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Configuration and Evolution of China's Marine Carbon Inclusion Policy: A Stage-Theme-Instrument Analysis (2015-2026)

Lili Li
Shandong University of Technology
yang bai
by8119@163.com

Ocean University of China
Qingshun liu
Jiyang College of Zhejiang A&F University
Mengyue zhang
Shandong University of Technology

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Lili Li[a], Yang Bai[b*], Qingshun Liu[c*], Mengyue Zhang [a]

Abstract

As an emerging governance arrangement in China, marine carbon inclusion refers to integrating blue carbon into the voluntary carbon market and adopting economic incentives to promote the sustainable management of marine carbon ecosystems, thereby linking public low-carbon actions with the realisation of marine carbon-sink value. It incorporates dispersed emission-reduction activities and marine ecological conservation practices into an institutional framework through which their carbon contributions can be quantified, incentivised, and potentially linked to value-realisation mechanisms. Focusing on China's marine carbon inclusion policies, this study develops a three-dimensional analytical framework comprising policy stages, themes, and instruments. Based on a quantitative analysis of 65 policy documents, this study examines policy evolution, configuration, and patterns of instrument adoption. The study further identifies key areas for policy refinement, aiming to consolidate the policy system and improve the allocation of policy resources. The study finds that China's marine carbon inclusion policy has evolved through successive phases, from promoting the concept to building institutions and finally to implementing and governing the system. A notable finding is that China's policy instruments tend to focus on specific themes and stages, but there remains a need for better coordination across different policy areas. China's marine carbon inclusion policy also faces an insufficient level of institutionalisation, uneven policy attention, and an imbalanced instrument structure. The study recommends strengthening national strategic planning, improving thematic coordination, optimising the mix of policy instruments, and establishing clearer mechanisms for marine carbon-sink value realisation.

Keywords: Marine carbon inclusion; Instrument configuration; Dual Carbon Goals; Policy text analysis; Marine governance

Introduction

Against the backdrop of deepening global climate governance and accelerating progress towards carbon neutrality, enabling the ecological value of marine carbon sinks to be recognised, quantified, certified, and traded has become a central issue in the transition of marine ecological governance from a predominantly protection-oriented approach towards greater integration of conservation and value realisation. In China, this transition has seen the emergence of marine carbon inclusion, an institutional approach that seeks to link marine ecological conservation and carbon sequestration to measurable low-carbon actions and corresponding incentives.

Marine carbon inclusion is conceptually related to, but distinct from, the broader fields of blue carbon governance and marine carbon-sink policies. Blue carbon governance primarily concerns the protection, restoration, monitoring and sustainable management of coastal and marine ecosystems that store and sequester carbon. Marine carbon-sink policies, in turn, refer to policy arrangements governing the identification, accounting, conservation and potential value realisation of marine carbon sinks. Both concepts encompass a relatively broad range of governance activities, including ecological conservation, carbon measurement, project development and market-based mechanisms. Marine carbon inclusion represents a more specific institutional and policy approach within this broader governance landscape. It emphasises the incorporation of marine-related ecological and

low-carbon activities into carbon-inclusion mechanisms through the identification, quantification and potential recognition of carbon-reduction or carbon-sink benefits. Its institutional significance lies not only in the ecological protection of marine carbon sinks, but also in linking measurable environmental contributions to participation incentives, benefit allocation and public engagement mechanisms. Accordingly, marine carbon inclusion can be understood as an emerging policy arrangement situated at the intersection of marine ecological governance, carbon accounting and inclusive low-carbon participation[1]. This distinction is important for defining the analytical scope of the present study. Rather than examining all policies concerning blue carbon ecosystems or marine carbon sinks, this study focuses on policy documents that explicitly establish, support or operationalise arrangements related to marine carbon inclusion. Policies concerning marine ecological conservation, carbon-sink accounting and low-carbon development are included only where they have a demonstrable institutional or functional connection to the development of marine carbon inclusion.

Research on carbon inclusion has shifted from conceptual and behavioural inquiries to institutionalisation and policy assessment. Early studies have focused on the definition of carbon inclusion[2,3], influencing factors[4,5,6], behavioural mechanisms[7,8] and public participation[9,10]. Recently, greater attention has been paid to mechanisms for integrating eligible carbon-inclusion activities or quantified emission reductions into the China Certified Emission Reduction (CCER) framework to strengthen incentives and facilitate value realisation. Relevant policies foster individual emission reduction actions. Zhou et al. (2026) found that the marine carbon-sink policy has significantly improved public cognition and participation behaviours regarding low-carbon activities[11]. However, a gap remains between macro-level policies and individual actions[12,13]. An increasing body of research has focused on incentive mechanisms, policy optimisation and methodological standardisation. Carbon inclusion policies have also been shown to increase residents' willingness to adopt low-carbon lifestyles and to reduce consumption-side emissions. The mismatch between the priorities of marine carbon inclusion policies and individual actual benefits constrains policy effectiveness[14,15,16]. These gaps point to the need for more systematic assessment of policy configuration, institutional design, and effectiveness [17].

Research on marine carbon inclusion can be divided into four broad strands. The first focuses on mechanisms for realising the value of marine carbon sinks, covering the quantification of carbon storage[18,19] and environmental factors influencing marine ecosystems[20,21]. Recognising the role of marine carbon sinks in tackling climate change[22], researchers have also investigated how they might be incorporated into the international climate governance framework[23]. The second strand examines the implementation of marine carbon-sink policies, their practical outcomes, and the opportunities, challenges and factors shaping their implementation across different countries[24,25,26,27]. Japan's J-Blue Credit scheme, for example, is administered by the Japan Blue Economy Association (JBE) under government authorisation and provides a mechanism for certifying CO_2 absorption by blue-carbon ecosystems, including seagrass beds and tidal flats, and issuing tradable credits[28]. In South Korea, a pilot seaweed-farming carbon trading project in Wando County converts carbon absorption into carbon credits and plans to return part of the resulting revenues to local communities through a 'marine pension' scheme. These international experiences provide useful reference points for the further development of marine carbon inclusion policy in China. In this international context, China's marine carbon-sink

governance has developed rapidly[29]. The policy has gradually shifted from a preliminary exploration to a more integrated management and sustainable development model. At the same time, policy priorities have shifted from ecosystem protection towards comprehensive governance and carbon-sink enhancement. Policy instruments have become increasingly standardised, a broader range of implementing agencies has been involved, and policy objectives have become more closely integrated. The third strand examines the relationship between carbon inclusion and marine carbon sinks. Carbon inclusion is increasingly regarded as a potential complement to China's carbon market and as a pathway for realising the value of blue carbon. Existing carbon trading systems constrain the extent to which the social value of marine carbon sinks can be realised[30]. Fourth, quantitative studies have examined policy evolution, instrument adoption, and policy implementation[31,32,33]. However, existing research still lacks a comprehensive account of the policy framework, thematic priorities and instrument configuration, which hinders the sustainable development of marine carbon inclusion.

