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China's land-sea environmental regulatory system: reforms and impacts

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The updated "Marine Environment Protection Law of the People's Republic of China," effective from January 1, 2024, emphasizes enhanced land and marine development in a coordinated way. The revised law has been amended from the original ten chapters comprising 97 articles to nine chapters comprising 124 articles, with an addition of 27 clauses. In particular, the original law had only 3 clauses related to regulatory bodies, which increased to 8 after the revision. Chapter II Supervision and Control over the Marine Environment has added 4 clauses and revised 4 clauses to pursue coordinated land and marine development and regional linkage. As for marine ecological protection, there are 3 new clauses in Chapter III. Through specifying authorities' responsibilities, fostering a coherent approach to land-sea environmental governance, and bolstering ecological safeguards, these amendments fill a gap in regulations concerning land and marine development in a coordinated way. On this basis, the implementation of the new law will promote a positive interaction between the marine economy and the land-based economy, and facilitate the collaborative governance of ecological environments in both terrestrial and marine areas.

KEYWORDS

Marine Environment Protection Law, land and marine development in a coordinated way, environmental regulation, legal framework, environment pollution

1 Introduction

As global warming intensifies and human activities continue to increase, marine ecosystems are facing unprecedented challenges, including loss of biodiversity, worsening pollution,and overexploitation (Dugoua, 2023). These phenomena not only threaten the survival and reproduction of marine life, but also disrupt the balance and stability of marine ecosystems, thereby exerting a profound impact on global economic and social development. The preservation of ocean ecosystems has become a paramount concern for nations worldwide (CEPR, 2024).For one thing, as a coastal country with vast territorial seas, China is facing domestic emerging threats such as pollution from land-

based activities and overfishing. For another, as the world's second-largest economy, China actively participates in marine governance, promotes regional cooperation, demonstrating its responsibility as a major country (Meng et al., 2021). On October 24, 2023, the Standing Committee of the Fourteenth National People's Congress of China convened for its Sixth Session, where it approved substantial amendments to the Marine Environmental Protection Law, herein referred to as the new MEPL. These revisions enhance the existing legal structures dedicated to the preservation of marine environments, aim to protect China's maritime sovereignty, and strive to elevate the prominence of China's marine environmental standards on an international scale. The adjustments specifically address challenges encountered in the prior enforcement of marine laws (Ministry of Ecology and Environment), embedding "land and marine development in a coordinated way and regional coordination" as foundational pillars for the management and oversight of marine ecosystems. The law now distinctly identifies which entities will oversee its implementation, delineates their specific responsibilities and authority, and sets forth a framework for their interaction and cooperative efforts. Furthermore, the revised Marine Environmental Protection Law explicitly commits to a principle of terrestrial-maritime integration for environmental conservation, establishing a cohesive system for overseeing marine environments that includes comprehensive strategies for planning, standardizing procedures, and enhancing monitoring techniques (Protecting and Improving the Marine Environment to Promote Harmonious Coexistence between People and Nature). This analysis seeks to elucidate how the principle of land and marine development in a coordinated way is manifested in the amendments to the law, to explore the adjustments in regulatory approaches in marine environmental management compared to previous versions, and to evaluate the potential implications of these changes for the marine ecological environment of China.

2 Literature review

Historically, the regulatory frameworks addressing the interface between land and marine environments have not received adequate attention. Traditionally, land-sea dynamics have been compartmentalized, with separate strategies for each domain (Li, 2023). When national land planning was crafted, the planners often excluded considerations of the interplay between terrestrial (Segura Landa, 2024) and marine ecosystems (Chen et al., 2021). Initially, urban-centric policies dominated the discourse, and the concept of maritime spatial planning did not emerge until the 1970s (Bruno and Valdivia, 2023). The early attempts at integrating these two spheres were mostly confined to transportation logistics that bridged land and sea (Andrade et al., 2016). However, from an environmental standpoint, the division between land and sea is artificial as both realms are interconnected. Pollutants originating from terrestrial sources frequently find their way into marine settings, establishing a complex, open-system interaction (Li and Zhang, 2022) that underscores the marine environment's vulnerability to terrestrial influences. Therefore, it is imperative for environmental regulations to encompass the dynamics between these two environments comprehensively (Wallington et al., 2005).

In recent discussions within the academic and governmental sectors, the synergistic role that terrestrial and marine environments play in environmental conservation has increasingly gained attention. Numerous studies have explored these ecosystems thoroughly from diverse perspectives (Webb, 2012). The interface between land and sea is critical for understanding the intricate connections between terrestrial and marine ecosystems (Barceló et al., 2023). Despite the rich body of research, detailed knowledge regarding the interactions between these environments is still notably deficient (Stoms et al., 2005).

Currently, there is a broad agreement among nations that safeguarding the marine environment necessitates a unified approach that incorporates both terrestrial and maritime elements (Smith, 2011). Isolating land from sea makes effective marine ecosystem management unattainable. One of the primary obstacles in achieving coordinated land and sea development is the creation of an appropriate set of indicators (Wang et al., 2019). Analytical research indicates that between 26% and 41% of the world's oceans must be managed and preserved through strategies that integrate terrestrial and maritime efforts (Jones, 2020). The degradation caused by human activities extends beyond species reduction and extinctions (McCauley et al., 2015); it also includes the rapid deterioration of untouched ecosystems on both land and sea (Jones et al., 2018). This ongoing loss of biodiversity has spurred demands for dedicating half of the Earth's surface to nature conservation (Dudley et al., 2018), with Marine Protected Areas (MPAs) being increasingly established worldwide to preserve marine biodiversity (Gill et al., 2017). The importance of integrated land-sea planning is also critical for maintaining national food security and fostering an ecological civilization (Fan et al., 2023). This approach is gaining traction globally, emphasized by both the international community and numerous countries. For instance, the Convention on Biological Diversity (CBD) resolved in 2008 to identify Ecologically or Biologically Significant Marine Areas (EBSAs) within the global oceans to prioritize conservation and management initiatives (Dunstan et al., 2016). In the United States, the Commission on Ocean Policy has ignited interest in a cohesive conservation policy that accounts for ecological interactions (Conference reports, 2021) within coastal ecosystems. Similarly, in Europe, ecosystem-based management principles have been incorporated into policy frameworks, such as the EU's directives for water and marine systems. Australia has adopted strategies for Ecologically Sustainable Development, and there is a growing trend towards integrated coastal zone management worldwide (Belfiore, 2003). In the Asia-Pacific region, land-sea integration policies are gaining increasing significance as countries strive for sustainable development. Japan has emphasized coastal zone management through its Coastal Zone Management Act. The act includes provisions for establishing coastal protection zones, managing coastal facilities, and protecting fishery ports and their environments, complementing the "estuary ecological restoration" clause in China's new law. South

Korea's "Marine Ecosystem Protection Act" focused on promoting sustainable fisheries and aquaculture practices, aiming at protecting marine ecosystems.

3 Methodology

This study adopts a three-pronged approach to systematically investigate the legislative evolution and practical implications of China's MEPL amendments, with a focus on land-sea integration mechanisms. The methodology integrates comparative analysis, narrative synthesis, and multi-source triangulation to ensure analytical rigor and contextual depth.

