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

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Abstract

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

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

1. Introduction

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

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

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

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

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

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

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

2. Case Study Description

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

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

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

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

3. Methodology for Exploring SH Insights

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

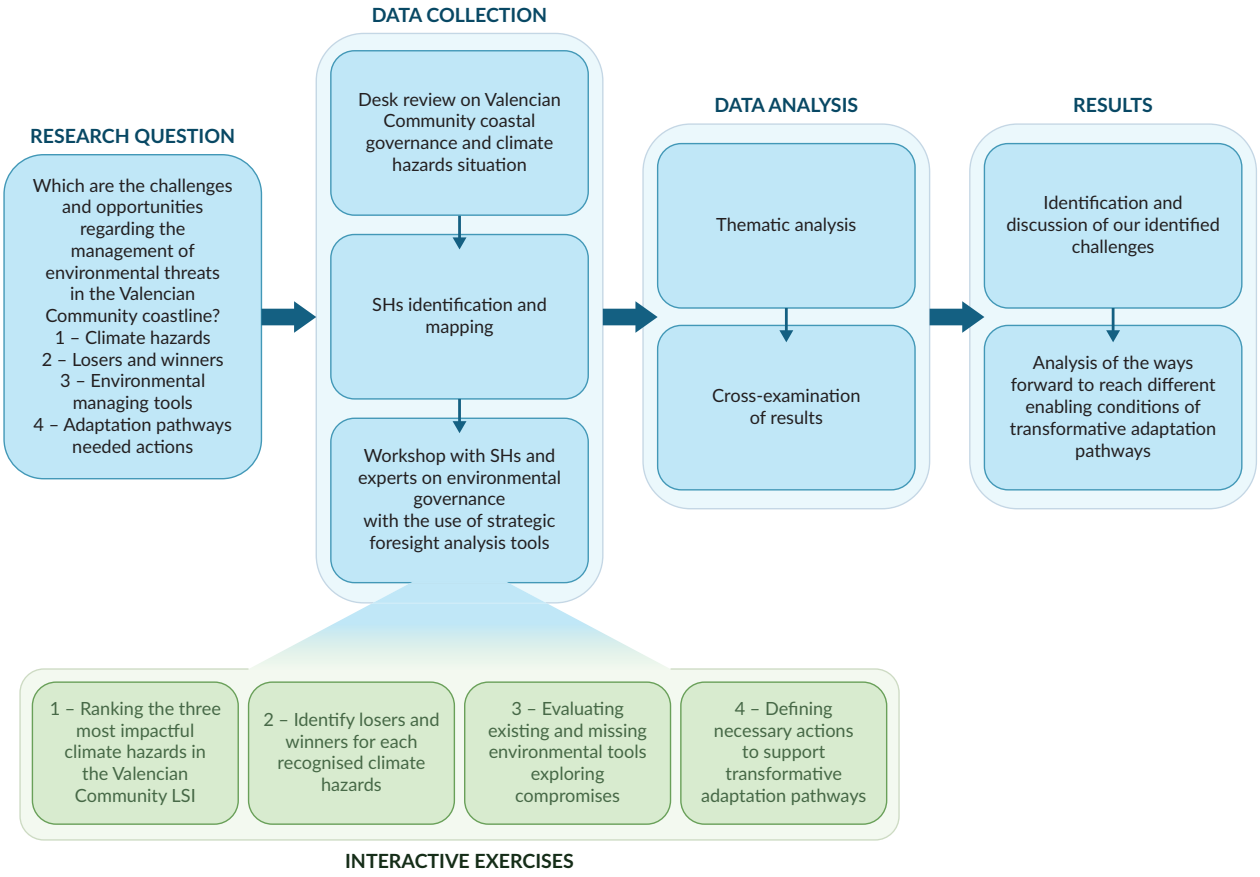

Figure 2. Step-by-step methodological framework, including the main topics addressed.

