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MAPPING THE INTERSECTIONS OF THE BLUE ECONOMY AND BLUE CRIME: A MULTI-METHOD BIBLIOMETRIC, THEMATIC AND FACTORIAL ANALYSIS

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ABSTRACT

The rise of the Blue Economy as a framework for sustainable ocean development is increasingly challenged by Blue Crime, including illegal, unreported and unregulated (IUU) fishing, piracy, trafficking and environmental offences that threaten ecological resilience and governance stability. This study presents the first multi-method mapping of scholarship at the Blue Economy-Blue Crime nexus, using integrated bibliometric, thematic and factorial analyses of Scopus and Web of Science publications from 2015 to 2024. Research output has surged since 2019, reflecting global attention to SDG 14 and maritime security concerns. Two primary thematic clusters emerge: Governance- and sustainability-focused research on ocean policy integration and security-oriented studies on crime typologies, enforcement gaps and regional vulnerabilities, particularly in the Gulf of Guinea and Western Indian Ocean. Factorial and conceptual analyses reveal a persistent divide between security-driven and sustainability-driven scholarship, underscoring field fragmentation. Despite emerging collaborations, knowledge production remains regionally concentrated. This synthesis offers an evidence-based roadmap for advancing interdisciplinary research and informing policy to secure and sustain the Blue Economy.

Introduction

The Blue Economy positions the oceans not only as reservoirs of natural resources but also as platforms for sustainable development that integrate economic growth, social inclusion and ecological resilience (Perkiss *et al*., 2022). Over the past decade, its remit has expanded from traditional maritime industries such as fisheries and shipping, to include tourism, aquaculture, renewable energy and emerging digital ocean services, fostering optimism regarding new livelihood opportunities and national development strategies (Bueger & Mallin, 2023). Yet this expansion heightens vulnerability to a spectrum of illicit activities broadly termed Blue Crime, which threatens ecological integrity, undermines economic gains and weakens the governance systems essential for sustainable maritime economies (Witbooi *et al*., 2020). Blue Crime encompasses illegal, unreported and unregulated (IUU) fishing, organised fisheries crime, piracy, human and drug trafficking, marine environmental crimes

and fraud across seafood supply chains. These activities compromise food security, public revenues, and the rule of law central to SDG 14 (Witbooi *et al*., 2020; Lindley, 2021).

Recent empirical and policy-oriented work situates Blue Crime at the core of global debates about ocean governance. High-profile analyses reveal how organised crime in fisheries depletes stocks, drives destructive harvesting practices and creates governance vacuums that fuel broader insecurity (Witbooi *et al*., 2020; Okafor-Yarwood, 2020). Environmental stressors, such as climate change, resource scarcity and degraded ecosystems, further intensify maritime criminality, particularly in regions such as the Western Indian Ocean and the Gulf of Guinea, where regulatory enforcement remains weak (McCabe, 2023). In parallel, emerging research from 2024 to 2025 incorporates digital technologies including blockchain and artificial intelligence into discussions of traceability, transparency and market-based interventions against illegal fishing and seafood fraud (Khan *et al*., 2025; Roberson *et al*., 2025). These developments reflect a growing understanding that sustainable Blue Economy outcomes depend on integrated responses that align economic development, environmental protection and criminal deterrence.

The rapid expansion of Blue Economy sectors is, thus, increasingly threatened by escalating Blue Crime activities, including IUU fishing, piracy, trafficking and environmental offences that collectively erode ecosystem health, impair institutional effectiveness and jeopardise long-term economic sustainability (Witbooi *et al*., 2020; Okafor-Yarwood, 2020). These crimes pose significant risks to human security, coastal livelihoods and the viability of ocean resources, especially in contexts with limited surveillance capabilities and fragmented regulatory regimes (McCabe, 2023; Amao *et al*., 2024). Recognising the severity of these intertwined challenges underscores the importance of developing integrated, evidence-based approaches that strengthen monitoring, enforcement coordination and strategic governance. Nonetheless, existing reviews typically address maritime security, IUU fishing and Blue Economy development as separate themes, leading to fragmented insights that overlook the structural interdependence between sustainable ocean development and maritime criminality (Perkiss *et al*., 2022; Bueger & Mallin, 2023). Many reviews emphasise either economic potential or security implications, without generating a unified synthesis that incorporates bibliometric patterns or conceptual linkages across these domains (Chen *et al*., 2024; Castillo *et al*., 2025). This fragmentation obscures how scholarly conversations converge, diverge, or underexplore emerging intersections.

