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A study on the governance pathways of the Law of the Sea in response to climate change

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The legal systems for ocean governance and climate change governance are based on the United Nations Convention on the Law of the Sea and the United Nations Framework Convention on Climate Change, respectively. However, due to differences in their negotiation backgrounds, legal scope, goals, and tasks, there is a lack of interaction between the two at the legal system level. The ocean plays a crucial role in regulating the Earth's climate system, yet its value is often underestimated in the United Nations Framework Convention on Climate Change. The aim of this study is to analyze the effectiveness of the United Nations Convention on the Law of the Sea in addressing climate change. Specifically, we will examine the Convention's ability to mitigate and adapt to climate change, and identify areas where it falls short, such as inadequate regulation of sea level rise, ocean acidification, and ocean fertilization. Based on this, proposals for governance paths from the perspective of the United Nations Convention on the Law of the Sea include developing the Agreement relating to the climate change and ocean governance and reinterpreting the United Nations Convention on the Law of the Sea in accordance with the Paris Agreement. The content should be adapted more flexibly to current climate change challenges, and provisions related to sea level rise and maritime boundaries should be reinterpreted to fill legal gaps. In addition, it is important to establish coordinated regulatory rules and framework agreements to address the issues of ocean fertilization and ocean acidification. Finally, to remedy the shortcomings in proving causation, scientific theories and due diligence obligations should be attributed. Through these measures, effective ocean law governance paths that address climate change can be explored.

KEYWORDS

UNCLOS, climate change, governance pathways, marine environmental protection, UNFCCC

1 Introduction

In December 2022, the Climate Change and International Law for Small Island States Initiative (COSIS), led by a coalition of small island states including Antigua, Barbuda, and Tuvalu, filed a significant legal request with the International Tribunal for the Law of the Sea (ITLOS). This request aims to interpret the legal obligations of States under the Article 192 of the UNCLOS to prevent pollution, address the adverse impacts of climate change on the marine environment, and protect the oceans from issues such as ocean warming, sea level rise, and ocean acidification (LSE, 2023). On May 21, 2024, the ITLOS issued an advisory opinion on climate change and international law. This is the first time that an international tribunal has issued an advisory opinion on the obligations of states to mitigate climate change. The Advisory Opinion addresses several key issues relating to the application of the UNCLOS in the context of climate change, including the interaction between UNCLOS and the global climate change regime, as well as the specific obligations of States to reduce climate-warming greenhouse gas emissions (GHG). However, a crucial question arises: How can the ITLOS, as a judicial body with global jurisdiction over disputes related to the law of the sea, contribute to addressing the challenges posed by climate change?

From the perspective of the convention, there are two parallel lines of development in climate change governance and ocean governance approaches, as shown in Figure 1. In the realm of climate change governance, there are three primary conventions: UNFCCC, the 1997 Kyoto Protocol, and the 2015 Paris Agreement. The UNFCCC serves as the overarching agreement to address climate change, while the Kyoto Protocol and Paris Agreement complement, strengthen, and refine the UNFCCC, facilitating the transition from a framework to implementation. In contrast, UNCLOS aims to address all issues related to the oceans. A comparative analysis of the content of the conventions reveals that the UNFCCC and the Kyoto Protocol devote minimal attention to the oceans and seas. This is evidenced by the fact that only a reference is made in the preamble. Furthermore, the legal provisions lack practicality and effectiveness. Additionally, climate change is not directly addressed in the UNCLOS, which was developed in 1982, a time when the issue of climate change was not a prominent one in the international arena. (Carolina et al., 2023) The oceans, while suffering from climate change impacts such as acidification and rising sea levels due to the absorption of greenhouse gases, also play a crucial role in mitigating climate change by sequestering these gases, highlighting an undeniable connection between oceans and climate that has driven governmental dialogues since 2020 (Siegel, 2019; UNFCCC, 2023).

In 2021, the Conference of the Parties to UNFCCC requested the Subsidiary Body for Scientific and Technological Advice (SBSTA) to convene an annual dialogue on oceans and climate. The SBSTA was also asked to consider enhanced action on mitigation and adaptation within the oceans–climate relationship (IPCC, 2023). To date, the Conference of the Parties has held three dialogues on oceans and climate change. It is evident that the Conference of the Parties is interested in integrating the oceans into the climate regime.