Existing research has largely focused either on blue carbon governance as a broad policy field or on specific dimensions such as carbon accounting, ecological restoration and carbon trading. However, there are still three significant gaps. First, the policy evolution of marine carbon inclusion has received insufficient attention. Marine carbon inclusion is a distinctive institutional domain and therefore warrants separate examination. Second, few studies have used a shared analytical framework to examine policy priorities, instrument configurations, and shifts in theme–instrument relationships across stages of institutional development. Third, existing research has not yet fully answered a fundamental question: how to promote the institutionalisation of marine carbon inclusion. Therefore, it is necessary to systematically analyse the policy evolution of marine carbon inclusion, identify the policy themes that have received attention, and examine how policy instruments have been configured across different stages.

China provides a useful empirical environment for studying this process. Sound policy establishes a critical institutional foundation for the development of carbon inclusion. Over the last decade, there has been a significant expansion in policies related to marine carbon sinks, ecological restoration, carbon accounting, and carbon inclusion. These initiatives have accelerated marine carbon-sink governance and expanded the means by which blue carbon value can be realised. Coastal provinces such as Shandong, Guangdong, and Hainan have carried out practical initiatives and established preliminary institutional frameworks for marine carbon inclusion. With the gradual improvement of carbon inclusion methods, governance arrangements and market mechanisms, marine carbon inclusion is expected to become an important component of China's carbon peaking and carbon neutrality goals. China has begun to establish a policy framework for marine carbon inclusion, but many challenges remain, including the limited application scenarios, the absence of national recognition mechanisms, and inconsistent methodological standards. To date, no model has emerged that can be replicated, sustained and scaled up. This institutional shortfall constrains marine carbon inclusion from realising its full potential. This combination of policy-driven expansion and institutional lag makes China a particularly valuable case for examining the institutionalisation of emerging marine carbon governance mechanisms.

Against this background, this study addresses three research questions: How has China's marine carbon inclusion policy evolved across different stages of policy development? What thematic priorities and policy instruments characterise this

evolution, and how are they configured across different stages? To what extent does the observed configuration of policy themes and instruments indicate a transition from policy experimentation towards institutionalisation, and what governance challenges remain? By addressing these questions, this study moves beyond a descriptive account of policy development to examine the structural relationship between policy stages, thematic priorities and instrument configurations. It seeks to explain not only how China's marine carbon inclusion policy has expanded, but also whether and how such expansion has translated into a more coherent institutional arrangement.

Relative to earlier research, this study makes three contributions. First, it develops an integrated Stage–Theme–Instrument framework to analyse the temporal, thematic and instrumental dimensions of emerging policy systems, providing a more systematic understanding of their overall configuration and evolution. Second, it conceptualises marine carbon inclusion as an emerging institution, distinguishing policy expansion from institutionalisation and highlighting the potential time lag between policy experimentation and institutional consolidation. Third, it examines policy evolution through the perspectives of policy mix coherence and institutional adaptation, highlighting the importance of instrument complementarity and how stable theme–instrument relationships may generate path dependence and thematic lock-in, constraining policy adaptability.

Research Design

Data Collection

Relevant policy documents were identified using the following keywords: marine carbon inclusion; marine carbon sinks; blue carbon; marine carbon sink trading; marine fishery carbon sinks; blue carbon trading; and carbon sinks in mangroves, salt marshes, and seagrass beds. Documents were collected from the PKU-Law database (Peking University Law Database) and official government websites, and then screened against these criteria. First, documents were required to be issued by legislative bodies or government authorities. Second, only documents with explicit regulatory or strategic intent were retained; these included laws and regulations, strategic plans, implementation schemes, announcements, notices, decisions, administrative measures, development plans and policy guidelines. Government bulletins and approval notices were excluded. Besides, this study focuses on policy documents that explicitly establish, support or operationalise arrangements related to marine carbon inclusion. After screening and filtering the documents for content relevance, 65 policy texts were retained as the sample analysed in this paper (Table 1).

Table 1. Selected policy documents related to marine carbon inclusion (part)

No.	Publication Date	Policy Title	Issuing Authority
1	April 2015	Opinions on Accelerating the Construction of Ecological Civilisation	Central Committee of the Communist Party of China, etc.
⋮	⋮	⋮	⋮
33	April 2023	Guangdong Province Mangrove Carbon Inclusion Methodology (2023 Edition)	Guangdong Provincial Department of Ecology and Environment
⋮	⋮	⋮	⋮
65	2026.6	Methodology for Shanghai Carbon Inclusion Emission Reduction Projects: Production of Recycled Biomass Fuel from Marine Litter	Shanghai Municipal Bureau of Ecology and Environment

Research Methods

Given the need to align research methods with the policy themes and policy instruments, this study adopts a hybrid analytical approach that combines Latent Dirichlet Allocation (LDA) with content analysis. The LDA model is used to identify

thematic clusters within the policy texts[34]. Content analysis enables a systematic and replicable description of policy texts through coding and data transformation, and helps to reveal the substantive features and evolutionary trends reflected in the textual data[35]. Using NVivo 15, this study maps the policy landscape and quantitatively analyses marine carbon inclusion policies; it traces the evolution of the policy system and its instrument configuration, clarifies how China's marine carbon inclusion policy operates, and explores possible pathways for its further development.

Conceptual Framework: A Stage-Theme-Instrument Perspective

The institutional development of an emerging policy domain involves more than the accumulation of policy documents. It also entails changes in policy priorities, institutional arrangements and the instruments through which policy objectives are pursued. To capture these interconnected dimensions, this study develops a Stage-Theme-Instrument analytical framework (Figure 1). The analytical value of integrating these three dimensions lies in examining their relationships rather than treating them as independent categories. Their interaction makes it possible to identify whether policy instruments are appropriately aligned with shifting governance priorities and whether the expansion of policy attention is accompanied by the development of more coherent institutional arrangements.