Given the dispersed and multidisciplinary nature of the literature, there is a clear need for integrative mapping of intellectual trends, conceptual networks, and collaboration structures. Bibliometric and thematic analyses can synthesise this complex evidence base, identifying central research clusters, influential authors, leading institutions and persistent gaps that traditional narrative reviews may not detect (Bueger & Mallin, 2023). Recent reviews also emphasise the importance of stronger monitoring and evaluation frameworks to assess how maritime crimes influence Blue Economy outcomes, particularly for achieving SDG 14 and guiding national ocean strategies (Chen *et al*., 2024; Castillo *et al*., 2025). Responding to this imperative, the present study adopts a multi-method bibliometric, thematic and factorial analytical approach to examine relationships between the Blue Economy and Blue Crime

from 2015 to 2024. Using techniques such as co-authorship analysis, thematic mapping, correspondence analysis and multidimensional scaling, the study identifies intellectual structures, collaboration geographies, thematic priorities and evolving conceptual clusters.

To guide this inquiry, the study poses three research questions concerning thematic trends, collaboration patterns and persistent geographic or conceptual gaps. Addressing these questions produces an actionable roadmap that supports transdisciplinary inquiry, targeted enforcement, institutional capacity-building and technology-enabled governance reforms (Phayal *et al*., 2024; Khan *et al*., 2025). By synthesising recent scholarship, the study advances a more coherent research agenda and provides evidence to inform governance innovations essential to protecting the Blue Economy and achieving SDG 14.

Empirical Literature Review

Empirical research on the Blue Economy-Blue Crime nexus has expanded substantially, yet it remains geographically concentrated and thematically uneven. Mixed-method empirical studies consistently show how organised fisheries crime and related maritime offences weaken economic and ecological resilience. Witbooi *et al*. (2020) provide a foundational empirical assessment demonstrating how criminal networks distort markets, deplete fish stocks and erode governance structures. Regional studies deepen these findings by embedding maritime crime within socio-ecological contexts. In West Africa, particularly the Gulf of Guinea and Nigeria, Okafor-Yarwood (2020) and Amao *et al*. (2024) use interviews, case evidence and crime statistics to link IUU fishing and piracy to livelihoods, insecurity and weak enforcement. Complementary evidence from the Western Indian Ocean highlights how climate variability and resource pressures exacerbate maritime crime and challenge enforcement capacity (McCabe, 2023). These analyses collectively show that Blue Crime is rooted in localised governance failures and environmental stressors.

Quantitative spatial and econometric studies add causal depth. Desai and Shambaugh (2021) use spatial analysis to associate destructive fishing practices with piracy patterns, while Phayal *et al*. (2024) argue that illegal fishing can serve as a precursor to piracy, applying spatial and mixed-method evidence to trace these dynamics. Policy-oriented empirical work evaluates intervention strategies, including marine insurance reforms, seafood imports controls, blockchain traceability and FinTech monitoring (Miller *et al*., 2016; Roberson *et al*., 2025; Khan *et al*., 2025). These studies suggest that supply-chain transparency can reduce illicit incentives but stress that technological tools require governance and capacity-building support. Legal and regulatory analyses contribute empirical evidence on court judgments, penalties and enforcement training, revealing persistent deterrence gaps (Feng *et al*., 2020; Warikandwa, 2023).

Despite these advances, gaps remain. Empirical research is regionally biased, with limited evidence from Latin America, Southeast Asia, and small island states. Few studies integrate economic valuation with social outcomes such as food security, and rigorous evaluations of AI, blockchain, and trade-based interventions remain limited (Khan *et al*., 2025; Roberson *et al*., 2025). Broader comparative and collaborative research are needed to generate policy-relevant evidence capable of safeguarding the Blue Economy and advancing SDG 14.