3.1 Comparative analysis framework

The study employs a structured comparative analysis of the pre- and post-amendment versions of the MEPL, as shown in Figure 1, focusing on three critical dimensions: regulatory architecture, land-sea planning integration, and marine ecological restoration mechanisms. This framework is grounded in governance theory, which emphasizes the role of institutional design and policy coherence in addressing complex environmental challenges.

Regulatory Architecture: A clause-by-clause comparison of legal texts identifies shifts in jurisdictional authority, accountability structures, and enforcement mechanisms. For instance, we analyze the expansion of the responsibilities of the national ecological environment department to strengthen the relevance of land and sea policies.

Land-Sea Planning Linkage: Drawing on systems theory, we examine how the revised law operationalizes land-sea coordination by strengthening the land-sea interface in the planning system, harmonizing of land and sea pollutant discharge standards and discharge permit systems and promoting the process of monitoring data sharing.

Ecological Restoration Mechanisms: Based on an overview of the reasons for the ecological vulnerability of the land-sea interface zone, we have pointed out the necessity and urgency of ecological restoration. Next, we made specific comparisons between the old and new laws in terms of the provisions on the restoration of natural shorelines, the protection of coastal zones and the control of estuaries, thereby highlighting the significance of this reform.

3.2 Multi-source data triangulation

To ensure analytical objectivity and comprehensive coverage, the study integrates four data streams:①Legal Documents (as listed in the Appendix): Primary analysis of official texts from the Legislative Affairs Office of the State Council, including pre-2024 and post-amendment MEPL versions. ②Government Reports: Quantitative data on enforcement actions (e.g., pollution fines, ecological compensation cases) extracted from annual reports of the Ministry of Ecology and Environment and provincial-level government work plans. ③Academic Literature: Systematic review of peer-reviewed studies, focusing on keywords like land-sea integration and blue-green development to contextualize global trends (e.g., EU's Marine Strategy Framework Directive) and domestic innovations. ④Stakeholder Perspectives: Qualitative insights from interviews with policymakers, NGO representatives (e.g., WWF-China), and industry experts to triangulate official narratives with on-the-ground implementation challenges.

3.3 Narrative synthesis and limitations

Thematic narrative analysis is applied to construct a causal chain linking legislative changes to observed outcomes in three domains: economic development patterns (e.g., coastal industrial zones), ecological indicator trends (e.g., seawater quality improvements in key bays), and institutional learning processes. While government sources provide critical baseline data, their potential limitations—such as underreporting of enforcement gaps—are mitigated through cross-referencing with academic critiques and practitioner feedback. Additionally, the study acknowledges the evolving nature of China's marine governance ecosystem, where legal amendments must be viewed as part of a broader institutional adaptation process rather than isolated policy instruments.

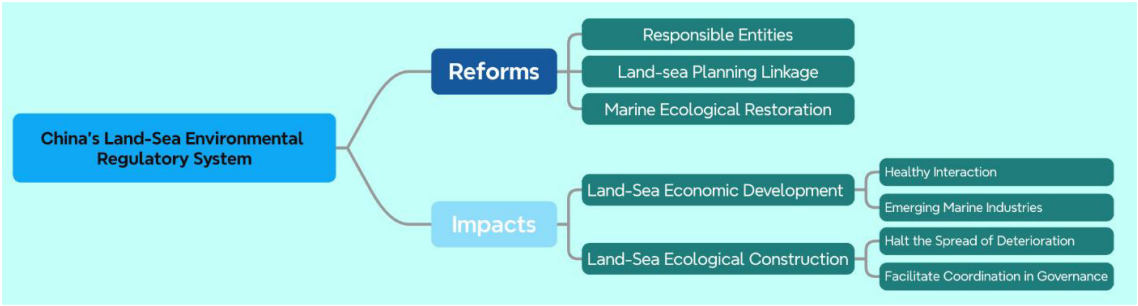

FIGURE 1
Analytical framework. Source: Authors' compilation.

4 The reform of the land-sea environmental supervision and management system in the Marine Environment Protection Law

4.1 Clarifying the responsible entities for land-sea environmental supervision

The ecological environment is characterized by itself as a comprehensive and systemic one, and thus needs management tactics, such as all environmental factors, ecosystems and administrative partitions, covering all elements. In addition, this approach must harmonize the interactions between terrestrial and aquatic environments and between upstream and downstream connections in a watershed as well as encompass surface and subsurface areas. With regard to environmental protection, there has been established a collaborative governance model through which government agencies, businesses and the broader public work together. This "triadic governance" model leverages the dynamics of both vertical and horizontal relationships across different levels of government and between various departments, promoting a varied and evolving approach to environmental governance (Zhu et al., 2018). The existence of this system improves coordinated efforts and urges environmental strategies to evolve so as to achieve integrated and efficient management of ecological resources.

Environmental governance faces persistent challenges influenced by divergent development priorities, local protectionist policies, and fragmented departmental interests. These issues are reflected in decentralized management structures, difficulties in resolving conflicts of interest between stakeholders (Institute of Geographic Sciences and Natural Resources Research, CAS, 2024), and the urgent need for improved mechanisms to coordinate integrated land-sea governance. Furthermore, cooperation between central and local authorities is often insufficiently optimized, while the participation of stakeholders remains both limited in scope and lacking in diversity. Addressing these multifaceted challenges requires the application of theoretical frameworks such as "collaborative governance theory," "multi-layered authority systems," "multi-center governance," "triple helix governance," and models of "central-local coordination" and "intergovernmental cooperation." Efforts should be directed toward harmonizing competing interests and resolving disputes at multiple levels, including central and local governments, higher and lower administrative tiers, cross-regional counterparts, intra-regional departments, as well as among government entities, private enterprises, and individual stakeholders (Zhao et al., 2025). To achieve this, it is essential to establish and refine mechanisms for decision-making integration, coordinated implementation, supervision, performance evaluation, data sharing, and the provision of financial and technological resources for watershed and marine environmental governance. Such mechanisms should facilitate effective collaboration across multiple dimensions: vertically between different governance levels, horizontally across regions and departments, and externally by incorporating both internal and external actors. This requires fostering dynamic and synergistic relationships through the integration of top-down directives, bottom-up participation, lateral coordination between regions and sectors, and comprehensive internal and external alignment (Ma et al., 2020). By adopting these strategies, governance entities can collectively promote stronger collaboration and create positive interactions, thereby advancing the effectiveness of integrated environmental management.