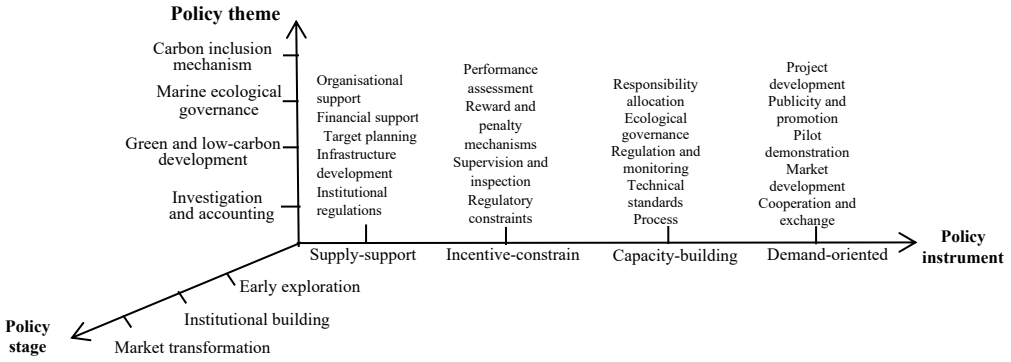

Figure 1. The three-dimensional analytical framework.

Policy stage dimension

Policy stage captures the temporal and institutional trajectory of policy development. It distinguishes between different phases according to changes in policy objectives, institutional arrangements and implementation practices. The evolution of China's marine carbon inclusion policy has followed a gradual process of institutional development, from the introduction of the concept and strategic agenda setting through local pilot programmes and standard development to market-oriented practice. *The Opinions on Accelerating the Construction of Ecological Civilisation (2015)* incorporated blue carbon into national policy planning and recognised marine carbon sinks as a key means of addressing climate change. *The National Ecological Civilisation Experimental Zone (Hainan) Implementation Plan (2019)* called for strategic support, including standards and trading mechanisms, for local blue-carbon pilot programmes. 2022 marked a watershed year for policy development. The rapid growth of national and local carbon inclusion methodologies has laid the groundwork for unified rules on marine carbon-sink accounting. These initiatives helped to move marine carbon inclusion beyond conceptual exploration towards institutionalisation. Since 2025, policy attention has gradually shifted to linkage with the CCER framework and institutionalised deployment. Methodological development and

project implementation have also been combined, with many proposed methodologies, such as the *Carbon Inclusion Method of Marine Seaweed Carbon Sequestration in Shandong Province (2025)* and the *Carbon Inclusion in Shanghai Emission Reduction Project Method: Recycling Marine Waste for Biomass Fuel Production (2026)*. According to policy content and institutional changes, this study divides the policy evolution into three stages: Early Exploration (2015-2021), Institutional Building (2022-2024), and Market Transformation (2025-present). These stages are used to identify shifts in the dominant orientation of policy development.

Policy theme dimension

Policy theme identifies the substantive governance priorities reflected in policy documents. It examines which policy issues receive attention and how these priorities change over time. Following data preprocessing, Jieba segmentation, and topic mining on the 65 policy documents, we determined the optimal number of topics. The evaluation results for perplexity and coherence scores showed that when the number of topics (K) was 4 (Figure 2), the decrease in perplexity slowed and stabilised, while the coherence score peaked. This indicated that the 4-topic scheme offered better interpretability and model fit.

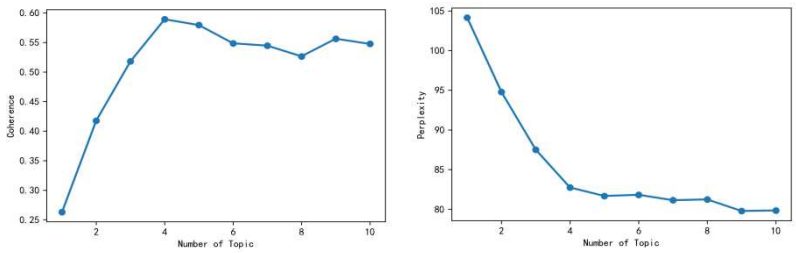

Figure 2. Change in the degree of topic coherence and perplexity.

To visualise the topic clustering effect of the LDA model, we used the LDA analysis tool to generate a topic visualisation map (Figure 3). The LDA model analysis showed that the topic distribution exhibited a degree of independence. Topics 1 and 3 were relatively dispersed, indicating high content independence. This reflected a robust classification result for China's marine carbon inclusion policy content.

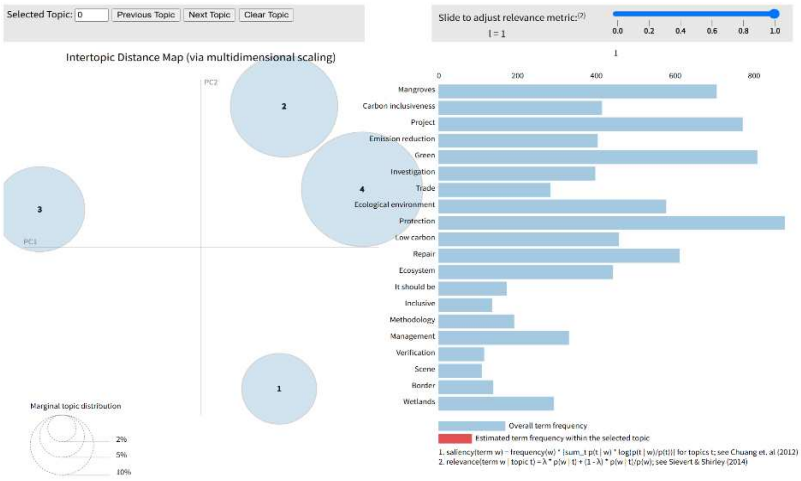

Figure 3. Visualisation of policy themes. The bubble size represents the relative proportion of each topic in the corpus, and the distance between bubbles reflects the semantic similarity between topics. The light blue bar indicates the overall term frequency of the words in the whole corpus, and the red bar indicates the estimated term frequency within the selected topic.

By synthesising the characteristic words and contribution degrees within each cluster, the analysis yielded four distinct thematic categories, as presented in Table 2.