Methodology

This study applied a multi-method bibliometric and thematic analysis to investigate the Blue Economy-Blue Crime nexus from 2015 to 2024. By combining quantitative bibliometric mapping with qualitative thematic interpretation, the approach enabled a comprehensive assessment of publication trends, collaboration structures and conceptual developments across this multidisciplinary domain. Bibliometric techniques are widely recognised for their capacity to synthesise large datasets and trace the evolution of complex research fields (Zupic & Čater, 2015; Aria & Cuccurullo, 2017). Data were sourced from Scopus and Web of Science due to their extensive coverage and citation reliability (Mongeon & Paul-Hus, 2016; Martín-Martín *et al*., 2018), with Table 1 detailing the inclusion and exclusion criteria guiding the final dataset of 23 documents. The selected timeframe aligns with the post-2015 global emphasis on marine sustainability following the adoption of SDG 14 (Bueger & Mallin, 2023).

The article selection process followed PRISMA guidelines, involving independent screening and full-text assessment by two authors, with disagreements resolved through consensus. The complete selection process is visually summarised in the PRISMA flowchart presented in Figure 1. Analytical procedures were conducted using Biblioshiny, incorporating co-authorship mapping, co-word analysis, and trend analysis (Aria & Cuccurullo, 2017). Advanced techniques such as thematic mapping, correspondence analysis, multiple correspondence analysis and multidimensional scaling further illuminated conceptual structures and emerging research clusters within the field (Greenacre, 2017).

Table 1: Inclusion and Exclusion Criteria for Literature Selection

Stage	Inclusion Criteria	Exclusion Criteria
Database Search	• Peer-reviewed articles, books, book chapters, conference proceedings, reviews. • Published 2015-2024. • Keywords related to Blue Economy AND Blue Crime.	• Non-peer-reviewed material • Publications before 2015 or after 2024. • Documents not in English.
Full-Text Screening	• Explicitly analyses the intersection/ interrelationship between Blue Economy and Blue Crime concepts. • Provides empirical, conceptual, or policy insights.	• Focuses solely on Blue Economy (development only) or Blue Crime (security only) without connecting the two. • Lacks substantive analysis. • Duplicates.

