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From Stakeholder Priorities to Blue Economy Transition Pathways:

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Abstract

The transition towards a sustainable Black Sea blue economy requires coordinated responses to shared environmental, socio-economic and governance challenges while recognising differences in national and sectoral contexts. This study examines the convergence and divergence of stakeholder-defined blue economy transition pathways developed through Multi-Actor Forums (MAFs) conducted in six countries: Bulgaria, Georgia, the Republic of Moldova, Romania, Türkiye and Ukraine. Drawing on the participatory processes undertaken within the EU-funded DOORS project, the analysis examines 309 milestones across six blue economy sectors: ocean observation, ports and maritime transport, fisheries and aquaculture, marine tourism, blue biotechnology, and marine renewable energy. A literature-informed thematic classification framework comprising 14 dimensions was applied to assess the thematic composition of the pathways, using raw and fractional thematic weights to identify similarities and differences across countries and sectors. The temporal distribution of milestones was also examined across short-, medium- and long-term implementation horizons extending to 2050. The findings reveal convergence around broad sustainability objectives, particularly environmental protection, governance and sustainable resource management, alongside considerable variation in the interventions proposed to achieve them. Country-level differences are reflected in the relative emphasis placed on technological development, scientific capacity, infrastructure and socio-economic objectives, while sectoral comparisons demonstrate that similar long-term ambitions may be pursued through different combinations of regulatory, technological and infrastructural measures. Almost half of the milestones are concentrated in the short-term horizon (2025–2030), although their temporal distribution varies across countries and sectors. Overall, the findings highlight the coexistence of shared regional ambitions and differentiated national transition pathways, suggesting that effective Black Sea cooperation should build on common objectives while accommodating context-specific priorities and implementation approaches. The study demonstrates how participatory milestone analysis can support the comparative assessment of sustainability transitions and inform more coordinated regional blue economy planning.

1. Introduction

The Black Sea is a strategically important marine basin connecting Europe and Asia and supporting a wide range of economic activities, including fisheries and aquaculture, maritime transport, coastal tourism and emerging ocean-based industries. These activities contribute to regional development and coastal livelihoods, but their long-term sustainability depends on the condition of the marine environment and the capacity of countries to manage shared resources. As a semi-enclosed sea with limited water exchange and distinctive ecological characteristics, the Black Sea is particularly vulnerable to the cumulative effects of human activities and environmental change. Eutrophication, chemical pollution, overexploitation of marine living resources, invasive species and habitat degradation have long been recognised as major transboundary challenges (Black Sea Commission, 2009). Climate change adds further pressure through warming, deoxygenation and changes in marine ecosystem dynamics, with implications for biodiversity, fisheries and other ocean-based activities (Black Sea Commission,

2019; EPRS, 2025). These interconnected pressures underline the need to reconcile economic development with environmental protection and ecosystem resilience.

The transition towards a sustainable blue economy is therefore particularly relevant to the Black Sea region. The concept of the sustainable blue economy extends beyond the expansion of ocean-based economic activities to consider their environmental sustainability, resource efficiency, social benefits and long-term resilience (Bennett et al., 2019; European Commission, 2021; OECD, 2016, 2025). However, achieving these objectives is challenging in a region characterised by differences in economic development, institutional arrangements, technological capabilities and sectoral priorities. The Black Sea countries share a marine ecosystem and many associated environmental pressures, yet they operate within different national policy frameworks and face different constraints in mobilising investment, developing infrastructure and implementing sustainable practices. These challenges have been further complicated by Russia's war against Ukraine, which has disrupted maritime activities, damaged infrastructure and created additional environmental risks, while also affecting opportunities for regional cooperation (EPRS, 2025). In this context, advancing a sustainable blue economy requires not only common objectives but also a better understanding of how these objectives can be translated into actions that respond to national and sectoral circumstances.

Regional cooperation has progressively become an important component of efforts to address these challenges. The Convention on the Protection of the Black Sea Against Pollution, commonly known as the Bucharest Convention, established an early framework for cooperation on marine environmental protection, while the Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea identified priority transboundary environmental problems and corresponding management actions (Black Sea Commission, 2009). More recently, the Common Maritime Agenda for the Black Sea (CMA), endorsed in 2019, established a regional framework for promoting healthy marine and coastal ecosystems, a competitive and sustainable blue economy, and investment in maritime activities (European Commission, 2019). In parallel, the Black Sea Strategic Research and Innovation Agenda (SRIA) sought to strengthen scientific knowledge, research and innovation, supporting infrastructures, and education and capacity building. Together, these initiatives reflect a growing recognition that the region's environmental and economic challenges cannot be addressed effectively through isolated national or sectoral measures.

Stakeholder engagement has played an increasingly important role in the development of these regional agendas. The Black Sea CONNECT initiative, which supported the development and implementation of the SRIA, adopted a multi-country, multidisciplinary co-creation process involving policymakers, researchers and other relevant actors. Through national consultations and regional dialogue, stakeholders contributed to identifying common challenges, research needs and priorities for future action (Salihoglu et al., 2024). Such processes are particularly relevant in the Black Sea, where the development of shared strategies must accommodate differences in national capacities, policy priorities and sectoral interests. By incorporating knowledge from actors directly involved in marine and maritime

activities, participatory approaches can complement scientific and policy assessments with practical insights into implementation barriers, opportunities and local development needs.

More recent studies have examined stakeholder perspectives on the barriers and opportunities associated with sustainable blue economy development in the region. Seyhan et al. (2025), drawing on a multi-sectoral stakeholder forum in Türkiye, identified challenges relating to fisheries management, environmental pressures, technological development, institutional coordination and access to financial resources. Their findings highlighted the importance of stronger science-based governance, regulatory enforcement and collaboration across sectors. Similarly, Papadaki et al. (2026a), examining the application of Multi-Actor Forums within the DOORS project, demonstrated how structured stakeholder engagement can support the identification of sectoral priorities and the co-creation of blue economy transition pathways. Extending this perspective, Papadaki et al. (2026b) analysed participatory processes undertaken through the DOORS and BRIDGE-BS projects, identifying recurring challenges such as fragmented governance, limited technological and institutional capacity, and difficulties translating policy ambitions into local implementation. These studies demonstrate the value of participatory approaches for understanding the conditions affecting sustainable blue economy development, while also revealing the complexity of coordinating transitions across different countries and sectors.

The need to understand these differences can be further situated within the literature on sustainability transitions. Transitions are generally understood as long-term processes involving changes in technologies, institutions, markets, infrastructures, social practices and governance arrangements (Geels, 2002; Markard et al., 2012). They are shaped by interactions among multiple actors and by the specific institutional and socio-economic conditions in which they unfold. Transition governance therefore requires approaches that recognise uncertainty, facilitate collective learning and support the development of shared long-term directions while allowing for adaptation to changing circumstances (Loorbach, 2010). Participatory visioning and pathway development can contribute to these processes by enabling stakeholders to articulate desired futures and identify interventions considered necessary to move towards them. Importantly, however, agreement on a common vision does not necessarily imply agreement on the measures required to achieve it, or on the order and timeframe in which these measures should be implemented.

This distinction is particularly important in a transboundary setting such as the Black Sea. Countries may share broad objectives relating to environmental protection, sustainable resource management and technological innovation, while differing in the relative emphasis they place on regulatory reform, infrastructure development, scientific capacity, investment or changes in production practices. Similar differences may arise between sectors, reflecting their distinct technological requirements, environmental pressures and governance arrangements. Examining these variations can provide a more detailed understanding of regional alignment than assessments based solely on common challenges or strategic objectives. In particular, identifying where national and sectoral pathways converge or diverge may help reveal opportunities for cooperation, complementary investments and knowledge exchange, as well as areas where differentiated approaches are likely to be necessary.

Although existing Black Sea initiatives and studies have made important contributions to identifying blue economy challenges, stakeholder priorities and opportunities for collaboration, less attention has been given to the systematic comparison of the specific milestones through which stakeholders envisage achieving long-term sustainability objectives. Previous participatory research has largely focused on identifying needs and barriers, prioritising sectors, or examining the outcomes of individual engagement processes. A comparative assessment of the thematic composition and temporal distribution of stakeholder-defined milestones can extend this work by examining not only what countries and sectors seek to achieve, but also how and when they propose to pursue these objectives. Such an assessment is particularly relevant for understanding whether shared regional ambitions are accompanied by similar intervention priorities or whether they give rise to differentiated national and sectoral pathways.