However, incorporating climate change considerations into the law of the sea regime would be more beneficial for the resolution of oceanic issues resulting from climate change for two reasons. Firstly, there is no mandatory dispute settlement jurisdiction under the UNFCCC, the dispute settlement mechanism in UNCLOS could be invoked to fulfil these climate change-related obligations by holding States accountable for failing to meet their commitments or for causing damage to the marine environment through inadequate mitigation or adaptation measures, which making the UNCLOS dispute settlement system an appealing alternative (Klein, 2020). Secondly, Article 194 of the United Nations Convention on the Law of the Sea establishes the general framework of the obligations of states to protect and preserve the marine environment. The incorporation of climate change responses into this framework would facilitate the resolution of marine issues arising from climate change. The legal support of UNCLOS for the climate change regime, particularly in the areas of climate change mitigation and adaptation, is a key consideration (Marciniak, 2017).

The current body of research places a strong emphasis on the institutional interaction between the law of the sea and climate change law (Klerk, 2023). However, the majority of studies in this

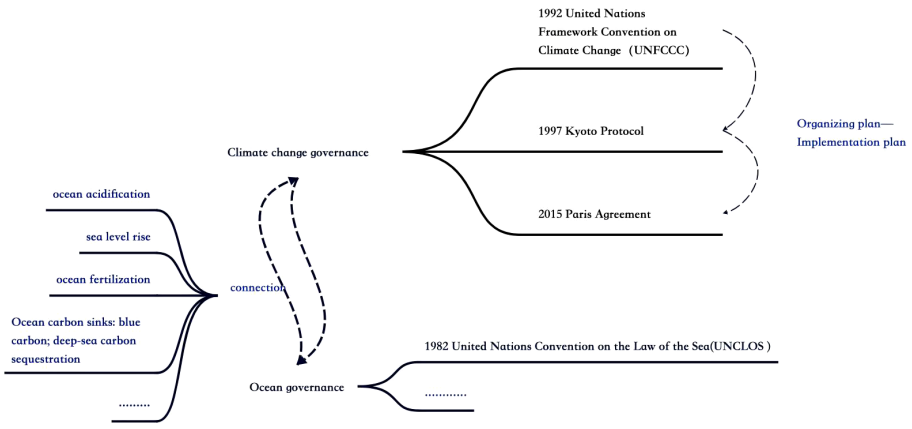

FIGURE 1
Climate change governance and ocean governance.

field focus on "point" analyses, such as the incorporation of sea level rise (O'Donnell, 2021), ocean fertilization, and ocean acidification into the legal framework for climate change or the governance framework of the UNCLOS, and adjustments to the dispute settlement regime of the UNCLOS to respond to climate change. While previous studies have analyzed the various aspects of the law of the sea that deal with climate change in a bullet-point manner, the present study builds on the fact that anthropogenic greenhouse gases are marine pollutants before it can begin to address other issues. In order to study this issue, a comprehensive and systematic approach is required. This paper fills this gap by synthesizing and analyzing the provisions of the UNCLOS relevant to climate change mitigation and adaptation. The paper critically examines the challenges faced by UNCLOS in this context and proposes solutions that are consistent with and extend the existing governance framework. Building on and interacting with the governance frameworks discussed in previous studies, the paper makes a new contribution to the field, aiming to enhance the overall response of the law of the sea to climate change.

2 Provisions of the United Nations Convention on the Law of the Sea on climate change mitigation and adaptation

The Third United Nations Conference on the Law of the Sea (1973–1982) did not deal with climate change, as it was not yet part of the international environmental agenda at that time, and therefore 1982 UNCLOS did not make direct references to climate change (Lin, 2020). 1982 UNCLOS considers climate issues indirectly, mainly in the context of oceans and seas, and supports States Parties in taking action on climate change mitigation and adaptation in three main ways (Hassan and Soininen, 2015). Firstly, by defining the jurisdiction of particular States over parts of the oceans and seas, UNCLOS delineates which States can take action on climate change. Secondly, UNCLOS provides a framework for cooperation among States in addressing climate change. Finally, Advisory Opinion 31 of the ITLOS unambiguously identifies anthropogenic emissions of carbon dioxide as marine pollutants and the obligation of States to combat climate change. This provides the basis for the theory presented in this article. Consequently, Chapter 3 examines the challenges of UNCLOS in addressing climate change, with a particular focus on the difficulties associated with addressing the impact of climate change on the marine environment and the procedural issues encountered in implementing UNCLOS in this context. Chapter 4 then presents potential solutions to these challenges.