Table 2. Policy Themes of Marine Carbon Inclusion Policies

Topic	Theme	High relevant vocabulary
Topic 1	Carbon Inclusion Mechanisms	0.039863*Carbon Incentive + 0.029527 *Emission Reduction + 0.021141*Project+ 0.016952*Ecological Environment + 0.016400 *Trading + 0.014791* Management + 0.013247*Should+ 0.012630 *Incentive+ 0.012349 *Methodology + 0.010764 *Verification + 0.010441* Green + 0.010361 *Encouragement + 0.010239 *Development + 0.010207*Scenario + 0.010196*Related+ 0.010158*Organisation+ 0.009726 *Society+ 0.009164*Institution+ 0.007526 *Individual + 0.007525 *Carry out
Topic 2	Marine Ecological Governance	0.020603 *protection+ 0.019719 *construction+ 0.014860 *strengthening+ 0.014820 *ecological environment+ 0.013252 *restoration+ 0.012780*monitoring+ 0.010783*promotion+ 0.009490*capacity+ 0.009109*development + 0.008415*focus+ 0.008403*improvement+ 0.007914*sea area+ 0.007856*supervision+ 0.007719*system+ 0.006869*bay+ 0.006628 *establishment+ 0.006436*environment+ 0.006237*strengthening+ 0.006227*management+ 0.005934*region
Topic 3	Investigation and Accounting	0.045526*Red Mangroves+ 0.029428*Project+ 0.020772*Protection+ 0.019693*Survey+ 0.018458*Restoration+ 0.016837*Ecosystem+ 0.011845*Wetland+ 0.008818*Boundary+ 0.008606*Salt Marsh + 0.007926*Biomass+ 0.007510*Including + 0.007454*Reserves+ 0.007226*Blue Carbon + 0.007073*Vegetation + 0.007012*Carry out+ 0.006880* Accounting+ 0.006839*Seagrass+ 0.006405*Activities+ 0.006378*Method+ 0.005997*Monitoring
Topic 4	Green and Low-Carbon Development	0.025522*green+ 0.020850*development+ 0.014382*low-carbon+ 0.012974*construction+ 0.012880*proceeding+ 0.009917*emission+ 0.009209*carbon peak+ 0.008749*accelerate+ 0.008638*system+ 0.008531*promote+ 0.008319*energy+ 0.008258*strengthen+ 0.008179*product+ 0.007446*energy conservation+ 0.006796*establish+ 0.006696*improve+ 0.006388*focus+ 0.006230*civilisation+ 0.006214*mechanism+ 0.006036*utilisation

Based on a synthesis of the quantitative findings and national strategic priorities and policy objectives, this study identifies four core themes of marine carbon inclusion policies: carbon inclusion mechanisms, marine ecological governance, investigation and accounting, and green and low-carbon development.

Policy instrument dimension

Policy instrument examines the mechanisms through which policy objectives are translated into administrative and practical action. The Rothwell framework is commonly employed in environmental policy research and offers a useful starting point for analysing policies for the inclusion of marine carbon[36]. Accordingly, this study adopts the conventional distinction between supply-support and demand-oriented instruments[37], while further disaggregating the environmental dimension of the Rothwell framework into incentive-constraint and capacity-building instruments, to capture the structural features of this emerging governance system. Marine carbon inclusion is therefore conceptualised as the outcome of interactions among four types of instruments: supply-support, incentive-constraint, capacity-building, and demand-oriented instruments. These four types serve distinct governance functions: providing resources, shaping behaviour, strengthening institutional capacity, and stimulating market demand.

Supply-support instruments provide the financial resources, infrastructure, technical capacity, and human resources required for policy implementation. These include financial and organisational support, infrastructure development, target planning, and institutional regulations. Demand-oriented instruments create market demand and stimulate market participation through guidance and incentives. Instruments in this category include project development, publicity and promotion, pilot demonstration, market cultivation, cooperation and exchange, carbon trading and regional pilots. Incentive-constraint instruments shape stakeholder behaviour through positive incentives and restrictive mechanisms, encouraging engagement and enhancing compliance with policy requirements. They consist of Performance Assessment, Reward and Penalty Mechanisms, Supervision and Inspection, Regulatory Constraints, and Effectiveness Evaluation. Capacity-building instruments establish institutional and enabling conditions that strengthen stakeholders' capacity to participate and to support the effective operation of the system. They include responsibility allocation, ecological governance, regulation and monitoring, technical standards, and process management.

Policy text coding and consistency testing

This study employed a deductive coding approach to categorise and analyse the content of the 65 collected policy documents. The coding unit was defined as a policy document–clause–statement segment, which enables the analysis to capture the substantive policy provisions.

The coding process involved first establishing the analytical dimensions for marine carbon inclusion policy instruments based on the theoretical framework established earlier. Second, relevant clauses and statements concerning marine carbon inclusion policy instruments were identified as the basic coding units. These units were then systematically coded item by item according to the coding scheme of "Policy Serial Number-Clause Number-Statement"[①], thereby producing a structured dataset for content analysis. In total, 530 policy-instrument coding units were identified (Table 3).

Table 3. Partial Coding Examples of Blue Carbon Policy Documents

Code	Instrument	Theme	Policy content	Policy title
G1-5	Environmental	Marine ecological governance	Increase measures such as forest, grassland, wetland, and marine carbon sinks	Opinions on Accelerating the Construction of Ecological Civilisation
G2-19	Demand-based	Marine ecological governance	Strengthen international cooperation on climate change	Integrated Reform Plan for Promoting Ecological Progress
⋮	⋮	⋮	⋮	⋮
S65-5	Supply-support	Investigation and accounting	Accounting boundary	Methodology for Shanghai Carbon Inclusion Emission Reduction Projects: Production of Recycled Biomass Fuel from Marine Litter

To assess intra-coder reliability, the same researcher performed the coding across two rounds of review. The second round involved a systematic re-examination of the coded materials, with particular attention to coding consistency, category boundaries and the handling of potentially overlapping policy provisions. Ambiguous segments were cross-checked against their surrounding textual context and the operational definitions of the coding categories.

Evolutionary Characteristics

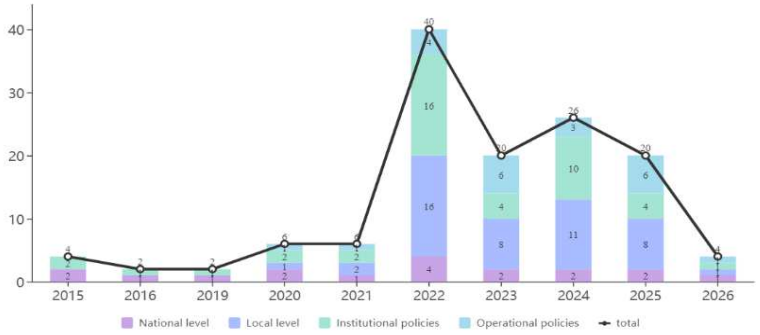

Figure 4. The annual releases of China's marine carbon inclusion policies from 2015 to 2026. The stacked histogram in the figure represents the number of policies released each year. Due to the absence of collection-related policies in 2017 and 2018, these two years are missing.