Against this background, the present study examines the convergence and divergence of blue economy transition pathways developed through the second round of Multi-Actor Forums (MAF2) organised within the EU-funded DOORS project. The analysis draws on 309 stakeholder-defined milestones from Bulgaria, Georgia, the Republic of Moldova, Romania, Türkiye and Ukraine, covering six sectors: ocean observation, ports and maritime transport, fisheries and aquaculture, marine tourism, blue biotechnology, and marine renewable energy. Using a common framework of 14 thematic dimensions, the study assesses the thematic composition of national and sectoral pathways, identifies areas of convergence and divergence, and examines the distribution of proposed milestones across short-, medium- and long-term implementation horizons extending to 2050.

The study addresses three research questions: (i) What thematic priorities characterise the national and sectoral blue economy transition pathways developed through the DOORS Multi-Actor Forums? (ii) To what extent do these pathways converge or diverge across countries and sectors, despite their shared long-term sustainability objectives? and (iii) How do the proposed milestones and thematic priorities vary across implementation horizons? By addressing these questions, the study contributes to the understanding of participatory sustainability transitions in transboundary marine regions. It also provides a comparative analytical approach for examining how common regional visions are translated into context-specific pathways, with implications for the coordination of blue economy policies, investments and cooperation initiatives in the Black Sea.

2. DOORS Multi-Actor Forums

The Multi-Actor Forums (MAFs) were established within the EU-funded DOORS project as participatory platforms to support the transition towards a sustainable blue economy in the Black Sea region. Building on a System Innovation Approach (SIA), the forums sought to bring together stakeholders from academia, industry, public authorities and civil society to identify sectoral challenges, explore opportunities for innovation and contribute to the development of shared visions and transition pathways. The approach recognised that addressing the region's interconnected environmental, economic and institutional challenges requires more than technological solutions; it also depends on successfully engaging with key players in the region, understanding their needs and priorities and setting

together the milestones towards a sustainable future (Akinsete et al., 2025a; Guittard Alice et al., 2023; Papadaki, Akinsete, & Koundouri, 2026). The MAFs were implemented across six Black Sea countries—Bulgaria, Georgia, the Republic of Moldova, Romania, Türkiye and Ukraine—and were designed as a sequential participatory process. Stakeholder identification and engagement followed a quadruple-helix approach, involving representatives from research and academia, government, industry and civil society (Arnkil et al., 2010). The initial stakeholder mapping considered actors' influence and interest in blue economy development, providing a basis for identifying relevant participants and encouraging engagement across different sectors and institutional levels (Akinsete et al., 2025a; Papadaki, Akinsete, & Koundouri, 2026).

The first round of workshops focused on establishing a common understanding of national blue economy contexts and identifying the sectors and challenges requiring particular attention. Participants reviewed established and emerging blue economy activities, prioritised sectors according to their national relevance and examined the political, economic, social, technological, legal and environmental factors affecting their development. The discussions revealed both shared regional concerns and country-specific challenges, particularly regarding environmental degradation, governance fragmentation, insufficient technological capacity and the need for stronger cooperation between research institutions, policymakers and industry (Akinsete et al., 2025a; Seyhan et al., 2025). The second round of MAF workshops, conducted between February and May 2024, built on these initial findings and shifted the focus from identifying challenges towards developing possible transition pathways. After reviewing and refining the emerging vision for the Black Sea, participants co-developed sectoral innovation pathways and identified milestones that could contribute to achieving the desired future conditions. Rather than discussing sustainability objectives in general terms, participants were encouraged to consider the actions, institutional changes, technological developments and investments that would be needed over different time horizons.

The process was supported by participatory foresight tools, particularly the Future Radars approach, which facilitated the identification and sequencing of milestones across short-term (2025–2030), medium-term (2030–2040) and long-term (2040–2050) horizons. Participants also explored the relevance of existing and emerging innovations identified through the DOORS Blue Growth Accelerator, linking proposed milestones to potential technological, organisational or business solutions. This provided an opportunity to connect longer-term sustainability ambitions with more concrete interventions and available innovation opportunities. The resulting pathways reflected both common regional ambitions and the diversity of national development priorities. Across the participating countries, stakeholders identified milestones concerning environmental protection, sustainable resource management, technological innovation, infrastructure development, capacity building and governance reform. However, the proposed interventions varied according to sectoral characteristics and national circumstances. For example, pathways concerning fisheries and aquaculture addressed sustainable production and resource management, while those relating to ports and maritime transport placed greater emphasis on infrastructure, digitalisation and decarbonization (Akinsete et al., 2025b). Ocean observation pathways highlighted monitoring capabilities and data systems, whereas marine tourism

pathways considered sustainable destination development, environmental pressures and service diversification.

The MAF process also contributed to the wider DOORS objective of strengthening the relationship between scientific knowledge, innovation and policy development. Stakeholder discussions informed the identification of research and innovation needs relevant to the project's System of Systems (SoS), while the innovation pathways provided a means of connecting these needs with longer-term blue economy development objectives. As highlighted by Papadaki et al. (2026), participatory approaches of this kind can help address the disconnect between regional policy ambitions and local implementation capacities, particularly where institutional fragmentation, limited resources and insufficient technical expertise constrain the adoption of sustainable practices.

Taken together, the two rounds of MAFs provided a progression from the identification of sectoral priorities and development barriers to the co-creation of future-oriented transition pathways. The second round was particularly important in translating the challenges identified during the initial consultations into time-bound milestones and potential innovation opportunities. These milestones constitute the empirical basis for the present study, which examines their thematic composition and temporal distribution to identify patterns of convergence and divergence across countries and blue economy sectors.

3. Methodology and Data Collection

3.1. Research design and analytical approach

This study examines the extent to which national blue economy transition pathways in the Black Sea region converge around shared priorities or diverge in their proposed approaches to sustainable development. The analysis draws on the transition milestones developed through the second round of Multi-Actor Forums (MAF2) organised within the EU-funded DOORS project. The study adopts a comparative research design combining qualitative content analysis with descriptive quantitative indicators. This approach was selected to capture both the substance of the proposed interventions and the extent to which particular themes recur across countries, sectors and implementation periods. Rather than treating national pathways as directly comparable policy programmes, the analysis considers them as stakeholder-informed representations of possible transition directions, shaped by different environmental, institutional and socio-economic circumstances.

The analytical approach builds on sustainability transitions research, which understands systemic change as a process involving technological development, institutional adaptation, changes in practices and interactions among multiple actors (Geels, 2002; Markard et al., 2012). From this perspective, the transition towards a sustainable blue economy cannot be reduced to the adoption of new technologies or the expansion of individual economic activities. It also depends on the development of appropriate governance arrangements, scientific and technical infrastructure, financing mechanisms and forms of

cooperation that enable innovations to emerge and become embedded in existing systems (Hekkert et al., 2007; Loorbach, 2010).

3.2. Data sources and units of analysis

The analysis uses the national transition pathways documented through the DOORS MAF2 process. The dataset comprises 309 identifiable milestones developed for Bulgaria, Georgia, the Republic of Moldova, Romania, Türkiye and Ukraine, covering six blue economy sectors: ocean observation, ports and maritime transport, fisheries and aquaculture, marine tourism, blue biotechnology and marine renewable energy. The individual milestone was selected as the primary unit of analysis. Each milestone represents a proposed intervention, institutional change, investment, technological development or longer-term sustainability objective. The original milestone descriptions were retained, together with information on the country, sector, target year and implementation horizon. The milestones were organised according to the three planning horizons used in the national pathways: short-term (2025–2030), medium-term (2030–2040) and long-term (2040–2050). Where an individual target year was specified, this information was recorded separately to preserve the temporal detail of the original pathway. This distinction was important because milestones assigned to the same planning horizon did not necessarily share the same implementation deadline. Retaining both variables made it possible to examine broad transition sequences while also considering differences in the timing of specific interventions.

The dataset also includes references to innovations identified as potentially relevant to individual milestones during the DOORS process. These matching innovations were retained as contextual information but were not used as an independent basis for assigning thematic codes. This separation was necessary to distinguish the objectives explicitly stated by stakeholders from the technological or organisational characteristics of possible solutions associated with those objectives.

3.3. Development of the thematic classification framework

To enable comparison across countries and sectors, a common thematic coding framework was developed through a literature-informed deductive approach. The purpose was to identify a set of analytical dimensions broad enough to accommodate different blue economy activities while remaining sufficiently specific to distinguish between technological, institutional, environmental and socio-economic interventions.

