea agreements are underway at an institutional level, such as those related to the EU Restoration Law, aimed at promoting integrated land-sea connection (European Union, 2024), coordination between sectors remains insufficient. Therefore, it is clear the need to establish specific sector coordination to harmonies the concept of land-sea integration.

In this respect, strategic foresight could play an extremely significant role in guiding the long-term planning of environmental decisions, particularly for the LSI. It can contribute in several key aspects, including (i) monitoring existing problems; (ii) managing uncertainty by highlighting emerging threats and improving the understanding of emerging risks, challenges, and their potential implications; (iii) promoting the emergence of innovative solutions by identifying the best strategies to address issues; (iv) planning strategically for the future by exploring a broader range of alternative futures; (v) testing the resilience of policies by evaluating existing or proposed strategies against different future scenarios, to improve our ability to adapt and respond to future shocks; (vi) defining a research agenda (Cook et al., 2014; Ednie et al., 2023; UNDP, 2022b). Accordingly, integrating strategic foresight within LSI planning seems crucial to ensure that future policies and actions are informed by a complete and integrated understanding of the overall system.

## 5.2 Challenges and opportunities in expanding tool diversity and integration

The present review highlights that strategic foresight is not based on a single or rigid set of techniques, but rather on numerous types of foresight methods and tools. Accordingly, one of the strengths of the foresight science framework lies in its intrinsic characteristic of multiple tools integration to produce complete and accurate frameworks that can lead to effective sustainable decisions (Cook et al., 2014; Ednie et al., 2023; Kelly et al., 2022).

However, there is a marked trend in literature, toward using single elements or isolated tools: the review results reveal a tendency to primarily use certain tools, e.g. horizon scanning and scenario planning. Horizon scanning approaches tend to exhibit similar steps and processes, such as ranking exercises during workshops and prioritization questionnaires.

Conversely, the use of scenario planning in different thematic contexts reveals a wide range of approaches and activities. These include narrative storylines creation (Bohensky et al., 2011; Haward et al., 2013; Wyatt et al., 2021), innovative creative techniques such as role-plays and drawings (Eaves et al., 2023; Faysse, Errahj, et al., 2014; Nash et al., 2022), and modelling



approaches (Bohnet, 2010; Gammage & Jarre, 2021; Harris-Lovett et al., 2019; Tulloch et al., 2024).

Some studies, such as Tulloch et al. (2024), exemplify how the integration of qualitative and quantitative methodologies can improve the foresight process by combining ecological modelling with community engagement. This example involved predictive models to assess the cumulative impacts of future development scenarios, also integrating indigenous knowledge through structured interviews and focus groups, as better outlined in Box 1. The combination of qualitative and quantitative methodologies allows not only to identify potential future impacts but also to integrate local and contextual knowledge that is crucial for the success of adaptation and mitigation strategies.

**Box 1: Combining cumulative impact assessment and community engagement for integrated foresight Tulloch et al., 2024 “Predicting regional cumulative effects of future development on coastal ecosystems to support Indigenous governance”**

**Addressed issue:**

How industrial development (salmon aquaculture, energy/mining, forestry, tourism) threatens the health of regional ecosystems.

**What was done:**

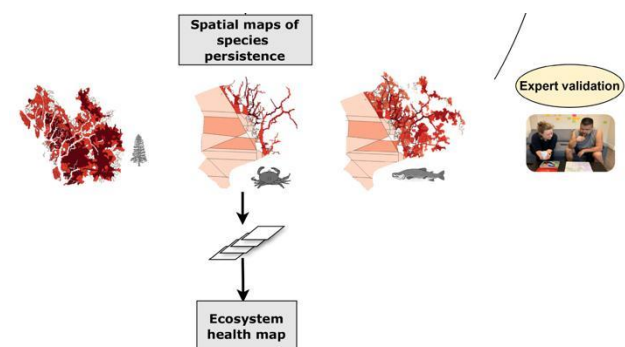
- › Selection of Ecosystem components and development of species and pressures maps
- › Horizon scanning for interaction matrix and single species cumulative impact maps
- › 3Analysis of the megatrend and scenario planning through Bayesian Network: predicting probability of persistence and comparing ecosystem health under different development scenarios

**Stakeholders engagement:**

Indigenous and scientific experts engaged through elicitation workshops, semi-structured interviews, online questionnaires and iterative review of results.

**Key outputs:**

Interaction matrices for Bayesian analyses spatial maps of species persistence and ecosystem health, future development scenarios (ecotourism, renewable resources, intensive development), an interactive online application (Shinyapp), and guidelines for ecosystem management



**Figure 10.** Adapted from Tulloch et al. (2024)



From these insights, a key challenge identified within the review is that many foresight tools mentioned, including those recommended by international frameworks such as UNDP (2022b) appear underutilized in scientific studies (e.g., Backcasting and Road Mapping). Although the results obtained from this literature review encompass a wide range of topics and goals, as shown in Table 4, it is important to note that the tools discussed in scientific papers indexed in Scopus, may differ from those applied in grey literature or in actual planning and policy-making processes. Notably, the case study by Roggema et al., 2021, described in Box 2, uses visioning and backcasting to explore the future and the needed stages and steps for developing an adaptive future landscape.

While the scientific focus often emphasizes the proven effectiveness of specific methods, this approach limits the exploration of combinations and variations that could provide new insights for planners and decisionmakers. By incorporating and investigating these under-utilized tools, foresight processes can become more valuable, serving as a dynamic resource that benefits from structured and flexible approaches. This will enable the full potential of strategic foresight to be exploited for comparing alternative futures, mapping potential pathways and setting milestones that align with long-term goals.

#### **Box 2: Use of non-common tools for land-sea interface adaptation pathways.**

*Roggema et al., 2021: "Designing the adaptive landscape: Leapfrogging stacked vulnerabilities"*

##### **Addressed issue:**

The complex interplay between sea level rise, salinity, the risk of flooding and unsustainable freshwater-dependent agriculture, and loss of biodiversity, soil subsidence as a result of gas extractions, declining economic and social wellbeing.

##### **What was done:**

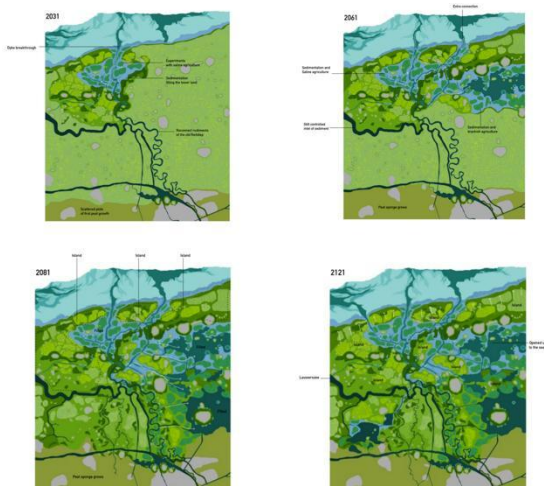
- › Envisioning future of agricultural systems, climate change, and ecology in a 100 year horizon
- › Planning an integrated spatial future of the landscape adaptation
- › Designing a staged process of implementing an adaptive future landscape using a backcasting approach, and designing thematic implications of different interventions for food, ecology, and safety.