4.1.1 The responsibilities for marine environmental protection have been further integrated into the national ecological environment department

The previous version of the "Marine Environmental Protection Law" assigned marine environmental protection responsibilities separately to the environmental protection department under the State Council and the State Oceanic Administration. It was conceived that environmental protection department was in charge of pollution prevention and control from sources on the land and from coastal development project, and State Oceanic Administration handled pollution induced by marine engineering activities and dumping of waste at sea. The allocation was based on the principle of separating land and sea management. However, the resulting partitioning also made it difficult to establish coherent governance of marine environmental issues. Rearising the necessity for a more integrated approach, large reforms were introduced in the revised Article 4 of the law. As shown in Figure 2, the new provision unifies marine environmental supervision functions under the ecological environment department, and does not make separate provision for the functions of different entities. This reform not only aligns with the broader goals of institutional restructuring

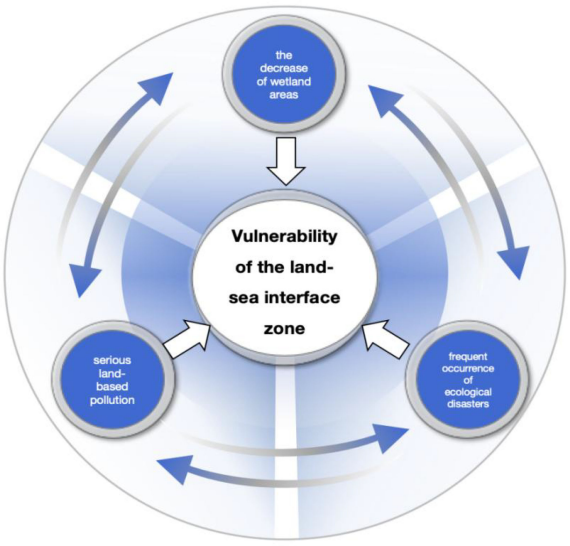

FIGURE 2
Analysis of the reasons for vulnerability of China's land-sea interface zone.

but also adheres to the principles of "land and sea integration," ensuring a more unified and efficient system for marine environmental governance.

4.1.2 Local governments are uniformly responsible for the quality of the inland marine environment under their jurisdiction

Influenced by the exchange of environmental elements between land and sea, the deterioration of marine ecological environment quality often originates from environmental pollution and ecological damage on land, which requires coastal local governments to effectively assume the responsibility of protecting the quality of land-sea ecological environment (Li and Cheng, 2023). The original MEPL did not explicitly include marine ecological environment quality in the local government's environmental quality target management and assessment mechanism, resulting in marine ecological environment quality being excluded from the environmental quality target management responsibilities of some local governments. Phenomena such as "reclaiming land from the sea," "demanding housing along the coast," and illegally approving land reclamation and infilling projects have occurred frequently, causing significant negative impacts on the marine ecosystem (Delevaux et al., 2018). From 2013 to 2017, for example, Zhejiang Province reclaimed 8,820 hectares of land from the sea, with 42.38% of it left unoccupied. From 1970 to 2018, the mainland coastline of Zhejiang Province advanced seaward, enclosing and reclaiming a total of approximately 147,700 hectares of land from the sea (Ministry of Natural Resources of the People's Republic of China, 2018). Similarly, in Hainan Province,from 2013 to 2016, the average annual land reclamation area reached 550 hectares, which was about five times the average annual land reclamation area over the previous 20 years (Hainan Provincial Department of Natural Resources and Planning, 2020). A large amount of land reclaimed from the sea was used for real estate development, exerting significant pressure on the marine ecological environment.

To address these challenges, the newly revised Article 5 of the "Marine Environmental Protection Law" introduces explicit requirements regarding territorial responsibility for marine environmental quality. This article begins with a statement that 'within their jurisdictional boundary, local people's governments at or above the county level along the coast shall bear the responsibility for the quality of the marine environment[1].' This provision is in alignment with Article 6 of the "Environmental Protection Law of the People's Republic of China," which mandates that "people's governments at all levels shall assume responsibility for the quality of the environment within their administrative regions." As a result of this revision, the responsibility for production of the quality of land and marine environment is formally laid on the shoulders of the local governments making them the main recipient of the ecological management in their jurisdictions. In addition, the law is also meant to encourage local governments to collaboratively manage land and sea ecosystems in an integrated and non fragmented manner. This legal reform defines responsibility of local government for marine ecological quality, thereby setting out a framework for addressing ecological degradation (Zheng, 2016), reducing harmful practices and for the sustainable development of land and marine areas. The shift to local focus in legislation grants local authorities a more critical role in governance of ecological work and emphasizes that they will play an active part in the conservation and restoration of connected terrestrial and marine ecosystems.

The previous version of the "Marine Environmental Protection Law" provided limited provisions on how to hold local governments accountable for maintaining the quality of the marine environment. Article 10 only mentions that work plans of all levels of government in the coastal regions shall include marine environmental protection objectives and tasks. However, the newly revised "Marine Environmental Protection Law" introduces a more comprehensive framework in Article 5(2) by establishing a target responsibility system and an assessment and evaluation mechanism for marine environmental protection. As stated in this provision, marine environmental protection objectives will now play an important role in government performance appraisal. The evaluation system of local governments moving forward will not only evaluate terrestrial ecological and environmental governance status, but also the quality of the marine environment, and will improve the quality of the marine environment (Li et al., 2021). Local governments will be formally obliged to comprehensively take into account the protection and enhancement of the terrestrial and marine ecological environments in their governance frameworks judged by the environmental performance evaluation as the main internal regulatory tool.

4.2 Achieving the integration of land-sea environmental supervision

The manifestation of marine environmental issues lies in the sea, but their root cause is on land. Article 12 of the revised "Marine Environmental Protection Law" stipulates that a cohesive and regionally coordinated management system for both land and sea must be instituted by the state. This section calls for a significant enhancement in the integration and coherence of various governance activities, including planning, setting standards, and monitoring between terrestrial and maritime zones. This element was not addressed in earlier versions of the legislation, signaling a notable shift in the strategic direction for marine environmental management and supervision.

4.2.1 Strengthening the land-sea interface in the planning system

Planning serves as a strategic framework that significantly influences the developmental trajectories and conservation efforts within terrestrial and maritime domains (Smith, 2011). To foster alignment between the objectives of coastal economic growth and

1 Marine Environmental Protection Law of the People's Republic of China (MEPL). (2023). Article 5. Retrieved from http://www.npc.gov.cn/zgrdw/npc/zfjc/zfjcelys/2018-11/12/content_2065782.htm.

ecological conservation, both terrestrial and marine, it is crucial to integrate marine ecological conservation goals within governmental planning frameworks (Wen and Liu, 2019). The updated "Marine Environmental Protection Law" through its Articles 13, 14, and 15, as conveyed by Figure 2, introduces stipulations for the integration of terrestrial and maritime planning systems. This integration manifests primarily in two key areas: firstly, activities related to the development and utilization of marine resources or those impacting the marine environment are now uniformly included under the directives of territorial spatial planning and use regulations. This includes incorporating marine environmental protection into the environmental assessments of such spatial plans. Secondly, the national plan for marine ecological environment protection, along with ecological zoning and control programs, and environmental access lists, are synchronized with national land and spatial planning initiatives. This alignment underscores the mandated coordination between land and sea planning efforts.

