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Navigating the Ocean-Climate Nexus Through Participatory Workshops for a Sustainable Blue Economy

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Abstract

The complex interrelations between ocean governance, climate change, and innovation create both challenges and opportunities for sustainable development in the Black Sea region. The blue economy—encompassing fisheries, tourism, ports, shipping, and marine transport—plays a crucial role in regional prosperity but faces mounting pressures from overfishing, pollution, geopolitical instability, and the low capacity for technological and institutional adaptation. The EU-funded projects DOORS and BRIDGE-BS address these challenges through participatory, system-based approaches that engage stakeholders from across the quadruple helix (academia, industry, government, and civil society). While DOORS sought to identify policy and innovation gaps at the regional level through multi-actor forums, BRIDGE-BS explored future pathways for a sustainable and resilient blue economy using living labs and participatory foresight. Together, they reveal a persistent disconnect between local implementation capacity and national policy ambition, as local actors often remain locked in existing practices and lack the skills and resources to embrace emerging sectors. The results indicate that the sectors have similar goals, such as capture fisheries, marine and coastal tourism, ports and shipping, and marine transport. They also face similar problems, such as weak law enforcement, fragmented governance, bureaucratic inefficiencies, and a lack of new technology. The study underscores the value of participatory multi-actor engagement in bridging the science–policy practice gap, supporting skills development, and co-designing actionable pathways toward climate-resilient ocean governance. Lessons from the Black Sea demonstrate that integrating systems innovation, participatory governance, and capacity building can inform broader regional and global initiatives under the

EU Mission: Restore our Ocean and Waters, the UN Ocean Decade, and the SDGs, providing a transferable model for advancing sustainable blue transitions in politically sensitive marine regions.

Keywords
Black Sea; blue economy; living labs; multi-actor forums; ocean governance; systems approaches; sustainability; systems innovation

1. Introduction

For many years, the role of the ocean was largely absent from the climate discourse. Its formal debut occurred in the preamble to the Paris Agreement in 2015, which acknowledges the significance of maintaining the integrity of ocean ecosystems. The ocean absorbs approximately 25% of human CO_2 emissions and 93% of the excess heat resulting from global warming, thereby mitigating the much higher warming that would have occurred on land (Oceans Aware, n.d.). However, these benefits are not without costs. The absorption of CO_2 results in acidification, while excessive heat causes the sea surface to warm, ice to dissolve, sea levels to rise, and oxygen to be depleted.

At the same time, oceans are central drivers of the prosperity of coastal regions and of the economy worldwide. Since 1995, the ocean economy has expanded by 2.5 times the average rate of global economic growth. In 2023, the global trade in ocean commodities and services reached record highs (approximately $899 billion for goods and $1.3 trillion for services; UN Trade and Development, 2025). It is estimated that fisheries and aquaculture generate approximately $100 billion annually and provide employment opportunities for approximately 260 million individuals worldwide (UN, n.d.). In numerous developing or low-income economies, small-scale fisheries, aquaculture, and coastal tourism are essential. Specifically, according to a recent report by the OECD, the livelihoods of over 3 billion individuals are contingent upon marine and coastal biodiversity, either directly or indirectly (OECD, 2025).

Ocean acidity (reduced pH), oxygen levels, ice cover, and ocean currents are all influenced by climate change (Pörtner, 2021). These alterations pose a threat to the structure and services of the ecosystem, including the preservation of coastlines, habitat, and fisheries. This risk is exacerbated by a variety of factors, including underinvestment, pollution, overfishing, habitat devastation, and weak governance. A sustainable blue economy strives to achieve a harmonious equilibrium between long-term ecosystem health and ocean-based economic development. This is achieved by enhancing human well-being and equity, mitigating environmental risks, and recognising the value of ecosystem services, including those that are not typically monetised, such as coastal protection and carbon sequestration (Copernicus Marine Service, n.d.). The World Bank (2025) defines the blue economy as "low-carbon, resource-efficient growth that reduces poverty and creates jobs," which integrates ocean sectors in a manner that restores ocean health.

The Black Sea (BS) is bordered by six nations, which collectively have around 17.5 million residents reliant on its resources (Salihoglu et al., 2024). The BS is a dynamic geopolitical area situated inside a complex socio-ecological system rich in resources. The BS presents both significant challenges and considerable opportunities within the blue economy sectors. It is a strategic bridge located on the perimeter of the EU that links the Mediterranean Sea, Asia, and the Middle East in southern Europe. However, the region's blue

economy remains overlooked, despite its significant economic potential. The BS is among the most contaminated bodies of water globally and exemplifies the deteriorating environmental condition of European seas, despite its resource richness. Fish populations have been decimated, and species diversity has been undermined due to substandard water quality. A crucial shift towards a more sustainable blue economy development path is essential due to the socio-economic impacts of inadequate environmental conditions on employment, food security, tourism, and health.

The Burgas Vision and the Common Maritime Agenda (CMA) underlined the strategic importance of the blue economy for regional development (Common Maritime Agenda for the Black Sea, n.d.; European Commission, 2018), laying the groundwork for the BS Strategic Research and Innovation Agenda (SRIA; Connect Black Sea, 2019). Despite growing EU-funded efforts, such as ANEMONE (2018–2020) and BS CONNECT (2019–2023), stakeholder-focused analyses of the region remain limited (BS Connect, 2023; ANEMONE, n.d.). Early studies, such as Avoyan (2016), already highlighted fragmented governance, weak interinstitutional coordination, and poor implementation of strategic plans. Subsequent regional processes, including the 2019 BS Synergy: The Way Forward Stakeholder Conference, reaffirmed the need for coordinated, cross-sectoral governance (Afanasyev et al., 2020). Workshops and citizen-science activities under ANEMONE demonstrated that participatory engagement can build trust, strengthen data collection, and mobilise local communities around marine challenges (Gheorghe et al., 2021). Likewise, BS CONNECT's extensive national and regional consultations played a central role in co-developing and validating the SRIA, showing how structured stakeholder processes can support more inclusive and durable marine governance in the region.

Over the past decade, scholars have shown that participatory foresight tools—such as visioning, scenario co-development, and backcasting—play a critical role in empowering stakeholders to engage with long-term ocean–climate uncertainties (Ende et al., 2021; Matti et al., 2025). These methods help move governance beyond reactive policy cycles by fostering anticipatory capacity, collective sense-making, and experimentation. In parallel, marine governance research highlights co-creation as a pathway to more legitimate and adaptive decision-making, particularly in complex socio-ecological systems (Raha et al., 2024). A recent study by Bisinicu et al. (2025) shows that engagement is often consultative rather than co-creative, with stakeholders invited to events or surveys but rarely involved in decision-making or co-design of research and policy agendas. The impact and results of these mechanisms are further exacerbated by the limited representation of local communities, small-scale fishers, women, and youth in comparison to academia, NGOs, and government officials. The authors also observe that the institutional capacity to manage engagement processes is restricted due to the absence of trained facilitators, participatory methods, or evaluation frameworks.