2.1 Clarifying jurisdiction

UNCLOS identifies marine areas and boundaries, such as the territorial sea, the exclusive economic zone (EEZ), and the continental shelf. Each of these areas grants specific rights and jurisdiction to coastal and other states (Treves, 2015). The convention provides a framework for the jurisdiction of these states over different marine areas. The territorial sea area is an example where the coastal state has sovereignty up to 12 nautical miles from the baselines (Article 3). The impacts of climate change can be mitigated by the implementation of conservation measures, such as the establishment of Marine Protected Areas (MPAs), within specific marine areas. MPAs can enhance biodiversity, improve reproductive output, and enhance the socio-ecological system sustainability of coastal communities (Gillingham et al., 2024). By protecting key ecosystem services, such as carbon sink functions, these areas help reduce atmospheric carbon dioxide concentrations and combat global warming (Jankowska et al., 2022). Furthermore, MPAs can function as buffer zones to mitigate the impacts of climate change on marine life. This can be achieved, for instance, through the protection and restoration of coastal wetlands and macroalgae (Arafeh-Dalmau et al., 2023). Clarity of jurisdiction is crucial in determining which States and entities have the right and decision-making power to take action to mitigate and adapt to climate change in specific maritime areas. UNCLOS complements the UN climate regime by clarifying most of the rules on maritime jurisdiction.

2.2 Provisions for mitigation of or adaptation to climate change

Although the UNCLOS does not contain direct references to global climate change in its text, its content on mitigation of and adaptation to climate change can be interpreted from a number of perspectives. First, it should be noted that the UNCLOS was developed in the context of the early 1980s, when awareness of the potential seriousness of climate change was just beginning to surface. As such, the UNCLOS does not contain direct provisions on climate change. Nevertheless, the UNCLOS indirectly reflects concern about climate change through its provisions on the protection of the marine environment.

Under the UNFCCC, States are required to take measures to reduce greenhouse gas emissions in order to mitigate the effects of climate change (Broberg, 2020). Such measures include, but are not limited to, energy efficiency, the use of renewable energy sources and changes in land management practices. Although the UNCLOS is primarily concerned with the legal aspects of the oceans, it indirectly supports efforts to mitigate climate change through the protection and enhancement of marine carbon sinks. For example, through various geoengineering programs that promote better absorption of carbon dioxide and other greenhouse gases from the Earth's atmosphere into the oceans and forests (Warner, 2004). Second, UNCLOS, through its provisions for marine protected areas, provides space for marine ecosystems to adapt to the impacts of climate change. These protected areas help to conserve biodiversity and maintain ecosystem health and functioning, thereby helping the oceans to better adapt to the challenges posed by climate change (Bodansky, 2021). Furthermore, although UNCLOS does not directly refer to climate change, it indirectly supports the oceans' increased resilience to climate change through the promotion of marine scientific research and technological development (Harrison, 2017). Finally, Part XII of the UNCLOS,

which deals with the protection and preservation of the marine environment beyond areas of national jurisdiction, provides a certain legal framework for responding to changes in the marine environment brought about by climate change (Oral, 2018). This framework includes obligations for States to prevent, reduce, and control pollution of the marine environment from various sources, cooperate on a global and regional basis, and conduct environmental impact assessments. These provisions are crucial for fostering international collaboration and implementing measures to mitigate and adapt to the impacts of climate change on marine ecosystems.