The policy hierarchy presents a clear model: central guidance and local piloting. Within this hierarchical structure, local policies play an increasingly important role in shaping China's supply of marine carbon inclusion policies. Since 2022, this trend has been particularly evident (Figure 4). The rapid expansion of local policy initiatives has promoted a governance model characterised by central strategic guidance and local practical pilots. National policies undertake the functions of strategic planning, cross-domain coordination, and institutional development. Local policies focus on

[①]The policy serial number refers to the chronological ranking of the policy document to which the coded entry belongs, based on its publication date, while the clause number represents the smallest subdivision unit of that coded entry within the policy text.

institutional innovation, pilot implementation according to local conditions. Institutional development is promoted by this vertical structure, and local governments have gradually accumulated practical experience through pilot initiatives. This structure also brings challenges: this decentralised model may lead to differences in interregional carbon sink accounting methods, method certification, digital platform construction and trading rules. Policy fragmentation and weak institutional coordination may also follow. Furthermore, the evolution of policies and operational policies indicates that the focus of marine carbon inclusion policies is gradually shifting. Policy-making no longer remains at the stage of concept advocacy and system design. Instead, specific regulatory arrangements and implementation mechanisms are increasingly being provided. Overall, China's marine carbon inclusion policy has gradually shifted from initial exploration and rapid expansion to steady consolidation, marking a shift from policy experimentation to standardised governance.

The policies reveal a gradual transition from institutional arrangements towards implementation mechanisms. The two categories are plotted separately in the figure. In the early stage, policy was predominantly institutional in nature, focusing on a broad set of institutional arrangements, strategic orientations, and governance frameworks; by contrast, operational policies remained relatively scarce. Since 2022, however, operational policies have increased significantly, pointing to a gradual move from macro-level institutional design towards more specific implementation mechanisms. Alongside the sharp increase in policy output, operational provisions have become increasingly prominent within the marine carbon inclusion policy system. The focus of policymaking has consequently extended beyond basic questions such as "whether and why marine carbon sinks should be developed" to more specific concerns about implementation: who is responsible for action, how carbon sinks should be quantified and certified, how activities should be managed and how carbon benefits should be allocated. Taken as a whole, these changes reflect a gradual reorientation of marine carbon inclusion policy, from concept promotion and institutional development towards more refined regulation and policy implementation.

Configuration structure

Distribution of policy themes

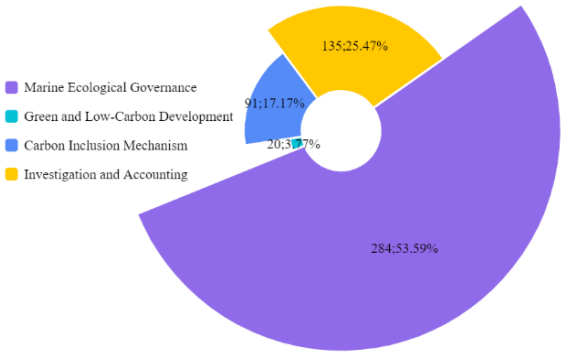

Figure 5. Types and distribution of policy themes.

Policy themes reflect the governance issues to which policymakers give priority. The LDA results identify four major thematic areas in China's marine carbon inclusion policies (Figure 5). Among the four themes, Marine Ecological Governance has received the most policy attention and has come to occupy the core position in the

theme structure, accounting for 53.59% of all coding units. The results suggest that marine carbon-sink protection and enhancement remain the main focus of the policy system. Investigation and Accounting ranks second, accounting for 25.47% of all coding units. This shows that measurement and verification remain an important component of the marine carbon inclusion policy. In contrast, although the Carbon Inclusion Mechanism is an emerging field of institutional innovation, it has received significantly less attention (17.17%). Accordingly, greater policy support is needed for methodological development, ecological compensation, pilot projects and industrial incubation to promote the development of marine carbon inclusion. Green and Low-carbon Development receives the least attention, accounting for only 3.77% of all coding units.

Configuration characteristics of policy instruments

A total of 530 policy instrument coding units were identified across China's marine carbon inclusion policies. Capacity-building instruments were the most frequently used of the four categories, with 216 coding units (40.75%). Supply-support instruments ranked second, with 180 coding units (33.96%). Demand-oriented and incentive-constraint instruments were far less prominent, at 15.28% and 10.00%, respectively (Figure 6). The policy distribution of China's marine carbon inclusion policies is centred on capacity building and institutional supply, together with clear supply orientation, strong ecological concern, and relatively limited demand-side stimulus. The current policy framework has laid a solid foundation for institutional arrangements and governance capacity. The mechanism for realising marine carbon-sink value, especially for economic incentives, and stakeholder participation, remains underdeveloped. Accordingly, the policy configuration has not yet fully moved beyond a government-led model centred on institutional provision. It still needs to shift towards a more market-oriented governance system, one in which stakeholder participation and diverse incentive mechanisms assume a more prominent role.

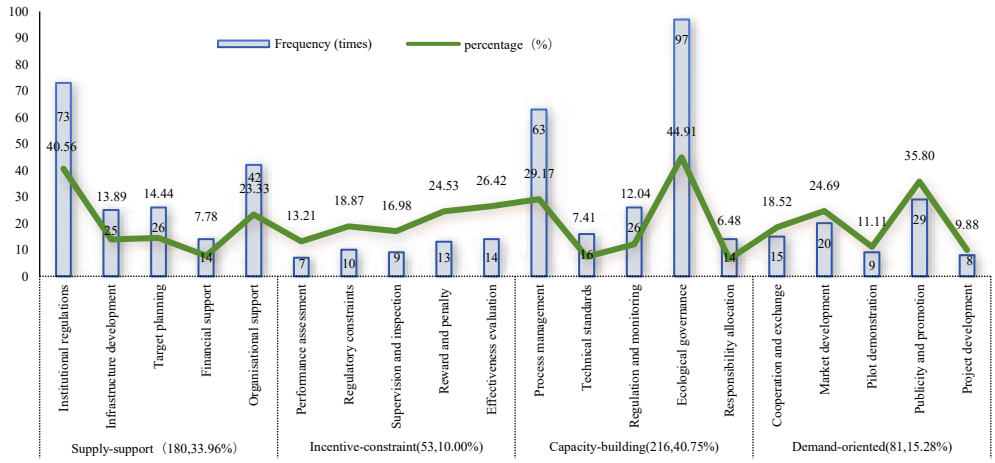

Figure 6. Configuration of policy instruments.

Apart from the imbalance in quantity, the allocation of policy instruments also exhibits a clear and distinct orientation. The policy resources are mainly used for system construction and governance capacity building, while they are relatively limited in terms of stimulating the creation of demands and the realisation of value. Within capacity-building instruments, Ecological Governance is the most frequently deployed, with a total of 97 coding instances, accounting for 44.91% of all capacity

building coding units. This configuration pattern indicates that policy attention remains centred on ecological restoration and the enhancement of marine carbon-sink capacity. Process Management ranks second (29.17%), reflecting the government's growing attention to public participation and value realisation. In contrast, less policy attention has been paid to Regulation and Monitoring, Technical Standards, and Responsibility Allocation. Their limited deployment may constrain the foresight, incentive effect and regulatory effectiveness of the current policy framework.