Two EU-funded projects, DOORS and BRIDGE-BS, aim to address these gaps by investigating the potential of the blue economy in six BS countries: Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine (BRIDGE-BS, 2021; DOORS-BS, n.d.). The DOORS project, supported by Horizon 2020, focuses on providing scientific assistance to address environmental challenges by creating a system-of-systems. This framework is designed to connect citizens, scientists, and industry, facilitating access to crucial datasets for addressing climate change and marine ecosystem impacts. Concurrently, the BRIDGE-BS project complements DOORS by enhancing the marine research and innovation ecosystem. It focuses on developing an ecosystem-based management framework, which promotes policy adoption and public engagement. Significant outputs of these projects are

the identification of blue economy priorities and challenges and the co-designed transformative pathways for the blue economy, aiming for a sustainable use of ecosystem services impacted by various stressors, thereby guiding key sectors towards sustainability in the BS region.

Stakeholder engagement is achieved by employing two distinctive tools: national multi-actor forums (MAFs) in the DOORS project and local living labs (LLs) in the BRIDGE-BS project. Both approaches are based on systems innovation, specifically focusing on the co-creation of results rather than mere consultation, with stakeholders placed at the centre of discussions to collaboratively establish a path forward. These workshops are conducted with the assistance of experienced facilitators and common guidelines to ensure that all stakeholders participate equally and that the results are comparable. Stakeholder representativeness is guaranteed by a detailed stakeholder mapping conducted prior to the engagement of the stakeholders and founded on including stakeholders from the quadruple helix and diverse blue economy sectors.

MAFs bring together national stakeholders from Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine of all different backgrounds to assist scientists in prioritising BS issues with a focus on blue economy sectors and policies and the use of innovations to fill identified gaps. The results of the MAFs were also validated by an online survey that was disseminated to stakeholders who did not participate in the MAFs (Akinsete et al., 2025a; Seyhan et al., 2025). Complementarily, LLs have been implemented in Ukraine (Odessa), Romania (Constanta), Bulgaria (Varna), Türkiye (Istanbul Bosphorus and Sinop), and Georgia (Batumi), focusing on ecosystem services and the blue economy. In the BRIDGE-BS context, LLs represent an instrument to empower local communities in the future sustainable management of the BS, breaking sectoral silos and ensuring a systemic approach for the sustainable development of the blue economy. Through a series of workshops, they create a new local participative dynamic to explore alternative forms of governance while acting as a focal point for greater interconnection between physical and socio-economic sciences (Guittard et al., 2023).

This study explores how participatory approaches in the form of LLs are used to support the transition towards a sustainable blue economy in the BS region through the coordinated implementation of LLs from two EU Horizon-funded projects working on sustainability issues in the BS. The article seeks to share insights on how participatory workshops at local and national levels have been used in the context of the ocean-climate nexus; how a system innovation approach (SIA) has been implemented to foster stakeholder engagement for a sustainable blue economy; and how collaboration across LLs can strengthen stakeholder engagement's process, foster trans-boundary networks of actors, and trigger bottom-up regional collaborations and policy recommendations.

2. Conceptual Framework

The SIA is a methodological framework that enables systemic change based on an interconnected set of innovations, where each influences the other, with innovation both in the parts of the system and in the ways in which they interconnect. SIA is rooted in system thinking (Meadows, 2008) and its implementation within the context of the transition management concept (Loorbach & Rotmans, 2006; Roorda et al., 2014). It aspires to address persistent problems and facilitate sustainability, while it is grounded on a highly participatory method in which stakeholders are actively engaged in workshops to co-identify an interconnected set of innovations that can drive sustainability. In this context, MAFs and LLs act as open

innovation spaces that foster co-creation with users. The end result is expected to better solve stakeholder needs and engage actors from many different domains and scale levels in solving problem-oriented activities, co-producing knowledge, and co-designing solutions in an iterative process (Akinsete et al., 2023; Akinsete et al., 2025b; Geels & Schot, 2007; Roorda et al., 2014).

SIA can offer a more comprehensive perspective on marine governance, a complex socio-ecological system in which ecological, economic, technological, and social subsystems interact dynamically. Systems innovation encourages cross-sectoral, integrated change to target root causes and interdependencies, rather than addressing individual issues (e.g., pollution, fisheries, etc.) in isolation (Akinsete et al., 2025a). By prioritising stakeholders, governance can be transformed into a learning system in which policies are perpetually refined in response to stakeholder input and real-world experimentation. The concept of transition pathways is introduced by systems innovation, which involves the development of strategic, long-term trajectories to transition from unsustainable practices (e.g., overfishing, pollution, etc.) to sustainable alternatives. Ultimately, SIA ensures that decisions are socially legitimate and evidence-based by bridging gaps between research outputs (e.g., ecosystem models), policy instruments, and community requirements. These pathways combine institutional and behavioural change (e.g., new governance frameworks, incentives for collaboration, etc.) with technological innovation (e.g., clean transportation, digital monitoring, etc.; Akinsete et al., 2025c; Geels & Schot, 2007).

3. Methodology

3.1. Case Study Context: The DOORS and BRIDGE-BS Projects

DOORS BS created a series of MAFs to bring together citizens, scientists, and industry for the important restoration of the BS, creating new opportunities for the "blue economy," along with a system-of-systems to tackle the effects of humans and climate change on the marine ecosystem. To assist scientists in the prioritisation of BS issues, these forums are facilitating the collaboration of diverse national stakeholders in Georgia, Bulgaria, Turkey, and Romania. The primary emphasis is on the implementation of innovations to resolve identified deficiencies and blue economy policies. These forums are designed to assist scientists in the process of prioritising issues that are associated with the BS.

In the BRIDGE-BS context, LLs represent an instrument to empower local communities in the future sustainable management of the BS (Figure 1), breaking sectoral silos and ensuring a systemic approach. They create a new local participative dynamic to explore alternative forms of governance and simultaneously creating a nexus for greater interconnection between physical and socio-economic sciences. Various participative tools exploit and enhance the inter-actor exchanges to create a learning loop, raise awareness on ecosystem services and their multi-stressors, current and future, stimulate thinking out of the box, and develop trust and collaborations to foster the adoption and implementation of innovative eco-solutions. The primary outputs consist of transformative pathways for the blue economy that address key stressors on marine ecosystem services, including climate change, specific to each targeted country.

Figure 1. BS basin geographic coverage. Source: NASA Earth Observatory (2006).

Both the DOORS MAFs and BRIDGE-BS LLs are grounded in the SIA, which draws conceptually from the transition theory, particularly the multi-level perspective (Geels & Schot, 2007), and from the broader field of participatory and collaborative governance (Ansell & Gash, 2008; Bryson et al., 2013). Table 1 presents the step-by-step application of SIA in the two projects. Consistent with the multi-level perspective, the process begins by mapping key actors within the socio-technical system (step 1), identifying their positions within niches, regimes, and landscape pressures. This mapping, supported by the quadruple helix framework, recognises that transitions emerge from the interplay between established structures (regimes) and emerging innovations (niches), and therefore requires a systemic understanding of power, interests, and institutional dynamics. In step 2, the co-identification of challenges and needs across blue economy sectors surfaces the regime lock-ins, path dependencies, and cross-scale tensions that constrain sustainable transitions in the BS. This stage aligns with the participatory governance theory, which emphasises joint problem framing as a prerequisite for trust-building and collaborative action.