Its primary focus is on the legal aspects of the oceans and seas, rather than directly addressing climate change (Boyle, 2016). However, as part of the international legal regime for the oceans, UNCLOS provides an important legal framework and guiding principles for addressing ocean-related climate change issues. This means that while UNCLOS sets out comprehensive regulations for maritime activities and environmental protection, it does not explicitly target climate change mitigation or adaptation measures. However, as part of the international legal regime for the oceans, UNCLOS provides an important legal framework and guiding principles that can be interpreted to address ocean-related climate change issues. The challenge lies in the fact that these provisions are often broad and require further specification and implementation through additional treaties, national legislation, or international cooperation. This indirect approach results in gaps and inconsistencies in the application of UNCLOS to climate change, highlighting the need to interpret the relevant elements of the treaty or to develop a new agreement to more directly and effectively tackle these urgent issues. Therefore, while UNCLOS forms a foundation, there is a pressing need to interpret its relevant provisions or to create new agreements that comprehensively address the multifaceted impacts of climate change on marine environments.

2.3 Anthropogenic greenhouse gas emissions as a form of pollution of the marine environment

Article 192 of Part XII of UNCLOS establishes an affirmative general obligation to "protect and preserve the marine environment." In accordance with Article 194(3), Contracting Parties must take measures to prevent, reduce, and control "all sources of pollution" of the marine environment. The United Nations Convention on the Law of the Sea (UNCLOS) defines pollution as the introduction of substances or energy into the marine environment by humans which cause or are likely to cause "harmful effects" on the marine environment [Article 1(1)(4)]. In addition, UNCLOS specifically emphasizes the obligation to prevent marine pollution in relation to "rare or fragile ecosystems" such as coral reefs (Article 194(5)). Furthermore, Part XII of UNCLOS establishes the obligation of states to adopt legislation and regulations to prevent, reduce, and control pollution of the marine environment from land-based sources (articles 194, 207, and 213) and from or through the atmosphere, in accordance with "internationally agreed rules, standards, and recommended practices" (article 212). Such measures must include "measures designed to prevent, reduce, and control pollution of the marine environment from land (articles 194, 207, and 213) and from or through the atmosphere." These measures must include measures "designed to minimize to the maximum extent practicable" "discharges of toxic, noxious or poisonous substances from land-based sources" as well as "pollution from ships or offshore installations" [art. 194(3)]. Therefore, in general, UNCLOS does not explicitly identify GHG emissions as a specific pollutant.

3 Challenges of the UNCLOS in addressing climate change

Climate change is currently one of the most significant challenges facing UNCLOS. The relevance of the oceans to climate change is evident through a variety of mechanisms, including warming and acidification of the oceans, ocean-atmosphere interactions, changes in primary productivity and carbon sequestration, sea-level rise, and changes in ocean carbon sinks. For instance, the exchange of heat, water, gases, particles, and momentum between the ocean and the atmosphere plays a pivotal role in regulating global climate (Bigg et al., 2003). Changes in ocean circulation driven by factors such as increasing CO2 concentrations can significantly affect the distribution of heat globally, thereby influencing surface climate patterns (Winton et al., 2013). Furthermore, the ocean's capacity to absorb CO2 represents a significant sink for anthropogenic CO2, influencing the global carbon budget (Garuba et al., 2018). Additionally, sea-level rise can affect the determination of maritime jurisdiction, potentially undermining existing maritime boundaries and turning some islands into "rocky outcrops incapable of sustaining human habitation or economic life of their own" or low-tide elevations, significantly impacting the rights of States to their maritime zones (Minas, 2019). These various impacts of climate change on the marine environment underscore the necessity for UNCLOS to address these challenges explicitly. The following chapter will delve into how UNCLOS provisions currently tackle these issues and explore the gaps and potential avenues for enhancing the Convention's effectiveness in responding to climate change.

3.1 Ocean fertilization: regulatory inconsistency and lack of scientific certainty

Ocean fertilization (OF) is a theoretical method for removing CO2 that involves stimulating phytoplankton growth by adding trace or large amounts of nutrients, such as iron or urea, to waters with low biological productivity (ORG, 2021). The newly grown phytoplankton absorbs atmospheric carbon dioxide and sinks to the seafloor when it dies, storing the carbon on the seafloor (Schulz and Maher, 2023). Over the past 30 years, at least 16 open ocean fertilization experiments have been conducted (Geoengineering Monitor, 2021). However, these experiments have failed to demonstrate the effectiveness of ocean fertilization as a method of carbon storage (Silverman-Roati et al.,