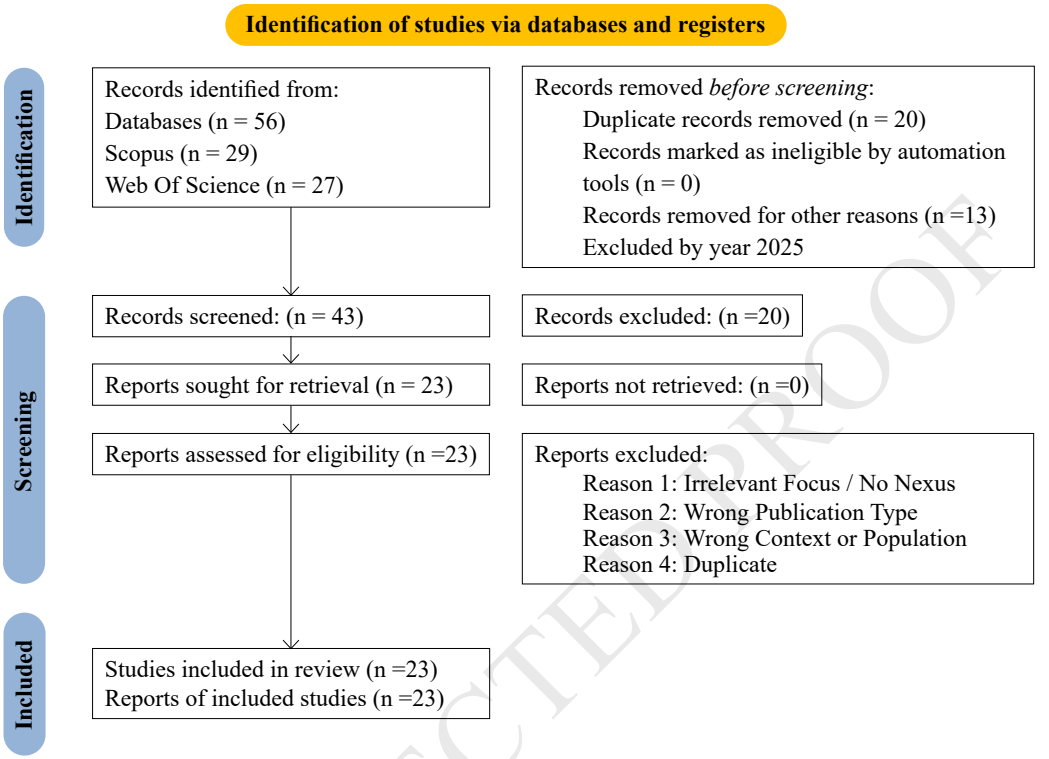

Figure 1: The PRISMA flow chart.

Conceptual Framework

The conceptual framework in Figure 2 underpinning this research links the Blue Economy with the sustainable and inclusive use of ocean resources with Blue Crime, which encompasses illicit maritime activities that jeopardise ecological integrity, governance and economic resilience. By mapping these interconnections, the framework conceptualises maritime security, governance capacity and environmental sustainability as interdependent pillars of ocean development (Okafor-Yarwood, 2020; Witbooi *et al*., 2020). Empirical insights from the bibliometric and factorial analyses are thus situated within a broader theoretical logic: That achieving a sustainable Blue Economy requires understanding and mitigating Blue Crime through collaborative governance, data transparency and regional partnerships. This integrated methodological and conceptual design allows the study to offer both descriptive analytics and prescriptive implications for policy and research on sustainable ocean governance.

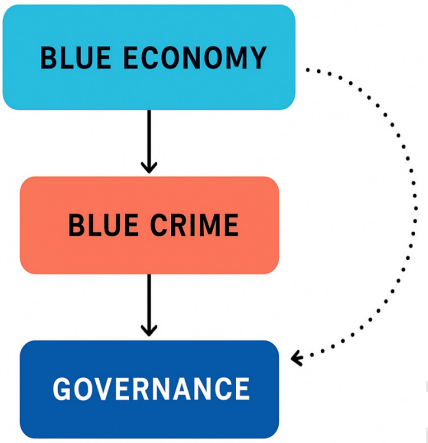

Figure 2: Conceptual Framework

Results

Thematic Clusters and Temporal Trends at the Blue Economy-Blue Crime Nexus

Figure 3 visually represents the frequency of all author keywords through a word cloud, where larger terms indicate higher prominence. "Maritime security" and "Blue Economy" dominate the visualization, reflecting their central role in the research discourse. Other significant terms include "Gulf of Guinea", "piracy", "IUU fishing" and "ocean governance", highlighting regional and thematic priorities. The presence of terms like "sustainable development", "accountability" and "capacity building" suggests a growing emphasis on governance and sustainability frameworks. The word cloud effectively captures the field's focus on balancing economic opportunities with security and regulatory challenges. However, the underrepresentation of terms related to technology, community involvement or specific regions beyond Africa indicates potential gaps in the current literature. This visualisation reinforces the findings from textual analyses, providing an accessible summary of key research themes.

Figure 3 World Cloud for All Keywords

Figure 4 uses a tree map to categorise and visualise the distribution of author keywords based on their frequency and thematic relationships. The tree map organises keywords into blocks, with size and color indicating their relative significance. "Fisheries" and "piracy" are among the largest blocks, each accounting for 5% of the dataset, underscoring their importance in the Blue Crime discourse. Other prominent themes such as "maritime security", "economy" and "climate change" each make up 3% of the dataset, reflecting their interconnectedness. The inclusion of terms like "HIV/AIDS" and "migration" points to the socio-economic dimensions of maritime issues, while "governance approach" and "policy" highlight institutional and regulatory concerns. The tree map reveals the field's multidisciplinary nature, bridging environmental, economic and security studies. However, the fragmentation of themes into small, isolated blocks suggests a lack of cohesion in certain sub-fields, calling for more integrated research approaches.