In step 3, participants co-develop desirable future visions, a central component of both systems innovation and transition management. Visioning provides a collectively negotiated direction for change and articulates long-term landscape-level aspirations that can guide regime destabilisation and niche development (Bennett et al., 2021; Milkoreit, 2017; Riedy & Waddock, 2022). Finally, step 4 employs a backcasting approach to translate visions into transformative pathways, consisting of innovations, management measures, governance reforms, and behavioural shifts sequenced across short, medium, and long-term time horizons. This reflects the transition management literature's emphasis on iterative experimentation, niche amplification, and the orchestration of systemic transformations through coordinated action by public,

private, and civil actors. Across all steps, SIA operationalises participatory governance by positioning stakeholders as co-designers rather than consultees, enabling collective learning and enhancing the societal legitimacy of proposed pathways.

Table 1. Systems innovation methodology employed by the DOORS and BRIDGE-BS projects.

Step 1: Stakeholder analysis	Step 2: Problem scoping	Step 3: Envisioning a sustainable future	Step 4: Path towards sustainability
Step 1 aims at identifying the relevant stakeholders from the quadruple helix to be involved in the LL based on their level of power (decision-making) and influence, and on their interest in being actively engaged in activities aiming at solving the problem at stake. Stakeholder mapping tools are used (i.e., influence/interest matrix) to define the pool of stakeholders to engage in the LL activities	Step 2 focuses on unravelling key challenges, needs, risks, and opportunities around a sustainability problem, based on shared knowledge across key stakeholder groups. The result is a holistic and shared understanding of the key dynamics, driving a system (i.e., the blue economy system) around a sustainability change	Step 3 aims at co-developing a common vision describing a desirable, sustainable future ("what would the future look like in 2050?"). Visioning is not a predictive exercise but rather a means to provide a sense of direction, a goal to be achieved. It has to be credible, practical, and feasible enough in order to be useful	Step 4 consists of co-developing the path towards the future vision using a back-casting approach. A portfolio of social and technological innovations targeting different sectors is co-identified, along with the necessary policy instruments and governance arrangements, creating a trajectory for change with short, mid, and long-term solutions to be implemented

Table 2 offers a comparative analysis of the methodological approaches employed in the BRIDGE-BS and DOORS projects, both of which are dedicated to the development of the blue economy and sustainability transitions in the BS region. The table delineates the primary differences and shared components of the SIA frameworks. The DOORS project expands its scope to include Moldova, whereas BRIDGE-BS concentrates on two distinct Turkish sites (Istanbul-Bosphorus and Sinop) to capture local ecosystem variation, despite the fact that both projects span the primary BS countries—Bulgaria, Georgia, Romania, Turkey, and Ukraine. Each project implements a quadruple-helix strategy that encompasses academia, industry, government, and civil society. Nevertheless, DOORS primarily engages national-level stakeholders through the MAFs, whereas BRIDGE-BS emphasises community and site-specific innovation through LLs, which allows for local-level engagement. In regard to the general objective, DOORS is dedicated to identifying policy and innovation gaps across the blue economy sectors, while BRIDGE-BS is focused on understanding and

Table 2. A methodological comparison between the BRIDGE-BS and DOORS projects.

SIA methodology	Common elements	Differences
Geographic coverage	BS countries (Bulgaria, Georgia, Romania, Turkey, and Ukraine)	DOORS reached an additional country, Moldova, while BRIDGE-BS looked at 2 different sites in Turkey, namely Istanbul-Bosphorus and Sinop
Stakeholders engagement	Blue economy representatives from the quadruple helix	DOORS engaged national-level stakeholders, while BRIDGE-BS targeted local-level stakeholders
General objectives	Support the development of a sustainable and resilient blue economy in the BS region	DOORS aimed at identifying policies and innovation gaps related to the BS, while BRIDGE-BS sought to tackle the marine ecosystem services multi-stressors

mitigating multiple stressors on marine ecosystem services. In general, Table 2 demonstrates how these complementary initiatives integrate systems innovation methodologies at varying scales (national vs. local) and foci (policy vs. ecosystem), thereby jointly contributing to a more comprehensive understanding of blue economy transitions in the BS.

3.2. Workshop Design and Implementation

As stated in Section 3.1, both projects together designed and implemented workshops in six BS countries: Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine. The initial phase of implementing SIA entails a detailed stakeholder mapping and selection process. One key component of the SIA is the intentional mapping and selection of the stakeholders who are invited to the respective workshops. Stakeholders are listed and mapped using the quadruple helix model, namely, academia, industry, government, and civil society (Arnkil et al., 2010). The quadruple helix model assists in the identification of the interconnections between institutional actors and citizens within a socio-economic system. It is a diagnostic instrument that is used to identify individuals, the manner in which they interact, and the areas in which there are gaps or imbalances. Then, stakeholders are assessed using an "influence/interest" matrix (Figure 2), where "influence" denotes the stakeholder's power and capacity to effect change, and "interest" denotes the likelihood of the stakeholder participating in activities pertinent to the case study, whether due to potential benefits or negative consequences (Arnkil et al., 2010; Eden & Ackermann, 1998).

Figure 2. Influence-interest matrix. Note: Example from the DOORS MAF in Georgia.

In addition, stakeholders are mapped onto the EU blue economy sectors, which are relevant to the project objectives, including marine living and non-living resources, renewable energy, port activities, shipbuilding, transportation, and tourism (European Commission, 2021). The map is then evaluated by an external expert, such as members of the project advisory board or other local specialists, after the plotting process is complete. The analysis aims to identify the most suitable stakeholders to be involved in the corresponding workshops (MAFs and LLs). The primary participants are selected from the upper right quadrant of a stakeholder matrix, indicating individuals with substantial influence and interest. However, stakeholders from the lower right and upper left quadrants are also shortlisted; the former includes those who can implement recommendations, while the latter consists of individuals with local expertise who often lack decision-making power.

Importantly, both projects put emphasis on including groups that are traditionally under-represented in marine governance processes, such as women, small-scale fishers, coastal community groups, and NGOs working with marginalised populations. This was achieved by cross-checking invite lists with gender indicators and consulting local partners to identify informal or community-based actors who may not appear in formal institutional networks. This participant selection methodology helps highlight stakeholders who are most relevant to the workshop objectives and are more likely to engage in research efforts (Akinsete et al., 2025a, 2025d).

BRIDGE-BS LLs and DOORS MAFs were implemented through a series of three and two (respectively) participatory workshops (Table 3) following the SIA framework (Table 1). Both efforts engaged stakeholders

Table 3. DOORS and BRIDGE-BS implementation stages.

SIA steps	Project	Activities	Data collection	Tools used	Main outcomes
Step 1: Stakeholder analysis	BRIDGE-BS	Stakeholder mapping and selection of LL participants in six regions across the BS (see Figure 2)	Desk work in liaison with country leaders in each BS country	Influence/ interest matrix	20 to 30 representatives of the local blue economy community engaged in each workshop
	DOORS	Stakeholder mapping and selection of MAFs participants in six countries across the BS (see Figure 2)			
Step 2: Problem scoping	BRIDGE-BS	Workshop No. 1: Identification of the key ecosystem services and the related risks and pressures, blue economy needs, challenges, and opportunities	Online (due to the Covid-19 epidemic) or face-to-face participatory workshops	Individual and group mapping activities (e.g., PESTLE framework, etc.)	A system map providing a holistic and systemic view of challenges and opportunities, and a problem statement expressing the challenge focus of the LL
	DOORS	Workshop No. 1: Prioritisation of the blue economy sectors per BS country and mapping of the challenges related to these sectors			A map of the most important blue economy sectors per country and of the common challenges

Table 3. (Cont.) DOORS and BRIDGE-BS implementation stages.