The framework draws on three complementary strands of literature. The first strand of literature focuses on marine knowledge, science and technology, providing the conceptual basis for examining ocean observation and blue biotechnology. Research on ocean observing systems emphasises the importance of sustained scientific measurements, monitoring networks and research infrastructures for understanding marine processes and supporting evidence-informed decision-making. Lindstrom et al. (2012), through the Framework for Ocean Observing, highlight the need for coordinated observation systems that connect scientific requirements with the collection and delivery of ocean information. Building on this framework,Tanhua et al. (2019) demonstrate how sustained observations, technological advances and international coordination contribute to the development of integrated ocean observing

systems. The management and accessibility of the resulting information are equally important.Wilkinson et al. (2016) introduce the FAIR principles, emphasising that scientific data should be findable, accessible, interoperable and reusable to facilitate knowledge exchange and further research. Beyond ocean observation, theOECD (2016) identifies marine biotechnology as an emerging knowledge-intensive ocean industry, illustrating how advances in marine science and biological research can support the development of new products and applications.

The second strand addresses the sustainable utilisation of marine resources, with particular relevance to fisheries and aquaculture and marine renewable energy. The FAO Code of Conduct for Responsible Fisheries (FAO, 1995) establishes principles for the conservation, management and sustainable use of aquatic living resources, emphasising the importance of responsible harvesting practices, ecosystem protection and effective regulatory arrangements. More recently, the FAO Guidelines for Sustainable Aquaculture (FAO, 2024) highlight the need to balance aquaculture development with environmental sustainability, economic viability and social responsibility, while strengthening governance and institutional capacities. In the energy sector, the European Commission's Offshore Renewable Energy Strategy identifies the development of offshore wind and ocean energy as an important component of the transition towards climate neutrality, while recognising the need for technological advancement, infrastructure investment, maritime spatial planning and the management of potential environmental impacts (European Commission, 2020). Similarly, the OECD (2016) highlights the growing importance of ocean-based renewable energy and the opportunities associated with technological innovation and sustainable resource use.

The third strand concerns maritime infrastructure, transport and coastal services, encompassing ports and maritime transport and marine tourism. The OECD (2016) identifies maritime transport, port activities and coastal tourism among the established components of the ocean economy, highlighting their dependence on infrastructure, connectivity and the environmental quality of marine and coastal areas. Within maritime transport, the International Maritime Organization's 2023 Strategy on the Reduction of Greenhouse Gas Emissions from Ships establishes a framework for the sector's decarbonisation, emphasising the transition towards low- and zero-emission technologies, alternative fuels and improved energy efficiency (IMO, 2023). The European Commission (2021) similarly identifies sustainable maritime transport, greener ports and coastal tourism as important areas for advancing a sustainable blue economy, particularly through decarbonisation, circular practices and investment in sustainable infrastructure. In relation to tourism, UNEP (2005) emphasise that sustainable tourism development requires the integration of environmental protection, economic viability and the well-being of host communities into destination planning and management. Their approach also highlights the importance of stakeholder participation and the equitable distribution of tourism benefits.

Table 1
Literature-based justification of the thematic coding framework

Code	Thematic dimension	Conceptual justification	Literature
OBS	Observation and monitoring infrastructure	Sustained monitoring networks, sensors, observation platforms and scientific infrastructures generate the environmental and operational information required to understand marine systems and support evidence-informed management.	Lindstrom et al. (2012); Tanhua et al., (2019)
DATA	Data management and interoperability	Accessible, interoperable and reusable data systems enable the integration, exchange and application of scientific and operational information across institutions and sectors.	Tanhua et al. (2019); Wilkinson et al. (2016)
TECH	Advanced technologies and digitalisation	Digital technologies, automation, artificial intelligence and other technological advances support innovation, operational efficiency and the transformation of established practices across ocean-based activities.	(Geels, 2002; OECD, 2016; Tanhua et al., 2019)
CAP	Scientific and technical capacity	Sustainability transitions depend on the development of scientific expertise, technical skills, professional competencies and institutional learning capabilities.	Hekkert et al. (2007); Loorbach (2010); Markard et al. (2012)
GOV	Governance and regulation	Sustainable blue economy development requires appropriate institutional arrangements, regulatory frameworks, policy coordination and planning mechanisms to guide resource use and manage competing interests.	Loorbach (2010); FAO (1995); European Commission (2021)
ENV	Environmental protection and resilience	Ocean-based development must maintain ecosystem integrity, reduce pollution and environmental pressures, support climate mitigation and adaptation, and strengthen the resilience of marine and coastal systems.	Bennett et al. (2019); FAO (2024); European Commission (2021)
COOP	Cooperation and institutional integration	Systemic transitions require collaboration among public authorities, research institutions, businesses and civil society, including cooperation across administrative and geographical boundaries.	Loorbach (2010); Markard et al. (2012); Tanhua et al. (2019)
INNO	Innovation and entrepreneurship	The development and diffusion of new technologies, products, services and business models contribute to the transformation of ocean-based economic activities and the emergence of sustainable solutions.	Hekkert et al. (2007); Markard et al. (2012); OECD (2016)

Code	Thematic dimension	Conceptual justification	Literature
FIN	Finance and investment	The development, demonstration and scaling of sustainable technologies and infrastructure depend on access to financial resources, investment mechanisms and sustained resource mobilisation.	Hekkert et al. (2007); OECD (2016); European Commission (2020)
LIT	Ocean literacy and public engagement	Public understanding of ocean systems, environmental awareness and stakeholder participation can support informed decision-making, responsible practices and broader societal engagement in marine sustainability.	Santoro et al. (2017); IOC-UNESCO (2021)
RES	Sustainable resource management and production	The long-term viability of ocean-based activities depends on responsible resource use, sustainable production practices, resource efficiency and the application of circular economy principles.	FAO (1995); FAO (2024); OECD (2016)
INFRA	Blue economy infrastructure and facilities	Sustainable development across ocean-based sectors requires appropriate physical infrastructure, including ports, production facilities, research installations and renewable energy systems, alongside their environmental and operational adaptation.	OECD (2016); European Commission (2020, 2021)
SOC	Socio-economic development and inclusion	Sustainable blue economy development should generate economic opportunities while supporting livelihoods, employment, social well-being, equitable access and the fair distribution of benefits among communities and stakeholders.	Bennett et al. (2019); FAO (2024); UNEP & UNWTO (2005)
MOB	Sustainable mobility, transport and logistics	Maritime transport and logistics systems depend on efficient connectivity, operational coordination and the transition towards safer, more sustainable and lower-emission transport services.	OECD (2016); IMO (2023); European Commission (2021)

On this basis, 14 thematic dimensions were established. Table 1 presents the complete coding framework, including the definitions and literature supporting each dimension The resulting classification was not adopted from a single existing taxonomy. Rather, it represents an analytical synthesis of established concepts, adapted to the characteristics of the DOORS transition milestones and prioritized sectors. The thematic codes describe the nature of the interventions proposed within the six identified sectors. This classification allows the same thematic dimension to be examined across different economic activities and sectors. For example, technological development may concern autonomous observation systems in one sector, digital tourism services in another and smart port operations in a third.

3.4. Milestone classification and coding procedure

The milestones were classified using a deductive qualitative content analysis approach, following the general principles of systematic category development and text classification described by (Schreier, 2012). Each milestone was examined in relation to the 14 thematic dimensions. A non-mutually exclusive coding procedure was adopted because individual interventions frequently address more than one aspect of a transition, as presented in Table 1. For example, the development of AI-supported environmental monitoring systems may simultaneously concern observation infrastructure (OBS), advanced technologies (TECH) and environmental protection (ENV). Restricting such a milestone to a single category would therefore overlook relevant elements of its stated objective.

The classification was represented through a binary coding matrix:

$$x_{ijsc} = \begin{cases} 1, \ if \ milestone \ j \ in \ country \ i \ and \ sector \ s \ addresses \ theme \ c \\ 0, \ otherwise \end{cases}$$

1

The assignment of multiple codes was permitted when the milestone explicitly addressed several thematic dimensions. The coding focused on the stated content of each intervention rather than its possible indirect effects. For example, a milestone proposing the development of aquaculture infrastructure was associated with infrastructure development and sustainable production, but not automatically with technological innovation unless an innovative technological component was explicitly identified. Similarly, milestones concerning environmental protection were not automatically assigned to governance unless they referred to regulatory, policy or institutional measures.

The initial classification was supported by keyword-assisted coding rules implemented in Microsoft Excel. These rules were used to establish a preliminary and consistent coding matrix across the dataset. Because keyword-based approaches cannot fully capture the meaning of context-dependent or broadly formulated milestones, the initial assignments are treated as provisional and require qualitative verification against the original milestone descriptions. The coding matrix was structured to allow individual classifications to be reviewed and adjusted without altering the underlying calculation procedures. Each milestone was also assigned a review status to distinguish provisional classifications from those subsequently validated. This procedure provides a transparent basis for documenting coding decisions and facilitates the revision of ambiguous cases before the final comparative analysis.