##### **Stakeholders engagement:**

Collaborative workshops with collective design sessions and innovative approaches, and iterative evaluations of proposals through analytical reflections.

##### **Key outputs:**

Creation of a dynamic resilient landscape scenario aimed at enhancing biodiversity through a saline-fresh ecological gradient. It also resulted in a project structured in stages (2031 - 2061 - 2091 - 2121) with gradual reintroduction of saltwater, creation of agricultural land, and development of new ecological habitats and natural safety systems.



*Figure 11. Stages plan from Roggema et al. (2021)*

### 5.3 The climate change view: science-based and narrative approaches

Given the impacts which climate change is already causing and aware of the broad spectrum of available scenarios (Pörtner et al., 2022), it is crucial to be able to manage the LSI with a forward-looking perspective. For this reason, foresight seems to take on particular significance, as a tool for connecting different perspectives and sectors, fostering a more complete understanding of complex climate change challenges. Moreover, the large number of climate change-related data available today is a great resource also for planning. Incorporating large-scale data and predictive models into strategic foresight analysis gives the opportunities to go beyond narrative scenarios and provide valuable insights into potential future dynamics and risks of the LSI. A relevant example of integrating quantitative climate change data is described by Nagy et al. (2018) (Box 3), where the development of scenarios combines stakeholder input with data derived from IPCC AR-5 RCP 4.5 and 8.5 midterm projections.



### Box 3: Assessing threats on LSI socio-ecological systems to create strategic agendas *Nagy & Gutiérrez, 2018: "Scenario Planning Toward Climate Adaptation: the Uruguayan Coast"*

#### Addressed issue:

Threats posed by climate change and variability to coastal socio-environmental systems in Uruguay.

#### What was done:

- › Vulnerability Reduction Assessment (VRA) aimed at understanding perceptions of threats, impacts, vulnerabilities, and uncertainties among stakeholders
- › Scenario Planning combining top-down climate models with bottom-up stakeholder perceptions to develop plausible future scenarios and pathways for adaptation
- › Climate Drivers' Matrix & Management Drivers' Matrix tools employed to systematically assess how various drivers impact socio-environmental systems and identify potential responses

#### Stakeholders engagement:

Natural and social science experts, stakeholders, local managers, and community members engaged through workshops, interviews, focus group discussions, and brainstorming sessions.

#### Key outputs:

Scenarios for 2030–2050, which informed the creation of a strategic agenda for enhancing coastal resilience and climate adaptation planning in Uruguay.

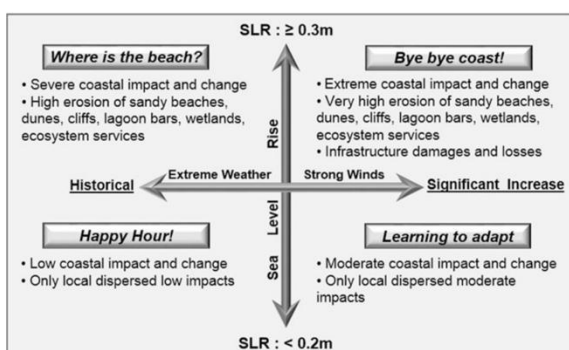


Figure 12. Scenarios from Nagy & Gutiérrez (2018)

Advanced tools and strategies, such as artificial intelligence, can streamline data collection, trend modelling, scenarios development, and smart decision support systems. This automation can reduce the time and effort required, improve the accuracy and relevance of foresight analysis, and enhance the understanding of environmental risks and drivers of change (Ednie et al., 2023; Kelly et al., 2022; Scoville et al., 2021).



However, it is essential to highlight how relevant data is often inaccessible or accompanied by insufficient metadata or lack of clarity regarding its structure and provenance, making it difficult to integrate into decisionmaking processes. Additionally, available dashboards tend to have limited functionality, and structured tools to facilitate data comparison and effective use are generally lacking. Ensuring accessible and transparent data systems is crucial to improving strategic foresight efforts. The development of structured systems would facilitate seamless data access, enabling effective connections between theoretical studies and the creation of concrete policies and actions.

Furthermore, promoting the use of digital tools beyond academic research, such as in hands-on activities like these or hackathons, could serve as valuable methods to test the robustness of these tools, and improve their applicability in real-world settings.

From the review findings, it seems promising that more than half of the key papers consider climate change into account. However, most of these studies only consider climate change just from a qualitative perspective, without showing quantitative trends or assessments. The studied papers tend to rely heavily on stakeholder choices with a paucity of numerically robust science-based approaches. As highlighted in Section 3.4 and shown in approaches such as those of Faysse, Errahj et al. (2014), Harris-Lovett et al. (2019) and Weeks & Adams (2018), which analysis focuses more on stakeholder involvement and the design of participatory processes, with an emphasis on qualitative approaches to evaluating future options.

The choice to focus on a qualitative approach may have been connected to several reasons but multiple factors may contribute to this, including the inaccessibility of crucial knowledge, such as limited access to relevant databases, or the potential loss of information within organizational archives.

In addition, capacity limitations, including insufficient time, financial resources, and specialized skills, as well as a lack of administrative capacity, particularly at the local level, further hinder the development and implementation of science-based foresight approaches (Ednie et al., 2023; Kermorvant et al., 2019; Legg & c, 2006; Miller et al., 2020). In this context, the integration of megatrends analysis using open access data in scenario building could be a way to guarantee innovation and establish an effective interface between science, politics, and society, giving the possibility to compare the expected and stakeholders' desirable scenarios.

## 5.4 The contrasting role of stakeholder engagement

The literature highlights the role of stakeholder involvement in strategic foresight analysis, showing how through participatory methods, policymakers and stakeholders in general can be directly involved in evaluating possible futures and therefore be in a better position to help shape the future, and adapt to changing conditions (Kok et al., 2007). Although strategic foresight analysis does not inherently depend on stakeholder involvement in all its stages and it is not itself a prerequisite for effectiveness (OECD, 2019; UNDP Global Centre for Public Service Excellence, 2018), it is recognized that engaging diverse perspectives can improve the foresight



process and highlights the need to facilitate inclusion throughout various stages, from the planning phase to the implementation of workshops (Faysse, Rinaudo, et al., 2014; Gumucio & Rueda, 2015). This inclusive approach promotes more effective decision-making by ensuring alignment between the needs of end users and the goals of research or implementation (Kelly et al., 2022; Kunkel et al., 2016; Nguyen et al., 2023).

To cite some examples, to understand how stakeholders were engaged in the foresight processes, the Brigham Arctic Shipping study (Brigham et al., 2008) included several public meetings for initial consultations; however, the actual scenario-building was outsourced to an external consultancy, with stakeholder involvement limited to the preliminary phase (as described in Box 4). Differently, Lucy et al. (2020) took an approach that involved direct and intensive stakeholder engagement during the operational phase of the process, from prioritization of invasive species to scenario generation. This type of participation, although targeted, was limited in time. Finally, Wedin and Wikman-Svahn (2021) implemented a comprehensive and continuous approach, actively involving stakeholders such as representatives of municipalities, technical institutions, environmental management bodies, and regional authorities. These actors participated intensively throughout all process phases, from defining the focal scenario question to creating the scenario itself, to identifying and discussing in detail the ethical values relevant to adaptation to sea level rise.