4.2.2 Harmonization of land and sea pollutant discharge standards and discharge permit systems

Previously, a significant impediment to the effective protection of marine ecosystems was the lack of synchronization between the standards and permits regulating pollutant discharges on land and at sea. The latest amendments to the "Marine Environmental Protection Law" aim to rectify this by harmonizing the regulations for discharges across both domains, advancing the goal of holistic marine environment management. Specifically, Article 18 of the revised law now stipulates that the standards for marine environmental quality must be considered a crucial foundation for setting inland water pollutant discharge standards. Additionally, Article 19 introduces a new mandate for the cohesive management of marine areas, ensuring that the systems for sewage discharge permits are aligned uniformly across terrestrial and maritime boundaries (Wang et al., 2019), a feature not provided in previous versions of the law.

4.2.3 Monitoring data sharing and coordinated surveillance mechanisms

As the primary orchestrator of activities integrating land and sea, the government's management mechanisms play a crucial role in the efficacy of protecting these interconnected ecosystems. These mechanisms are typically designed around defining the responsibilities and powers of various governmental bodies. The complex interactions between terrestrial and marine ecosystems necessitate continuous research and monitoring to gather essential data that supports coordinated conservation efforts (Stoms et al., 2005). Enhancing the systems for surveying terrestrial and marine natural resources, establishing comprehensive databases, and improving the mechanisms for monitoring, managing, and sharing information are vital. The new law in Article 24 mandates the sharing of information among the relevant State Council departments, marine police, and environmental authorities. Article 25 elaborates on the duty of these entities along with local governments at or above the county level in coastal areas to engage in comprehensive and coordinated monitoring. These provisions facilitate synergistic operations between central and local governments and among various authorities managing land and sea monitoring.

4.3 Improving the ecological protection mechanism of land-sea special spaces

Notably, special areas at the land sea interface are deemed to be the most vulnerable and the most ecologically significant. Studies have shown that coastal ecosystems provide a multitude of ecosystem services, including nutrient cycling, wave attenuation, and carbon sequestration, which are vital for maintaining global ecological balance (Barbier et al., 2011). Data from global assessments indicate that these ecosystems are under severe pressure, with many coastal habitats experiencing unprecedented rates of degradation and loss (IPCC, 2019).

Ecologically speaking, the fragility of China's land-sea interface zone remains significant: ecosystems are damaged, with a reduction in the wetland area at the mouth of the Yangtze River; biodiversity is declining, and the number of rare and endangered species is decreasing. For example, precious fish species such as the Chinese sturgeon in Bohai Bay are threatened due to the deterioration of their ecological environment; ecological disasters occur frequently, with green tide disasters affecting China's Yellow Sea from April to August 2022 (China News Service, 2024); land-based pollution is prominent, accounting for more than 80% of marine pollution sources (Li, 2024). As showed in Figure 2, these issues are intertwined and interact with each other, further damaging the ecosystem of the land-sea interface zone.

From the perspective of the structure and content of legal norms, compared to the original Marine Environmental Protection Law, which emphasized marine pollution prevention and control, the newly revised version significantly enhances the content on marine ecological protection, particularly focusing on the ecological maintenance and restoration of special areas at the land-sea interface. Moreover, these restoration efforts are all carried out with the core concept of "land and marine development in a coordinated way".

4.3.1 Provisions have been added on the management and restoration of coastal zones

The coastal zone represents a dynamic interface between land and sea, possessing unique ecological, economic, and social values. It serves as a transitional area with abundant biodiversity, a region rich in natural resources, and a hub for human maritime activities. So far, several provincial regulations have already been implemented to provide operational legal frameworks to ensure the sustainable exploitation and environmental protection of this unique area (Jankowska et al., 2022). For instance, the Jiangsu Provincial Coastal Zone Management Regulations (1991) and the Fujian Coastal Zone Protection and Utilization Management Regulations (2018) are examples of such efforts. But even so, there is an urgent need for centralized legislation to further

strengthen the protection and management of the coastal zone. While the original "Marine Environmental Protection Law" included general provisions addressing coastal engineering, it lacked specific legal measures for managing and conserving the resources of the coastal zone. But because of this deficiency, it became very difficult to protect valued ecological spaces like intertidal zones and mudflats to be used for biodiversity and general environmental health (Smit et al., 2024). Resurgent in these areas have been environmental degradation and legal ambiguity, as a result of absence of targeted regulations. In response, Article 36 of the newly amended "Marine Environmental Protection Law" introduces explicit requirements to ensure biodiversity is preserved during the development and use of marine and coastal resources. It fills a critical gap, because the new law hadn't included specific regulations for the coastal zone. The new law also puts more emphasis on protecting ecologically important areas where land meets the sea. Inclusion of such targeted provisions indicates the significance to sustainable practices in coastal zone management as well as marks a step up in level of ecological priorities in the reformed legal framework.

4.3.2 The natural coastlines will be strictly protect

Emergent provisions addressing management of shorelines, at control, protection, utilization, and restoration scales, reflect a broad approach to ecological preservation and recovery of important shoreline areas located at the interface between land and sea (Dudley et al., 2018). Shorelines act as the physical boundary between terrestrial and marine ecosystems and, as such, the condition of shorelines has a major influence on coastal ecological health, stability and sustainability (Bertness et al., 2021). A new framework for the control of natural shorelines under the constituent part of Article 39 has been provided which promises to be more detailed and robust, placing coastal local governments in a primary position with respect to the protection and restoration of shorelines(as showed in Figure 3). According to this provision, a categorized management system should be adopted for shorelines protection, rational use and restoration as needed. In particular, conservation and rehabilitation of natural shorelines are promoted under the new law, as a first priority being their ecological integrity. Moreover, it champions the conversion of artificial shorelines to environmentally friendly designs that will minimize the harsh impacts that resulted from previous developments. These reflect a transformation away from a focus on traditional hard engineering solutions to a perspective including ecological principles in shoreline management and planning. In addition, the revised law addresses shoreline governance explicitly for the first time ever, thereby filling a long standing gap that was missing in its predecessor law regarding focused legal provisions for this critical spatial area (CRS, 2023). These enhancements strengthen