3.5. Calculation of milestone-level thematic weights

Following the classification of milestones, descriptive weights were calculated to examine the relative representation of thematic dimensions within each national sectoral pathway. The analysis began by assigning equal overall importance to each milestone within a given country-sector combination. This decision was made because the milestones identified in MAF2 do not provide a consistent numerical ranking according to stakeholder preferences, financial requirements or expected impacts.

For a country i and sector s, the initial weight assigned to each milestone was calculated as:

$$MW_{ijs} = \frac{1}{N_{is}}$$

2

, where:

- MW_{ijs} is the initial weight of milestone j;
- N_{is} is the total number of milestones identified for country i in sector s.

This ensures that the combined weight of all milestones within a country-sector pathway equals one. However, since milestones may be associated with several thematic dimensions, a further adjustment was necessary to avoid assigning a full milestone weight to every thematic category. For this purpose, a fractional allocation procedure was applied:

$$FW_{ijsc} = \frac{x_{ijsc}}{N_{is}k_{ijs}}$$

3

, where k_{ijs} represents the number of thematic dimensions assigned to milestone j.

Under this approach, the weight of a milestone is distributed equally among its assigned thematic dimensions. For example, a milestone associated with two dimensions contributes half of its initial weight to each, while a milestone associated with four dimensions contributes one-quarter to each.

The procedure ensures that each milestone makes the same total contribution to the thematic distribution, irrespective of the number of codes assigned to it. The equal distribution of weight among assigned dimensions is an analytical assumption rather than an empirical assessment of their relative importance. It was adopted to provide a consistent and reproducible basis for comparing pathways with different levels of thematic complexity.

3.6. Aggregation of thematic weights at sector and country levels

Two complementary indicators were calculated to describe the thematic composition of the national pathways: raw thematic weights and fractional thematic weights.

Raw thematic weights

The raw thematic weight measures the proportion of milestones within a country-sector pathway that address a given thematic dimension:

$$RW_{isc} = \frac{\sum_{j=1}^{N_{is}} x_{ijsc}}{N_{is}} \, x \, 100$$

4

, where RW_{isc} is the raw thematic weight of dimension c in sector s of country i.

This indicator expresses the frequency with which a thematic dimension appears in the documented milestones. For example, a raw thematic weight of 60% indicates that six out of every ten milestones in the corresponding country-sector pathway address that dimension. Because milestones may receive multiple codes, the sum of raw thematic weights across all dimensions may exceed 100%. This does not represent a calculation error but reflects the multidimensional character of the proposed interventions. Raw thematic weights were retained because they provide an intuitive indication of the extent to which particular themes recur within each pathway.

Fractional thematic weights

Fractional thematic weights were calculated by aggregating the fractional contributions of individual milestones:

$$FTW_{isc} = \frac{100}{N_{is}} \sum_{j=1}^{N_{is}} \frac{x_{ijsc}}{k_{ijs}}$$

5

, where FTW_{isc} represents the fractional thematic weight of dimension c within the corresponding country-sector pathway.

Unlike raw thematic weights, fractional weights account for the number of thematic dimensions assigned to each milestone. Provided that all milestones receive at least one thematic code, the fractional weights sum to 100% within each country-sector combination. The two indicators therefore provide different but complementary information. Raw thematic weights describe how frequently a dimension appears, whereas fractional thematic weights describe its relative share of the overall coded milestone content. Both measures were retained to avoid relying on a single representation of thematic emphasis.

Country-level aggregation

The same procedure was applied to aggregate thematic weights across all sectors represented within each country. For the raw country-level thematic weight:

$$RW_{ic} = \frac{\sum_{s} \sum_{j=1}^{N_{is}} x_{ijsc}}{\sum_{s} N_{is}} \, x \, 100$$

6

For the fractional country-level thematic weight:

$$FTW_{ic} = \frac{100}{\sum_{s} N_{is}} \sum_{s} \sum_{j=1}^{N_{is}} \frac{x_{ijsc}}{k_{ijs}}$$

7

These indicators describe the overall thematic composition of the documented national milestones. Importantly, this aggregation gives equal weight to individual milestones rather than to economic sectors. As a result, sectors containing more milestones contribute more to the country-level distribution. Country-level results were therefore interpreted alongside sector-specific findings, particularly where the number of milestones differed substantially between sectors. The calculations were implemented in a formula-based Excel workbook, allowing changes to the binary coding matrix to be reflected automatically in the corresponding thematic weights.

3.7. Assessment of thematic convergence and divergence

The comparative analysis examined convergence and divergence at country, sector and temporal levels. Thematic convergence was assessed by identifying the extent to which the same thematic dimensions appeared across the national pathways within each blue economy sector. For each sector and thematic dimension, a country-level presence indicator was defined as:

$$P_{isc} = \begin{cases} 1, \ if\ at\ least\ one\ milestone\ in\ country\ i\ and\ sector\ s\ addresses\ theme\ c \\ 0, \ otherwise \end{cases}$$

8

The sector-specific convergence indicator was then calculated as:

$$C_{sc} = \frac{\sum_{j=1}^{I_s} P_{isc}}{I_s}\ x\ 100$$

9

, where I_s is the number of countries with documented milestones in sector s.

The indicator ranges from 0% to 100%, with higher values indicating that a thematic dimension is represented across a larger proportion of the countries included in the sectoral comparison. For example, a convergence value of 100% indicates that all countries represented in the corresponding sector have identified at least one milestone addressing the thematic dimension. A value of 50% indicates that the dimension appears in half of the countries with available milestones for that sector. The denominator was restricted to countries with documented milestones in the relevant sector, rather

than automatically including all six countries. This avoids treating the absence of sectoral data as evidence that a country did not prioritise a particular theme.

Although the convergence indicator provides a comparable measure of thematic presence, it does not establish that countries attach the same importance to a dimension or propose similar interventions. For this reason, thematic convergence was interpreted alongside the raw and fractional weights. A theme may appear in all countries while accounting for a substantial share of milestones in one national pathway and only a limited share in another. Divergence was therefore examined through differences in thematic frequency, relative thematic composition and the substantive content of the milestones. The analysis also considered whether countries proposed similar objectives through different intervention mechanisms. For example, environmental sustainability may be pursued through regulatory reform, technological innovation, infrastructure investment or changes in production practices. Such cases indicate convergence in the broader objective but divergence in the proposed transition approach.

3.8. Temporal analysis of transition pathways

To examine the sequencing of proposed transitions, milestones were also compared across the short-, medium- and long-term planning horizons. The temporal analysis considered the distribution of thematic dimensions within each period, with particular attention to whether different types of interventions were concentrated at particular stages of the transition. This enabled the assessment of whether national pathways emphasised institutional development, capacity building and preparatory measures in earlier periods, followed by infrastructure deployment, technological transformation or broader sustainability outcomes over longer time horizons.

The analysis also examined differences between countries in the timing of comparable interventions. A thematic dimension may be shared across national pathways while appearing at different stages of their respective transition processes. The temporal comparison was descriptive. The sequence of milestones was interpreted as the intended development trajectory documented through the participatory process, rather than evidence that earlier actions would necessarily cause or enable the achievement of later objectives. Where available, individual target years were used to supplement the broader planning-horizon classification.

4. Results

4.1. Thematic composition of national blue economy transition pathways

The analysis of the 309 milestones reveals considerable variation in the thematic composition of the six national blue economy transition pathways (Fig. 2). Environmental protection and resilience (ENV) emerges as a prominent dimension across all countries, although its relative weight differs substantially. It accounts for the largest share of the fractional thematic weight in Moldova (36.0%), Türkiye (27.1%) and Ukraine (23.2%), and is also among the leading dimensions in Bulgaria (23.0%), Georgia (17.3%) and

Romania (15.8%). This suggests that environmental considerations constitute a common element of the proposed transition pathways, even where countries place greater emphasis on other aspects of blue economy development.

Beyond this shared environmental orientation, the national pathways display distinct thematic profiles. Bulgaria places particular emphasis on governance and regulation (29.9%), followed by environmental protection (23.0%) and scientific and technical capacity (10.3%). Georgia's pathway is more strongly oriented towards sustainable resource management and production (19.2%) and environmental protection (17.3%), while governance accounts for a smaller share (11.4%). Moldova stands out for the relative prominence of environmental protection, which represents more than one-third of its allocated thematic weight, followed by cooperation and institutional integration (11.3%).

Romania exhibits a more distributed thematic profile, with environmental protection (15.8%), scientific and technical capacity (14.4%), innovation and entrepreneurship (12.1%), and cooperation (10.2%) accounting for substantial shares. Türkiye shows a particularly strong concentration on environmental protection (27.1%) and sustainable resource management (25.6%), which together represent more than half of its thematic composition. Ukraine, meanwhile, combines environmental priorities (23.2%) with a comparatively stronger emphasis on advanced technologies and digitalisation (13.0%), socio-economic development and inclusion (13.0%), and sustainable mobility and transport (11.4%).