**Box 4: Multi-stakeholder engagement structured around different goal-oriented steps** *Brigham et al., 2008: "Arctic Shipping Scenarios and Coastal State Challenges"*

**Addressed issue:**

Increase marine access and resource exploitation in the Arctic due to sea ice retreat and climate change.

**What was done:**

- › Analysis of the current Arctic marine use, assessing ongoing marine activities to establish a baseline for future analysis
- › Workshops for scenario development and maritime incident response: Scenario planning was employed to frame six potential matrices
- › Workshop on Arctic marine incidents: Stakeholder discussions to identifying critical uncertainties and challenges related to maritime safety and infrastructure.

**Stakeholder engagement:**

Engagement of Arctic states, indigenous residents, global maritime industry, and international experts through workshops and strategic discussions.

**Key outputs:**

Creation of four scenarios for Arctic navigation (Arctic Race, Arctic Saga, Polar Lows, Polar Preserve), along with identification of infrastructure gaps and recommendations for improved governance and safety regulations.

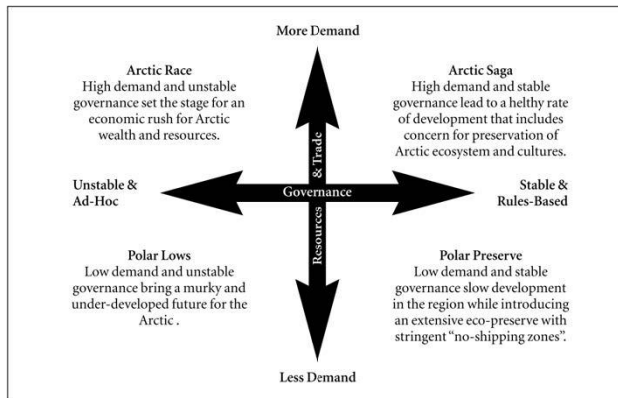


Figure 13. Scenarios from Brigham et al. (2008)

Even if grey literature suggests that there is increasing recognition of the importance of including a wider range of stakeholders (Amanatidou, 2017), review results show that in the academic application of strategic foresight analysis within the LSI context, engagement tends to be limited to experts and researchers, often excluding community members or Indigenous populations, and current directives, such as Marine Spatial Planning, frequently fail to adequately local knowledge, contributing to a non-completely equitable decision-making procedure within marine governance (Abdel-fattah et al., 2024; Papageorgiou et al., 2024; Rivers et al., 2023). Achieving broad participation from a diverse group of stakeholders is inherently complex, often involving tensions in managing conflicting viewpoints and balancing expert and non-expert knowledge (Amanatidou, 2017; van Hoof et al., 2014). This tension is rooted in the different ways stakeholders perceive and prioritize issues: experts may focus on technical rigour and evidence-based solutions, while other types of stakeholders, such as community members, might emphasize local knowledge, cultural values, or immediate socioeconomic concerns. The challenge of integrating scientific data with stakeholder opinions underscores a broader difficulty in harmonizing ecology with the social dimensions (Petrov et al., 2021). It is important to highlight that the analysis of weak signals and early indicators of change, such as for invasive species, is a highly specialized task requiring in-depth knowledge in specific fields (e.g., potential threats from invasive alien species), emphasizing the technical nature of foresight tasks that identify potential threats and inform timely action, in which non-expert stakeholders may have a limited understanding. This is evident in Roy et al., 2014 (Box 5), where an iterative consensus approach has been applied to gather expert judgement for prioritizing invasive alien species risk and possible management strategies.



**Box 5: Iterative consensus-building foresight focused on expert judgement**  
*Roy et al., 2014: “Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain”*

**Addressed issue:**

The significant threat posed by Invasive Alien Species (IAS) to biodiversity, particularly when these species interact with other environmental change drivers.

**What was done:**

- › Horizon scanning through preliminary consultation to derive ranked lists of potential IAS
- › Consensus-building through cross-group discussions to compile and rank a comprehensive list of IAS based on risk of arrival, establishment, and impact
- › Species risk categorization and list evaluation

**Stakeholders engagement:**

Collaborative research with input from multiple expert groups; a consensus method to prioritize species based on different risks; workshops and expert feedback through insights and comments.

**Key outputs:**

A ranked list of IAS, recommendations for managing IAS introduction pathways, and a framework for prioritizing IAS for management and policy interventions, with potential global applicability.

Expert group	Number of species considered during preliminary consultation	Number of species considered during consensus-building	Number of species within top 30
Plants	113	74	4
Freshwater invertebrates	41	32	5
Marine species	59	52	8
Vertebrates	335	60	7
Terrestrial invertebrates	43	27	6
Total	591	245	30

**Figure 14.** IAS selection from Roy et al. (2014)

In other contexts, incorporating diverse perspectives on existing norms and future scenarios allows for valuable comparisons between literature and real-world perceptions, fostering a shared understanding of the challenges communities face, addressing informational gaps, and enhancing the legitimacy of the foresight process, (Kok et al., 2007; Carlsson-Kanyama et al., 2008; Serrao-Neumann et al., 2019).

Lack of connections between actors with different expertise and priorities can result in “band-aid” interventions that are not sustainable in the long term. For example, post-storm interventions often focus on immediate recovery efforts rather than addressing underlying vulnerabilities or integrating local knowledge into broader resilience strategies. This approach can lead to short-term solutions that fail to address deeper structural issues or promote long-term sustainability.

Furthermore, stakeholder fatigue can be a limiting factor in achieving broad outcomes through participatory processes. While simply initiating conversations between experts and participants



to apply foresight approaches is valuable, it may not always reach the level of academic coherence desired by the process (Amoah et al., 2022).

To address these challenges, several strategies can be employed, such as promoting joint design and knowledge production, creating multidisciplinary and transdisciplinary platforms, developing participatory decision support systems, implementing adaptive evaluation methodologies, and strengthening capacities through shared training programs (Gourguet et al., 2021; Vineis et al., 2025)

Concrete strategies to enhance participation include organizing tailored workshops designed specifically for local communities, employing interactive approaches such as role-playing exercises to explore scenarios, and using digital tools that allow for real-time feedback and collaborative decision-making.

Furthermore, it is essential to recognize the importance of incorporating sex-disaggregated data and adopting gender-sensitive approaches, as they are crucial for capturing territorial complexities, contrasts, and complementarities in resilience efforts aimed at both women and men.

## 6. Conclusions

This document explores the use of strategic foresight in LSI, emphasizing its crucial role in addressing climate and environmental challenges, fostering interdisciplinary collaboration and supporting adaptive and integrated land-sea governance, to create new policies that are co-designed based on actor perspectives and scientific evidence.

The strategic dimension of foresight raises the question of the adequacy of their development within the framework of LSI governance processes. If in the usual definitions, the question of strategic foresight is based on the development of visions of the future, it would be interesting to continue this analysis to ask: what is strategic? for whom? why?

Similarly, if the development of visions of the future makes it possible to propose developments of the LSI studied, a complementary approach would consist of developing scenarios (backcasting, for example) in terms of actions to be taken to achieve the selected objectives. In both cases, the mobilization of stakeholders could be carried out to inform, raise awareness, analyze the adequacy of such visions and/or actions based on scientific and non-scientific knowledge, and assess their acceptability.

