DEPARTMENT OF INTERNATIONAL AND EUROPEAN ECONOMIC STUDIES

ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS

Multi-Actor Forums and Innovation Pathways in the Black Sea: The case of Sustainable Fisheries and Aquaculture, and Marine Tourism sectors

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Working Paper Series

25-33

May 2025

Multi-Actor Forums and Innovation Pathways in the Black Sea: The case of Sustainable Fisheries and Aquaculture, and Marine Tourism sectors

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Abstract

The Black Sea possesses significant potential for a thriving blue economy; nonetheless, it encounters distinct hurdles in achieving sustainable growth of marine businesses. DOORS Black Sea, a European Union-funded initiative, seeks to tackle these challenges by creating an open research support system. DOORS implements a system of systems (SoS) to mitigate the effects of human activity and climate change on the marine ecology, fostering 'blue economy' opportunities and revitalising the Black Sea. Engagement with stakeholders is essential for the effectiveness and usefulness of DOORS, as it links residents, research, and industry. Multi-Actor Forums (MAFs) assemble national stakeholders from Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine to aid scientists in prioritising Black Sea concerns. This paper delineates the MAF findings in the formulation of sectoral innovation paths for the Black Sea, integrating the outputs of the MAFs from all Black Sea nations. This approach facilitates the co-design of the region's System of Systems, equipping researchers with the requisite datasets to tackle environmental challenges and promote the sustainability of the Blue System. This study investigates the potential implications of the findings on the long-term development of the blue economy and associated policies in the region.

Key words

Black Sea, Stakeholder Engagement, Multi-Actor Forums, Innovation Pathways, Blue Economy, participatory approaches

1. Introduction

Climate change affects all regions. The melting of polar ice caps is resulting in a rise in sea levels. In certain areas, heat waves and droughts are increasing, whilst in others, extreme weather events and precipitation are escalating. The consequences will intensify if climate action is delayed. Various facets of living are jeopardised by climate change. Throughout the 20th century, sea levels rose, and they have continued to rise in recent years. Ocean thermal expansion is the principal component driving the rise. The thawing of glaciers and Antarctic ice sheets is a significant cause. The dissolution pace of the Antarctic ice sheet will lead to a 60–80 cm rise in sea level in Europe by the century's conclusion. The environment, infrastructure, enterprises, and individuals will all be affected by the intensified coastal flooding and erosion resulting from sea-level rise and other consequences of climate change. Rising sea levels will infiltrate subterranean aquifers with seawater, thereby diminishing freshwater supply. This may also lead to heightened saltwater intrusion into freshwater, potentially impacting agriculture and drinking water. The coastal biodiversity and its associated natural services and goods will be adversely affected. The loss of numerous wetlands will jeopardize the preservation of rare bird and plant species and the prevention of storm surges.

The Blue Economy (BE) is the economic contribution of marine or aquatic ecosystems, such as rivers and oceans, to the prosperity of a country or region. The blue economy of the EU is acknowledged as a significant contributor to economic development in Europe and has been designated as a growth priority, with an annual added value of 500 billion EUR (European Commission, 2012). Concurrently, the European seas are subject to numerous human pressures and are overexploited (Korpinen et al., 2012). Consequently, the European Commission has recognised the necessity of transitioning to a sustainable blue economy in accordance with the objectives of the European Green Deal (European Commission, 2019a). This is only possible through the preservation of marine ecosystem services and their resilience to numerous human-induced stresses.

The Black Sea (BS) is a dynamic geopolitical area situated inside a complex socio-ecological system rich in resources. The Black Sea presents both significant challenges and considerable opportunity in the blue economy industries. A "strategic bridge" links the Mediterranean Sea, Asia, and the Middle East in southern Europe, located on the perimeter of the EU. The region is characterised by its vibrant and diversified nature, which is a result of the high economic potential, divergent interests, and open conflict among the countries (European Commission, 2022). Still, the blue economy of the region is neglected, despite its substantial economic potential. In the Burgas Vision paper and the Common Maritime Agenda, key regional actors emphasized its significance for regional growth (European Commission, 2018, 2019b). The Black Sea is one of the most polluted oceans in the world and also serves as a representation of the poor environmental status of European oceans, despite its abundance of resources. Fish populations have been devastated, and species diversity has been compromised due to inadequate water quality. An imperative transition to a more sustainable Blue Economy development trajectory is necessary due to the socio-economic consequences of poor environmental status on employment, food security, tourism, and health.

The EU is funding DOORS Black Sea[1], a project that aims to provide the Black Sea with optimal and open research support in order to resolve these challenges. The DOORS project is designed to foster a new surge of potential for the 'blue economy' by uniting citizens, scientists, and industry to address the consequences of humans and climate change on the marine ecosystem. This will be achieved by developing a system of systems (SoS). This will be achieved by establishing connections between industry, scientists, and citizens. The level of engagement of the numerous stakeholders is the determining factor in the success, value, and impact of DOORS. They accomplish this by working in conjunction with researchers to cultivate scientific and technological expertise, which subsequently enhances the project's practical significance.

Living laboratories are a common method of involving policy makers, citizens, scientists, and industry in an active manner over an extended period (Ogonowski et al., 2013). It is possible to incorporate the value of concepts and ideas that have been co-created into services that subsequently integrate into society by utilising the living laboratories methodology. Currently, there is no unified definition of living laboratories. The word is associated with a multitude of contexts, processes, and meanings (Yasuoka et al., 2018). Living laboratories have been the subject of scholarly research for over a decade (Ballon et al., 2015; Hossain et al., 2019; Leminen et al., 2017). The existing body of literature investigates living labs as a captivating subject matter that provides a plethora of research opportunities for forward-thinking scholars, as well as an innovative approach, methodology, and design that enables practitioners to overcome a multitude of contemporary challenges and requirements (Rodrigues et al., 2018; Voytenko et al., 2016). Currently, there is a significant increase in the number of operational living labs, with Europe having the highest concentration, followed by Asia and Multi-Actor Forums (MAFs), which are essentially living labs, are being implemented in this context as a distinct stakeholder engagement structure (Guittard A. et al., 2023).