SIA steps	Project	Activities	Data collection	Tools used	Main outcomes
Step 3: Envisioning a sustainable future	BRIDGE-BS	Workshop No. 2: Validation of system map and co-development of a vision for a sustainable blue economy, integrating and representing all stakeholder perspectives	Participatory face-to-face workshops	Individual and group envisioning activities, as well as visuals to trigger imagination based on the concept of seeds for Anthropocene	A common understanding of the system and a future common vision at the pilot site level (BS coastal regions) was agreed upon across sector and stakeholder groups
	DOORS	Development of a shared vision that reflects the Burgas vision, the CMA for the BS, and the priorities identified in the first workshops	Desk work in liaison with country leaders in each BS country	—	—
Step 4: Path towards sustainability	BRIDGE-BS	Workshop No. 3: Validation of short, mid, and long-term milestones and identification of associated actions per key sectors to support the achievement of the vision	Online (due to the Covid-19 epidemic), face-to-face participatory workshop online (due to the Covid-19 epidemic, the ongoing conflict in Ukraine and limited resources), or face-to-face participatory workshops	Back-casting approach, the three Horizon framework, and the seed for the Anthropocene tool	Blue transformative pathways in each BS region
	DOORS	Workshop No. 2: Validation of the vision and of short, mid, and long-term milestones and identification of associated solutions from the Blue Growth Accelerator per key sector to support the achievement of the vision			

on a national (MAFs) and local (LLs) level from six BS countries, namely, Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine. Stakeholders were involved in individual and group activities for scientists to harness valuable local knowledge to build upon and co-develop scenarios and pathways to guide policy-makers in designing strategy and investment plans for the sustainable development of the blue economy in the BS regions. In between workshops, further interactions with stakeholders occurred in response to project needs. It took the form of online meetings, questionnaires, and communications to keep stakeholders informed on the progress of the projects. These efforts aimed at reaching not only participants but also stakeholders identified as relevant during the stakeholder mapping phase. Additionally, effort was put into disseminating LLs and MAFs results at the regional and European level (i.e., participation in scientific conferences, blue economy community events, etc.) to further attract attention to the initiative and main outputs.

4. Findings

4.1. Blue Economy Priorities Across the BS: A Local and National Perspective

The prioritisation exercise, which is part of the "problem scoping" phase, aims to identify the most important blue economy sectors for the BS countries, as defined by the Caribbean Development Bank (2018). Two approaches were employed in both projects to identify those sectors. In DOORS, participants in each BS country were requested to rank the three most significant sectors in their country, whereas in BRIDGE-BS, the sectors were determined through an analysis of the vision in each local pilot site. In BRIDGE-BS, the participants were asked about the key sectors outlined in the vision, specifically those anticipated to continue propelling the blue economy sustainably over the next 25 years, and to identify the sectors that should be prioritised in the transformative pathways.

The sectors that have been identified as significant in the workshops (MAFs and LLs) conducted under the DOORS and BRIDGE-BS projects are detailed in Table 4. The sectors that are designated as significant in both projects are depicted in green. The sectors that are identified in the MAFs (DOORS project) are in blue, while the sectors in the LLs (BRIDGE-BS project) are in orange. It is straightforward that fisheries, tourism, ports and shipping, and marine transport sectors are prioritised as important in all BS countries in at least one of the workshops held in each country. Those sectors are traditional blue economy sectors and well-established in the region, currently driving the blue economy.

Table 4. BS blue economy sector prioritisation: results from the DOORS (MAFs, National level) and BRIDGE-BS (LLs—Local level).

Sector	Definition	Bulgaria	Georgia	Moldova	Romania	Turkey	Ukraine
Capture fisheries (established)	The practice of obtaining naturally occurring living resources in both freshwater and marine environments in a sustainable manner	National/ Local	National/ Local	National	National/ Local	National/ Local	National/ Local
Marine and coastal tourism (established)	The provision of tourism-related services in and around littoral or marine environments, which support the local community's sustainable development	National/ Local	National/ Local	National	National/ Local	Local	National/ Local
Ports and shipping (established)	It includes the management, operation, and coordination of port terminals, harbours, and maritime logistics services, ensuring the efficient, safe, and environmentally sustainable movement of goods and passengers through maritime gateways	National/ Local	National/ Local	National	Local	Local	National/ Local

Table 4. (Cont.) BS blue economy sector prioritisation: results from the DOORS (MAFs, National level) and BRIDGE-BS (LLs—Local level).

Sector	Definition	Bulgaria	Georgia	Moldova	Romania	Turkey	Ukraine
Marine transport (established)	The transportation of commodities, individuals, and valuable resources through waterways, encompassing lakes, rivers, oceans, and watercraft, in the company of vessels such as ferries, boats, and ships	Local	Local	National	Local	Local	National/ Local
Marine aquaculture (emerging)	The practice of aquaculture and farming with the intention of minimising any adverse effects on the purity of air, water, and soil	Local	National	–	National/ Local	National	Local
Marine research and development (established)	The activities are centred around the advancement of technology, knowledge, and capabilities pertaining to marine environments, encompassing oceans, seas, and other aqueous bodies	National	National	–	National	National	–
Offshore wind energy (emerging)	The design, deployment, and management of wind turbines situated in aquatic environments with the purpose of extracting sustainable energy reserves and generating electrical power	Local	–	National	Local	Local	–
Shipbuilding (established)	The goods and services necessary for the construction, upkeep, restoration, and repair of vessels used for ecologically conscious maritime transportation	–	–	–	–	National	National
Ocean renewable energy (emerging)	The production of pure and renewable energy from natural sources, such as wave, tidal, and solar, at sea, offshore, on land, and in close proximity	–	–	–	National	National	–
Marine business services (established)	The commercial activities that rely on water and are associated with marinas and other vessel service operations	National	–	–	–	–	–

Table 4. (Cont.) BS blue economy sector prioritisation: results from the DOORS (MAFs, National level) and BRIDGE-BS (LLs—Local level).

Sector	Definition	Bulgaria	Georgia	Moldova	Romania	Turkey	Ukraine
Safety and surveillance (established)	Transportation, public spaces, and critical infrastructure are among the domains in which the application of technologies and measures designed to ensure protection, monitoring, and security is underway	–	–	National	–	–	–
Offshore oil and gas (emerging)	The extraction of gas and hydrocarbons from submerged sources	–	–	–	–	National	–

Notes: The BRIDGE-BS project did not implement any LL in Moldova, while ports, shipping, and marine transport were considered as one sector only; green denotes national and local priorities; blue denotes national-level priorities; orange denotes local-level priorities.