The question of strategy should then be part of a multi-actor governance process in which the future of LSIs would be discussed (in particular through the mobilization of a variety of tools to consider the evolution of interconnected dynamics between terrestrial and marine ecosystems) as well as the way of defining the strategy, in the sense of choosing the actions that would be carried out to respond to the sustainability issues of LSIs while taking into account social demands.

Strategic foresight has the potential to advance landscape conservation and restoration efforts, particularly in the context of climate change adaptation. By bringing people together to discuss these topics, strategic foresight can enable them to shed light on their strengths and



weaknesses, guiding collective action to strengthen resilience at multiple levels. This highlights the critical role citizen science will play in the coming decades to improve adaptive capacity, bring valuable local knowledge, and contribute to monitoring and response efforts.

However, it is important to highlight that the framework currently lacks a comprehensive system to monitor future projections and scenarios. The future is never linear and it is essential to identify planning limitations, study potential failures, and maintain focus on critical issues. Given the extensive literature already available, future planning strategies should build on this to directly influence practices, ensuring that foresight processes will inform decision-making. This gives the opportunity to bridge the gap between theoretical insights and applicative planning strategies. In this frame, a new level of governance could be enhanced through the use of advanced, technical, and scientific tools (i.e. e-tools).

Finally, forthcoming research should focus on foresight analysis of long-term impacts in empowering societies to navigate, adapt and shape the future. This will lead policymakers to take advantage of it, as a support for better anticipation, policy innovation and futureproofing.

## Bibliography

- Abdel-fattah, D., Wester, M., Martins, I., Ramos, S., & Kleiven, S. K. (2024). *Developing Equitable Maritime Spatial Planning in the EU : Case Studies from Portugal and Norway*. 99–109.
- Albrechts L. (2018) “Strategic planning. Ontological and Epistemological challenges”, in Gunder M., Madanipour A. and Watson V. (Eds.) *The Routledge Handbook of Planning Theory*, Routledge, London and New York, pp. 28-40.
- 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(May 2014), 381–409.  
<https://doi.org/10.1146/annurev-ecolsys-102209-144702>
- Amanatidou, E. (2017). “Foresight process impacts: Beyond any official targets, foresight is bound to serve democracy.” *Futures*, 85, 1–13.  
<https://doi.org/10.1016/j.futures.2016.11.003>
- Amoah, C., Buertey, J. T., Ayarkwa, J., & Adinyira, E. (2022). Stakeholder fatigue in participatory processes: Causes, impacts, and management strategies. *Engineering, Construction and Architectural Management*, 29(7), 2929–2950. <https://doi.org/10.1108/ECAM-08-2021-0746>
- Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, 1(1), 377–386. [https://doi.org/10.1162/qss\\_a\\_00019](https://doi.org/10.1162/qss_a_00019)
- Bathke, H., Munch, C., von der Gracht, H. A., & Hartmann, E. (2022). Building Resilience Through Foresight: The Case of Maritime Container Shipping Firms. *IEEE Transactions on Engineering Management*, 1–23. <https://doi.org/10.1109/TEM.2021.3137009>



- Battistella, C., & De Toni, A. F. (2022). Towards a foresight governance system: the case of the port system authority of Trieste. *2022 7th International Conference on Smart and Sustainable Technologies, SpliTech 2022*, 1–4.  
<https://doi.org/10.23919/SpliTech55088.2022.9854348>
- Bengston, D. N. (2019). Futures Research Methods and Applications in Natural Resources. *Society and Natural Resources*, 32(10), 1099–1113.  
<https://doi.org/10.1080/08941920.2018.1547852>
- Bengston, D. N., Kubik, G. H., & Bishop, P. C. (2012). Strengthening environmental foresight: Potential contributions of futures research. *Ecology and Society*, 17(2).  
<https://doi.org/10.5751/ES-04794-170210>
- Biggs, R., Schlüter, M., Biggs, D., Bohensky, E. L., Burnsilver, S., Cundill, G., Dakos, V., Daw, T. M., Evans, L. S., Kotschy, K., Leitch, A. M., Meek, C., Quinlan, A., Raudsepp-Hearne, C., Robards, M. D., Schoon, M. L., Schultz, L., & West, P. C. (2012). Toward principles for enhancing the resilience of ecosystem services. *Annual Review of Environment and Resources*, 37, 421–448. <https://doi.org/10.1146/ANNUREV-ENVIRON-051211-123836>
- Bohensky, E. L., Butler, J. R. A., & Mitchell, D. (2011). Scenarios for Knowledge Integration: Exploring Ecotourism Futures in Milne Bay, Papua New Guinea. *Journal of Marine Biology*, 2011, 1–11. <https://doi.org/10.1155/2011/504651>
- Bohnet, I. C. (2010). Integrating social and ecological knowledge for planning sustainable land- and sea-scapes: Experiences from the Great Barrier Reef region, Australia. *Landscape Ecology*, 25(8), 1201–1218. <https://doi.org/10.1007/s10980-010-9504-z>
- Briggs, C. M. (2010). Environmental security and strategic foresight: Risks and opportunities for national security planning. *Technological Forecasting and Social Change*, 77(9), 1448–1455. <https://doi.org/10.1016/j.techfore.2009.12.001>
- Brigham, L. W. (2008). Arctic shipping scenarios and coastal state challenges. *WMU Journal of Maritime Affairs*, 7(2), 477–484. <https://doi.org/10.1007/BF03195146>
- Caffrey, J. M., Baars, J. R., Barbour, J. H., Boets, P., Boon, P., Davenport, K., Dick, J. T. A., Early, J., Edsman, L., Gallagher, C., Gross, J., Heinimaa, P., Horrill, C., Hudin, S., Hulme, P. E., Hynes, S., Macisaac, H. J., McLoone, P., Millane, M., ... Lucy, F. E. (2014). Tackling invasive alien species in Europe: The top 20 issues. *Management of Biological Invasions*, 5(1), 1–20.  
<https://doi.org/10.3391/mbi.2014.5.1.01>
- Cano-Barbacid, C., Carrete, M., Castro-Díez, P., Delibes-Mateos, M., Jaques, J. A., López-Darias, M., Nogales, M., Pino, J., Ros, M., Traveset, A., Turon, X., Vilà, M., Altamirano, M., Álvarez, I., Arias, A., Boix, D., Cabido, C., Cacabelos, E., Cobo, F., ... García-Berthou, E. (2023). Identification of potential invasive alien species in Spain through horizon scanning. *Journal of Environmental Management*, 345. <https://doi.org/10.1016/j.jenvman.2023.118696>
- Carlsson-Kanyama, A., Dreborg, K. H., Moll, H. C., & Padovan, D. (2008). Participative backcasting: A tool for involving stakeholders in local sustainability planning. *Futures*, 40(1), 34–46. <https://doi.org/10.1016/j.futures.2007.06.001>
- Cavaciuti-Wishart, E., Heading, S., Kohler, K., & Saadia, Z. (2024). Global Risks Report 2024. In *World economic forum*.  
[https://www3.weforum.org/docs/WEF\\_The\\_Global\\_Risks\\_Report\\_2024.pdf](https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2024.pdf)