These forums are uniting national stakeholders from Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine, representing a diverse array of backgrounds, to help scientists prioritise Black Sea issues. The focus is on blue economy sectors and policies, as well as the utilisation of innovations to address identified gaps. This strategy also contributes to the co-design of the System of Systems for the region, with the objective of supplying researchers with the datasets necessary to address environmental concerns and develop strategies for the expansion of the blue economy in the region. The System of Systems is intended to provide researchers with the datasets necessary to perform their duties efficiently. The long-term sustainable blue growth of the Black Sea and associated policy in the region are the focus of this study, which investigates the potential consequences of established and emergent blue economy sectors. America. Research in the Black Sea region is limited. In order to perform an effective evaluation of the BE policy framework in the Black Sea, it is essential to have a thorough comprehension of the needs and priorities of the stakeholders and to subsequently adjust the framework to accommodate new policy recommendations.

[1] https://www.doorsblacksea.eu/blackseaaccelerator

Multi-Actor Forums (MAFs), which is essentially Living Labs, are being implemented here as a different form of stakeholder engagement structure (Akinsete et al., 2023). These forums are bringing together national stakeholders from Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine of all different backgrounds to assist scientists in prioritizing Black Sea issues with a focus on blue economy sectors and policies and the use of innovations to fill identified gaps. This strategy also contributes to the co-design of the System of Systems for the region, with the goal of providing researchers with the datasets they need to resolve environmental concerns and establish strategies for the growth of the blue economy in the region. The System of Systems is designed with the intention of giving researchers with the datasets they need to do their jobs effectively. This study explores the prospective consequences that established and emergent blue economy sectors hold for the long-term sustainable blue growth of the Black Sea and related policy in the region, focussing on one of the six DOORS case studies, Georgia.

2. Methodology

The System Innovation Approach (SIA) enables systemic transformation by utilising an interconnected collection of inventions that influence one another and innovate both within the system and its components (De Vicente Lopez, 2016). This research uses transition management and system thinking to solve persistent problems and promote sustainability (Loorbach et al., 2007; Meadows, 2008; Roorda et al., 2014). We emphasise the cross-sectoral system "as a whole" and its diverse actors, rather than concentrating on individual functions or sectoral advantages. Stakeholders are actively engaged in LLs to co-identify a connected collection of innovations that will facilitate the desired change. LLs are open innovation venues that promote user co-creation in order to more effectively address stakeholder demands. In an iterative approach, stakeholders from a variety of backgrounds and dimensions collaborate to resolve problems, generate knowledge, and develop solutions (Geels et al., 2007). They identify common objectives in a desirable future vision and map significant difficulties and requirements associated with the Black Sea Blue Economy. Imagining ideal possibilities is essential for the development of a sustainable future, as it provides a framework for positive change (Bennett et al., 2021; Milkoreit, 2017; Riedy et al., 2022). Pathways will then be co-developed to push the region toward a sustainable state and achieve national goals.

Multi-actor forums, commonly referred to as MAFs, are currently being implemented in this region as an alternative approach to fostering stakeholder engagement. These forums are uniting national stakeholders from Georgia, representing a diverse array of backgrounds, to help scientists prioritise Black Sea issues. The focus is on blue economy policies. The first round of workshops, held between November 2022 and February 2023, aimed at prioritising the blue economy sectors with the greatest value for each of the BS countries, as well as revealing the challenges associated with these sectors, using the PESTLE framework (Seyhan et al., 2025). The second round of MAFs was held between February and April 2024. The goals of the second round of MAFs included downscaling generic innovation pathways produced between workshops, reviewing the working

vision for the Black Sea, identifying milestones for achieving the vision in each relevant sector, and mapping relevant innovations onto these milestones.

The workshop focused on downscaling generic innovation pathways using the backcasting method, creating a "Normative Qualitative Scenario" (Vision) for the DOORS Black Sea Working Vision. This vision is based on the existing Burgas Vision for 2030 (European Commission, 2018) and aims to build on it for a longer time horizon (2050). The validated working vision presented in Figure 1, outlines specific goals, beliefs, and outcomes that represent a future that is more sustainable, equitable, or advantageous for the organization, community, or society. It can be summarised as follows: *"The Black Sea region is a model of resilience, sustainability, and regional cooperation, where societies are connected through innovation, education, and shared environmental stewardship. It fosters multi-disciplinary research and cutting-edge innovation in coastal, marine, and maritime sectors while developing smart, integrated observing and monitoring systems to support sustainable resource management. Through education, citizen engagement, and transparent policy dialogue, opportunities for green jobs are unlocked, ensuring an inclusive transition towards a sustainable blue economy. The region actively mitigates and adapts to climate change, protecting marine and coastal ecosystems while advancing circular economy principles, mobilizing green energy, and implementing innovative production models suited to changing climatic conditions".*