Figure 4: Treemap for All Keywords

Figure 5 illustrates a network analysis of conceptual relationships, with distinct clusters representing different thematic areas. The largest cluster revolves around fisheries, renewable resources, climate change and security, indicating their strong interconnections. Another prominent cluster groups economy, maritime security, policy and governance, suggesting a policy-oriented discourse on maritime economic sustainability. The separate cluster focusing on piracy, trafficking and illegal fishing emphasises security concerns and criminal activities within the maritime domain. The visualisation demonstrates the complexity of maritime issues, where economic, environmental and security-related topics are deeply intertwined.

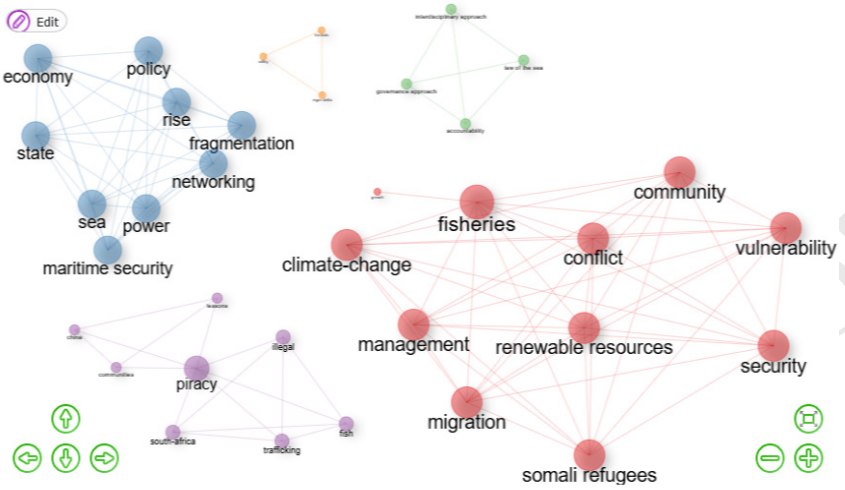

Figure 5: Thematic Map

Structure of Collaboration Networks among Authors, Institutions, and Countries

The structure of scientific collaboration reveals a fragmented and regionally concentrated field. Figure 6 illustrates author collaboration patterns, organised into 13 distinct clusters. Each cluster represents a collaborative group, with authors like Bueger C and Mallin F forming one cluster, while Okafor-Yarwood I and Ali K form another. The betweenness centrality values are uniformly zero, indicating that these clusters operate independently, with no authors acting as bridges between groups. The closeness centrality values vary, with some authors having scores of 1 (high connectivity within their cluster) and others as low as 0.143 (peripheral positions). This structure highlights the formation of tightly knit but isolated research teams, which may limit cross-pollination of ideas. The dominance of small, disconnected clusters underscores the need for broader networking initiatives to foster interdisciplinary and cross-regional collaborations in maritime security and Blue Economy research.

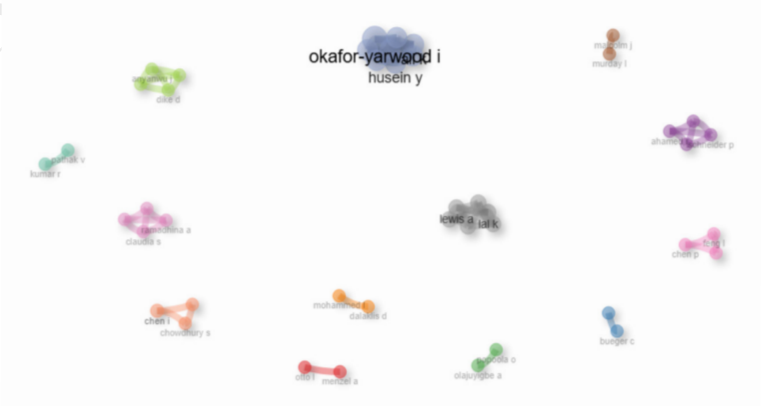

Figure 6: Collaboration Network by Authors

Figure 7 depicts the collaboration network among institutions, revealing clusters of research partnerships. The network is fragmented into nine clusters, with institutions like the University of Wollongong and King's College London acting as central nodes. However, the betweenness and closeness centrality values are low across all institutions, indicating limited interconnectivity between clusters. For example, the University of Wollongong and Nelson Mandela University operate within isolated clusters, with no bridging links to other groups. This siloed structure suggests that institutional collaborations are often confined to specific geographic or thematic circles, hindering the exchange of knowledge across regions and disciplines. The lack of high-betweenness nodes points to a missing layer of coordination, which could be addressed through international consortia or interdisciplinary research initiatives. The current network configuration reflects the nascent stage of global collaboration in Blue Economy and Blue Crime research.