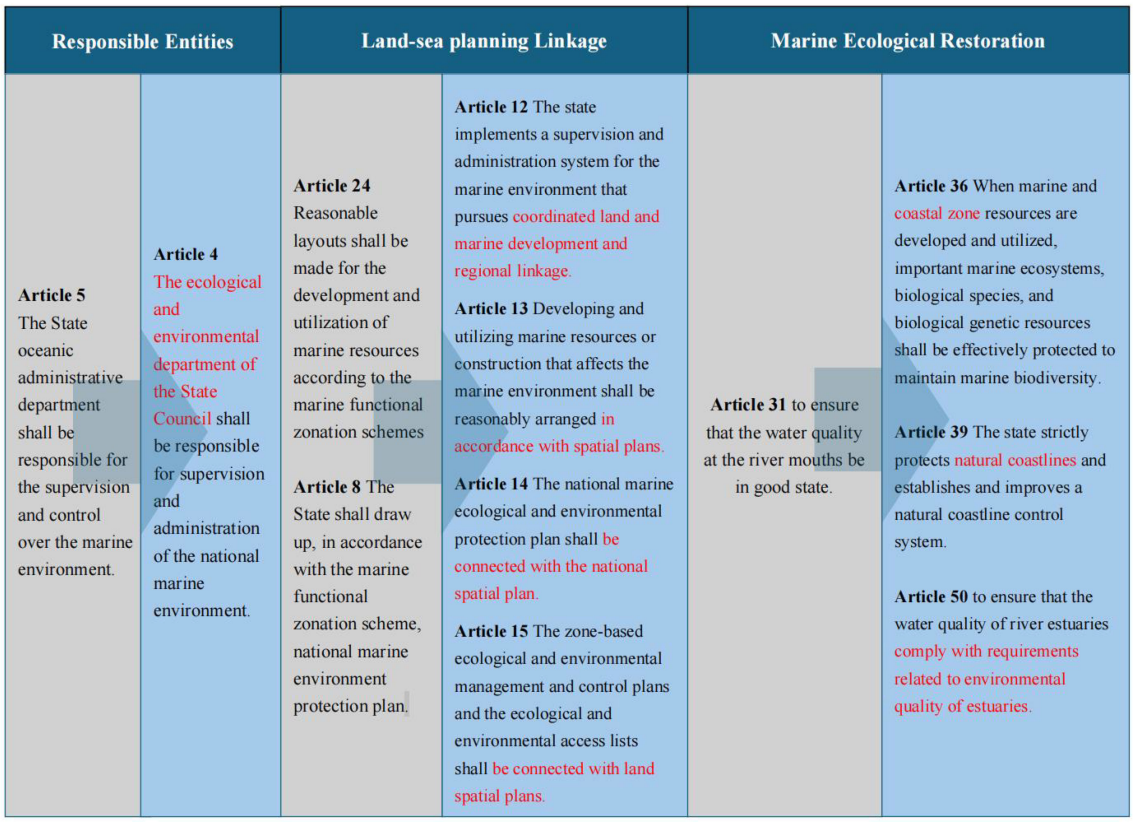

FIGURE 3
Comparison of the old sand new provisions (The grey area is the old law. The blue area is the revised law).

the legislative base for the protection of shoreline ecosystems, to strike a balance between the protection of the environment and the continued and sustainable use of natural resources and for maintaining the long term health of coastal ecosystems.

4.3.3 The new law clarifies the environmental quality requirements for estuaries

While rivers and estuaries are not technically part of the land-sea boundary, they play a critical role in shaping the quality of the marine ecosystem, acting as conduits between terrestrial and marine environments (UN, 2015). In 2022, the overall water quality of the national control sections of rivers flowing into the sea was good. However, the proportion of Class I-III water quality sections accounted for 80.0%, an increase of 8.3 percentage points year-on-year; the proportion of water quality sections worse than Class V remained unchanged at 0.4%. The average concentration of total nitrogen in the sections of rivers flowing into the sea was 3.92 milligrams per liter, an increase of 8.9% year-on-year (Ministry of Ecology and Environment of the People's Republic of China, 2023). Consequently, there is an urgent need to refine the legislation concerning rivers flowing into the sea to optimize the estuarine ecology.

The original "Marine Environmental Protection Law" included only a general provision requiring provincial environmental and water management authorities to ensure favorable water quality in estuaries. However, this earlier regulation lacked specificity, both in terms of the responsible entities and in defining the water quality standards, which were expressed ambiguously. The revised law, through Article 40, addresses these shortcomings by stipulating that the departments responsible for ecology, environment, and natural resources under the State Council must be consulted to establish ecological flow control indicators for major rivers discharging into the sea. Additionally, it requires that restoration programs for estuarine ecosystems adhere to the principle of river-sea integration, thereby promoting the comprehensive ecological restoration of both rivers and estuaries.

Chapter 4 of the Marine Environmental Protection Law, titled "Prevention and Control of Pollutants from Land-based Sources," introduces provisions for the establishment of a comprehensive regulatory framework encompassing nearshore water bodies, sea outfalls, sewage pipelines, and pollution sources. It insists on the construction of integrated system to manage these interconnected components efficiently. This law revises and strengthens regulatory mechanisms relating to pollution of the sea by reason of discharge of pollutants into the sea through open ditches and canals, pollution by reason of sewage and wastewater entering marine environments, agricultural runoff, and the entry of solid waste into the sea. These improvements intend to further improve pollution prevention and control in many domain areas. Moreover, the law revises and collates some provisions belonging, respectively, to former Chapters V (covering pollution prevention as regards coastal engineering and construction works) and VI (as to marine engineering and construction works) of the PEMA. These two chapters have been integrated into the new Chapter V, "Prevention and Control of Pollution from Engineering and Construction Projects." The unification of requirements provides a consistent, cohesive framework when dealing with marine environmental protection in both coastal and marine construction activities. The updated chapter encourages a commonality among environmental standards and practices, conducive to a wider approach to mitigate pollution from engineering and construction projects in marine and coastal areas.

Article 50 further clarifies the responsibilities of the relevant departments of the State Council, along with local governments and their subordinate authorities at or above the county level, mandating accountability for estuarine environmental quality. This aligns with Article 5, which details departmental responsibilities under the law. The earlier requirement for estuarine water quality to be in "excellent condition" has been replaced with a more precise standard—"in line with the relevant requirements of estuarine environmental quality." This change reflects a stronger reliance on environmental quality standards to regulate land-based pollutant discharges into the sea. Moreover, the revised law enhances the control of total nitrogen and total phosphorus discharges into marine environments. It explicitly assigns the responsibility for developing and implementing related control programs to the provincial governments of river basins discharging into the sea. These adjustments introduce stricter regulatory measures for addressing land-based pollutants that originate far from the coasts but are transported to marine ecosystems through rivers.

5 Impact of the land-sea environmental supervision and management system of the "Marine Environmental Protection Law"

5.1 Coordinating land-sea economic development

5.1.1 Promoting the healthy interaction between marine economy and land economy

In the country with vast land and marine resources, China's coastal regions are identified as the axis of economic activities on the basis of abundant production factors and economic advantages. The foundation for national economic growth has become these areas. The land based economy and the marine economy are closely interrelated and each is needed and plays a complementary role in total development (Gai and Liu, 2013). As a result of this historical tendency to prefer terrestrial economic development to that of marine development, there has been an absence of integration and coordination between terrestrial and marine sectors. The recent amendments to the "Marine Environmental Protection Law" reflect the Chinese government's renewed focus on fostering balanced and coordinated development between land and sea. These revisions seek to use the strengths of the land economy to develop the parts of the marine economy that have not yet been developed and leverage synergies which feed into the strengths of the broader Chinese economy and its healthy and sustainable development. This shift

represents an intentional movement towards convergence of economic resources and potentials across terrestrial and marine sectors with full utilization towards long term economic stability and achieved environmental sustainability.

Under the guidance of the principle of land and marine development in a coordinated way, Fujian's Xiamen Port has integrated with logistics parks and industrial parks in inland areas, forming an efficient logistics system to achieve integrated land-sea development. Xiamen Port has opened sea-rail intermodal transportation routes with Ganzhou and Shangrao in Jiangxi Province, such as the "Changsha-Xiamen One Port Pass" efficient container logistics path, providing a fast channel for Jiangxi goods to go to sea. According to statistics, the container volume of sea-rail intermodal transportation between Fujian and Jiangxi has grown rapidly, from 48,200 TEUs in 2020 to 135,900 TEUs in 2024 (Wu and Xue, 2025), representing a nearly twofold year-on-year increase. This fully demonstrates the important role of land-sea coordination in promoting regional economic development.