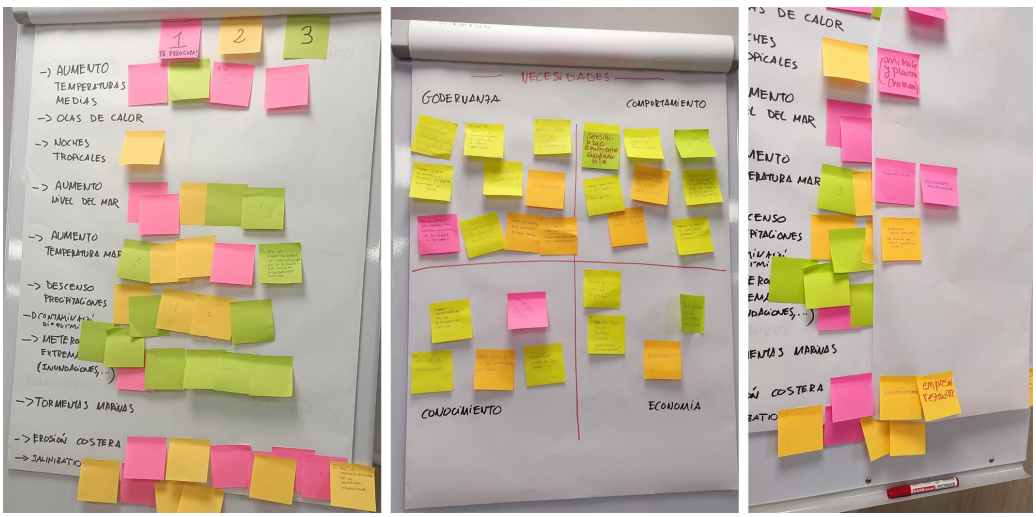

Figure 3. Visual insights from foresight exercises.

4. Analysis of Valencian Community Land–Sea Challenges

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

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

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

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

4.1. Main Climate Hazards Perception

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

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

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

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

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

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

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

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

4.2. Winner and Loser Dichotomy

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

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

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

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

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

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

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

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

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

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

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

4.3. Cooperation and Optimization of Environmental Management Tools

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

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

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

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

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

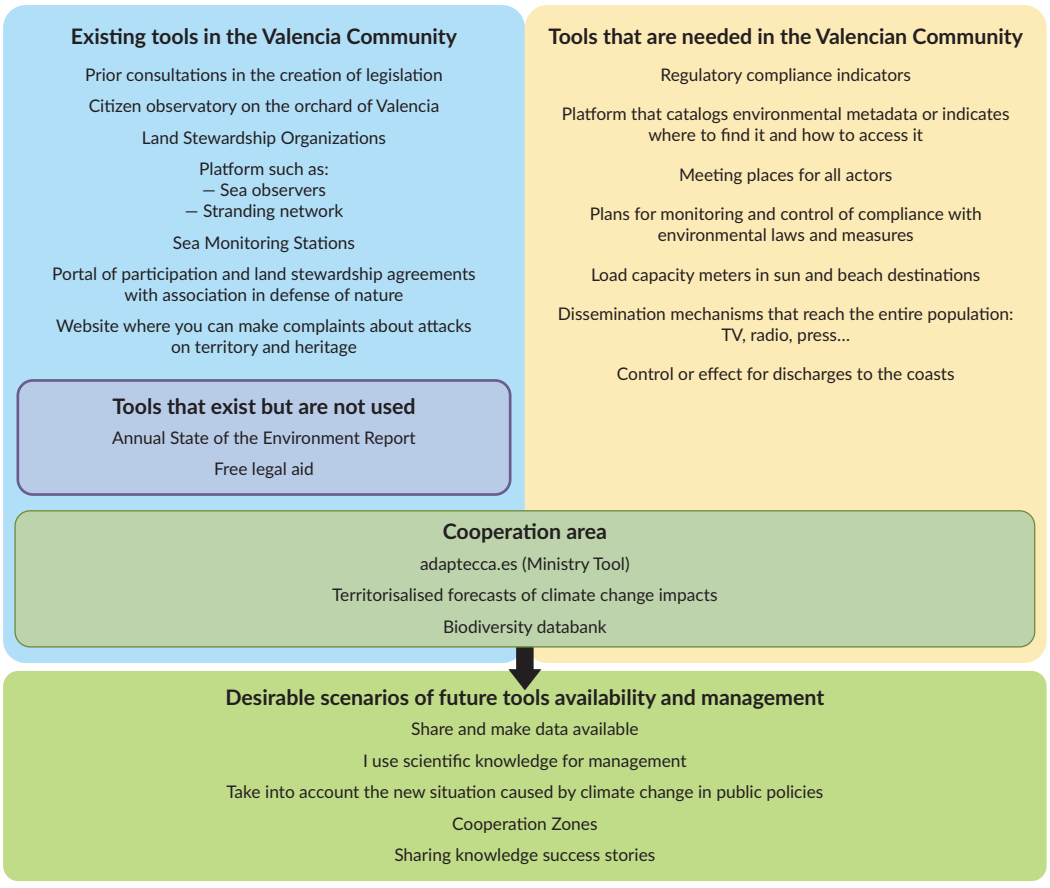

Figure 6. Mapping of tools in the Valencian Community, including existing, underutilised, and essential tools for enhanced environmental management, as well as areas of collaboration and optimal conditions for tools availability and integration.