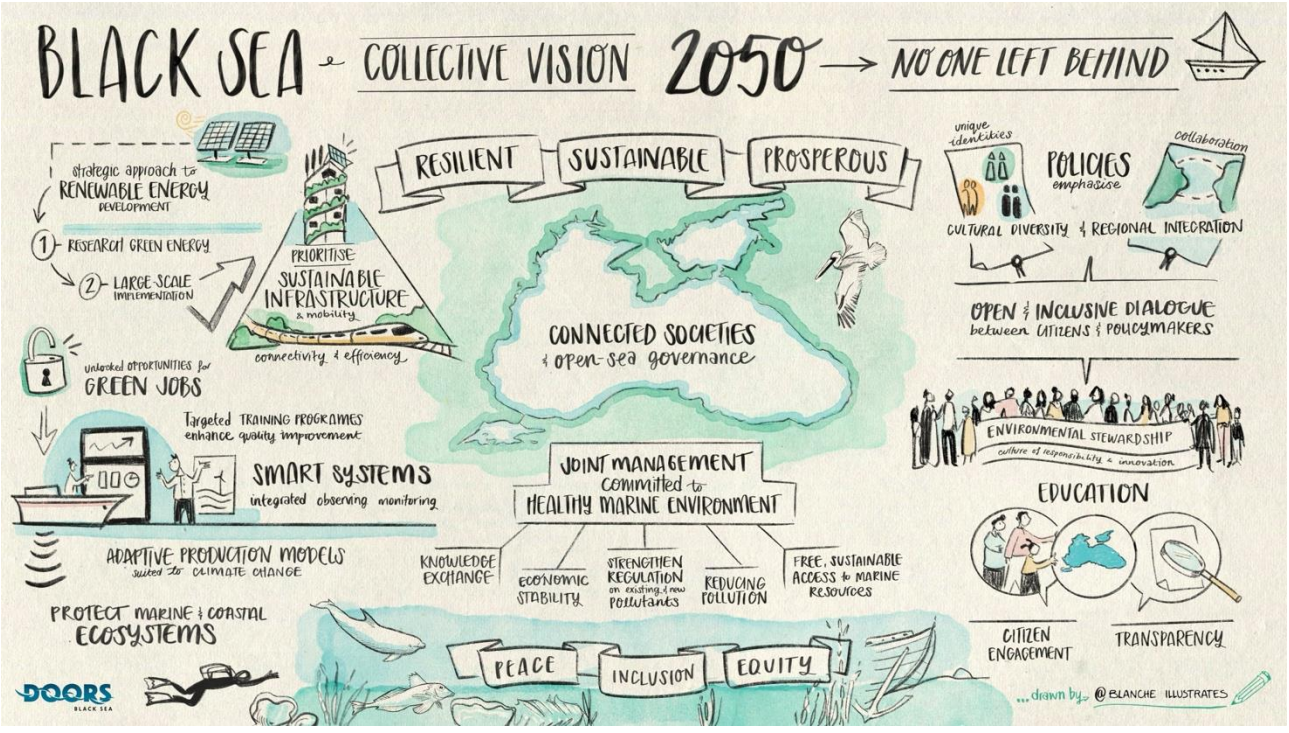

Figure 1 - Working vision for the Black Sea

Key milestones for 2050 were determined using the United Nations Sustainable Development Goals (SDGs), which are widely acknowledged as the most aspirational framework governing sustainable development in the present day. Lee et al. (2020) examined the scientific evidence

about the connection between the BE and the SDGs and the alignment of stakeholders on the relationship between the BE and SDGs. They found that the most pertinent SDGs for the Blue Economy are SDG 12 "Responsible Consumption and Production", SDG 14 "Life Below Water", SDG 15 "Life on Land", SDG 16 "Peach, Justice and Strong Institutions", and SDG 17 "Partnerships for the Goals". The Black Sea Strategic Research and Innovation Agenda (2019) and the BS SRIA Implementation Plan (Connect Black Sea, 2023) were used to pinpoint significant milestones to be achieved by 2030 (see Figure 2). The four main Pillars of the Black Sea SRIA were identified and used as key Milestones for all Black Sea countries.

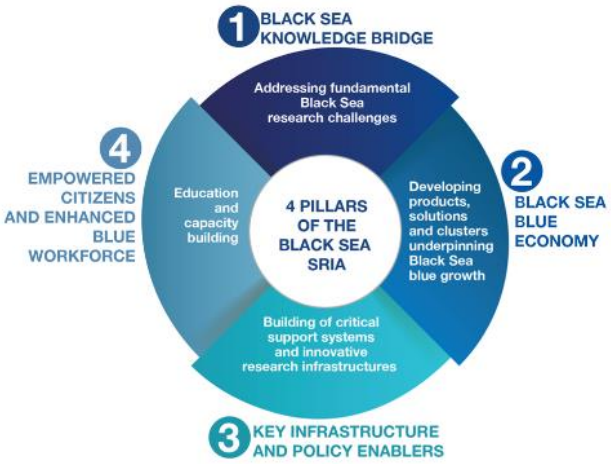

Figure 2 - Four Main Pillars of the Black Sea SRIA (source: (Connect Black Sea, 2019))

Innovation pathways were developed for each BE sector individually, matching prioritised sectors from the 1st MAF (see Table 1) with the BGA BE sectors used in the "Call for Innovation" launched in 2023. The sectors encompassed Ocean Observation, Ports and Transport, Fisheries and Aquaculture, Marine Tourism, Blue Biotechnology, Renewable Energy, and Nature-Based Solutions. During the second workshop, stakeholders were invited to revise the Working Vision and provide feedback. After establishing the vision, they were asked to create different possible pathways or scenarios to help realise the vision for each prioritised sector, as displayed in Figure 3. These hypothetical scenarios demonstrate several potential future advancements, taking into account factors such as technical advancements, societal trends, regulatory changes, and economic growth.

Table 1 - BE Sectors used for the innovation pathways

Sectors	Ocean Observation	Ports & Transport	Fisheries and Aquaculture	Marine Tourism	Blue Bio-technology	Renewable Energy	Nature-Based Solutions