After the implementation of the new law, China's marine economy in 2024 surpassed the 10 trillion yuan threshold for the first time, reaching 10,543.8 billion yuan(as shown in Figure 4 below), with a year-on-year growth rate of 5.9%. It accounted for 7.8% of the country's gross domestic product (GDP) and contributed 0.4 percentage points to national economic growth (Ministry of Natural Resources of the People's Republic of China, 2025).

5.1.2 Developing marine emerging industries to adjust industrial structure

The industrial structure, as a comprehensive system, combines land and marine industries, needing coordination for balanced development. However, the current industrial layout between China's terrestrial and marine economies suffers from significant disconnection and poor integration. Problems such as excessive similarity in industrial structures, irrational spatial distribution, and outdated industrial setups are prevalent (Luan et al., 2020). These hinder coordinated land-sea industry development. To solve this, holistic planning is needed, including rational industrial clusters, reduced resource, talent, capital, and technology barriers, and harmonious economic advancement. A key strategy is promoting emerging marine industries to drive structural transformation and upgrading (Wang and Wang, 2019).

At present, the proportion of emerging marine industries in China's overall industrial landscape remains relatively low, and their underdevelopment has restricted further economic growth. Figure 5 intuitively reveals the industrial structure distribution of China's Marine economy in 2022.According to the 2022 China Marine Economic Statistics Bulletin released by the Department of Marine Strategic Planning and Economic Affairs of the Ministry of Natural Resources, the national marine gross domestic product reached RMB 9,462.8 billion, an increase of 1.9% over the previous year. Among this, the added value of marine emerging industries amounted to RMB 192.6 billion, up 7.9% year on year (Ministry of Ecology and Environment of the People's Republic of China, 2023). Although this growth rate is significantly higher than that of the overall marine economy, in terms of absolute value, the proportion of emerging marine industries in the overall industrial structure is still relatively low, indicating significant growth potential and development space.

In the future, the focus must be on enhancing the quality of high-value marine economic activities, transforming traditional marine industries through digitization, intelligence, and modernization, and accelerating the growth of key sectors such as marine pharmaceuticals, marine biotechnology, and the comprehensive utilization of seawater. Achieving an optimized industrial structure to support the integrated development of land and marine economies relies heavily on the vigorous advancement of high-tech marine industries (National Renewable Energy Laboratory, 2021). Major breakthroughs are especially needed in fields such as deep-water exploration, green technologies, and safe, high-tech marine applications. This necessitates accelerating

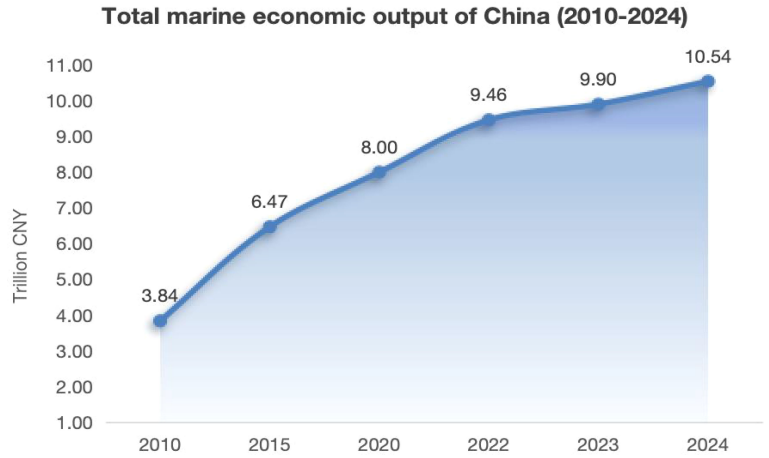

FIGURE 4
Growth trend chart of China's total marine economic output from 2010-2024. The above data is sourced from the China Marine Economic Statistical Bulletin of the corresponding years.

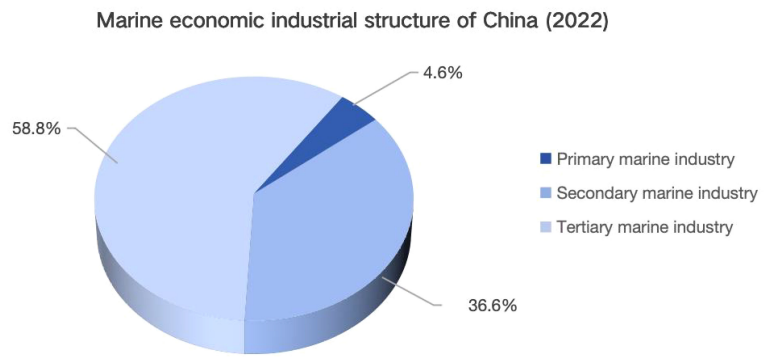

FIGURE 5
The proportion of China's marine economic industrial structure in 2022. Source: 2022 China Marine Economic Statistics Bulletin.

research and development in core technologies and addressing critical shared challenges in the transformation of the marine economy.

Guided by the values underlying the new law, marine emerging industries have shown strong momentum of vigorous development in 2024. The marine shipbuilding industry has achieved remarkable results, with an annual increase in added value of 137 billion yuan, up 14.9% year on year. The new orders for sea-going ships, the completions of sea-going ships, and the orders on hand for sea-going ships amounted to 43.01 million, 20.75 million, and 82.97 million compensated gross tons respectively, with international market shares exceeding 50% for the first time across all categories, reaching 68.2%, 50.3%, and 55.4% respectively. Notable progress has been made in advancing high-end, intelligent, and green development. The ratio of completed sea-going ships to their deadweight tonnage has reached a record high, and the international market share of new green ship orders has reached 78.5% (Ministry of Natural Resources of the People's Republic of China, 2025), highlighting China's strong competitiveness in the marine shipbuilding sector.

5.2 Coordinating land-sea ecological construction

5.2.1 Halting the continued spread of deterioration in marine ecological environment

As stated before, the pollution problem of China's marine ecosystem remains prominent. Alignment of standards environmental, pollutant discharge criteria and environmental quality and capacity management framework is extremely poor with big gaps in the integration and coordination of land, sea and air planning systems (Xu et al., 2024). These disparities underscore the necessity for expanded environmental investigation, real time monitoring and all encompassing evaluations.

In this context, the MEPL clearly stipulates that "the state implements a supervision and administration system for the marine environment that pursues coordinated land and marine development and regional linkage, and strengthens the connection and coordination between planning, standards, monitoring, and other supervision and administration systems"[2].It also establishes that "the national marine ecological and environmental protection plan shall be connected with the national spatial plan"[3], "the zone-based ecological and environmental management and control plans and the ecological and environmental access lists shall be connected with land spatial plans"[4],and "strengthen the management of rivers flowing into the sea, and coordinate the prevention and control of the pollution of the rivers, so as to ensure that the water quality of river estuaries comply with requirements related to environmental quality of estuaries"[5].