- Clarke, S. A., Vilizzi, L., Lee, L., Wood, L. E., Cowie, W. J., Burt, J. A., Mamiit, R. J. E., Ali, H., Davison, P. I., Fenwick, G. V., Harmer, R., Skóra, M. E., Kozic, S., Aislabie, L. R., Kennerley, A., Le Quesne, W. J. F., Copp, G. H., & Stebbing, P. D. (2020). Identifying potentially invasive non-native marine and brackish water species for the Arabian Gulf and Sea of Oman. *Global Change Biology*, 26(4), 2081–2092. <https://doi.org/10.1111/gcb.14964>
- Cook, C. N., Inayatullah, S., Burgman, M. A., Sutherland, W. J., & Wintle, B. A. (2014). Strategic foresight: How planning for the unpredictable can improve environmental decision-making. *Trends in Ecology and Evolution*, 29(9), 531–541. <https://doi.org/10.1016/j.tree.2014.07.005>
- Cottier-Cook, E. J., Bentley-Abbot, J., Cottier, F. R., Minchin, D., Olenin, S., & Renaud, P. E. (2024). Horizon scanning of potential threats to high-Arctic biodiversity, human health and the economy from marine invasive alien species: A Svalbard case study. *Global Change Biology*, 30(1). <https://doi.org/10.1111/gcb.17009>
- Davies, K., Fisher, K., Foley, M., Greenaway, A., Hewitt, J., Le Heron, R., Mikaere, H., Ratana, K., Spiers, R., & Lundquist, C. (2018). Navigating collaborative networks and cumulative effects for Sustainable Seas. *Environmental Science and Policy*, 83, 22–32. <https://doi.org/10.1016/j.envsci.2018.01.013>
- Eaves, A., Kench, P., McDonald, G., Dickson, M., & Storey, B. (2023). Modelling economic risk to sea-level rise and storms at the coastal margin. *Journal of Flood Risk Management*. <https://doi.org/10.1111/jfr3.12903>
- Ednie, G., Kapoor, T., Koppel, O., Piczak, M. L., Reid, J. L., Murdoch, A. D., Cook, C. N., Sutherland, W. J., & Cooke, S. J. (2023). Foresight science in conservation: Tools, barriers, and mainstreaming opportunities. *Ambio*, 52(2), 411–424. <https://doi.org/10.1007/s13280-022-01786-0>
- European Union. (2024). Regulation (EU) 2024/1991 of the European Parliament and of the Council of 11 December 2024 on nature restoration. Official Journal of the European Union, L 199, 12 December 2024, pp. 1–45. Retrieved from <https://eur-lex.europa.eu/eli/reg/2024/1991/oj>
- Faysse, N., Errahj, M., Imache, A., Kemmoun, H., & Labbaci, T. (2014). Paving the Way for Social Learning When Governance Is Weak: Supporting Dialogue Between Stakeholders to Face a Groundwater Crisis in Morocco. *Society and Natural Resources*, 27(3), 249 – 264. <https://doi.org/10.1080/08941920.2013.847998>
- Faysse, N., Rinaudo, J. D., Bento, S., Richard-Ferroudji, A., Errahj, M., Varanda, M., Imache, A., Dionnet, M., Rollin, D., Garin, P., Kuper, M., Maton, L., & Montginoul, M. (2014). Participatory analysis for adaptation to climate change in Mediterranean agricultural systems: Possible choices in process design. *Regional Environmental Change*, 14(SUPPL.1), 57–70. <https://doi.org/10.1007/s10113-012-0362-x>
- Gammage, L. C., & Jarre, A. (2021). Scenario-Based Approaches to Change Management in Fisheries Can Address Challenges With Scale and Support the Implementation of an Ecosystem Approach to Fisheries Management. *Frontiers in Marine Science*, 8. <https://doi.org/10.3389/fmars.2021.600150>



- Gammage, L. C., Jarre, A., & Mather, C. (2021). Failing to plan is planning to fail: lessons learned from a small- scale scenario planning process with marginalized fishers from South Africa's southern Cape. *Ecology and Society*, 26(4). <https://doi.org/10.5751/ES-12886-260432>
- Georghiou, L., Cassingena, J., Keenan, M., Miles, I., Popper, R., & Elgar, E. (2011). *The Handbook of Technology Foresight Concepts and Practice PRIME SERIES ON RESEARCH AND INNOVATION POLICY*. <https://www.e-elgar.com/shop/usd/the-handbook-of-technology-foresight-9781848448100.html>
- Goldsmith, J., McKindsey, C. W., Stewart, D. B., & Howland, K. L. (2021). Screening for High-Risk Marine Invaders in the Hudson Bay Region, Canadian Arctic. *Frontiers in Ecology and Evolution*, 9. <https://doi.org/10.3389/fevo.2021.627497>
- Gormley, K., Hague, E., Andvik, C., DaCosta, V., Davies, A., Diz, D., Alexander, K., & McWhinnie, L. (2023). First port of call: a horizon scanning workshop for sustainable Arctic marine infrastructure. *Polar Journal*, 13(1), 146–162. <https://doi.org/10.1080/2154896X.2023.2205243>
- Greenblott, J. M., O'Farrell, T., Olson, R., & Burchard, B. (2019). Strategic Foresight in the Federal Government: A Survey of Methods, Resources, and Institutional Arrangements. *World Futures Review*, 11(3), 245–266. <https://doi.org/10.1177/1946756718814908>
- Gourguet, S., Lesteven, L., Gascuel, D., & Macher, C. (2021). Participatory fisheries management: A necessary evolution of the ecosystem approach to fisheries. *Aquatic Living Resources*, 34. <https://doi.org/10.1051/alr/2021007>
- Gumucio, T., & Rueda, M. T. (2015). Influencing Gender-Inclusive Climate Change Policies in Latin America. *Journal of Gender, Agriculture and Food Security*, 1(2), 42–61.
- Harris-Lovett, S., Lienert, J., & Sedlak, D. (2019). A mixed-methods approach to strategic planning for multi-benefit regional water infrastructure. *Journal of Environmental Management*, 233, 218–237. <https://doi.org/10.1016/j.jenvman.2018.11.112>
- Havas, A. (2005). Terminology and Methodology for Benchmarking *Foresight Programmes*.
- Haward, M., Davidson, J., Lockwood, M., Hockings, M., Kriwoken, L., & Allchin, R. (2013). Climate change, scenarios and marine biodiversity conservation. *Marine Policy*, 38, 438–446. <https://doi.org/10.1016/j.marpol.2012.07.004>
- Hopkins, L., & Zapata, M. (2007). *Engaging the Future: Forecasts, Scenarios, Plans, and Projects*.
- Hughes, K. A., Pescott, O. L., Peyton, J., Adriaens, T., Cottier-Cook, E. J., Key, G., Rabitsch, W., Tricarico, E., Barnes, D. K. A., Baxter, N., Belchier, M., Blake, D., Convey, P., Dawson, W., Frohlich, D., Gardiner, L. M., González-Moreno, P., James, R., Malumphy, C., ... Roy, H. E. (2020). Invasive non-native species likely to threaten biodiversity and ecosystems in the Antarctic Peninsula region. *Global Change Biology*, 26(4), 2702–2716. <https://doi.org/10.1111/gcb.14938>
- Innocenti, A., & Musco, F. (2023). Land–Sea Interactions: A Spatial Planning Perspective. *Sustainability (Switzerland)*, 15(12). <https://doi.org/10.3390/su15129446>
- Kelly, R., Foley, P., Stephenson, R. L., Hobday, A. J., Pecl, G. T., Boschetti, F., Cvitanovic, C., Fleming, A., Fulton, E. A., Nash, K. L., Neis, B., Singh, G. G., & van Putten, E. I. (2022). Foresighting future oceans: Considerations and opportunities. *Marine Policy*, 140. <https://doi.org/10.1016/j.marpol.2022.105021>