BULGARIA							
GEORGIA							
MOLDOVA							
ROMANIA							
TURKEY							
UKRAINE							

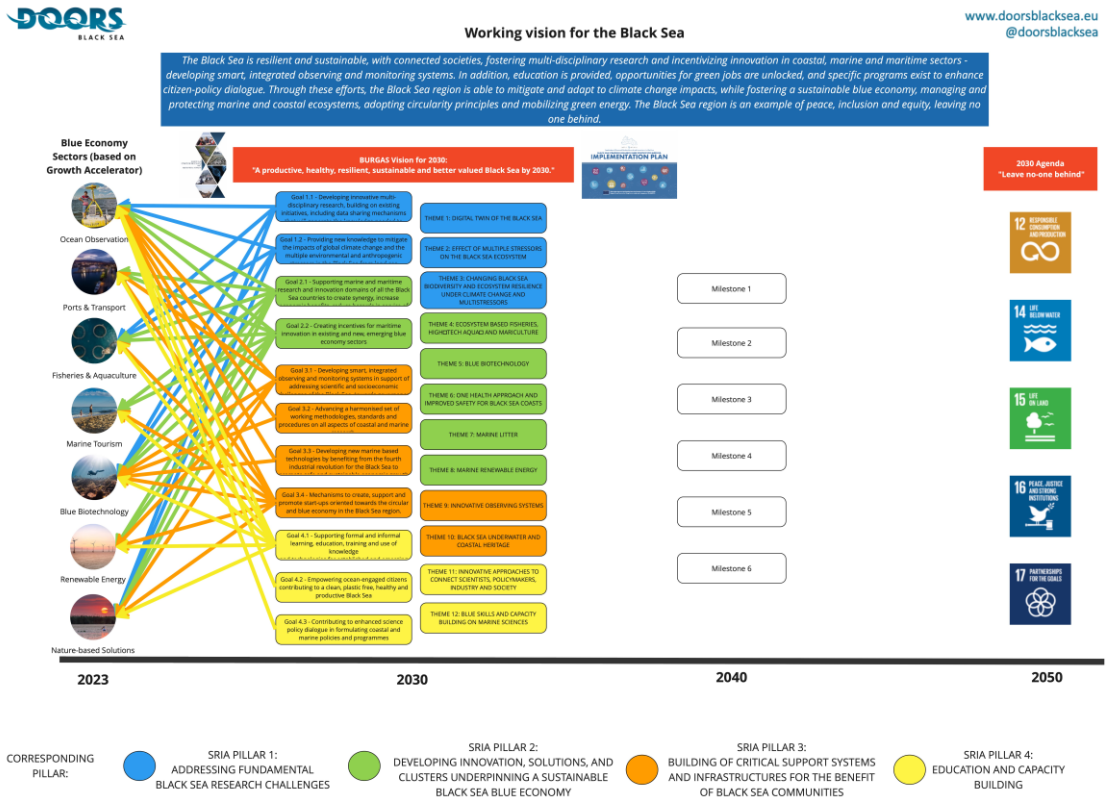

Figure 3 - MIRO Board for the 2nd MAF

3. Results and Discussion

The second round of MAFs led to the development of 26 national innovation pathways, which can be summarised in 6 sectorial innovation pathways for the Black Sea receiving input and feedback from more than 160 stakeholders. The stakeholders validated pathways for each priority sector separately, specifying the critical stages (milestones) that must be surmounted within each designated timeframe. Figure 4 presents an example of a pathway for the "Fisheries and

Aquaculture" sector in Georgia, as developed in the workshop. This paper is focusing on the "Fisheries and Aquaculture" and the "Marine Tourism" sectors which were selected by all BS countries as important, and thus the innovation pathways that correspond to these sectors contain insights from all countries.

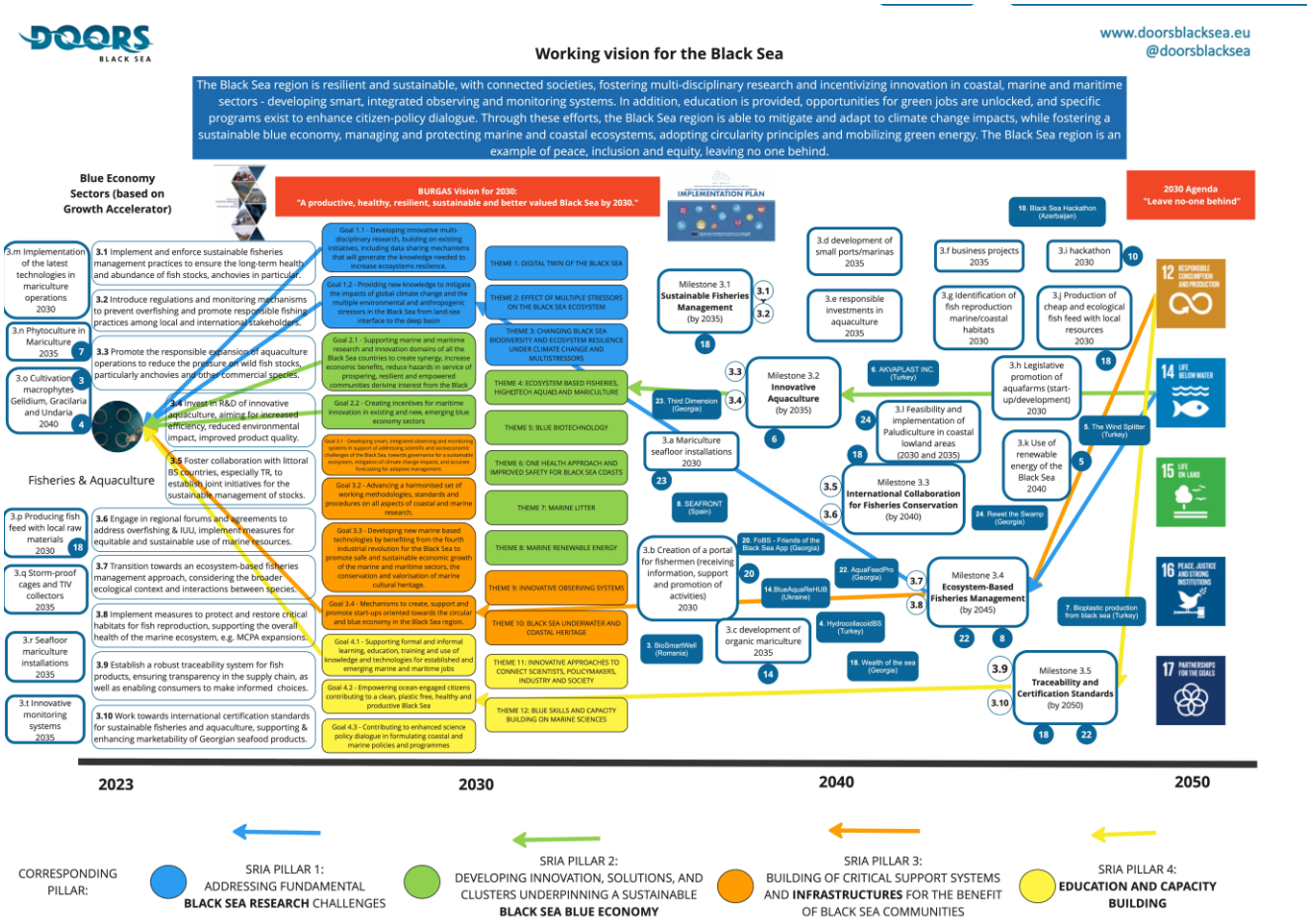

Figure 4 – 2nd MAF in Georgia - Innovation Pathways for the Fisheries and Aquaculture sector (example)