4.2. Convergence and divergence across national and sectoral pathways

The sectoral analysis provides a more detailed picture of where national transition pathways converge (Fig. 3). Environmental protection and resilience emerges as the most consistently represented thematic dimension across the sectors. In fisheries and aquaculture, all six countries include milestones addressing environmental protection, governance and regulation, and sustainable resource management. A similar pattern is observed in marine tourism, where environmental protection and governance appear in the pathways of all six countries. These results suggest that, despite differences in national priorities, stakeholders identify a common set of environmental and institutional considerations within these established blue economy sectors.

In ocean observation, the four countries represented in the dataset all include milestones related to observation infrastructure, scientific and technical capacity, governance, and environmental protection. The convergence of these dimensions reflects the interconnected requirements of developing marine observation capabilities, including scientific expertise, monitoring infrastructure and institutional support. In ports and maritime transport, environmental protection and governance are likewise represented across all five participating countries. Blue biotechnology shows convergence around scientific and technical capacity, environmental protection, and cooperation among the three countries for which milestones are available.

However, the presence of common thematic dimensions does not imply that countries propose identical interventions. The milestones may address the same broad objective through different technologies, institutional arrangements or implementation measures. Consequently, the convergence indicators should be interpreted as evidence of shared thematic concerns rather than agreement on specific transition pathways. The pairwise comparison of national thematic compositions further illustrates these differences (Fig. 4). The lowest divergence is observed between Georgia and Türkiye (30.47), followed by Bulgaria and Romania (34.59) and Georgia and Ukraine (34.69). These country pairs have relatively similar distributions of thematic weight, although the underlying milestones may differ in their content. By contrast, the greatest divergence is found between Romania and Türkiye (57.06), followed by Moldova and Ukraine (53.07) and Romania and Ukraine (50.47).

Taken together, the findings point to a combination of thematic convergence and national differentiation. Countries frequently identify similar environmental and governance challenges within individual sectors, but their overall pathways differ in the relative emphasis placed on the various dimensions of blue economy development. This distinction is important, as shared thematic priorities do not necessarily translate into similar implementation strategies.

4.3. Temporal distribution of transition milestones

The temporal distribution of the milestones provides an additional perspective on how the participating countries envisage their blue economy transitions (Fig. 5). Of the 309 milestones, 149 (48.2%) are assigned to the short-term horizon (2025–2030), 118 (38.2%) to the medium-term horizon (2030–2040), and 42 (13.6%) to the long-term horizon (2040–2050). The overall concentration of milestones in the first two periods indicates that the stakeholder-defined pathways place greater emphasis on interventions envisaged for implementation before 2040.

Nevertheless, the temporal distribution varies considerably across countries. Romania and Ukraine have the highest proportions of short-term milestones, at 63.5% and 66.7%, respectively. In Romania, only 3.2% of milestones are assigned to the long-term horizon, suggesting that its pathway is predominantly oriented towards measures proposed for implementation within the next decade. Ukraine also places substantial emphasis on short-term interventions, although its pathway includes a comparatively larger long-term component (22.2%). In contrast, Bulgaria, Georgia and Türkiye assign the largest shares of their milestones to the medium-term horizon. Medium-term interventions account for 44.8% of Bulgaria’s milestones, 47.0% of Georgia’s and 53.5% of Türkiye’s. Bulgaria also has the highest relative proportion of long-term milestones (27.6%), indicating a more balanced distribution across the three implementation periods. Moldova presents a relatively even distribution between the short- and medium-term horizons (46.3% and 44.4%, respectively), with fewer milestones extending beyond 2040.

4.4. Evolution of thematic priorities across implementation horizons

Examining thematic prevalence across the three implementation horizons reveals differences in the types of interventions proposed for the short, medium and long term (Fig. 6). Environmental protection and resilience is the most frequently represented dimension throughout the period, appearing in 26.2% of short-term milestones, 44.9% of medium-term milestones and 45.2% of long-term milestones. This indicates that environmental objectives remain relevant across the entire planning horizon, with particularly strong representation among interventions proposed for implementation after 2030.

In the short term, environmental protection is accompanied by governance and regulation (19.5%) and sustainable resource management and production (19.5%). Scientific and technical capacity also features in 13.4% of short-term milestones. These findings suggest that the initial phase of the proposed pathways encompasses a combination of environmental measures, institutional arrangements and capacity development. In the medium term, environmental protection becomes more prominent, while sustainable resource management remains an important dimension, appearing in 25.4% of milestones. Observation and monitoring infrastructure (13.6%) and blue economy infrastructure and facilities (11.9%) also feature among the more frequently represented themes. This distribution suggests a continued emphasis on environmental and resource-related objectives, alongside the development of supporting infrastructure.

The long-term horizon is characterized by the continued prominence of environmental protection (45.2%) and a stronger representation of governance and regulation (31.0%). Sustainable mobility, transport and logistics (16.7%) and socio-economic development and inclusion (14.3%) also account for notable shares of long-term milestones. These patterns indicate that the pathways extend beyond technological and environmental interventions to encompass longer-term institutional, transport and socio-economic objectives.

5. Discussion

5.1. Shared long-term objectives, differentiated national transition pathways

The findings reveal an important distinction between convergence in the overall direction of blue economy development and divergence in the interventions proposed to achieve it. Across the six Black Sea countries, stakeholders identified milestones that broadly support environmental sustainability, improved governance, technological development and the sustainable use of marine resources. However, these common objectives do not translate into uniform transition pathways. Instead, countries emphasise different combinations of regulatory reforms, technological investments, infrastructure development and capacity-building measures, reflecting the diversity of their national and sectoral contexts.

This distinction is particularly evident in ports and maritime transport. Georgia’s pathway envisages the adoption of green and blue port practices by 2030, followed by the integration of smart technologies by

2035 and circular economy practices in ports by 2045. The proposed sequence connects environmental improvements with the progressive digitalisation and transformation of port operations. Türkiye, by contrast, places greater emphasis on transport connectivity and operational practices. Its milestones include the development of multimodal transportation by 2030, the designation of specific areas for hull cleaning in ports by 2040, and the introduction of inter-district ferry services using autonomous vessels powered by green energy by 2050. Ukraine's pathway also addresses the environmental performance of maritime activities, but places particular emphasis on strengthening environmental legislation and monitoring systems in the short term, introducing circular production practices by 2035, and reducing greenhouse gas emissions from international shipping by 2045.

These examples illustrate how a shared objective of more sustainable maritime transport can be pursued through different combinations of interventions. Georgia emphasises the technological and environmental transformation of port infrastructure, Türkiye focuses on connectivity and cleaner transport services, and Ukraine combines regulatory measures with circular production and shipping decarbonisation. The differences are therefore not necessarily evidence of conflicting development priorities. Rather, they suggest that countries may contribute to a common regional transition through distinct, potentially complementary pathways.

A similar pattern emerges in fisheries and aquaculture. Georgia proposes the development of mariculture installations by 2030, sustainable fisheries management by 2035 and ecosystem-based fisheries management by 2045. This pathway combines the expansion of productive activities with a longer-term transition towards ecosystem-based management. Türkiye places greater emphasis on regulatory enforcement and production practices, proposing improvements to legal controls and sanctions by 2030, the identification of alternative aquaculture feed sources by 2035, and the elimination of toxic releases from antifouling paints by 2050. Moldova's milestones, meanwhile, include international knowledge exchange in aquaculture, the development and renovation of treatment facilities, and improvements in river runoff management. These interventions reflect a stronger emphasis on the environmental and infrastructural conditions supporting sustainable aquatic resource management.

Taken together, the sectoral examples suggest that convergence in environmental and governance objectives coexists with considerable variation in the practical measures considered necessary to achieve them. This finding is consistent with the understanding of sustainability transitions as context-dependent processes, in which institutional arrangements, technological capabilities and existing socio-technical systems influence the pathways through which change takes place (Geels, 2002; Markard et al., 2012).

5.2. Different approaches to marine tourism: technological innovation, environmental management and community engagement

Marine tourism provides a particularly clear illustration of how stakeholders translate a shared sustainability vision (see Fig. 1) into different sectoral priorities. While environmental protection and governance are represented across all six national pathways, the proposed milestones differ in their emphasis on technological innovation, destination management, community engagement and infrastructure development. Georgia's pathway combines sustainable tourism practices by 2030 with the development of digital tourism platforms by 2035 and climate-resilient tourism infrastructure by 2045. The proposed interventions suggest an approach in which digital innovation and infrastructure adaptation support the longer-term development of sustainable coastal tourism. Türkiye's milestones, in contrast, place greater emphasis on identifying environmentally sensitive tourism areas and strengthening public awareness. These include the designation of suitable areas for sustainable tourism by 2025, community information activities addressing the economic benefits of marine tourism by 2035, and further awareness-raising activities related to beach use and recreational development by 2050. The Turkish pathway therefore gives particular attention to the relationship between tourism development, spatial planning and community engagement.