2022). The regulation of ocean fertilization activities is primarily governed by the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), the 1996 Protocol to the London Convention, the Convention on Biological Diversity (CBD), as well as UNCLOS and UNFCCC and the Kyoto Protocol (Kordi, 2023). The London Convention and the Protocol to the London Convention provide international standards to guide and limit ocean fertilization activities. In 2008, the International Maritime Organization adopted a non-binding resolution that permits only ocean fertilization activities falling within the scope of legitimate scientific research. The Convention on Biological Diversity opposes the use of ocean fertilization as a method of mitigating climate change and recommends limiting ocean fertilization activities until the potential risks are better understood. The only exception is for "coastal waters or small-scale research" for specific scientific research purposes (Valckenaere, 2022).

The Paris Agreement, as stated by the UNFCCC, aims to globally regulate the increase in average global temperature. However, it does not permit or authorize the use of ocean fertilization technologies. While UNCLOS does not explicitly mention geoengineering technologies, some of its principles and concepts may be relevant to ocean fertilization activities. Ocean fertilization experiments are typically categorized as marine scientific research by the United Nations and other international organizations (Congressional Research Service, 2022). As such, they must adhere to the guidelines set forth in Part XII of UNCLOS, which aim to protect and preserve the marine environment. However, due to the lack of specificity in the Convention's definition of "pollution" regarding environmental harm and biological tolerance levels, it may not be feasible to classify all future ocean fertilization experiments as pollution. In addition, some consider ocean fertilization to contribute to the protection of the marine environment from the impacts of climate change (Gattuso et al., 2018; Scott, 2014; Keating-Bitonti, 2022). This is because it adds nutrients to the surface of the oceans, removes carbon dioxide from the atmosphere, and sequesters it in the deep ocean. Differences in the regulation of ocean fertilization activities under different legal regimes have led to several problems (Kordi, 2023). Legal uncertainty may arise if one regime considers ocean fertilization as a form of pollution while another does not, or if different regimes interpret harm thresholds differently. This uncertainty can reduce future investment in ocean fertilization technologies and may even undermine the scientific frameworks that have been put in place to provide an effective and transparent review process (Oliver, 2019).

Inconsistencies in the regulation of different regimes may slow down or even abandon opportunities to mitigate the impacts of climate change through ocean fertilization technologies (Johansen, 2020a; Johansen, 2020b). To ensure that ocean fertilization technology is an effective tool for climate change governance, it is important to prevent its misuse and increase its accuracy and predictability, while also reducing potential disruptions and eliminating unknown sequelae. Therefore, it is crucial to carefully consider and coordinate the overlap of different regulatory approaches.

3.2 Ocean acidification: a complex of regimes

The oceans have become more acidic due to the uptake of carbon dioxide, which poses a serious threat to marine species such as plankton and coral reefs (Union of Concerned Scientists, 2019). Although knowledge of ocean acidification is increasing, laws and policies have not kept pace with scientific progress. It appears that there are no existing international legal regimes or agreements that address ocean acidification directly. However, a number of measures that may indirectly impact ocean acidification can be inferred from the existing international legal framework and practice. One notable example is the 1999 Protocol to Reduce Acidification, Eutrophication, and Ground-level Ozone. However, it is important to note that the number of states parties to the protocol is only 51. It is evident that the Protocol has not been universally accepted by the international community. One of the critical gaps in the Protocol, which the UNFCCC also shares, is the lack of specific measures addressing ocean acidification. While the UNFCCC provides the legal basis for reducing greenhouse gas emissions, its primary focus remains on climate change, rather than on ocean acidification per se. Consequently, in practice, the UNFCCC has had limited effect in directly reducing the CO2 emissions that contribute to ocean acidification (Oral, 2018). Furthermore, the 1992 Convention on Biological Diversity, through target 10 of the 2010 Aichi Biodiversity Targets, identified obligations related to ocean acidification. However, it is clear that the objectives of target 10 have not been achieved. Similarly, the UNCLOS does not contain specific provisions directly referring to ocean acidification within its framework for environmental protection. Nonetheless, it provides a comprehensive set of tools for marine environmental protection that extends beyond mere pollution control. These tools include general principles such as precaution and environmental impact assessment, and specialized tools such as spatial and integrated planning and area protection (Pandey, 2021). All of these principles and tools are applicable to varying degrees, but are not directly specific to ocean acidification.