3.1. Fisheries and Aquaculture sector

The "Fisheries and Aquaculture" sector appears to be one of the predominant sectors throughout all six countries. As we can see in Figure 5 and Figure 6, the identified milestones are organised per implementation period: short-term (2025-2030; violet), mid-term (2030-2040; dark blue), and long-term (2040-2050; orange). The first figure displays a condensed map of the pathway, summarising the national milestones into regional milestones. The new milestones are colour-coded according to the SRIA Pillars, with blue indicating Pillar 1, green representing Pillar 2, and so on. The latter figure presents a detailed overview of the milestones co-defined per country, and it is matching them onto innovative solutions (blue boxes). The milestones without corresponding existing

solutions are circled in red and compiled in the right column labelled "innovation gaps". These gaps show the areas where interventions (social, policy, economic, or technological) are needed to support the achievement of the working vision for the Black Sea (Figure 1). For instance, we see that for Bulgaria, there is a need for a holistic management action plan of the natural resources that will ensure the restoration and conservation of the biodiversity in the area.

The innovation pathways within SRIA Pillars 1 and 2 demonstrate a synergistic interaction between the advancement of scientific knowledge and the implementation of practical solutions for a sustainable Black Sea. SRIA Pillar 1 emphasises enhancing comprehension via research to facilitate sustainable, ecosystem-orientated resource management by 2040, promote environmental protection and resistance to climate change effects, and mitigate land-based pollution sources by 2050. This fundamental science supports informed decision-making and strategic planning. Simultaneously, SRIA Pillar 2 facilitates the use of this information via innovation, with the objective of establishing sustainable aquaculture infrastructure by 2030, digitising governance processes for enhanced transparency, and applying circular economy concepts throughout blue economy sectors. It aims to promote sustainable practices in aquaculture and fisheries by 2040 and expedite the region's shift to a low-carbon, climate-resilient blue economy by 2050.

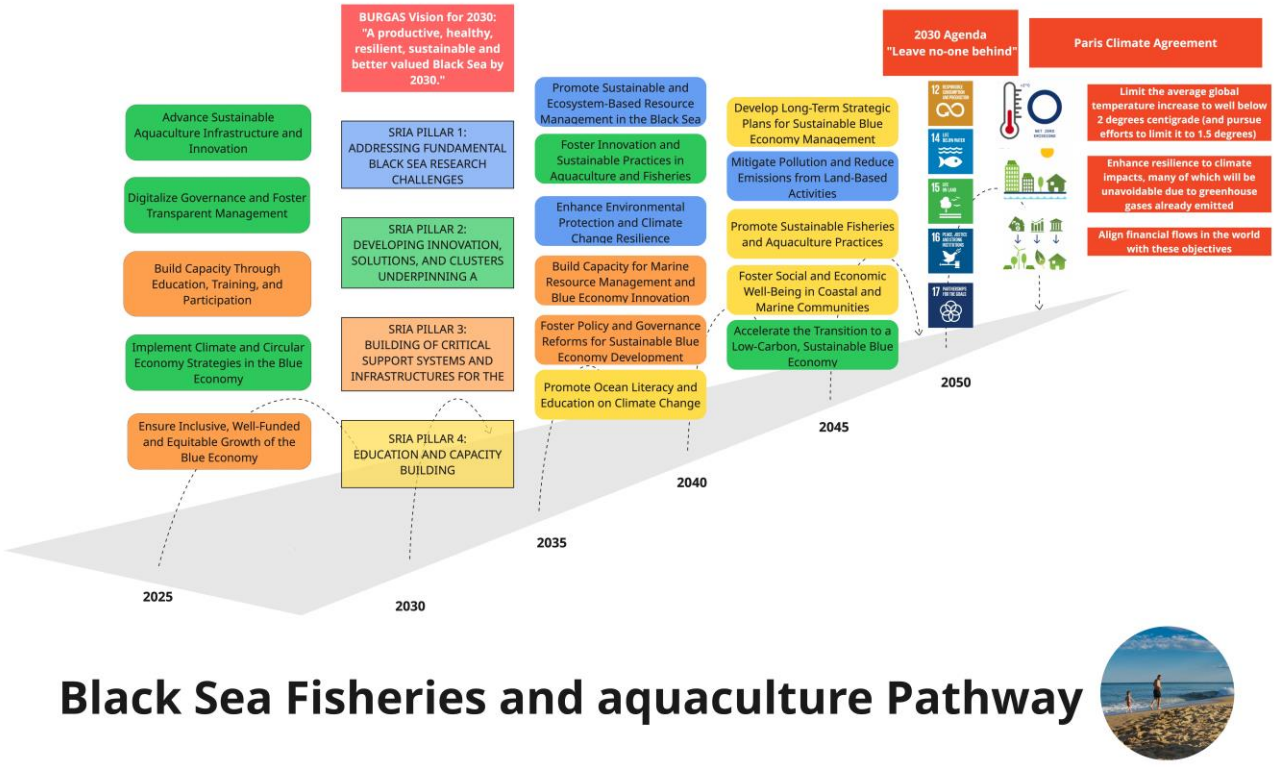

Figure 5 - Innovation Pathways for the Fisheries and Aquaculture sector in the Black Sea

The innovation pathways outlined in SRIA Pillars 3 and 4 highlight the essential human, institutional, and physical underpinnings required to foster a sustainable and inclusive Black Sea Blue Economy. SRIA Pillar 3 emphasises enhancing support systems by augmenting capacity via education, training, and stakeholder engagement by 2030, guaranteeing inclusive and equitable economic development, and establishing infrastructure for efficient maritime resource management and innovation. It also advocates for legislative and governance reforms by 2040 to establish conducive circumstances for long-term sustainability. Simultaneously, SRIA Pillar 4 enhances these initiatives by promoting ocean literacy and climate education by 2040, developing long-term strategic planning curricula for blue economy management, and cultivating comprehension of sustainable fisheries and aquaculture practices by 2050. It further seeks to improve social and economic welfare in coastal areas via focused training and empowerment initiatives.