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

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

4.4. Enabling Conditions for Transformative Action

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

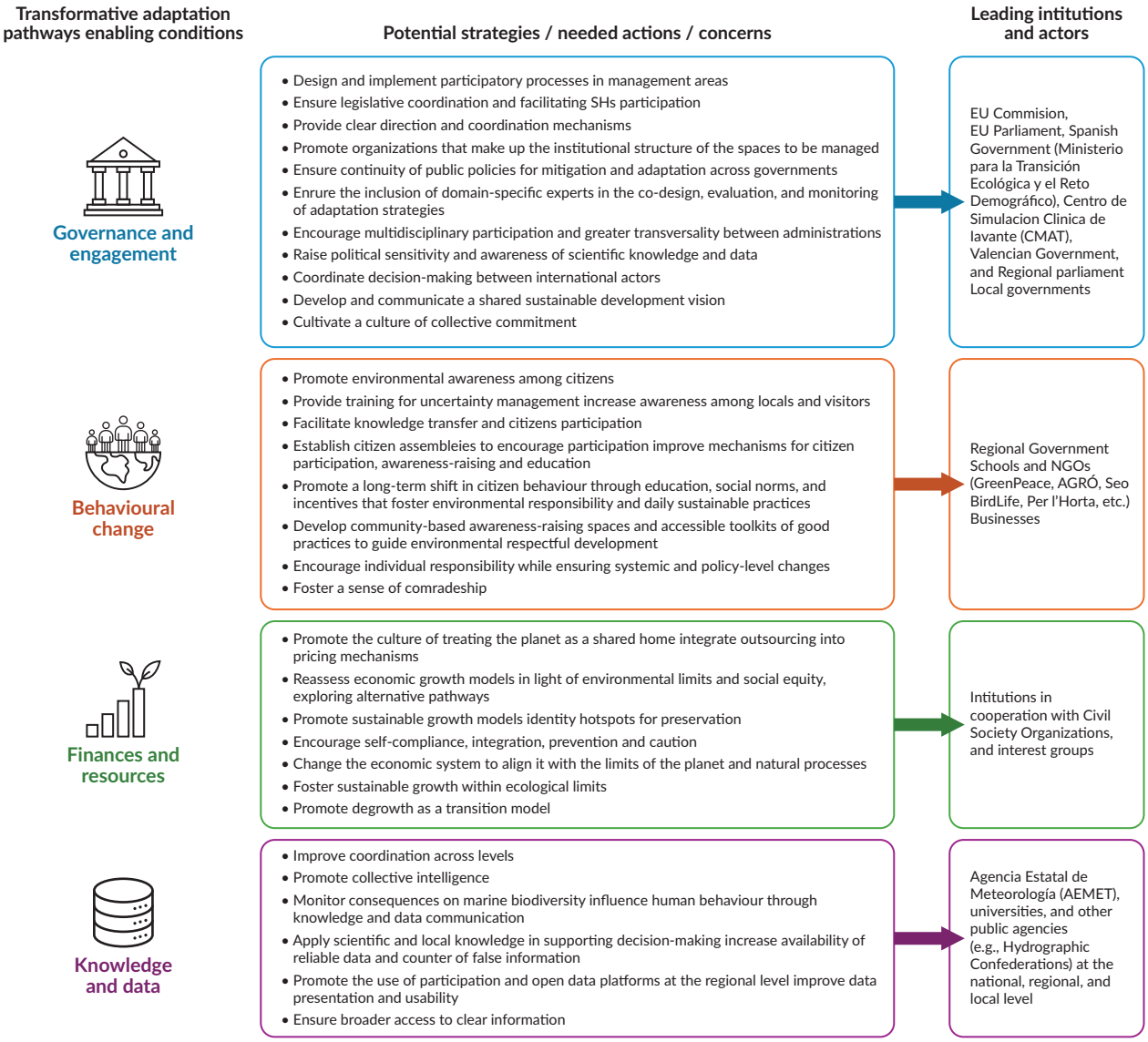

Figure 7. Potential strategies, necessary actions, and main concerns associated with the four enabling conditions for transformative adaptation pathways in the Valencian Community.

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

5. Recommendations for Transforming Adaptation Pathways

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

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

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

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

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

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

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

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

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

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

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

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

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

6. Conclusions

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

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

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

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

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

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

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

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

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

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

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

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

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Conflict of Interests

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

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