Taking Qinhuangdao City in Hebei Province as an illustrative case, the implementation of the new law has effectively reduced the total nitrogen discharge in the rivers flowing into the sea. Qinhuangdao has focused on addressing issues related to water-related enterprises, agricultural non-point source pollution, and urban non-point source pollution, adopting precise methods for reducing and controlling total nitrogen concentrations. The city has implemented a comprehensive treatment strategy of "reducing at the source, recycling, controlling during the process, and treating at the end." The average concentration of total nitrogen in the six national-controlled rivers flowing into the sea within the city has dropped from a rebound state in 2021 to 3.22 milligrams per liter from January to October 2023, a decrease of 35.7% compared to the same period last year (Qinhuangdao Ecological and Environmental Bureau, 2023), indicating remarkable treatment results. At the same time, the improvement of the water quality in the coastal waters has provided a more suitable living environment for marine organisms, contributing to the restoration and protection of marine biodiversity.

In terms of investigation and monitoring, as suggested in Figure 6, the MEPL mainly covers monitoring of marine ecological environment quality, investigation of marine resources,

2 Article12,MEPL
3 Article14,MEPL
4 Article15,MEPL
5 Article50,MEPL

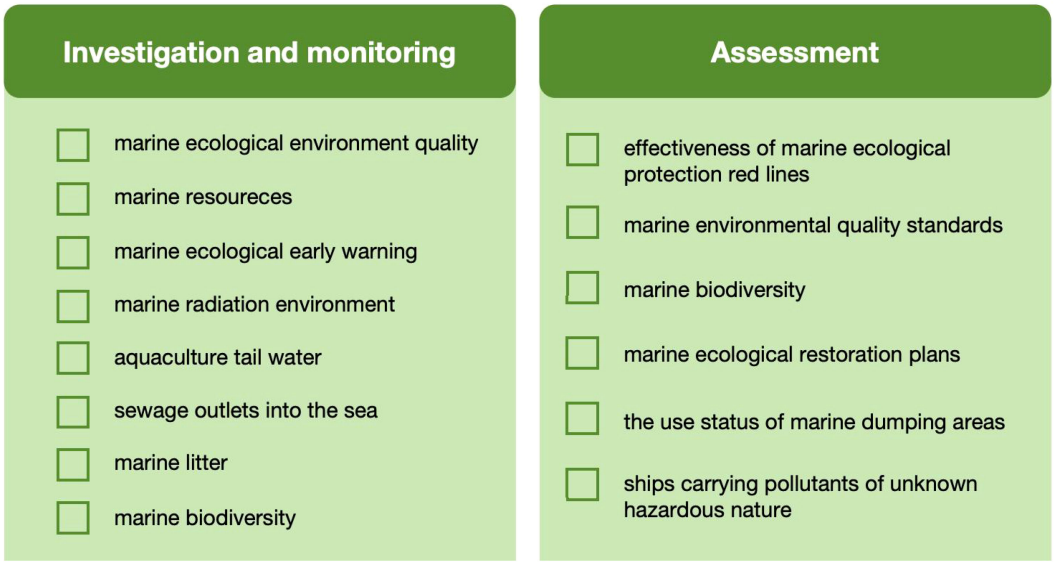

FIGURE 6
A summary table of monitoring and evaluation items in MEPL.

monitoring of marine ecological early warning, monitoring of marine radiation environment[6], monitoring of aquaculture tail water, monitoring of sewage outlets into the sea, monitoring of marine litter, investigation and monitoring of marine biodiversity, as well as comprehensive monitoring of water, sand, salinity, tidal flats, biological populations, and estuary morphology. It also includes monitoring of ship pollutants, ballast water, and sediment discharge. In terms of assessment, the law stipulates the assessment of the effectiveness of marine ecological protection red lines[7], regular assessment of marine environmental quality standards[8], assessment of marine biodiversity, assessment of marine ecological restoration plans and their effectiveness, assessment of the use status of marine dumping areas, and preliminary assessment of ships carrying pollutants of unknown hazardous nature. Among the relevant provisions on monitoring and assessment, some only involve the marine system, while others involve the collaborative governance of both the watershed and marine systems.

5.2.2 Facilitating coordination in terrestrial and marine ecological environment governance

First of all, and without fail, a coordinated protection, restoration and pollution prevention of ecosystems must be improved, across land and sea areas. Land and sea ecosystems are in interconnected since the ecological degradation in one area impacts the other and vice versa. Therefore, strengthening collaboration between terrestrial and marine ecosystems, and facilitating coordination among administrations, is necessary (Yang and Sun, 2014). The Third Plenary Session of the 18th Central Committee of the Communist Party of China required mechanisms be developed to jointly protect and restore ecosystems across water, land and sea areas (Qu and Zhang, 2024). To dismantle existing barriers between regions, industries and river basins, to implement comprehensive measures and to manage marine ecosystems in an integrated and overall manner. Similarly, the People's Congress report pointed to the need to advance water pollution prevention and control generally and comprehensive environmental management of river basins as well as coastal waters in particular (Delevaux et al., 2024). The efforts that these efforts aim at addressing include the development of collaborative frameworks that go beyond administrative and departmental boundaries to enable effective land – sea coordination. Moreover, it is of paramount importance to put in place the strictest ecological and environmental protection systems. We need to set up a modern regulatory framework to manage ecological environments, conserve resources. The development of pilot projects for a national park system has been accelerated, national parks have been designated within key ecological zones (such as tropical rainforests) and local parks and protected areas are being expanded in many locations. These measures seek to develop a robust regulatory system for the sustainable use of natural resources and ecosystems, and for the long term protection of such.

Specifically, Dalian was born and thrives by the sea, with its urban development advantages, potential, and momentum rooted in the ocean. In 2024, through meticulous planning and legislative norms, Dalian adhered to a strategy combining land-sea coordination, river-sea linkage, systematic governance, and precise policy implementation, actively promoting marine pollution prevention and control, ecological protection and restoration, and other related work. In terms of shoreline environment remediation, normalized monitoring and early

6 Article26, MEPL.
7 Article13, MEPL.
8 Article17, MEPL.

warning of sea water quality were implemented for eight key beaches, including Fujiazhuang, and concerted efforts were made to improve the beaches, achieving a 100% excellent water quality rate throughout the year. The "marine sanitation" mechanism was improved, and a "100-day intensive campaign" was launched. With joint efforts, the water quality excellence rate of Dalian's coastal waters has reached over 97% for five consecutive years. Dalian boasts 32 national-level marine ranching areas with a demonstration area of over 300,000 mu, ranking first in both number and scale nationwide (Dalian Municipal People's Government).

Here's another convincing example. With instructions of the Ministry of Natural Resources, Guangxi Zhuang Autonomous Region's Kongque Bay, in 2024, has implemented marine ecological protection and restoration projects (Ecological and Environmental Department of Guangxi Zhuang Autonomous Region, 2024). Taking the "Blue Bay" remediation action in Kongque Bay as an opportunity, they made active measures to promote the conversion of aquaculture to forestry, successfully restoring important marine ecosystems like mangroves and coral reefs[9].In the meanwhile, Kongque Bay has been deploying artificial reefs and cultivating seaweed farms. These initiatives have significantly improved the quality and stability of marine ecosystems.