The fishing sector is undoubtedly one of the main drivers of the blue economy in the BS, having generated $251 million of income in 2020 according to Food and Agriculture Organization (2020) estimates. However, the BS fleet heavily favours small vessels (Eca4Med, 2023). This activity, though, is also associated with negative externalities for the BS, which has experienced significant stock declines, particularly among predatory fish species, leading to an ecological shift favouring tiny pelagic species such as anchovy and sprat. Overexploitation is widely documented, with many commercial species in the BS being considered overexploited (e.g., turbot, anchovy, horse mackerel, whiting, etc.) or fished beyond sustainable levels (Altmayer, 2025).

Alongside fisheries, coastal tourism is a major economic sector in the BS region: many countries attract millions of tourists annually on a "sea, sand, and sun" basis. For instance, the Black Sea Economic Cooperation region as a whole received 143 million international arrivals in 2018, making it an important tourism region in Europe (UN World Tourims Organization, 2019). In coastal hubs such as Bulgaria's BS coast, the sector has driven rapid infrastructure expansion and posted high foreign tourist flows (e.g., 1.2 million foreign visitors to the southern coast in one recent season; "The Southern Black," 2024). However, the region faces pressing sustainability pressures, including excessive waste, coastline overdevelopment, pollution, eutrophication, and general environmental degradation in coastal zones (Varna University of Management, 2024).

Shipping in the BS has long been dominated by liquid bulk (hydrocarbons, chemicals, etc.) and dry bulk (raw materials) cargoes, which still constitute a large share of cargo volumes. The region's ports have a combined nominal traffic capacity of nearly 700 million tons, though actual usage is significantly lower today (Chkhenkeli & Jikia, 2025). The BS hosts dozens of commercial ports across riparian states, many of them medium to large-scale hubs. Today, the sector faces serious headwinds: the ongoing war has severely disrupted maritime flows and infrastructure (e.g., port blockades, re-routing, sanctions, etc.). Moreover, reliance on fossil fuel traffic (liquid bulk, hydrocarbons, etc.) makes the future uncertain under global decarbonization trends, which could reduce demand for such cargoes and accelerate pressure for greener shipping technologies and more diversified trade flows.

Despite structural and contextual challenges, those three sectors remain a priority for stakeholders from local and national levels to support the development of the blue economy in the region. However, to ensure their long-term sustainability, they will have to transition to new business models and practices. When it comes to emerging blue economy sectors, priorities diverge between local and national levels. Besides marine aquaculture and marine renewable energies, which are perceived as future major economic sectors at the local and national levels, the other sectors have not been identified as a priority at the local level. When certain sectors such as "marine research and development" and "shipbuilding and repair" are considered strategic at the national level, they are not perceived as holding great economic potential at the local level.

4.2. National-Level Challenges and Needs

During the first MAF workshops, the challenges associated with each prioritised sector in each country were identified using the PESTLE framework. These challenges were further validated via an online survey that was completed by 136 stakeholders across the BS. Figure 3 illustrates the hierarchy of challenges that most significantly impact the sustainability of the blue economy for each BS country, both individually and collectively. On a national level, the majority of the participating countries in the BS are experiencing pollution and environmental degradation, which is followed by marine litter and waste management. The absence of a system for beach quality award, such as the Blue Flag, and poor salaries are relatively insignificant.

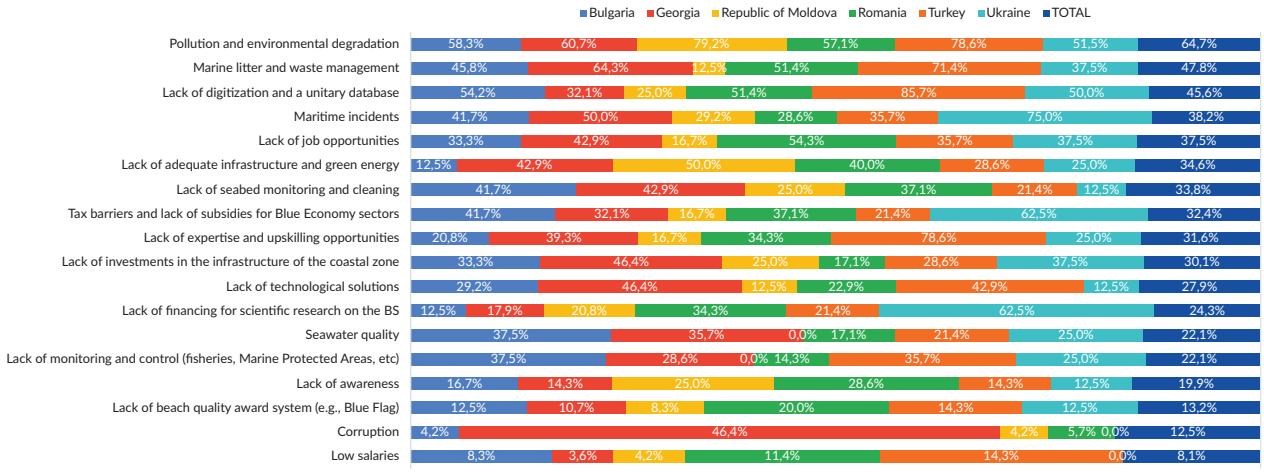

Figure 3. Challenges with the greatest impact on the blue economy development in each BS country. Note: Results from the online survey of the DOORS project.

A closer examination reveals that Bulgaria and Turkey confront their greatest challenge in the absence of digitization and a unified database. This suggests that the digital infrastructure of their governmental and organisational systems might be inadequate, thereby impeding the effectiveness of data management and communication. In the absence of digitization, operational procedures, including record-keeping, information sharing, and decision-making, might experience reduced efficiency and speed. Georgia, the Republic of Moldova, and Ukraine are significantly preoccupied with maritime-related incidents. This implies concerns such as maritime catastrophes, pollution in the seas, illicit fishing, or difficulties associated with port administration and security. It is imperative that these nations, which possess coastlines or substantial maritime investments, address these incidents in order to safeguard their economic and environmental interests.

Figure 4 shows the order of the challenges that exert the most significant influence on the work of individuals and groups in each BS country. For Turkey, Bulgaria, and Georgia, cooperation among national institutions emerged as a primary obstacle. This challenge signifies a formidable task in attaining efficient coordination and collaboration among diverse governmental entities within an individual nation. Insufficient collaboration may result in sluggish decision-making processes, policies that lack coherence, and suboptimal resource allocation. In order to surmount this obstacle, it is imperative to cultivate an environment that promotes collaboration, strengthen channels of communication between agencies, and potentially institute institutional changes that optimise workflows and increase productivity.