The specified milestones underscore a joint effort to improve sustainability, environmental conservation, and digital advancement in the marine and fisheries sectors. By 2025, a coordinated effort aims to enhance environmental regulations and monitoring systems and foster a sense of stewardship for conservation among the youth. The use of digital management systems and the integration of digital technology to address corruption signify a proactive initiative to guarantee accountability and transparency in governance within the industry. As time advances, the focus shifts to achieving sustainable mobility, general well-being, and complete legal frameworks that enable decarbonisation by 2030 and beyond. Ecosystem-based fisheries management, the promotion of novel aquaculture techniques, and equitable access to marine resources are programmes that emphasise a commitment to sustainable practices and the fair use of resources. The strategic emphasis on traceability, certification requirements, and technical advancement underscores a progressive approach to enhancing responsible aquaculture and fisheries management, aligning with the broader sustainability goals of the marine sector.

The sustained evolution of the blue economy depends on resolving many significant innovation gaps across interconnected sectors. The last column of Figure 6 shows the areas where interventions are needed. In Ecosystem Restoration and Biodiversity Management, there is an urgent requirement for scalable nature-based solutions—such as paludiculture and coastal forest buffers—coupled with integrated, real-time monitoring systems utilising AI to assess ecosystem health. Cross-border governance and data-sharing mechanisms are crucial for the comprehensive management of marine biodiversity. Innovation is required in sustainable feed (such as plant-based alternatives), carbon-neutral farming approaches, and large-scale Integrated Multi-Trophic Aquaculture (IMTA) under Circular and Sustainable Aquaculture, in addition to strong traceability and certification systems.

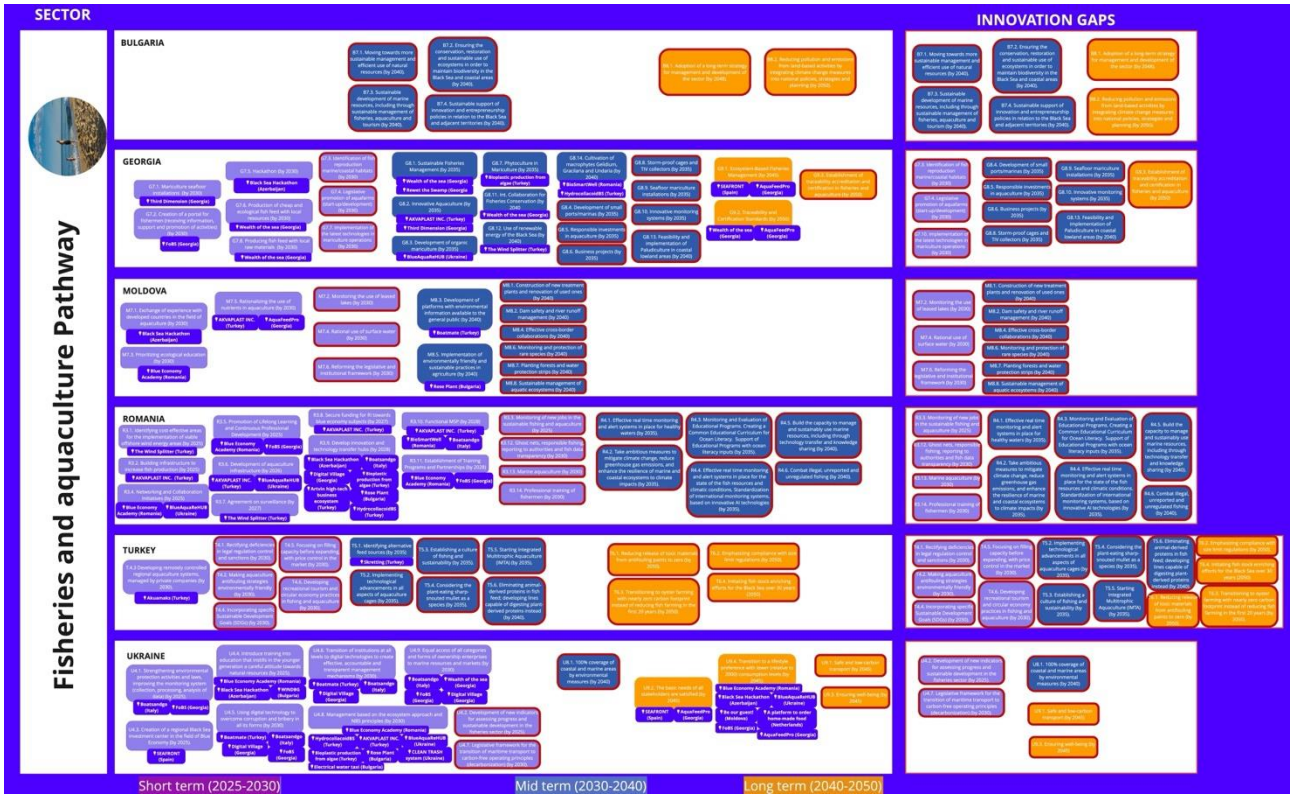

Figure 6 - Innovation Pathways for the Fisheries and Aquaculture sector per Black Sea country

The Fisheries Modernisation & Resource Protection sector necessitates the implementation of sophisticated enforcement mechanisms to identify illicit, unreported, and unregulated (IUU) fishing, alongside the creation of low-impact fishing equipment and enhanced stock management frameworks. With regard to climate-smart infrastructure and pollution control, innovation should facilitate emission-free marine infrastructure, sophisticated wastewater treatment, and novel technology for decarbonising maritime transport. The blue economy innovation and entrepreneurship ecosystem necessitates specialised incubators, customised finance instruments, and market-orientated procedures to facilitate circular practices in tourism and fisheries. Knowledge systems, literacy, and capacity building necessitate cohesive educational frameworks, interdisciplinary training for essential blue economy stakeholders, and the creation of instruments to assess and direct sustainable advancement. In Governance, Policy & Legislative Reform, it is essential to address the critical gaps of harmonising laws, recognising ecological services in institutional planning, and incorporating climate adaptation into long-term goals for systemic transformation.