Figure 7: Collaboration Network by Institution

Figure 8 analyses international collaboration patterns, revealing two primary clusters. The first cluster includes the United Kingdom, South Africa, Nigeria and several European and African nations, while the second cluster comprises China, Bangladesh, Finland and Germany. South Africa and Nigeria exhibit the highest betweenness centrality (7), indicating their role as bridges within their cluster. In contrast, the United Kingdom, despite having the most publications, has a betweenness centrality of zero, suggesting it operates in a more insular manner. The closeness centrality values further emphasise the connectivity within clusters, with China and Bangladesh scoring 0.333, reflecting their central roles in the second cluster. These findings reveal a geographically and institutionally fragmented collaboration landscape, where regional partnerships dominate and global integration remains limited. Enhancing North-South and cross-regional collaborations could address existing asymmetries and enrich the global research agenda.

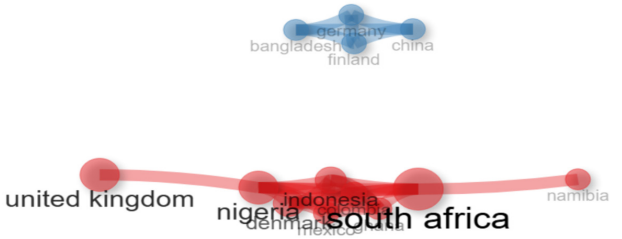

Figure 8: Collaboration Network by Countries

Conceptual Linkages and Identified Research Gaps

The factorial analyses were employed to uncover deeper conceptual structures and identify persistent gaps. The Correspondence Analysis (Figure 9) reveals a fundamental conceptual divide within the literature. One dimension is characterised by themes of "marine illegal fishing" and "criminal accountability" emphasising legal enforcement. The opposing dimension clusters around "the blue economy", "soft law" and "regional integration, focusing on economic and governance frameworks. This spatial separation highlights a theoretical tension between punitive and developmental approaches. The Multidimensional Scaling plot (Figure 11) reinforces this, clearly separating a "red cluster" of crime and security topics from a "blue cluster" of policy and opportunity themes. The Multiple Correspondence Analysis (Figure 10) introduces critical, yet peripheral, themes such as "marginalised groups" and "Namibia", which have high thematic value but low frequency.

Figure 9, the conceptual structure map using Correspondence Analysis (CA), shows two distinct thematic dimensions. One cluster, positioned in the negative space of Dim 1 and Dim 2, includes "marine illegal fishing" and "criminal accountability", highlighting legal enforcement and regulatory frameworks. The opposing cluster in the positive quadrant consists of "the blue economy", "soft law", and "regional integration", suggesting a focus on economic frameworks and governance mechanisms. The distribution of these clusters reflects the tension between economic development policies and the need for legal accountability in managing maritime resources.

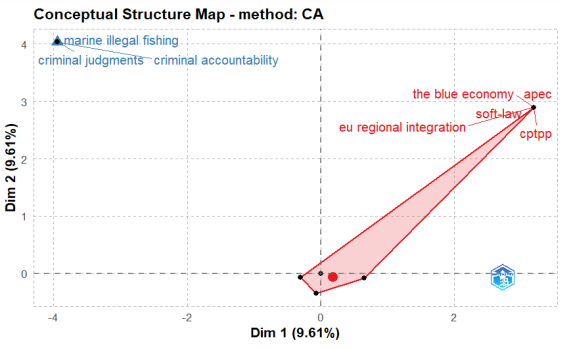

Figure 9 Correspondence Analysis

Figure 10, derived using Multiple Correspondence Analysis (MCA), identifies key themes related to sustainable development in the maritime sector. The dominant themes include "sustainable development", "Namibia", "law enforcement", and "conservation of marine resources". The high loading of Dim 1 (32.55%) and Dim 2 (29.35%) suggests that these factors significantly shape discussions around Blue Economy policies. The presence of "marginalised group" in the analysis points to concerns about social equity in resource management, reinforcing the need for inclusive and sustainable governance strategies.