6 Discussion

The revision of the MEPL boasts several core highlights. For instance, the principle of "integrated land-sea management" runs through the entire law. Unlike the decentralized legislative model in the United States—which relies on single-issue statutes and results in fragmented ocean governance—China's integrated approach systematically addresses marine environmental issues from both terrestrial and marine perspectives. Research by the National Marine Data and Information Service shows that this holistic model helps reduce administrative overlaps compared to the U.S. system (Alam and Xiangmin, 2018), significantly enhancing governance efficiency. Another advantage is the addition of "seasonal adjustment indicators" in Article 40 regarding ecological flow in estuaries. The EU's Marine Strategy Framework Directive only sets "minimum flow" requirements, while China's legal provisions incorporate seasonal variations in hydrological conditions, offering more nuanced protection, which improves estuary ecosystem resilience during dry seasons compared to static EU standards (Environment Agency, 2020).

At the same time, the revised law also has shortcomings. Firstly, the supporting implementation measures need to be improved. Although the new law has made many legislative improvements, the implementation details for specific clauses have not yet been issued, leading to certain difficulties in practical execution. In contrast, the UK's Marine and Coastal Access Act not only has a relatively complete legislative framework but also comes with a series of detailed implementation regulations and operational guidelines (Luo and Wang, 2018). Taking the prevention and control of marine litter pollution as an example, the new MEPL clearly stipulates that the local people's governments at or above the county level along the coast are responsible for the prevention and control of marine litter pollution in the sea areas under their jurisdiction, and they shall establish systems for monitoring and cleaning up marine litter. However, specific monitoring methods, cleaning standards, and responsibility implementation mechanisms have not yet been detailed. The UK's Marine and Coastal Access Act not only outlines the basic principles and objectives for the prevention and control of marine litter pollution but also releases detailed monitoring methods and cleaning standards to ensure the effective enforcement of the law.

Secondly, the public participation mechanism needs to be deepened. While the law acknowledges public reporting rights, it lacks concrete procedures for decision-making involvement, such as the hearing systems in the U.S. (e.g., California's Coastal Commission hearings) (California Coastal Commission, 2005). Canada emphasizes public participation in its marine legislation as well, which has established public consultation mechanisms and incorporated public participation in environmental impact assessments (Lee and Sun, 2016), fully safeguarding the public's right to know and right to participate, Japan's participatory model offers insights: since 2011, its Environmental Impact Assessment Act has required public consultations during planning stages, empowering citizens to shape policies (Ronald et al., 2018). Moreover, the new law still grants the right to initiate marine environmental public interest litigation to "departments exercising marine environmental supervision and management powers" and "people's procuratorates," excluding social organizations. This contrasts with the U.S., where non-governmental organizations, such as environmental protection groups and community organizations, play a significant role in environmental public interest litigation since 2010, according to the Environmental Law Institute (Huang and Hu, 2005). Such exclusion limits the role of social organizations in marine environmental protection.

Third, there are difficulties in the extraterritorial application of the law. Although the revision has improved the extraterritorial application system, it has not added new jurisdictional connecting points. The U.S. Clean Water Act, through cases like Sackett v. EPA (2023), has established robust extraterritorial jurisdiction based on "effects doctrine" and "personal jurisdiction," covering activities impacting U.S. waters regardless of location (China Green Hair Association, 2024). China's current provisions primarily focus on

9 According to the South China Sea Branch of Natural Resources, "A Declaration of Harmonious Coexistence Between Man and the Sea, A Green Portrait of Bay-City Development: The Case of Marine Ecological Protection and Restoration in Kongque Bay, Qinzhou City, Guangxi Zhuang Autonomous Region": Leveraging the "Blue Bay" remediation action in Kongque Bay, the project has implemented the conversion of aquaculture to forestry, repaired 5.3 kilometers of damaged coastline, and restored 90.12 hectares of mangroves. Adhering to the principles of source treatment and systematic restoration, the project has innovated mangrove cultivation techniques, restored wetlands, improved the mangrove habitat, and achieved a mangrove survival rate of over 90%.

protective jurisdiction, lacking comparable mechanisms for personal jurisdiction or flag state jurisdiction. For instance, while China's revised law addresses illegal activities within its exclusive economic zone, it does not explicitly regulate foreign-flagged vessels' pollution impacts on Chinese waters, unlike the EU's comprehensive Maritime Spatial Planning Directive which includes extraterritorial enforcement clauses (European Union, 2014).

7 Conclusion

In conclusion, the implementation of the new Marine Environmental Protection Law legally establishes China's commitment to integrated land-sea management in marine environmental protection. By clarifying supervisory entities, land-sea planning linkage, and facilitating marine ecological restoration, this revision provides direction for improving China's marine environmental supervision and management system. It is conducive to achieving the goal of "accelerating the construction of a maritime power", protecting marine biodiversity, realizing the orderly development and utilization of marine resources, and leaving a blue sea and clear sky for future generations (Cao, 2012). But that can not be ignored is that in the meanwhile, the enforcement of the new law may face issues of overlapping responsibilities between local environmental protection departments and marine fishery bureaus, leading to confusion and inefficiencies in the implementation of environmental protection measures. To address this, interdepartmental joint meeting mechanisms can be established to facilitate communication, coordination, and conflict resolution. Future researches should focus on developing a 'Land-Sea Ecological Economic Coupling Index' to quantitatively assess the coordinated development level of coastal provinces. Such an index would provide a valuable tool for evaluating the integration and balance between land-based and marine-based economic activities and their environmental impacts, so that policymakers and stakeholders can gain insights into the current state of ecological and economic coupling in coastal areas, identify areas for improvement, and develop targeted strategies to promote sustainable development.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

ZJ: Writing – original draft, Writing – review & editing. MY: Writing – original draft, Writing – review & editing.

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Appendix

Table A1 Official sources related to marine protection marine economy used in the article.

Category	Sources
China's legal documents	Marine Environmental Protection Law of the People's Republic of China (2023 Revision)
	Marine Environment Protection Law of the People's Republic of China (2017 Amendment)
Official government documents	Government Work Report in 2018-2024
	2022 Statistical Bulletin on China's Marine Economy
	2024 Statistical Bulletin on China's Marine Economy
	Three-Year Action Plan for High-Quality Development of Marine Economy and Promotion of Marine Strong Province Construction (2024-2026)
	2023 Xiamen Special Economic Zone Marine Economy Promotion Regulations
	2023 Qinhuangdao Municipal Marine Ecological Environment Protection "14th Five-Year Plan"
	2024 Several Policy Measures to Strengthen Natural Resource Element Guarantee and Promote High-Quality Development of Marine Economy
Marine of other legislation countries or regions	2019 Act on the Promotion of Marine Pollution Prevention of Japan
	1998 Canada Marine Act
	2008 Marine Strategy Framework Directive
	1977 The Clean Water Act (CWA) of the United States