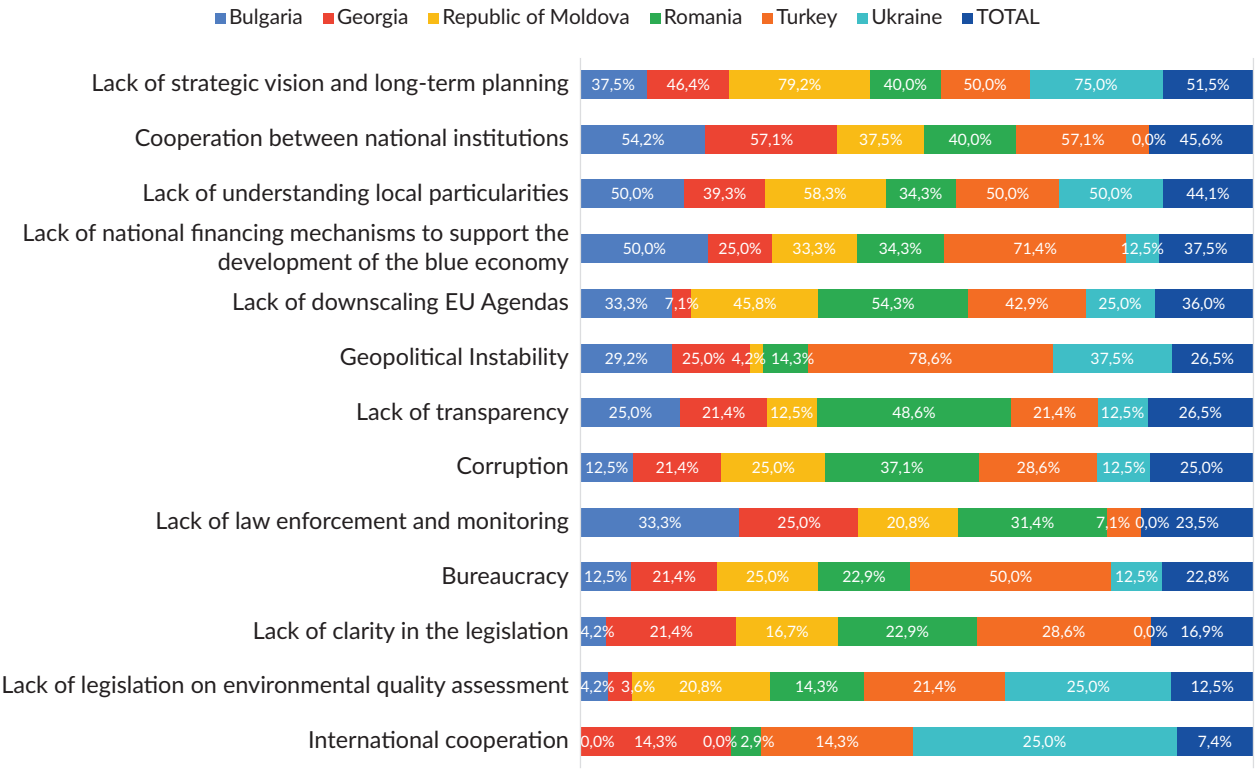

Figure 4. Challenges with the greatest impact on respondents' work in each BS country. Note: Results from the online survey of the DOORS project.

The necessity for interdisciplinary, international, and institutional collaboration to promote the adoption of the blue economy in the BS is readily apparent. Environmental degradation and pollution appear to be the most significant problems in each of the four BS states. At the national level, nevertheless, priorities vary. In Bulgaria, the lack of investments in infrastructure in coastal zones, inadequate infrastructure and renewable energy, and inadequate funding for scientific research on the BS appear to be the most significant obstacles. Georgia faces challenges pertaining to the administration of marine litter and waste, the absence of a beach quality award system, and inadequate funding for scientific research concerning the BS. In conclusion, both Turkey and Romania have prioritised the surveillance and control of marine litter and waste, with Romania emphasising the importance of digitalization.

4.3. Local-Level Challenges and Needs

Each country faces specific challenges and needs related to its historical, cultural, political, and economic environments. Nevertheless, common issues throughout the region can be noticed (Figure 5). The development of a sustainable blue economy in the BS faces numerous common social, economic, technological, and policy challenges, including low public engagement, lack of environmental awareness, weak law enforcement, and insufficient financial resources. Key priorities, across the sea basin, include raising public awareness of environmental and blue economy issues through education and citizen science programs, as the limited qualified workforce in maritime sectors (blue skills) is a challenge in all countries. Strengthening environmental protection by promoting marine protected areas is a common need from region to region. Common economic challenges in BS countries can be summarised in terms of general low financial incentives towards sustainable business models, practices, and sustainable infrastructure investment programs for effectively supporting a blue economy. Finally, BS countries are characterised by structural policy challenges, including a weak regulatory enforcement system, low horizontal and vertical institutional coordination, as well as corruption issues and regular political instability. Streamlining legislation for blue sectors, increasing research funding, and integrating environmental, economic, and social strategies will be critical to achieving a sustainable and thriving blue economy in the region.

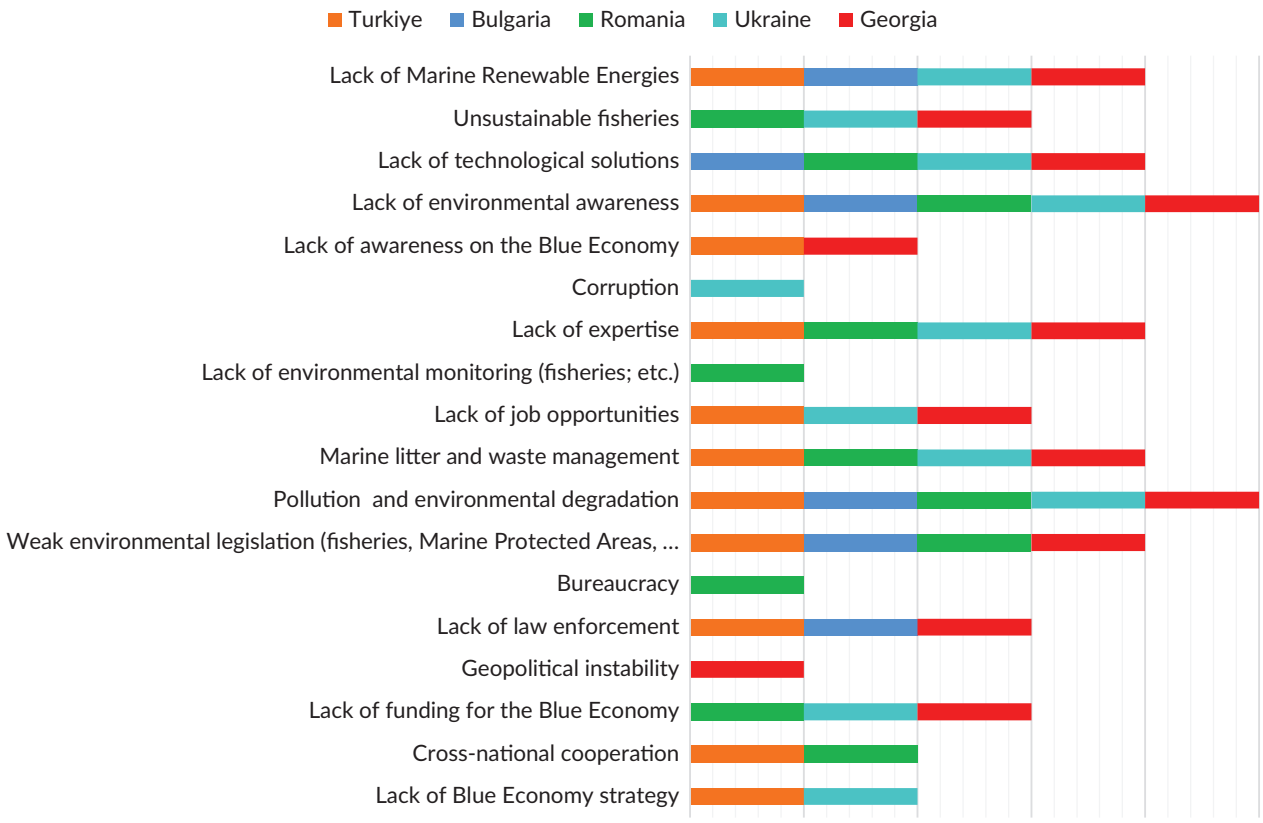

Figure 5. Challenges mentioned by local stakeholders in the BRIDGE-BS LL country workshop.