Moldova's milestones reflect another approach, beginning with the creation of sustainable tourism routes by 2030 and extending towards compliance with circular and blue economy principles by 2050. Romania, meanwhile, places emphasis on networking, collaboration and professional development, alongside broader measures addressing climate change mitigation and the resilience of marine and coastal ecosystems. Bulgaria similarly identifies personnel training and innovation support among the measures needed to strengthen the sector, while Ukraine's milestones emphasise environmental legislation, monitoring and the longer-term development of safe, low-carbon transport.

These differences highlight the multidimensional character of sustainable marine tourism. In some countries, the transition is framed primarily through technological and infrastructural development; in others, it is approached through environmental management, institutional capacity or changes in community awareness and practices. The findings are consistent with the integrated understanding of sustainable tourism advanced by UNEP and UNWTO (2005), which emphasises the need to consider environmental, economic and social objectives together. They also suggest that regional cooperation in marine tourism need not depend on the adoption of identical interventions. Instead, countries may benefit from exchanging experience across different areas of expertise, including digital tourism services, climate-resilient infrastructure, stakeholder engagement and sustainable destination management.

5.3. The sequencing of transition milestones: different routes towards 2050

Beyond differences in thematic composition, the milestones reveal variation in how stakeholders envisage the progression of blue economy transitions towards 2050. Although almost half of the proposed milestones are concentrated in the short-term horizon, the relative distribution of interventions differs across countries. Romania and Ukraine place greater emphasis on actions proposed for

implementation before 2030, whereas Bulgaria, Georgia and Türkiye allocate larger shares of their milestones to the medium-term horizon. These differences suggest that the national pathways are not organised around a common timetable, even where they address similar sustainability objectives.

The individual milestones provide further insight into these temporal differences. In Georgia's ocean observation pathway, the development of a fisheries monitoring pilot is envisaged in the short term, followed by the establishment of a marine and coastal observatory and data repository in the medium term. By 2050, the pathway anticipates the application of artificial intelligence and machine learning to marine and coastal monitoring in support of knowledge-based governance. This sequence suggests a progression from initial monitoring capabilities towards more integrated scientific infrastructure and advanced analytical applications.

Romania's ocean observation milestones, by comparison, include an educational programme on artificial intelligence by 2025 and the development of real-time monitoring and alert systems for healthy waters by 2030. The emphasis on technical education and monitoring capabilities at an earlier stage illustrates how similar technological objectives may be associated with different implementation horizons.

In fisheries and aquaculture, Georgia's proposed progression from mariculture installations to sustainable fisheries management and subsequently ecosystem-based fisheries management offers another example of how production-oriented and environmental objectives are distributed over time. Türkiye's pathway combines early regulatory improvements with medium-term innovation in aquaculture feed and longer-term pollution prevention. Although both countries envisage more sustainable fisheries and aquaculture, the milestones suggest different areas of intervention at each stage of the transition.

These examples indicate that temporal divergence is not simply a matter of countries assigning more milestones to one period than another. It also concerns the types of interventions envisaged at different stages. Some pathways place early emphasis on scientific capacity, monitoring and regulation, while others prioritise infrastructure, technological applications or changes in production practices. Such differences are relevant to sustainability transition theory, which recognises that systemic change involves interactions between technological innovation, institutional development and broader socio-economic processes.

5.4. What does convergence mean for regional cooperation?

The coexistence of thematic convergence and differentiated national pathways has important implications for regional blue economy governance. The findings suggest that shared objectives, particularly environmental protection, sustainable resource management and improved governance, can provide a common foundation for cooperation among Black Sea countries. However, the diversity of proposed interventions indicates that regional strategies should also recognise differences in sectoral development, institutional capacities and technological priorities.

Ocean observation provides a relevant example. Georgia's milestones envisage the development of a marine and coastal observatory and data repository, alongside the longer-term application of artificial intelligence to marine monitoring. Romania identifies real-time monitoring and alert systems, while Bulgaria emphasises the development of national scientific and technical expertise. These priorities are not identical, but they are potentially complementary. Strengthening scientific capacity, developing observation infrastructure and improving the accessibility and interoperability of marine data could support a more integrated regional knowledge base. This interpretation is consistent with the principles of coordinated ocean observation discussed by Lindstrom et al. (2012) and Tanhua et al. (2019), as well as the importance of reusable and interoperable scientific data highlighted by Wilkinson et al. (2016).

Comparable opportunities arise in fisheries and aquaculture. Georgia's emphasis on ecosystem-based fisheries management, Türkiye's focus on regulatory enforcement and sustainable production practices, and Moldova's attention to aquaculture knowledge exchange and water-related infrastructure could provide different entry points for cooperation on sustainable aquatic resource management. Rather than adopting a single set of interventions, regional initiatives could facilitate the exchange of practices, technical knowledge and institutional experience across these complementary areas.

The findings also indicate that opportunities for cooperation may differ across implementation horizons. In the short term, collaboration could focus on areas where countries have already identified related needs, including monitoring, capacity development and regulatory improvements. Medium-term cooperation could support the development of interoperable data systems, sustainable production technologies and infrastructure. Longer-term collaboration could address shared objectives relating to ecosystem resilience, low-carbon maritime transport and the integration of advanced technologies into marine management.

These implications should nevertheless be considered in light of the uneven sectoral coverage of the dataset. Marine renewable energy, for example, is represented only in Türkiye's pathway, where stakeholders identify the assessment of renewable energy potential and the identification of suitable areas for wave energy development as important milestones. Although these interventions may be relevant to wider Black Sea cooperation, the available data do not establish whether similar priorities are shared by other participating countries. The absence of milestones for a particular country or sector should therefore not be interpreted as an absence of interest or development potential.

6. Conclusions, Limitations and Future Research

The findings suggest that the transition towards a sustainable Black Sea blue economy is characterised by convergence in long-term objectives but considerable diversity in the interventions proposed to achieve them. Environmental sustainability, improved governance and technological development recur across national and sectoral pathways, yet countries differ in the relative emphasis they place on these dimensions and in the timing of the associated milestones. The sectoral comparisons further demonstrate that similar objectives may be pursued through different combinations of regulatory

reforms, infrastructure investments, technological applications and capacity-building measures. These differences should not necessarily be understood as obstacles to regional cooperation. Rather, they highlight the potential for a coordinated but differentiated approach, in which shared objectives provide a basis for collaboration while national and sectoral pathways remain responsive to their specific contexts.

The findings should nevertheless be interpreted in light of several limitations. First, the analysis is based on stakeholder-defined milestones rather than observed implementation outcomes, and therefore reflects anticipated transition pathways rather than demonstrated progress. Differences in the number, specificity and sectoral coverage of milestones across countries may also influence the comparisons. Furthermore, the thematic classification involves a degree of interpretation, particularly where milestones address multiple interconnected dimensions, while the initial keyword-assisted coding requires further validation. The weighting approach provides a consistent basis for comparison but assumes equal contributions across milestones and their assigned themes, without accounting for differences in feasibility, expected impact or stakeholder support. Finally, the convergence indicators capture the presence of shared thematic priorities rather than agreement on specific interventions or implementation strategies.

Future research could build on these findings by examining how stakeholder-defined pathways evolve over time and whether the proposed milestones are translated into policies, investments and concrete actions. Longitudinal assessments could help identify changes in national and sectoral priorities, while further stakeholder engagement could provide insights into the feasibility, perceived importance and interdependencies of individual milestones. Additional comparative studies could also explore how differences in institutional capacity, economic conditions and sectoral development influence the implementation of blue economy transitions across the region.

Overall, the contribution of this study lies not only in identifying where Black Sea countries converge or diverge, but also in demonstrating how stakeholder-defined milestones can reveal alternative routes towards a common regional sustainability vision. The findings suggest that effective regional cooperation need not depend on uniform national pathways, but rather on the ability to recognise shared objectives, accommodate different development priorities and identify opportunities for complementary action across countries and sectors.