3.2. Marine Tourism sector

Marine tourism is also set in all six MAFs as a common priority sector. Figure 7 and Figure 8 follow the same rationale described above. Innovation pathways for marine tourism in the Black Sea area

encompass all four SRIA pillars to cultivate a resilient, inclusive, and sustainable industry by the mid-21st century. The pathway connected to Pillar 1 (blue) emphasises ecosystem-based management and conservation (by 2030) via stringent environmental protection, climatic resilience, and enhanced monitoring and regulation (by 2040), establishing a platform for nature-positive tourism by 2050. The Pillar 2 pathway (green) underscores the amalgamation of digital governance, circular economy concepts, and entrepreneurship to propel sustainable infrastructure and cultivate resilient tourist models that are both commercially and environmentally sustainable. Indicatively, the roadmap shows that business ideas, such as digital tourism platforms or digital underwater museums, to be sustainable, need to be supported by sustainable maritime transport systems and sustainable systems of energy, water supply, wastewater and waste management following EU directives. Other milestones under the Pillar 2 pathway mention the elimination of single-use materials as well as the tourism waste and the illegal dumping of trash.

The Pillar 3 pathway (orange) is grounded in establishing enabling circumstances by investing in sustainable transportation, connectivity, and inclusive growth by 2030, thus assuring equitable advantages of marine tourism for coastal communities. Some examples of tourism development include diving tourism and recreational fishing, as well as the development of sea transportation between cities with a coastline on the Black Sea and the establishment of facilities for cruise ships. Pillar 4 (yellow) ultimately bolsters these objectives by advocating for education, awareness, and sustainable governance measures to facilitate capacity building and leadership for a flourishing marine tourist sector in the Black Sea by 2050. Ocean literacy is central to this initiative aimed at educating both residents and visitors about the advantages and difficulties, enabling them to make educated and responsible choices about ocean stewardship and resource utilisation.

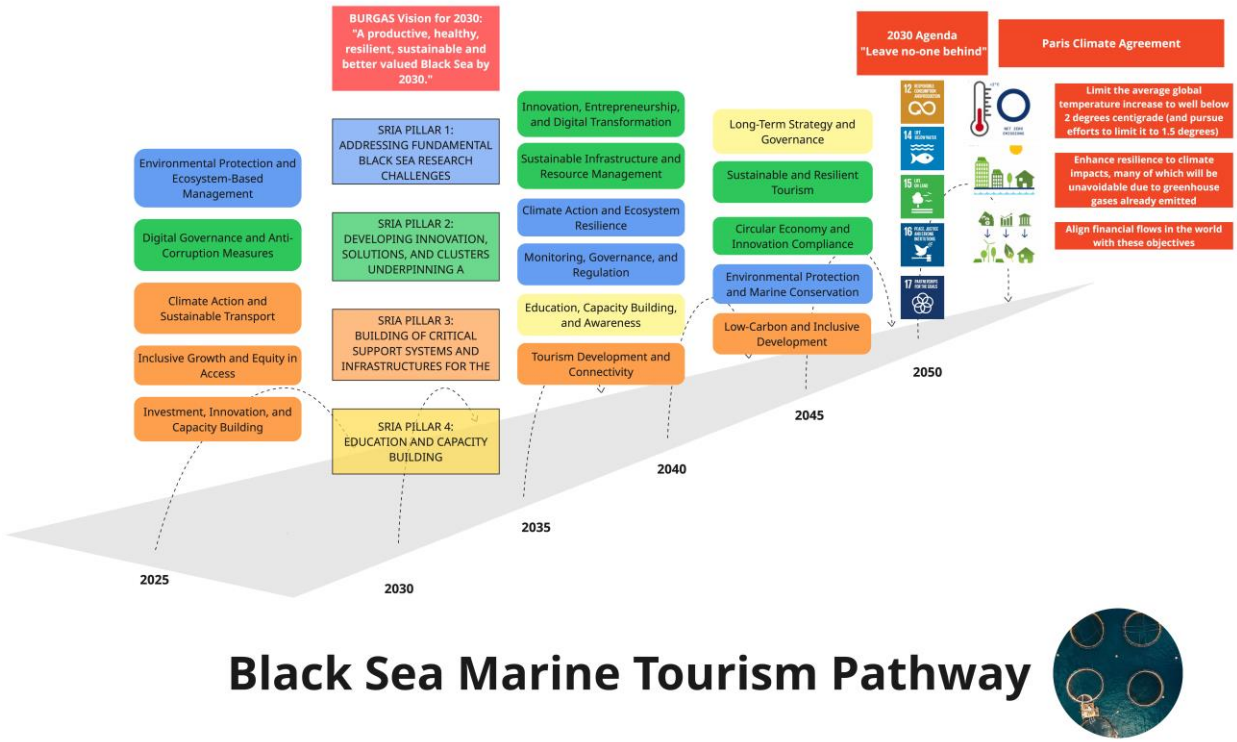

Figure 7 - Innovation Pathways for the Marine Tourism sector in the Black Sea

As we see in Figure 8, innovative solutions coming mainly from the BGA are unable to address all the needs of the sector. The last column of Figure 8 shows the areas where interventions are needed. To bridge the innovation gaps in the Black Sea area, comprehensive governance, legal, and regulatory frameworks are required. This entails the formulation of cohesive regional policies that align maritime development with sustainable tourism, accompanied by enforced measures to address illicit activities such as overfishing, seabed exploitation, and unauthorised resource extraction in protected zones. A comprehensive management strategy (e.g., milestone B11.1) is crucial for steering the sector until 2048, while immediate measures such as seabed legislation (G10.2), a decarbonisation regulatory framework (U7.8), and initiatives to address illegal fishing (M10.1) should be prioritised to safeguard biodiversity and marine ecosystems.

Simultaneously, climate resilience and environmental protection necessitate nature-based solutions for the rehabilitation of rivers and coasts, alongside data-driven marine monitoring systems to assess and manage pollution, emissions, and climate effects—ensuring extensive environmental oversight across coastal and marine areas by 2040 (U8.1). Concurrent advancements in blue tourism, marine safety, and human capital development are essential for fostering a resilient coastal economy. Promoting sustainable tourism frameworks that mitigate seasonality and environmental challenges while empowering local populations is essential (as detailed in milestones T7.1 and T8.1–T8.5). This encompasses allocated zones for diving and recreational fishing, social engineering to alter public opinions of marine tourism, and the establishment of low-carbon, urban-integrated maritime transport and cruise infrastructure. To

protect these advancements, integrated monitoring systems (M10.2), marine safety instruments (G10.6), and emergency response capabilities are essential. The foundation of this initiative is the necessity for a proficient workforce: cross-sector educational programs, ocean literacy curricula (R6.2), and reskilling partnerships (B9.1, R3.11) must be expanded by 2035 to guarantee a future-ready populace adept at navigating and spearheading the transition to a sustainable Blue Economy.