The challenge mapping shows that the region encounters challenges related to fragmented governance, insufficient institutional capacity, and inadequate policy coordination, which impede adherence to EU and regional frameworks. Environmental pollution, loss of biodiversity, unsustainable fishing practices, and

inadequate local climate action continue to be critical challenges, underscoring the necessity for restoration efforts, ecological education, and nature-based solutions. There is a notable lack of awareness regarding the blue economy, accompanied by limited workforce skills and inadequate public engagement, highlighting the critical need for education and reskilling initiatives. Legally, outdated strategies, bureaucratic complexity, and ineffective law enforcement highlight the necessity for harmonised legislation and integrated marine spatial planning that aligns with EU directives. Technological gaps in innovation, research infrastructure, and digitalisation, such as the lack of marine observatories and smart port systems, hinder modernisation efforts. Limited access to finance, weak business engagement, and low investment in emerging blue sectors hinder sustainable growth. The analysis also illustrates a connected framework in which governance, innovation, and capacity deficits mutually reinforce each other. This interdependence underscores the necessity of cross-sectoral cooperation, stakeholder engagement, and ongoing funding to attain resilience in the blue economy of the BS.

4.4. Local vs. National Perspectives

Several challenges appear to have emerged at both local and national levels. The region encounters challenges related to fragmented governance, insufficient institutional capacity, and inadequate policy coordination, which impede adherence to EU and regional frameworks. Environmental pollution, loss of biodiversity, unsustainable fishing practices, and inadequate local climate action continue to be critical challenges, underscoring the necessity for restoration efforts, ecological education, and nature-based solutions. There is a notable lack of awareness regarding the blue economy, accompanied by limited workforce skills and inadequate public engagement, highlighting the critical need for education and reskilling initiatives. Legally, outdated strategies, bureaucratic complexity, and ineffective law enforcement highlight the necessity for harmonised legislation and integrated marine spatial planning that aligns with EU directives. Technological gaps in innovation, research infrastructure, and digitalisation, such as the lack of marine observatories and smart port systems, hinder modernisation efforts. Limited access to finance, weak business engagement, and low investment in emerging blue sectors hinder sustainable growth. The analysis shows a connected framework in which governance, innovation, and capacity deficits mutually reinforce each other. This interdependence underscores the necessity of cross-sectoral cooperation, stakeholder engagement, and ongoing funding to attain resilience in the blue economy of the Black Sea.

The sectors that should be prioritised include those within the economy that hold significant potential to bolster the blue economy in the BS, specifically fisheries, tourism, ports and shipping, and marine transportation (Table 4). It is clear that many of the local barriers (identified in the BRIDGE-BS Project) are not taken into account in the national challenges (identified in the DOORS Project). National challenges mention low economic resilience and financial crisis, but they do not capture the granular, project-level funding bottlenecks that local actors face—such as lack of investment capital, limited access to EU funds, or the high costs of technology deployment. On a national level, limited technological modernisation is raised, but it doesn't address digital readiness gaps, skills shortages, or standardisation issues that hinder innovation adoption locally. These represent critical enablers for modernisation that remain overlooked in policy discourse. "Fragmented governance" is a term that was frequently mentioned in the MAFs; however, it fails to account for the lack of incentives for local authorities to take action and the fragmentation that occurs at the port or municipal level. Bureaucratic silos, local institutional inertia, and inadequate prioritisation of tourism or fisheries policies are more operational than systemic.

Sociocultural resistance or low community ownership at the local level can affect the implementation of blue transition initiatives. Practical obstacles, such as community buy-in, change management, and stability, are not explicitly reflected in the "political interference" that is acknowledged in national challenges. In addition, tourism-related environmental pressures, waste infrastructure deficits, and regional inequalities in coastal economies are rarely recognised, despite the national discussion of "marine litter" and "environmental degradation." Finally, the skills and training dimensions that are essential for digitalisation, innovation, and sustainable management—particularly problematic in fisheries, tourism, and port operations—were also omitted by nationwide challenges, such as the "lack of education and awareness." The results show that local issues underscore finance deficiencies, digital readiness, and implementation capability, whereas national challenges focus on policy coherence and structural governance.

5. Discussion

5.1. The Added Value of MAFs and LLs

This research employs MAFs and LLs as a mechanism to integrate science with societal realities and acquire valuable insights into local practices. Understanding deeply the factors driving change, elucidating the relationships between coastal communities and the sea, and heightening awareness of human contributions to the ongoing degradation of the marine environment are some of the outcomes participatory approaches can bring. Furthermore, these tools enable participants to engage actively in discussions, consider diverse perspectives, and practice active listening rather than passively engaging in events or surveys. Before each workshop, train-the-trainer sessions were conducted in both projects to guarantee that the facilitators would be capable of handling discussions and facilitating the equal participation of all stakeholders.

MAFs and LLs influence governance learning through three mechanisms: (a) problem re-framing, where actors collectively redefine challenges through shared system maps and, in doing so, recognise interdependencies they previously overlooked; (b) social learning, generated through repeated interaction and reflection, which helps actors internalise alternative practices and understand others' constraints; and (c) experiential governance, where the co-design and testing of solutions (e.g., monitoring tools, new policy concepts, stakeholder networks, etc.) serve as "safe-to-fail" environments that allow institutions to experiment and adjust policies iteratively. Such mechanisms mirror the literature on experimentalist governance (Sabel & Zeitlin, 2012) and transition management.

Here, the stakeholder engagement efforts of both projects addressed the gaps highlighted by Bisinicu et al. (2025) by intentionally including vulnerable and often underrepresented groups—such as small-scale fishers and local community representatives—alongside institutional actors (see Figure 2). Stakeholder selection was guided through the quadruple helix model, which maps actors across academia, industry, government, and civil society (Arnkil et al., 2010). The quadruple helix framework helps identify interactions, gaps, and potential synergies within the socio-economic system, ensuring balanced representation and highlighting where influence, knowledge, and values intersect. As such, it provides a foundation for participatory governance by supporting "user-oriented innovation," where end-users participate as co-designers rather than passive consultees.