Declarations

Author Contribution

Lydia Papadaki contributed to the conceptualization, methodology development, investigation, data curation, formal analysis, visualization, and writing of the original manuscript, as well as its review and editing. Ebun Akinsete contributed to the methodology development, investigation, data collection, and validation of the manuscript. Phoebe Koundouri contributed to the scientific supervision, funding

acquisition, project administration, and review and editing of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Data Availability

The data analysed in this study comprise 309 stakeholder-defined milestones developed through Multi-Actor Forums (MAFs) conducted in six Black Sea countries within the framework of the EU-funded DOORS project. The dataset includes the thematic classification of milestones across 14 dimensions, their sectoral and geographical distribution, and their proposed implementation horizons. The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request, subject to applicable project data-sharing arrangements and confidentiality considerations.

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Figures

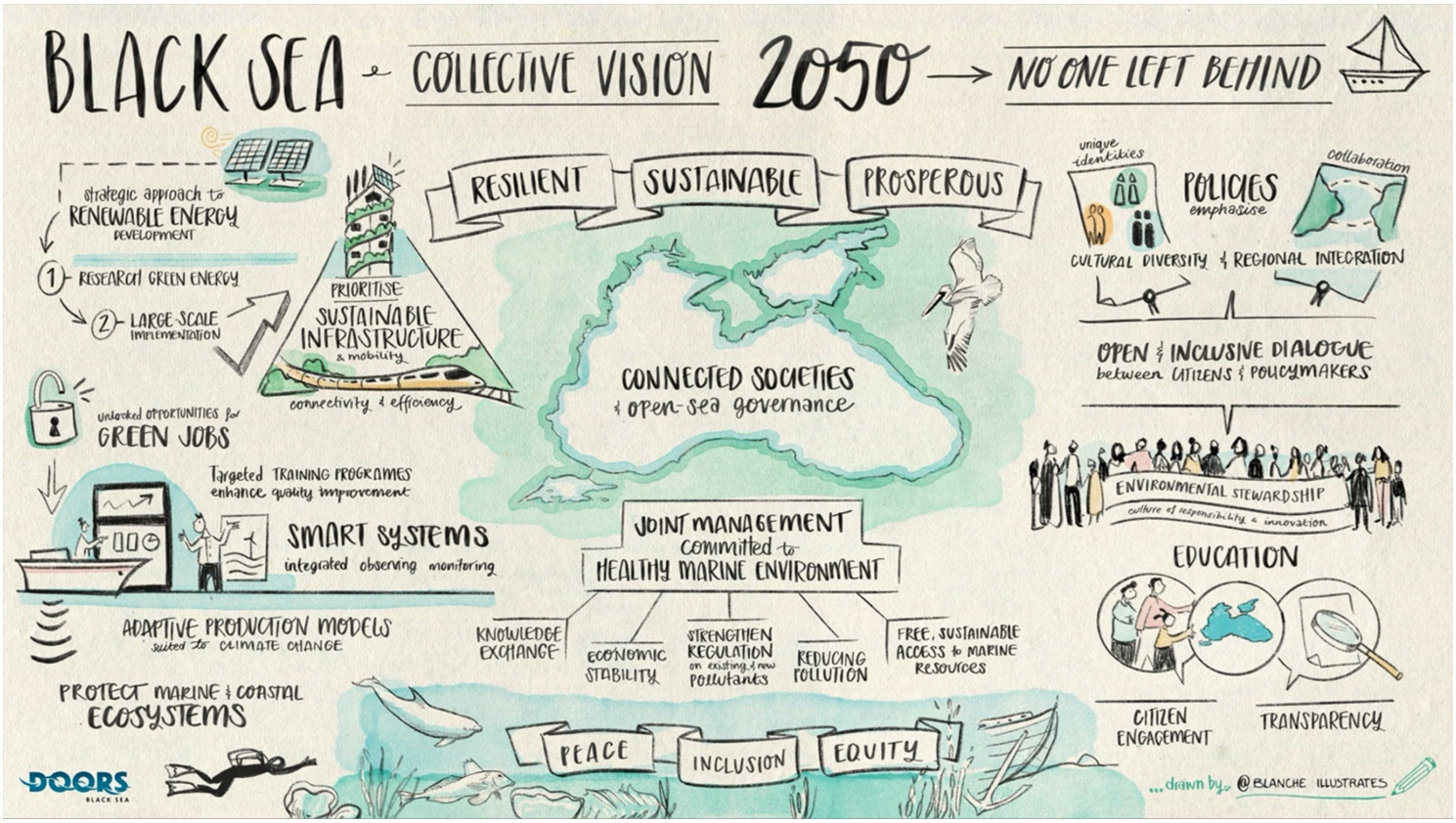


Figure 1

Black Sea collective vision for 2050



Figure 2

Country thematic composition (FTW, %)

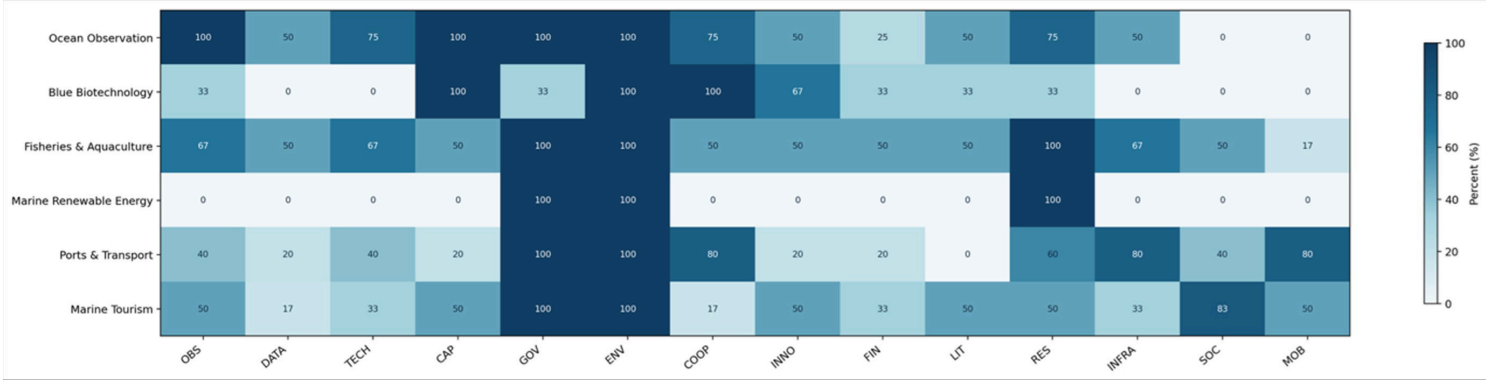


Figure 3

Sector-specific thematic convergence (country presence, %)

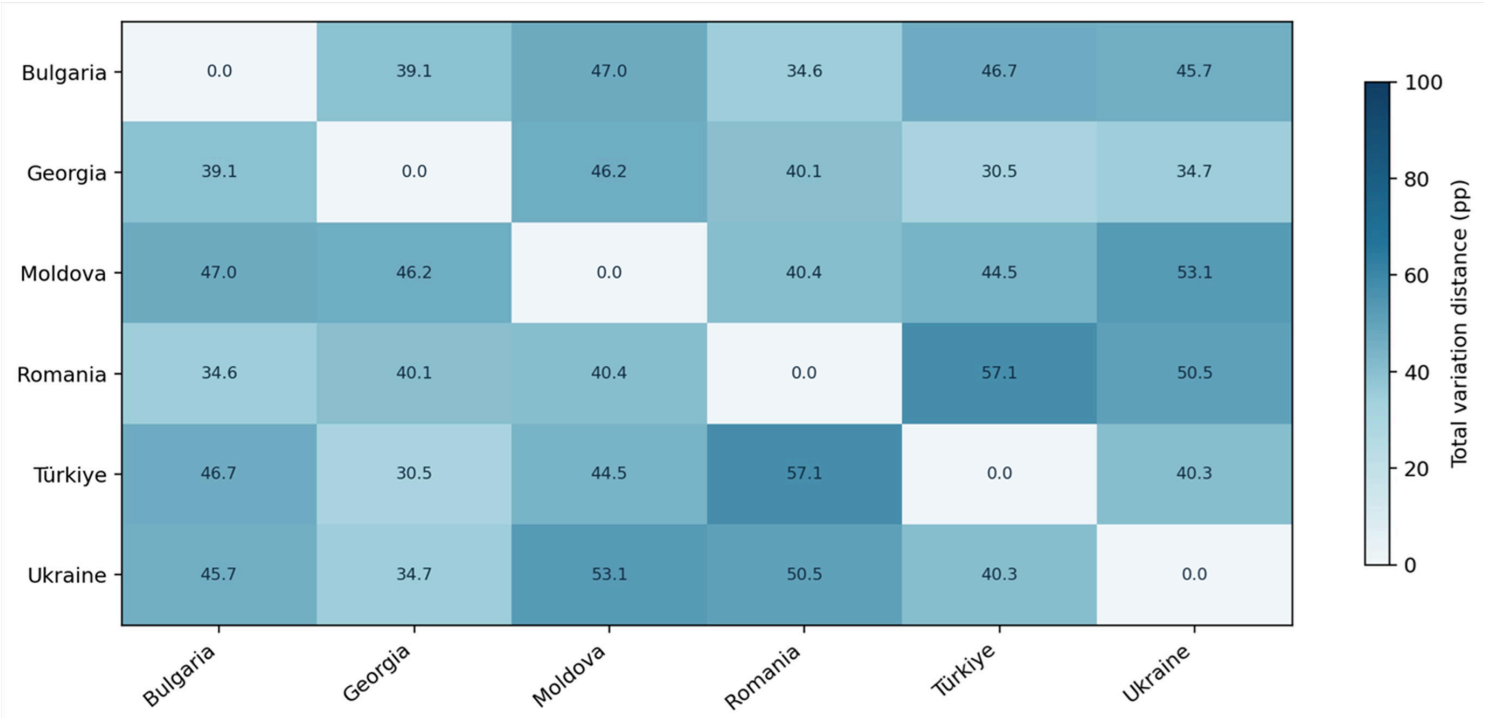


Figure 4

Pairwise country thematic divergence (TV distance, pp)