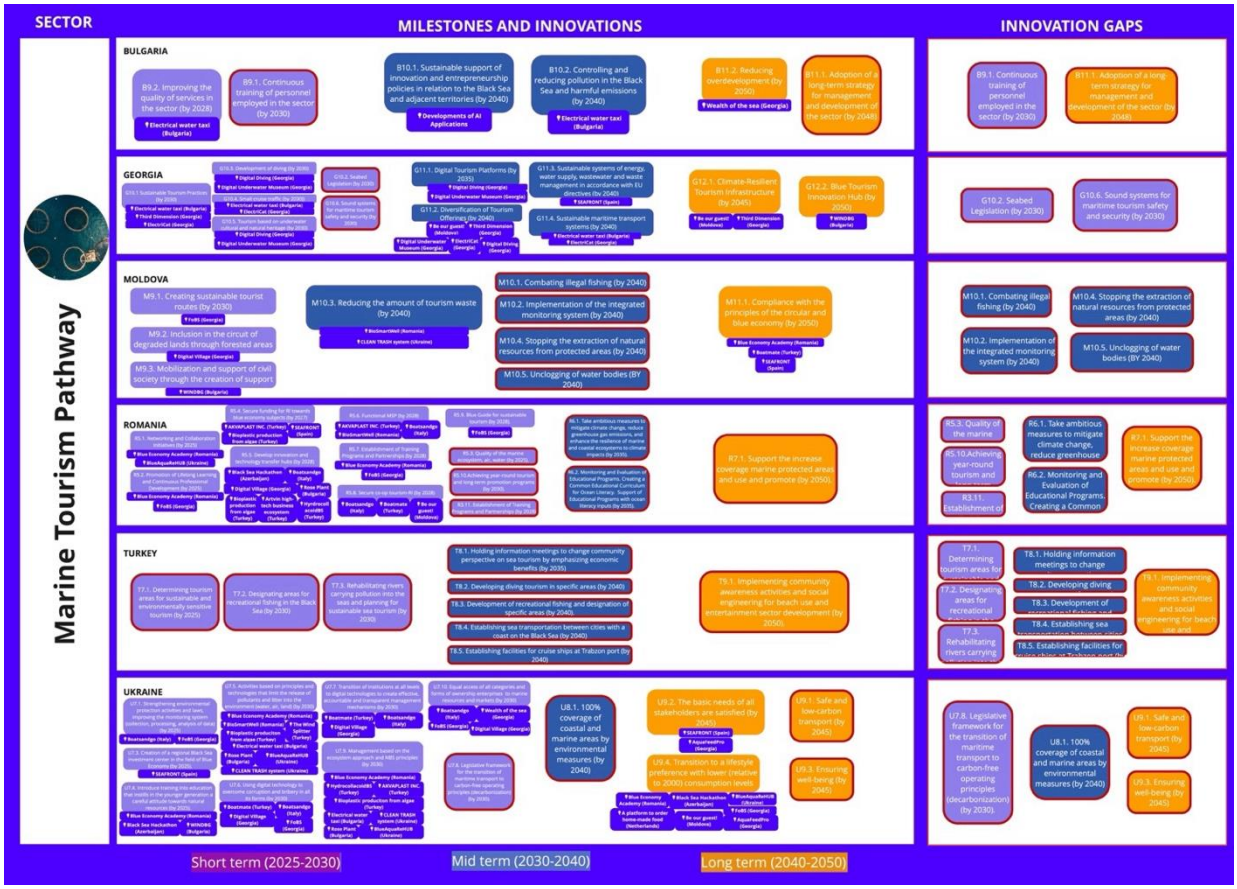

Figure 8 - Innovation Pathways for the Marine Tourism sector per Black Sea country

4. Conclusions and Future Research

The Black Sea, a resource-rich region, presents both challenges and opportunities for the blue economy. This research was conducted under the auspices of the EU-funded DOORS Black Sea project, which aims to address these issues by linking individuals, scientists, and industry to alleviate the effects of human activity and climate change on marine ecosystems. Multi-Actor Forums (MAFs) effectively included national players from six Black Sea countries (Bulgaria, Georgia, Moldova, Romania, Turkey, and Ukraine) to examine issues related to the Blue Economy in the region. In the MAFs, participants from the triple Helix highlighted issues and problems pertaining to the Black Sea, focussing on blue economy sectors; they developed a strategic vision for the Black Sea and customised innovation pathways for each BS country. This study investigates the potential effects of both established and emerging blue economy sectors on the long-term sustainable development of the Black Sea and related regional policies, focussing on the "fisheries and aquaculture" and "marine tourism" sectors, recognised as the principal sectors across all six countries. The System Innovation Approach (SIA) tackles persistent challenges and promotes sustainability.

Pollution, environmental degradation, and the lack of strategic foresight and cooperation are seen as the primary issues for urgent intervention. Despite the burgeoning innovation ecosystem in Europe and the challenges associated with the Blue Economy, there is a lack of mature solutions to effectively monitor the marine environment, support data-driven decision-making, governance, and anti-corruption efforts, improve scientific and technical capacity, and restore ecosystems and biodiversity. Potential solution providers and innovation accelerators seeking to rectify the identified innovation deficiencies in the "fisheries and aquaculture" and "marine tourism" sectors should focus on ecosystem restoration and sustainable aquaculture; governance, policy, and legal frameworks; climate resilience and environmental protection; safety and decarbonisation; monitoring and risk management; as well as capacity building and ocean literacy. Investment in these industries has the potential to revolutionise the Black Sea.

Acknowledgment

This paper is an output of the science project DOORS. DOORS has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under grant agreement No. 101000518. This work benefitted 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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