- Kermorvant, C., Caill-Milly, N., Bru, N., & D'Amico, F. (2019). Optimizing cost-efficiency of long term monitoring programs by using spatially balanced sampling designs: The case of manila clams in Arcachon bay. *Ecological Informatics*, 49(November 2018), 32–39.  
<https://doi.org/10.1016/j.ecoinf.2018.11.005>
- Kok, K., Biggs, R., & Zurek, M. (2007). Methods for developing multiscale participatory scenarios: Insights from Southern Africa and Europe. *Ecology and Society*, 12(1).  
<https://doi.org/10.5751/ES-01971-120108>
- Kunkel, K. E., Moss, R., & Parris, A. (2016). Innovations in science and scenarios for assessment. *Climatic Change*, 135(1), 55–68. <https://doi.org/10.1007/s10584-015-1494-z>
- Lacroix, D., David, B., Lamblin, V., de Menthière, N., de Lattre-Gasquet, M., Guigon, A., Jannès-Ober, E., Hervieu, H., Potier, F., Ragain, G., & Hoummady, M. (2016). Interactions between oceans and societies in 2030: Challenges and issues for research. *European Journal of Futures Research*, 4(1). <https://doi.org/10.1007/s40309-016-0089-x>
- Lambert, P., Lassalle, G., Acolas, M. L., Bau, F., Castelnaud, G., Daverat, F., Jatteau, P., Rigaud, C., Rochard, E., Roqueplo, C., & de Jouvenel, F. (2019). A foresight analysis in fisheries science: The case study of migratory fish research. *Futures*, 111, 90–103.  
<https://doi.org/10.1016/j.futures.2019.06.001>
- Legg, C. J., & Nagy, L. (2006). Why most conservation monitoring is, but need not be, a waste of time. *Journal of Environmental Management*, 78(2), 194–199.  
<https://doi.org/10.1016/j.jenvman.2005.04.016>
- Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P. A., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. In *Journal of clinical epidemiology* (Vol. 62, Issue 10).  
<https://doi.org/10.1016/j.jclinepi.2009.06.006>
- Lucy, F. E., Davis, E., Anderson, R., Booy, O., Bradley, K., Britton, J. R., Byrne, C., Caffrey, J. M., Coughlan, N. E., Crane, K., Cuthbert, R. N., Dick, J. T. A., Dickey, J. W. E., Fisher, J., Gallagher, C., Harrison, S., Jebb, M., Johnson, M., Lawton, C., ... Trodd, W. (2020). Horizon scan of invasive alien species for the island of Ireland. *Management of Biological Invasions*, 11(2), 155–177. <https://doi.org/10.3391/mbi.2020.11.2.01>
- Miller, R. L., Marsh, H., Benham, C., & Hamann, M. (2020). Stakeholder engagement in the governance of marine migratory species: barriers and building blocks. *Endangered Species Research*, 43, 1–19. <https://doi.org/10.3354/esr01049>
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., Gøtzsche, P. C., ... Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *PLoS Medicine*, 6(7). <https://doi.org/10.1371/journal.pmed.1000097>
- Nagy, G. J., & Gutiérrez, O. (2018). Scenario Planning Toward Climate Adaptation: The Uruguayan Coast. In *Climate Change Management* (pp. 457–476). Springer.  
[https://doi.org/10.1007/978-3-319-56946-8\\_28](https://doi.org/10.1007/978-3-319-56946-8_28)



- Nash, K. L., Alexander, K., Melbourne-Thomas, J., Novaglio, C., Sbrocchi, C., Villanueva, C., & Pecl, G. T. (2022). Developing achievable alternate futures for key challenges during the UN Decade of Ocean Science for Sustainable Development. *Reviews in Fish Biology and Fisheries*, 32(1), 19–36. <https://doi.org/10.1007/s11160-020-09629-5>
- Nations, U. (2018). The Sustainable Development Agenda - United Nations Sustainable Development. In *About*. <https://www.un.org/sustainabledevelopment/development-agenda/>
- Nguyen, N. T., Collins, A., & Collins, C. M. (2023). Trends and patterns in the application of co-production, co-creation, and co-design methods in studies of green spaces: A systematic review. *Environmental Science and Policy*, 152(October 2023). <https://doi.org/10.1016/j.envsci.2023.103642>
- OECD. (2019). *Strategic Foresight for Better Policies*. October, 1–12. [https://www.oecd.org/strategic-foresight/ourwork/Strategic Foresight for Better Policies.pdf](https://www.oecd.org/strategic-foresight/ourwork/Strategic%20Foresight%20for%20Better%20Policies.pdf)
- Oficialdegui, F. J., Zamora-Marín, J. M., Guareschi, S., Anastácio, P. M., García-Murillo, P., Ribeiro, F., Miranda, R., Cobo, F., Gallardo, B., García-Berthou, E., Boix, D., Arias, A., Cuesta, J. A., Medina, L., Almeida, D., Banha, F., Barca, S., Biurrun, I., Cabezas, M. P., ... Oliva-Paterna, F. J. (2023). A horizon scan exercise for aquatic invasive alien species in Iberian inland waters. *Science of the Total Environment*, 869. <https://doi.org/10.1016/j.scitotenv.2023.161798>
- O’shaughnessy, K. A., Vilizzi, L., Daniel, W., McGarrity, M. E., Bauer, H., Hartman, L., Geiger, S., Sammarco, P., Kolian, S., Porter, S., Dutton, J., McClure, M. R., Norberg, M., Fogg, A., Lyons, T. J., Procopio, J., Bantista, L., Bennett, W., Wicksten, M., ... Copp, G. H. (2023). Horizon scanning for potentially invasive non-native marine species to inform trans-boundary conservation management – Example of the northern Gulf of Mexico. *Aquatic Invasions*, 18(4), 415–453. <https://doi.org/10.3391/ai.2023.18.4.114182>
- Pace, L. A., Borch, K., & Deidun, A. (2023). Bridging Knowledge Gaps towards 2030: The Use of Foresight for the Strategic Management of a Sustainable Blue Economy. *Sustainability (Switzerland)*, 15(13). <https://doi.org/10.3390/su151310026>
- Pace, L. A., Saritas, O., & Deidun, A. (2023). Exploring future research and innovation directions for a sustainable blue economy. *Marine Policy*, 148. <https://doi.org/10.1016/j.marpol.2022.105433>
- Papageorgiou, M., Pozoukidou, G., Istoriou, T., & Kostopoulou, T. (2024). Inclusive Maritime Spatial Planning: Stakes at the Regional Level. *Sustainability (Switzerland)*, 16(22). <https://doi.org/10.3390/su162210148>
- Parsons, E. C. M., Favaro, B., Aguirre, A. A., Bauer, A. L., Blight, L. K., Cigliano, J. A., Coleman, M. A., Côté, I. M., Draheim, M., Fletcher, S., Foley, M. M., Jefferson, R., Jones, M. C., Kelaher, B. P., Lundquist, C. J., Mccarthy, J. B., Nelson, A., Patterson, K., Walsh, L., ... Sutherland, W. J. (2014). Seventy-one important questions for the conservation of marine biodiversity. *Conservation Biology*, 28(5), 1206–1214. <https://doi.org/10.1111/cobi.12303>
- Petrov, A. N., Smith, M. S. R., Krivorotov, A. K., Klyuchnikova, E. M., Mikheev, V. L., Pelyasov, A. N., & Zamyatina, N. Y. (2021). The Russian arctic by 2050: Developing integrated scenarios. *Arctic*, 74(3), 306–322. <https://doi.org/10.14430/arctic73242>