Supply-support instruments are concentrated in a narrow set of categories. The most frequently deployed sub-instrument was Institutional Regulation (40.56%), followed by Organisational Support (23.33%), reflecting increasing emphasis on cross-departmental coordination and organisational capabilities. By contrast, Infrastructure Construction accounted for merely 13.89%, while Financial Support was only 7.78%. This suggests that direct resource allocation for sustaining marine carbon-sink projects remains limited. The current supply-support instrument configuration is therefore characterised by institutional arrangements as the priority, Organisational Support as the foundation and relatively limited resource inputs. This configuration reflects the heavy reliance of an emerging policy area on regulatory frameworks and organisational foundations in the early stage of institutionalisation. It also indicates that policy provision has not yet shifted fully towards resource allocation mechanisms that support project implementation, market operation and carbon value realisation. China has incorporated blue carbon development into its national strategic development plan [38], aligning blue carbon policy with the carbon peaking and carbon neutrality goals and the planning orientation of the maritime power agenda. Even so, supporting mechanisms for translating marine carbon inclusion from institutional design into large-scale implementation remain inadequate.

Demand-oriented instruments account for a relatively modest share. This points to an underdeveloped mechanism for realising marine carbon-sink value, and to a continuing need to strengthen market-driven demand stimulation. Among them, Publicity and Promotion is the most frequently deployed (35.80%), indicating that the government has attached considerable importance to raising awareness and fostering public participation in marine carbon inclusion. It also suggests that the existing attention and understanding of marine carbon inclusion by the public are very restricted, calling for additional efforts in communication and participatory incentives to promote wider public engagement. Market Cultivation and Cooperation and Exchange are also frequently deployed, at 24.69% and 18.52% respectively. These patterns indicate that China has incorporated marine carbon sinks into its carbon trading schemes[39]. Nevertheless, the policy arrangements are not well defined and the practical guidance on implementation in the market is insufficient[40]. By contrast, Project Development is the least frequently deployed demand-oriented instrument, accounting for only 9.88%. The limited deployment of project-based instruments may hinder the implementation of ecological restoration initiatives, carbon sink augmentation projects and associated technical applications, therefore reducing the overall efficacy of demand-oriented policy interventions.

The deployment of incentive-constraint instruments remains limited and relies predominantly on performance-oriented governance mechanisms. Their sub-instruments are distributed as follows: Effectiveness Evaluation accounts for 26.42%, followed by Reward and Penalty Mechanisms (24.53%), Regulatory Constraints (18.87%), Supervision and Inspection (16.98%), and Performance Assessment (13.21%). The top two sub-instruments jointly account for 50.95%, constituting the largest component of this category. These findings suggest that

current policies rely predominantly on a "performance assessment-incentive adjustment" mechanism to influence behaviour, while mandatory measures rooted in legal constraints and supervision remain limited. Broadly speaking, performance-based incentives dominate the structure of incentive-constraint instruments, with coercive regulation deployed far less extensively. Stronger and more stable incentive mechanisms, accountability arrangements and monitoring, and evaluation systems will be required to strengthen policy continuity and institutional capacity as the policy system transitions from experimental piloting to routine operation.

Configuration of Policy Instruments across Different Policy Themes

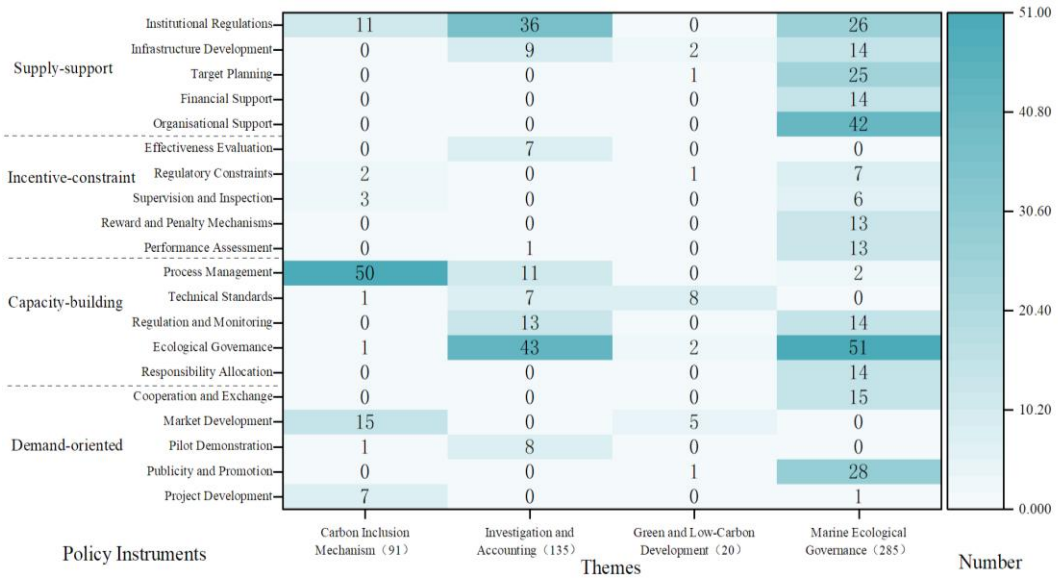

Figure 7. Distribution density of policy instruments across different themes. The number in the cell represents the frequency of a specific policy instrument in the corresponding theme. The depth of the cell colour corresponds to the frequency scale (Number) of the right legend, with darker blue indicating higher frequencies.

The "theme-instrument" configuration matrix may help to reveal the evolving relationship between policymakers' objectives and their selected governance approaches (Figure 7). The heatmap illustrates the structural configuration of policy instruments, with darker shades indicating greater instrument concentration. Marine Ecological Governance exhibits the most diversified configuration, with 285 applications, led by Ecological Governance (51), Organisational Support (42), Publicity and Promotion (28), Institutional Regulations (26), and Target Planning (25). Other instruments, including Financial Support, Responsibility Allocation, Supervision and Regulation, and Reward and Penalty Mechanisms, were also deployed to varying degrees. It shows that marine ecological governance policies focus more on organisational implementation, process management and policy input, and less on performance evaluation and standardisation.