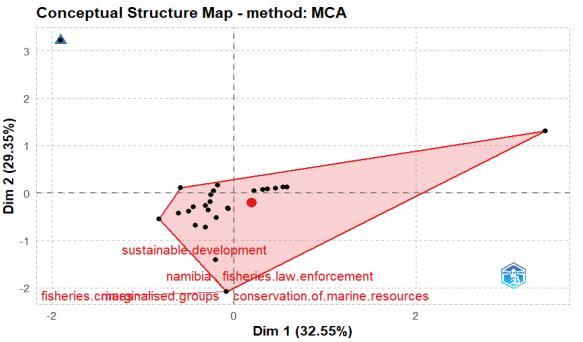

Figure 10 Multiple Correspondence Analysis

Figure 11, constructed through Multidimensional Scaling (MDS), presents a conceptual structure of maritime governance and security. The red cluster encompasses topics such as "piracy", "illegal fishing", "maritime security", "fisheries" and "organised crime", reflecting the dominant concerns in maritime crime and governance. In contrast, the blue cluster highlights "policy", "challenges", "opportunities" and "threats", suggesting a focus on policy-driven responses to maritime security risks. The spatial separation of these clusters underscores the ongoing policy debates regarding enforcement measures versus developmental opportunities in the Blue Economy.

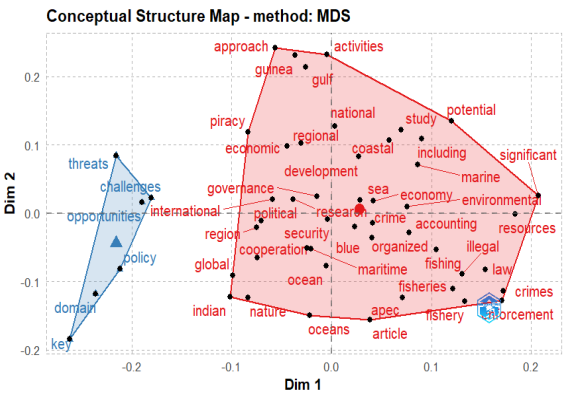

Figure 11: Multidimensional scaling

Discussion

This study reveals a concentrated, security-driven orientation in Blue Economy scholarship, indicating that the sustainability agenda of ocean governance remains heavily shaped by maritime crime and enforcement concerns. This pattern reflects persistent vulnerabilities in maritime jurisdictions where weak governance, limited surveillance and socio-economic marginalisation foster illicit activities (Okafor-Yarwood, 2020; McCabe, 2023). The prominence of security themes underscores a theoretical imbalance; while the Blue Economy is conceptualised as a developmental framework for growth and inclusion (Perkiss *et al*., 2022), its realisation is systematically undermined by governance deficits and organised crime (Witbooi *et al*., 2020). This security-oriented discourse reflects a reactive, rather than preventive, research focus, limiting the development of proactive policies that integrate ecological resilience, social equity and regulatory innovation.

Furthermore, limited cross-regional collaboration and uneven authorship distribution highlight epistemic asymmetries. Knowledge production is disproportionately concentrated in the Global North, despite the Global South bearing the brunt of Blue Crime's impacts, mirroring wider geopolitical hierarchies in environmental governance (Bueger & Mallin, 2023). Consequently, local narratives and indigenous knowledge remain underrepresented. Addressing this requires deliberate collaboration and capacity-building in coastal institutions of the Global South. The dominance of the security paradigm also implies that coercive measures alone are insufficient; Blue Crime is a developmental and governance issue rooted in poverty and exclusion (Okafor-Yarwood, 2020; McCabe, 2023), necessitating an integrated governance model that aligns enforcement with economic empowerment and community participation.