Across Romania, Bulgaria, Georgia, and Turkey, the first round of BRIDGE-BS LLs delivered a concrete set of shared key drivers, pressures, and opportunities, supporting the argument for a coordinated regional blue economy strategy. Similarly, the DOORS MAFs generated a stakeholder-owned national challenge map that is explicitly tied into existing regional governance frameworks, such as the CMA and the BS SRIA. In addition, the BRIDGE-BS and DOORS projects have demonstrated that the establishment of effective participatory governance in the ocean–climate nexus necessitates the reconciliation of a persistent disconnect between local and national levels of engagement. The LLs of the BRIDGE-BS project illustrated that local stakeholders frequently encounter difficulty in imagining new opportunities that extend beyond their current activities. Limited institutional capacity, low innovation preparedness, and a lack of skills to adapt to emerging sectors such as blue biotechnology, renewable energy, or digital maritime services have resulted in many communities remaining confined to existing practices. In contrast, policymakers at the national level tend to articulate forward-thinking visions; however, there are still voids in the provision of sufficient support mechanisms, training, and policy alignment to facilitate local transitions. This underscores the necessity of targeted upskilling and reskilling programs, such as those that assist fishers in acquiring competencies that are pertinent to sustainable aquaculture, coastal monitoring, or circular economy activities. In contrast, the MAFs of the DOORS project identified governance challenges predominantly at a higher policy level, frequently without concrete local illustrations, indicating a disconnect between abstract policy discourse and practical, place-based experience. Together, these teachings emphasise the necessity of participatory governance to progress beyond consultation and towards capacity-building, cross-scale alignment, and skill development. This will guarantee that ocean–climate strategies result in tangible, inclusive transformations throughout the blue economy.

5.2. Implications for BS Governance

Persistent disconnects between local and national perspectives reflect well-documented issues in multi-level governance systems, where mandates, resources, and responsibilities are unevenly distributed. In the BS, national ministries retain formal authority over fisheries, shipping, and environmental protection, while local authorities carry implementation burdens without corresponding capacity or financial autonomy. This structural asymmetry creates chronic misalignment between policy ambition and practical delivery. Using insights from the challenge mapping, the region exhibits several "lock-ins": Economic lock-ins, such as dependence on established sectors (fisheries, fossil-fuel shipping, etc.), which discourages risk-taking in emerging sectors; cognitive lock-ins, where actors reproduce familiar routines, hindering innovation uptake; and institutional lock-ins, including rigid hierarchies, bureaucratic procedures, and unclear mandates that impede cross-sector cooperation. These patterns are consistent with Geels (2005) multi-level perspective, where incumbent regimes resist change even in the face of environmental and market pressures.

An additional issue is that in several BS countries, the blue economy remains subordinated to short-term political objectives, patronage networks, and competing geopolitical interests. For instance, political constituencies often use small-scale fisheries, and local tourism sectors are often used as political constituencies, making enforcement politically sensitive. Similarly, fragmented port governance—split between national agencies, municipal authorities, and private operators—creates incentive misalignment that discourages coordinated planning or investment in environmental compliance. These dynamics explain why governance reforms remain slow despite international frameworks like the Marine Strategy Framework Directive, Water Framework Directive, and Common Maritime Agenda. While MAFs and LLs create spaces

for co-learning, they cannot fully compensate for structural deficits such as underfunded local governments, weak regulatory enforcement systems, or politicised decision-making. Therefore, systemic disconnects persist not because participatory tools are ineffective, but because they operate within broader institutional environments shaped by conflicting interests, limited resources, and path-dependent governance traditions.

The MAFs and LLs have demonstrated the pressing necessity of enhancing regional cooperation and governance coherence in a basin that is both environmentally fragile and politically sensitive. Although the projects were conducted in different countries, they both designated the same priority sectors—capture fisheries, marine and coastal tourism, ports and shipping, and marine transport—which are the foundation of the regional blue economy. Nevertheless, these sectors are confronted with systemic governance challenges that impede their sustainable development. These challenges include a lack of interinstitutional cooperation across national borders, persistent political conflict, and limited conformance with EU political obligations. Technological and innovation gaps impede modernisation, particularly in fisheries management and monitoring systems, while environmental degradation, ineffective enforcement of laws, and bureaucratic inefficiencies continue to undermine effective policy implementation. Additionally, local actors are inadequately prepared to capitalise on emergent blue economy opportunities due to inadequate investment in capacity-building and skills. In order to resolve these concerns, it is necessary to establish coordinated regional mechanisms that convert research outputs into actionable governance measures, thereby bridging the science–policy practice divide. In order to establish a more collaborative, resilient, and adaptive governance model for the BS, it is necessary to invest in marine research, innovation, and workforce reskilling, support small-scale fisheries, and harmonise national and EU legislation.

5.3. Broader Lessons for the Ocean–Climate Nexus

Participatory approaches, such as MAFs and LLs, provide valuable, transferable models for governing the ocean–climate nexus in other regional seas. These tools can be customised to suit case studies beyond the BS, such as the Mediterranean, Baltic, or North Seas, where ecosystem-based management and multi-country cooperation are equally important, by integrating stakeholder dialogue, co-creation, and systems thinking. The implementation of global and European frameworks, such as the UN SDGs (SDG 13 on "climate action" and SDG 14 on "life below water"), the EU Mission: Restore our Ocean and Waters, and the UN Decade of Ocean Science for Sustainable Development (2021–2030), is directly influenced by their emphasis on inclusivity and science–policy–society integration. By establishing collaborative spaces for experimentation, innovation, and shared learning, MAFs and LLs assist in the operationalisation of these agendas. Within these spaces, stakeholders collaborate to co-design solutions for climate adaptation, sustainable resource use, and resilient coastal communities. Consequently, the BS experience offers a scalable governance model that demonstrates the effective use of participatory, science-informed processes to expedite the global transition to climate-resilient and sustainable ocean systems.

6. Conclusion

This study shows that despite structural differences across the BS region, the DOORS and BRIDGE-BS projects reveal a consistent pattern: The blue economy continues to rely on four mature sectors—capture fisheries, coastal tourism, ports and shipping, and marine transport—yet these sectors are constrained by governance fragmentation, weak enforcement, environmental degradation, and widening technological and skills gaps.

The findings highlight that sustainable transitions in the region hinge less on identifying new opportunities and more on addressing persistent institutional lock-ins that inhibit change. Limited local capacity, insufficient digitalisation, and the uneven integration of EU standards amplify vulnerabilities across the basin. The added value of participatory approaches lies in how LLs and MAFs surface implementation barriers that are often overlooked by national policies. These include funding bottlenecks, skills shortages, and bureaucratic obstacles that constrain effective action on the ground. By grounding governance dialogue in lived experience and co-creating actionable pathways, these platforms strengthen social legitimacy and accelerate the uptake of innovations essential to climate-resilient ocean management.

For national policymakers, the key priority is institutional coherence: aligning fisheries, environment, tourism, and transport policies, while investing in enforcement capacity, digital monitoring, and targeted upskilling for vulnerable groups. Regional bodies such as CMA/SRIA and Black Sea Economic Cooperation can turn shared priorities into coordinated action on pollution, fisheries control, marine litter, and climate adaptation. For the EU and international organisations, supporting local implementation—skills, standards, data interoperability—remains critical to avoiding widening regional disparities. Future research should examine the durability of participatory outcomes over time, evaluate how LL and MAF processes reshape governance behaviours, and develop comparative evidence on their transferability to other regional waters. Strengthening cross-country longitudinal studies will be essential to understand how ocean–climate transitions can be scaled equitably and effectively across politically sensitive marine basins.

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Conflict of Interests

The authors declare no conflict of interests.

Data Availability

The data supporting the findings of this study are not publicly available.

LLMs Disclosure

This work benefited from the use of AI tools, including ChatGPT and QuillBot, for editing text and data analysis. All analyses and interpretations are the sole responsibility of the authors.

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