The Investigation and Accounting theme encompasses 135 coding units. The largest shares are held by Ecological Governance (43) and Institutional Regulations (36), indicating sustained attention to marine carbon-sink monitoring and standardisation. Mutual recognition, certification, and the realisation of marine ecological value remain underdeveloped. Technical standardisation is therefore necessary, yet it alone cannot form a complete institutional chain. Further efforts are required to develop an integrated institutional chain spanning measurement, certification, registration, application, and value realisation.

Process Management covers 50 of the 91 coding units under the Carbon Inclusion Mechanism theme, accounting for more than half of the total. The other sub-instruments are much less frequently represented, suggesting that policy focus has shifted beyond conceptual advocacy towards routine operational management. Although Market Development (15) instruments have emerged, their limited scale prevents them from providing a stable basis for marine carbon value realisation. This points to a gap between the expansion of policy practices and the development of mature institutional capacity.

The Green and Low-carbon Development theme has the lowest policy-instrument configuration, comprising only 20 coded instruments, including 8 Technical Standards, 5 Market Development instruments, and 7 other instruments. Target Planning, Publicity and Promotion, Ecological Governance, and Regulatory Constraints receive little consideration. This suggests that the broader green and low-carbon transformation agenda has not sufficiently integrated marine carbon, particularly the linkage between the value generated by marine carbon-sinks and a broader low-carbon approach.

Overall, China's marine carbon inclusion policy framework prioritises governance capacity-building and technical development, while offering relatively limited support for marine carbon-sink contributions into market value and public incentives. Weak interconnections across policy themes may have constrained the transition from a predominantly ecological governance mechanism to a broader framework for society-wide carbon reduction and green development.

Evolutionary Characteristics of Policy Instruments and Policy Themes

Drawing on a cross-dimensional analysis of policy instruments, policy themes, and policy stages, this study further explores variations in instrument deployment and the evolutionary trajectories of these instruments across different development periods, as shown in Figure 8.

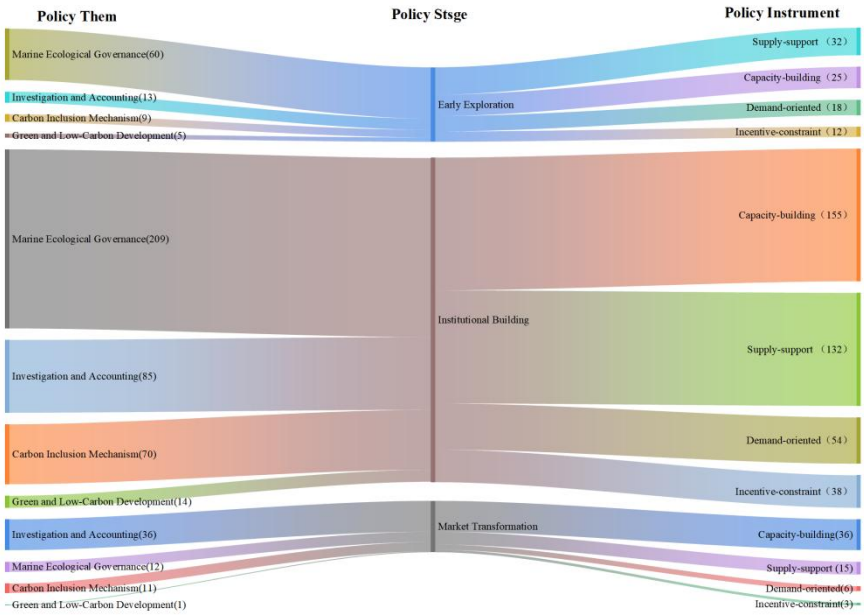

Figure 8. The dynamic configuration relationship between policy themes and instruments in the stages of institutional development. The middle column is the policy stage, and the connection bandwidth represents the policy frequency. The numbers in brackets represent the policy frequency under the corresponding category.

The cross-comparison of development stages, policy themes, and policy instruments contributed to an in-depth analysis of the deployment and transformation

of policy instruments in the evolution of marine carbon inclusion governance. The Sankey diagram intuitively shows the dynamic correlation path between different policy stages and specific instrument types and policy themes. It also reveals changes in policy priorities and instrument allocation in each stage.

In the Early Exploration stage, the relatively narrow flows indicate a limited range of policy interventions. Supply-support (32 records) and Capacity-building (25 records) were the main instruments used. Marine Ecological Governance (60 records) took the largest share of the thematic distribution, followed by Investigation and Accounting (13 records). Policy focus at this stage centred on conceptual advocacy and institutional exploration.

During the Institutional Building stage, the policy path was the most extensive and concentrated, corresponding to the peak period of policy expansion. Capacity-building instruments emerged as the dominant category, with 155 records. Demand-oriented and Supply-support instruments also increased markedly, reaching 132 and 54 records, respectively. The policy agenda continued to centre on marine ecological governance (209 records). Marked growth was recorded for Investigation and Accounting and Carbon Inclusion Mechanisms, at 85 and 70 records, respectively. The Green and Low-carbon Development received relatively little attention, indicating that the integration of marine carbon sinks with the low-carbon transformation strategy was still insufficient.

In the Market Transformation stage, the configuration of policy themes shifted noticeably. Investigation and Accounting has become the dominant theme, with 36 records, indicating that the governance approach is gradually shifting from conservation-oriented governance towards a more comprehensive framework focused on measurement, monitoring and verification. At this stage, Capacity-building and Supply-support instruments remain the two most frequently deployed categories of policy instruments, with 36 and 15 records, respectively. Their continued centrality indicates that institutional capacity and foundational support are indispensable parts of marine carbon sink governance even in the process of the gradual transformation of the policy system towards value realisation.

Discussion

Policy expansion and institutionalisation: from policy experimentation to institutional consolidation

The evolution of China's marine carbon inclusion policy highlights the distinction between policy expansion and institutionalisation in emerging environmental governance. Initial efforts focused on introducing the concept of marine carbon sinks and fostering ecological awareness, followed by pilot initiatives, methodological development, carbon accounting and certification, and more recent efforts towards standardisation and inter-institutional coordination. This trajectory reflects a gradual shift from policy experimentation towards institutionalisation, rather than a linear process whereby policy accumulation automatically yields a mature institutional system.

Institutionalisation requires not only broadening policy objectives but also establishing stable rules, clearly defined responsibilities, operational procedures and coordination mechanisms. Although local pilots facilitate institutional learning, their experiences may remain fragmented in the absence of consistent standards and integrated governance arrangements. The findings reveal that marine ecological governance, marine carbon-sink development and technical arrangements have

received substantial policy attention, whereas public participation, market demand and ecological value realisation remain less systematically addressed. This imbalance indicates that technical and administrative foundations are advancing faster than the mechanisms linking ecological contributions to public incentives and market recognition. The core challenge is therefore to consolidate institutional arrangements by linking ecological protection, carbon measurement, project certification, market application and benefit distribution.