- Peyton, J. M., Martinou, A. F., Adriaens, T., Chartosia, N., Karachle, P. K., Rabitsch, W., Tricarico, E., Arianoutsou, M., Bacher, S., Bazos, I., Brundu, G., Bruno-McClung, E., Charalambidou, I., Demetriou, M., Galanidi, M., Galil, B., Guillem, R., Hadjiafxentis, K., Hadjioannou, L., ... Roy, H. E. (2020). Horizon Scanning to Predict and Prioritize Invasive Alien Species With the Potential to Threaten Human Health and Economies on Cyprus. *Frontiers in Ecology and Evolution*, 8. <https://doi.org/10.3389/fevo.2020.566281>
- Polajnar Horvat, K., Gašperič, P., Leban, K., Tičar, J., & Smrekar, A. (2022). Participatory Approach to Wetland Governance: The Case of The Memorandum of Understanding of the Sečovlje Salina Nature Park. *Sustainability (Switzerland)*, 14(16). <https://doi.org/10.3390/su14169920>
- Pörtner, H.-O., Roberts, D. C., Tignor, M. M. B., Poloczanska, E., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Sina Löschke, Vincent Möller, Andrew Okem, & Bardhyl Rama (eds.). (2022). Impacts, Adaptation, and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report of the Intergovernmental Panel on Climate Change. In O., Roberts, DC, Tignor, M., Poloczanska, ES, Mintenbeck, K., Ale, A., Eds. <https://doi.org/10.1017/9781009325844.Front>
- Pörtner, H.O., Scholes, R.J., Agard, J., Archer, E., Arneth, A., Bai, X., Barnes, D., Burrows, M., Chan, L., Cheung, W.L., Diamond, S., Donatti, C., Duarte, C., Eisenhauer, N., Foden, W., Gasalla, M. A., Handa, C., Hickler, T., Hoegh-Guldberg, O., Ichii, K., Jacob, U., Insarov, G., Kiessling, W., Leadley, P., Leemans, R., Levin, L., Lim, M., Maharaj, S., Managi, S., Marquet, P. A., McElwee, P., Midgley, G., Oberdorff, T., Obura, D., Osman, E., Pandit, R., Pascual, U., Pires, A. P. F., Popp, A., Reyes-García, V., Sankaran, M., Settele, J., Shin, Y. J., Sintayehu, D. W., Smith, P., Steiner, N., Strassburg, B., Sukumar, R., Trisos, C., Val, A.L., Wu, J., Aldrian, E., Parmesan, C., Pichs-Madruga, R., Roberts, D.C., Rogers, A.D., Díaz, S., Fischer, M., Hashimoto, S., Lavorel, S., Wu, N., Ngo, H.T. (2021) IPBES-IPCC co-sponsored workshop report on biodiversity and climate change, IPBES and IPCC, doi:10.5281/zenodo.4782538.
- Pratchett, M. S., Caballes, C. F., Cvitanovic, C., Raymundo, M. L., Babcock, R. C., Bonin, M. C., Bozec, Y. M., Burn, D., Byrne, M., Castro-Sanguino, C., Chen, C. C. M., Condie, S. A., Cowan, Z. L., Deaker, D. J., Desbiens, A., Devantier, L. M., Doherty, P. J., Doll, P. C., Doyle, J. R., ... Wilson, S. K. (2021). Knowledge Gaps in the Biology, Ecology, and Management of the Pacific Crown-of-Thorns Sea Star *Acanthaster* sp. on Australia's Great Barrier Reef. *Biological Bulletin*, 241(3), 330–346. <https://doi.org/10.1086/717026>
- Ramírez, R., & Selin, C. (2014). Plausibility and probability in scenario planning. *Foresight*, 16(1), 54–74. <https://doi.org/10.1108/FS-08-2012-0061>
- Raudsepp-Hearne, C., Peterson, G. D., Bennett, E. M., Biggs, R., Norström, A. V, Pereira, L., Vervoort, J., Iwaniec, D. M., McPhearson, T., Olsson, P., Hichert, T., Falardeau, M., & Aceituno, A. J. (2020). Seeds of good anthropocenes: developing sustainability scenarios for Northern Europe. *Sustainability Science*, 15(2), 605 – 617. <https://doi.org/10.1007/s11625-019-00714-8>



- Rivers, N., Strand, M., Fernandes, M., Metuge, D., Lemahieu, A., Nonyane, C. L., Benkenstein, A., & Snow, B. (2023). Pathways to integrate Indigenous and local knowledge in ocean governance processes: Lessons from the Algoa Bay Project, South Africa. *Frontiers in Marine Science*, 9(January), 1–17. <https://doi.org/10.3389/fmars.2022.1084674>
- Rogers, A., Harborne, A. R., Brown, C. J., Bozec, Y. M., Castro, C., Chollett, I., Hock, K., Knowland, C. A., Marshall, A., Ortiz, J. C., Razak, T., Roff, G., Samper-Villarreal, J., Saunders, M. I., Wolff, N. H., & Mumby, P. J. (2015). Anticipative management for coral reef ecosystem services in the 21st century. *Global Change Biology*, 21(2), 504–514. <https://doi.org/10.1111/gcb.12725>
- Roggema, R., Tillie, N., & Hollanders, M. (2021). Designing the adaptive landscape: Leapfrogging stacked vulnerabilities. *Land*, 10(2), 1–25. <https://doi.org/10.3390/land10020158>
- Rogut, A., & Piasecki, B. (2011). Foresight methodology as a tool for elaboration of plans for sustainable management of water, energy, the environment and society. *Ecology and Hydrobiology*, 11(3–4), 261 – 272. <https://doi.org/10.2478/v10104-011-0049-9>
- 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>
- Rozanec, J., Nemeč, P., Leban, G., & Grobelnik, M. (2023). AI, What Does the Future Hold for Us? Automating Strategic Foresight. In *ICPE 2023 - Companion of the 2023 ACM/SPEC International Conference on Performance Engineering* (Vol. 1, Issue 1). Association for Computing Machinery. <https://doi.org/10.1145/3578245.3585336>
- Rudd, M. A. (2015). Scientists' framing of the ocean science-policy interface. *Global Environmental Change*, 33, 44–60. <https://doi.org/10.1016/j.gloenvcha.2015.04.006>
- Rutting, L., Vervoort, J., Mees, H., & Driessen, P. (2022). Strengthening foresight for governance of social-ecological systems: An interdisciplinary perspective. *Futures*, 141. <https://doi.org/10.1016/j.futures.2022.102988>
- Sano, M., Baum, S., Bussey, M., Carter, B., Crick, F., Golshani, A., Choy, D. L., Richards, R., Roiko, A., Serrao-Neumann, S., Splinter, K., Smith, T., & Tomlinson, R. (2012). Adapting coasts to climatic futures. An Australian perspective. *Proceedings of the Coastal Engineering Conference*. <https://doi.org/10.9753/icce.v33.management.21>
- Schlüter, M., Hertz, T., & Mancilla Garcia, M. (2020). Social-Ecological Intertwinedness : An Attempt at a Clarification. *SSRN Electronic Journal*.
- Scoville, C., Chapman, M., Amironesei, R., & Boettiger, C. (2021). Algorithmic conservation in a changing climate. *Current Opinion in Environmental Sustainability*, 51, 30–35. <https://doi.org/10.1016/j.cosust.2021.01.009>
- Serrao-Neumann, S., Schuch, G., Cox, M., & Low Choy, D. (2019). Scenario planning for climate change adaptation for natural resource management: Insights from the Australian East Coast Cluster. *Ecosystem Services*, 38. <https://doi.org/10.1016/j.ecoser.2019.100967>