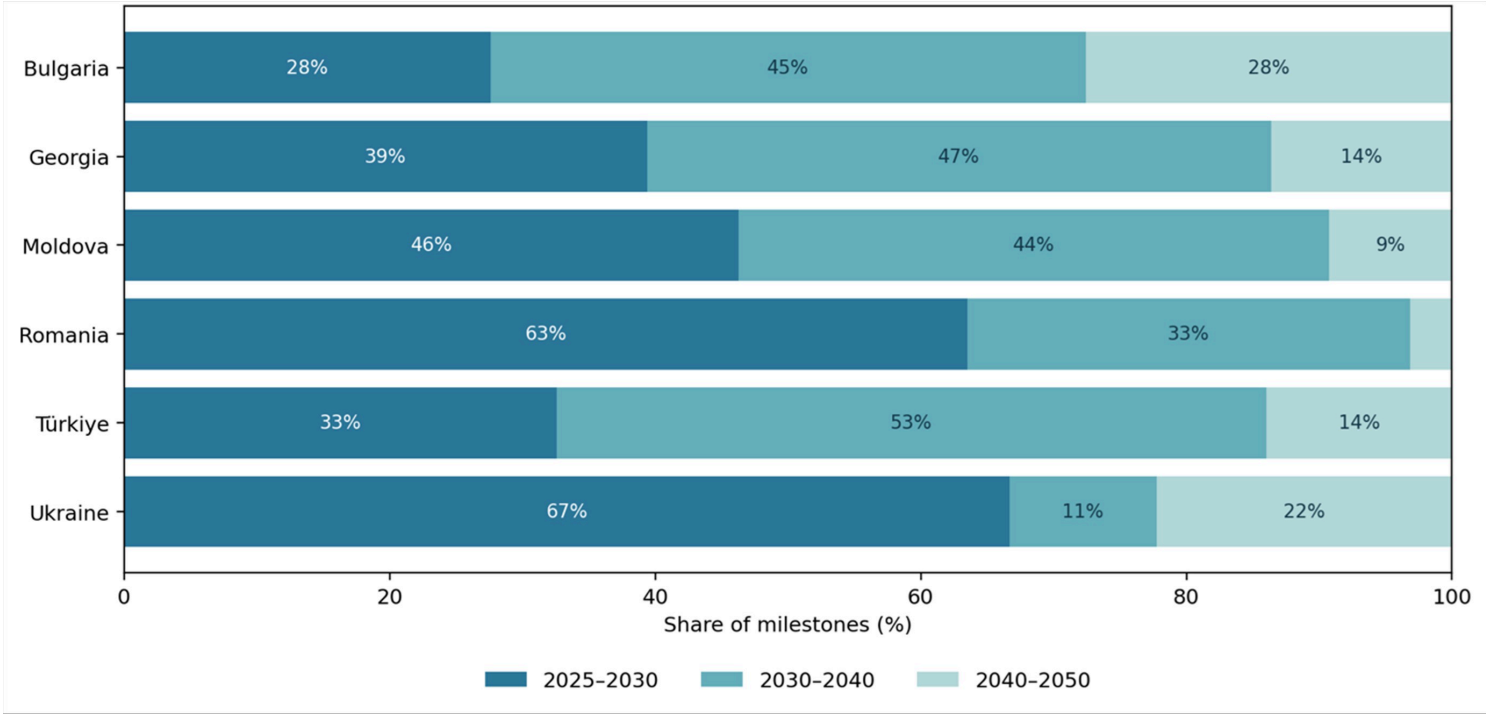


Figure 5

Temporal distribution of milestones by country

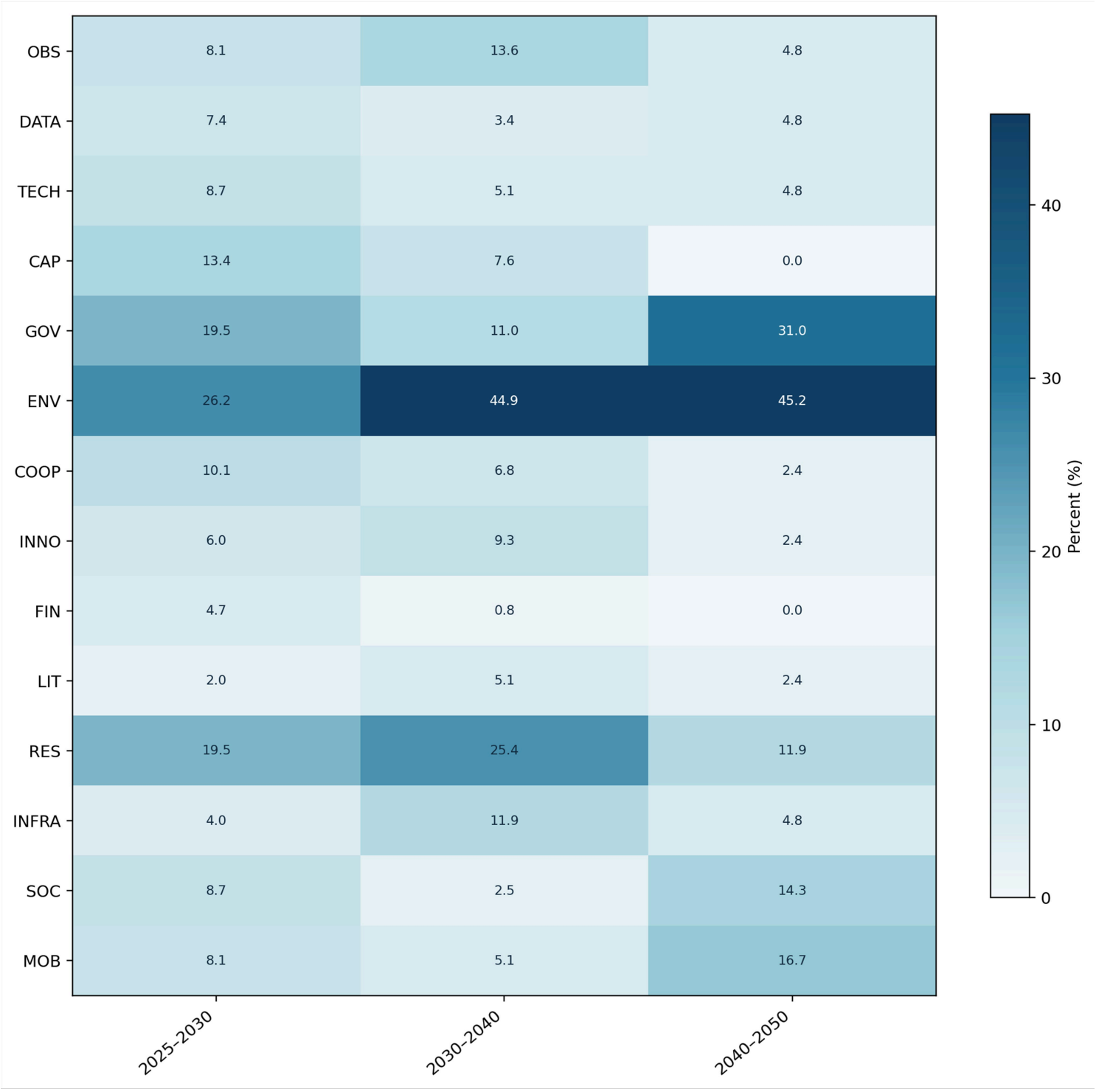


Figure 6

Thematic prevalence by implementation horizon (RW, %)