Policy instrument configuration and policy mix coherence

The findings reveal an expanding portfolio of policy instruments, encompassing institutional provision, technical support, supervision, project implementation and market-related measures. However, instrument diversity does not necessarily guarantee policy mix coherence, which depends on the complementarity and coordination of different instruments. Capacity-building and Supply-support instruments predominate, while Demand-oriented and Incentive-constraint instruments remain less prominent. Although these instruments provide essential foundations for project identification, carbon accounting and methodological standardisation, their dominance may constrain subsequent market application and value realisation.

The stage-based analysis further identifies shifts in instrument configuration. Early Exploration relied primarily on capacity-building and supply-support, while instrument diversity increased during the Institutional Building stage. In Market Transformation, Investigation and Accounting remained particularly prominent, highlighting the continued importance of technical and institutional capacity. Nevertheless, stronger demand-side incentives and market-oriented measures are required to translate these foundations into practical applications and value realisation. A coherent policy mix therefore requires capacity-building and supply-support to establish institutional foundations, demand-oriented instruments to create application opportunities, and incentive-constraint measures to strengthen accountability and enforcement.

Policy path dependence and thematic lock-in in marine carbon inclusion governance

The analysis reveals relatively stable associations between policy themes and instrument combinations. Ecological governance draws on a broad range of organisational, regulatory and capacity-building measures, whereas investigation and accounting rely more heavily on institutional rules and technical support. While these alignments sharpen policy targeting and governance continuity, they may also reinforce policy path dependence by constraining adjustments to established institutional arrangements and limiting the adoption of new instruments.

This tension is reflected in the uneven policy attention across themes. Ecological protection, carbon-sink development and technical standardisation remain prominent, whereas public participation, market demand and ecological value realisation receive comparatively less attention. Such an imbalance points to potential thematic lock-in, whereby established priorities continue to shape policy attention and resource allocation, constraining more integrated, multi-actor and market-oriented approaches.

Taken together, marine carbon inclusion governance is shaped by the interaction of institutional consolidation, policy mix coherence and path dependence. Policy expansion facilitates institutional learning, instrument deployment determines the support available for distinct governance functions, and established arrangements

shape subsequent policy adaptation. Institutionalisation thus depends not merely on accumulating policy initiatives, but on coordinating existing arrangements and adapting them to evolving governance needs.

Policy Implications

First, stronger national coordination is needed to translate successful local experiments into consistent institutional arrangements. A national governance framework should establish common principles and standards for marine carbon-sink project classification, carbon accounting, certification, data management and carbon-credit management. An integrated management platform could facilitate information sharing and coordination across administrative departments. Meanwhile, local governments should retain sufficient flexibility to adapt implementation to regional differences in marine ecosystems, resource endowments and industrial structures. Combining nationally consistent rules with locally adapted approaches would help balance institutional coherence and regional diversity.

Second, greater attention should be given to policy coordination and value realisation. Value realisation should therefore be recognised as a distinct governance priority, linking ecosystem protection and carbon-sink enhancement with project development, certification, market application and benefit distribution. Value realization should therefore be recognized as a distinct governance priority, linking ecosystem protection and carbon-sink enhancement with project development, certification, market application and benefit distribution. Public participation should also be more systematically incorporated, connecting individual and collective low-carbon behaviours with identifiable incentives and sustained engagement opportunities.

Third, policy instrument portfolios should be refined to improve functional complementarity across governance objectives and development stages. Capacity-building and Supply-support instruments remain essential in emerging or institutionally uncertain domains, whereas more mature arrangements require greater emphasis on Demand-oriented and Incentive-constraint instruments to support market application, accountability and implementation continuity. Instrument selection should therefore reflect the institutional maturity and specific requirements of each policy domain.

Finally, the long-term development of marine carbon inclusion requires a more complete and coordinated institutional chain. Methodologies and carbon accounting rules should be progressively incorporated into formal institutional arrangements, drawing on experience from local pilots. More importantly, the policy process should connect carbon-sink identification and monitoring with accounting, project development, certification, registration, market application and benefit distribution. Without effective linkages between these stages, advances in technical measurement may not translate into practical value realisation. A unified national database and management platform could reduce information fragmentation, facilitate data sharing and strengthen policy coordination. Through institutional standardisation, local adaptation and cross-sectoral coordination, marine carbon inclusion can gradually move beyond fragmented experimentation towards more coherent governance.

Conclusion

The central finding of this study is that the expansion of China's marine carbon inclusion policies should not be equated with the consolidation of an integrated

institutional framework. Although policy initiatives have broadened in scope and technical arrangements have advanced, the allocation of thematic attention and policy instruments remains uneven. This indicates that institutionalisation involves more than the accumulation of policy documents or the introduction of technical methodologies. It demands the coordinated development of standards, organisational responsibilities, implementation procedures, participation incentives and value-realisation mechanisms. The distinction between policy expansion and institutional consolidation offers a valuable analytical perspective for understanding the development of emerging environmental governance arrangements, particularly where local experimentation and multi-level institutional coordination occur simultaneously.

This study also has several limitations. First, the analysis is mainly based on the policy documents collected on the official website, and the information of some informal policy practices may not be fully covered. Second, the content analysis mainly examines the institutionalized configuration of policy tools, rather than their actual implementation results. Therefore, the conclusions of the study should be regarded as evidence of policy priorities and institutional arrangements, rather than a direct measure of policy effectiveness. Future research can combine policy text analysis and implementation results evaluation to better understand the institutionalization process of marine carbon inclusion.

Author contributions Lili Li: Writing-original draft, Writing-review & editing, Methodology, Investigation, Formal analysis, Conceptualisation, Data curation, Funding acquisition. **Yang Bai:** Writing-original draft, Writing-review & editing, Conceptualisation, Investigation, Funding Acquisition, Formal analysis. **Qingshun Liu:** Writing-review & editing, Investigation, Data curation, Methodology, Validation. **Mengyue Zhang:**Writing-review&editing, Investigation, Data curation, Visualisation, Validation.

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Declarations

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Authors and Affiliations

[a]School of Law, Shandong University of Technology, Zibo, China
[b]School of Law, Ocean University of China, Qingdao, China
[c]School of Humanities, Jiyang College of Zhejiang A&F University, Zhuji,China

*** Principal Corresponding Author:** *E-mail address:* by8119@163.com (Yang Bai)
***Additional Corresponding Author:** *E-mail address:* li286917377@163.com (Qingshun Liu)