The emergence of technological governance themes such as blockchain and AI (Khan *et al*., 2025; Roberson *et al*., 2025), signals a shift toward data-driven solutions. However, their effectiveness hinges on equitable access and institutional readiness, risking the reinforcement of existing power gaps if not implemented inclusively. Disciplinary fragmentation also inhibits holistic insights, underscoring the need for interdisciplinary frameworks like Earth System Governance and Blue Justice to bridge divides and emphasise accountability and fairness (Bueger & Mallin, 2023). Finally, marked research gaps in regions like Latin America and Southeast Asia, despite their vulnerability, call for comparative studies and advanced methodologies like causal modelling and geospatial analytics to move the field toward predictive, policy-relevant science. Achieving a sustainable Blue Economy thus demands an integrated governance architecture that aligns environmental conservation, social justice and technological capacity through cross-disciplinary collaboration and equitable participation.

Implications

Theoretically, this study bridges the conceptual divide between environmental sustainability and maritime security by framing Blue Crime as a structural constraint to the Blue Economy's resilience. It moves beyond treating the Blue Economy as solely a developmental paradigm (Perkiss *et al*., 2022) and Blue Crime as merely a security concern (Okafor-Yarwood, 2020), instead reconceptualising ocean governance as an interdependent system. This integrated

view fosters a more holistic understanding of sustainability that encompasses both ecological protection and crime prevention (Witbooi *et al*., 2020). For policymakers and global institutions like the IMO, FAO and UNODC, the findings underscore the necessity of multi-scalar governance, harmonised legislation, and coordinated data sharing. Furthermore, investment in digital infrastructure, such as blockchain traceability and AI-assisted surveillance (Khan *et al*., 2025; Roberson *et al*., 2025), should be combined with socio-economic empowerment to ensure effective and inclusive maritime governance.

Limitations and Future Research Directions

This study's limitations include its reliance on Scopus and Web of Science, which may exclude valuable grey literature and regional journals, underrepresenting perspectives from developing coastal regions. The focus on English-language publications (2015-2024) also risks overlooking foundational or non-English contributions. Methodologically, the bibliometric analysis of metadata, rather than full-text content, limits the capture of deeper semantic and contextual insights. Future research should integrate text-mining and natural language processing for greater semantic precision. Employing mixed-method and geospatial approaches can better analyze the spatial and economic dimensions of Blue Crime. Furthermore, leveraging AI-based monitoring and satellite imagery could enable predictive modelling of criminal hotspots and proactive enforcement (McCabe, 2023). Expanding comparative studies in underrepresented regions and fostering transdisciplinary networks are crucial for a globally inclusive understanding of how to safeguard the Blue Economy.

Conclusions

This study systematically mapped the intellectual landscape at the intersection of the Blue Economy and Blue Crime through an integrated bibliometric, thematic and factorial analysis. The findings reveal a significant increase in research output since 2019, concentrated in security and governance-oriented journals. Thematic and conceptual analyses identified two major, fragmented clusters: one focused on governance and sustainability, and the other on crime typologies and enforcement. This highlights a persistent conceptual divide between security-driven and sustainability-driven scholarship. Furthermore, collaboration analyses exposed limited cross-regional cooperation. Collectively, these results demonstrate that Blue Crime, including illegal fishing, piracy and trafficking, poses a systemic threat to Blue Economy objectives, yet scholarly discourse remains fragmented. By synthesising global scholarship, this study advances theoretical understanding by framing these issues as interconnected, offers actionable insights for policymakers and identifies the critical need for future research that integrates security and sustainability perspectives to effectively secure a sustainable ocean economy.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

Author Contributions Statement

The authors confirm contribution to the paper as follows: study conception and design: Marhaini Mohd Noor, Jagan Jeevan; data collection: Marhaini Mohd Noor, Ali Umar Ahmad; data analysis and interpretation: Jagan Jeevan, Ali Umar Ahmad; draft manuscript preparation: Marhaini Mohd Noor, Jagan Jeevan. All authors reviewed the results and approved the final version of the manuscript.

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