- Slocum, N. (2003). Participatory Methods Toolkit: A practitioner's manual. In *King Baudoin Foundation And Flemish Institute For Science And Technology Assessment In Collaboration With The United Nations University Comparative Regional Integration Studies*.  
<https://cris.unu.edu/participatory-methods-toolkit-practitioners-manual>
- Spaniol, M. J., & Hansen, H. (2021). Electrification of the seas: Foresight for a sustainable blue economy. *Journal of Cleaner Production*, 322(September 2021), 128988.  
<https://doi.org/10.1016/j.jclepro.2021.128988>
- Stoms, D. M., Davis, F. W., Andelman, S. J., Carr, M. H., Gaines, S. D., Halpern, B. S., Hoenicke, R., Leibowitz, S. G., Leydecker, A., Madin, E. M. P., Tallis, H., & Warner, R. R. (2005). Integrated coastal reserve planning: Making the land-sea connection. *Frontiers in Ecology and the Environment*, 3(8), 429–436.  
[https://doi.org/10.1890/15409295\(2005\)003\[0429:ICRPMT\]2.0.CO;2](https://doi.org/10.1890/15409295(2005)003[0429:ICRPMT]2.0.CO;2)
- Störmer, E., Bontoux, L., Krzysztofowicz, M., Florescu, E., Bock, A. K., & Scapolo, F. (2020). Foresight – Using Science and Evidence to Anticipate and Shape the Future. *Science for Policy Handbook*, 128–142. <https://doi.org/10.1016/B978-0-12-822596-7.00012-7>
- Sutherland, W. J., Adams, W. M., Aronson, R. B., Aveling, R., Blackburn, T. M., Broad, S., Ceballos, G., Côté, I. M., Cowling, R. M., Da Fonseca, G. A. B., Dinerstein, E., Ferraro, P. J., Fleishman, E., Gascon, C., Hunter, M., Hutton, J., Kareiva, P., Kuria, A., MacDonald, D. W., ... Watkinson, A. R. (2009). One hundred questions of importance to the conservation of global biological diversity. *Conservation Biology*, 23(3), 557–567.  
<https://doi.org/10.1111/j.15231739.2009.01212.x>
- 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 and Policy*, 158(March), 103763.  
<https://doi.org/10.1016/j.envsci.2024.103763>
- Tsiamis, K., Azzurro, E., Bariche, M., Çinar, M. E., Crocetta, F., De Clerck, O., Galil, B., Gómez, F., Hoffman, R., Jensen, K. R., Kamburska, L., Langeneck, J., Langer, M. R., Levitt-Barmats, Y., Lezzi, M., Marchini, A., Occhipinti-Ambrogi, A., Ojaveer, H., Piraino, S., ... Cardoso, A. C. (2020). Prioritizing marine invasive alien species in the European Union through horizon scanning. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 30(4), 794–845.  
<https://doi.org/10.1002/aqc.3267>
- Tulloch, V. J. D., Adams, M., Finn, R., Bourbonnais, M., Avery-Gomm, S., Penn, B., & Martin, T. G. (2024). Predicting regional cumulative effects of future development on coastal ecosystems to support Indigenous governance. *Journal of Applied Ecology*.  
<https://doi.org/10.1111/1365-2664.14659>
- UNDP. (2022a). *Foresight Playbook*.
- UNDP. (2022b). UNDP RBAP: Foresight Playbook. New York, New York.
- UNDP Global Centre for Public Service Excellence. (2018). *Foresight Manual - Empowered Futures for the 2030 Agenda*.



- UNIDO. (2005). *UNIDO Technology Foresight Manual*. 1, 153.  
[https://open.unido.org/api/documents/4788518/download/POLLUTANTS IN TANNERY EFFLUENT. INTERNATIONAL SCENARIO ON ENVIRONMENTAL REGULATIONS AND COMPLIANCE \(23440.en\)](https://open.unido.org/api/documents/4788518/download/POLLUTANTS_IN_TANNERY_EFFLUENT_INTERNATIONAL_SCENARIO_ON_ENVIRONMENTAL_REGULATIONS_AND_COMPLIANCE_23440.en)
- van Hoof, L., Hendriksen, A., & Bloomfield, H. J. (2014). Sometimes you cannot make it on your own; drivers and scenarios for regional cooperation in implementing the EU Marine Strategy Framework Directive. *Marine Policy*, 50, 339–346.  
<https://doi.org/10.1016/j.marpol.2014.03.031>
- Vecchiato, R., & Roveda, C. (2010). Strategic foresight in corporate organizations: Handling the effect and response uncertainty of technology and social drivers of change. *Technological Forecasting and Social Change*, 77(9), 1527–1539.  
<https://doi.org/10.1016/j.techfore.2009.12.003>
- Vineis, P., Marris, C., & Scott, A. (2025). Beyond Predictions: A Participatory Framework for Multi-Stakeholder Decision-Making. arXiv. <https://arxiv.org/abs/2502.08542>
- Voros, J. (2003). A generic foresight process framework. *Foresight*, 5(3), 10–21.  
<https://doi.org/10.1108/14636680310698379>
- Wedin, A., & Wikman–Svahn, P. (2021). A Value Sensitive Scenario Planning Method for Adaptation to Uncertain Future Sea Level Rise. *Science and Engineering Ethics*, 27(6).  
<https://doi.org/10.1007/s11948-021-00347-0>
- Weeks, R., & Adams, V. M. (2018). Research priorities for conservation and natural resource management in Oceania’s small-island developing states. *Conservation Biology*, 32(1), 72–83. <https://doi.org/10.1111/cobi.12964>
- Wilkinson, A., & Kupers, R. (2013). Living in the futures. *Harvard Business Review*, 91(5), 1–8.
- Williams, S. M., Tibbetts, I. R., & Holmes, B. J. (2023). The future of fish and fisheries in Australia: Prioritisation of research needs through a horizon scanning approach. *Pacific Conservation Biology*. <https://doi.org/10.1071/PC23020>
- Wyatt, K. H., Arkema, K. K., Wells-Moultrie, S., Silver, J. M., Lashley, B., Thomas, A., Kuiper, J. J., Guerry, A. D., & Ruckelshaus, M. (2021). Integrated and innovative scenario approaches for sustainable development planning in The Bahamas. *Ecology and Society*, 26(4).  
<https://doi.org/10.5751/ES-12764-260423>