Provisions addressing ocean acidification are considered a "regime complex", consisting of parallel regimes and institutions with overlapping functions that are not hierarchical and interact with each other in their respective areas of operation (Scott, 2020). Soft law norms are emerging at the intersection of these regimes, while also connecting and evolving within them to address changes in ocean pH. However, there are structural limitations to relying on non-binding documents as the foundation for binding regimes. Some suggest that ocean acidification should be explicitly addressed alongside climate change in the regulatory scope of the UNFCCC. However, the UNFCCC's ultimate goal is to reduce and maintain carbon dioxide emissions at a level that only slows down the rate of ocean acidification, without addressing the existing ocean acidification (Harrould-Kolieb, 2012). Neither the climate regime nor the law of the sea regime directly addresses ocean acidification or provides a clear set of tools to do so (Kim, 2023). It is important to note that this issue is not adequately covered by either regime, and therefore requires further attention.

3.3 Sea level rise: legal gaps

Global mean sea level rise is primarily caused by two factors related to global warming: the addition of new water due to the melting of land-based ice sheets and glaciers, and the expansion of seawater as it warms, thus adding more water to the oceans (NASA, 2023). Sea-level rise will not significantly impact the high seas, but it will increase the likelihood of disasters in low-lying islands, coasts, and communities. These disasters include more frequent or severe coastal flooding and increased coastal erosion, among other hazards. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) states that global mean sea level has risen faster since 1900 than in any of the past 3,000 centuries. The report predicts that global mean sea level could rise between 0.44 and 0.76 meters by 2100 under a medium GHG emissions scenario, but 1.01 meters under a very high emissions scenario (IPCC, 2023). According to satellite data, it has already risen by 100.5 millimeters from 1933 to 2023, as shown in Figure 2.

Sea level rise creates legal uncertainty regarding the baselines of national territorial seas and the ocean space measured from them. Baselines in the law of the sea serve to establish the point from which the outer limits of the maritime zones of coastal states are measured. As sea levels rise, the low-water mark on many coasts will move inward, destabilizing existing boundaries between states (Freestone, 2020). Sea-level rise may pose a significant challenge to the sustainability of the international legal system. As of 2006, less than half of the world's maritime boundaries were delimited, leading to numerous maritime delimitation disputes and an incomplete maritime political landscape (Dundua, 2006). This situation has persisted, with Østhagen (2020) confirming that a significant portion of maritime boundaries remains unresolved, continuing to contribute to geopolitical tensions (Østhagen, 2020). Sea-level rise further complicates the issue of maritime delimitation. While the phenomenon of sea-level rise may result in the downgrading of the status of some islands from that of States with exclusive economic zones and continental shelves to that of rocks,this does not necessarily entail a loss of maritime rights. Established maritime zones, once set, are generally not affected by changes in baselines due to natural phenomena. The UNCLOS define islands and rocks as distinct entities based on their natural attributes and their capacity to support the natural existence of humans. Islands exhibit a more intricate geological structure and ecological conditions, while rocky reefs are primarily composed of rock and lack these characteristics (Hayashi, 2020). However, which could lead to challenges in maintaining island state status under UNCLOS and the 1933 Montevideo Convention. This status requires a defined territory, a resident population, an effective government, and the ability to establish relations with other states (Millicent, 2019).

In addressing legal uncertainties arising from changes in coastlines, the International Law Association (ILA) has established the Baselines Committee and the Sea Level Rise Committee (International Law Commission, 2023). The International Law Commission (ILC) has started studying the impact of climate change on baselines and maritime boundaries and has suggested legal reforms to prevent destabilization. However, it is uncertain whether UNCLOS will be amended to address these challenges or if new approaches and cooperation within the current legal framework will suffice. Although the UNFCCC provides a general framework for adaptation, it does not specifically cover the legal issues related to sea-level rise. As a result, neither regime has fully addressed the legal issues associated with sea-level rise.

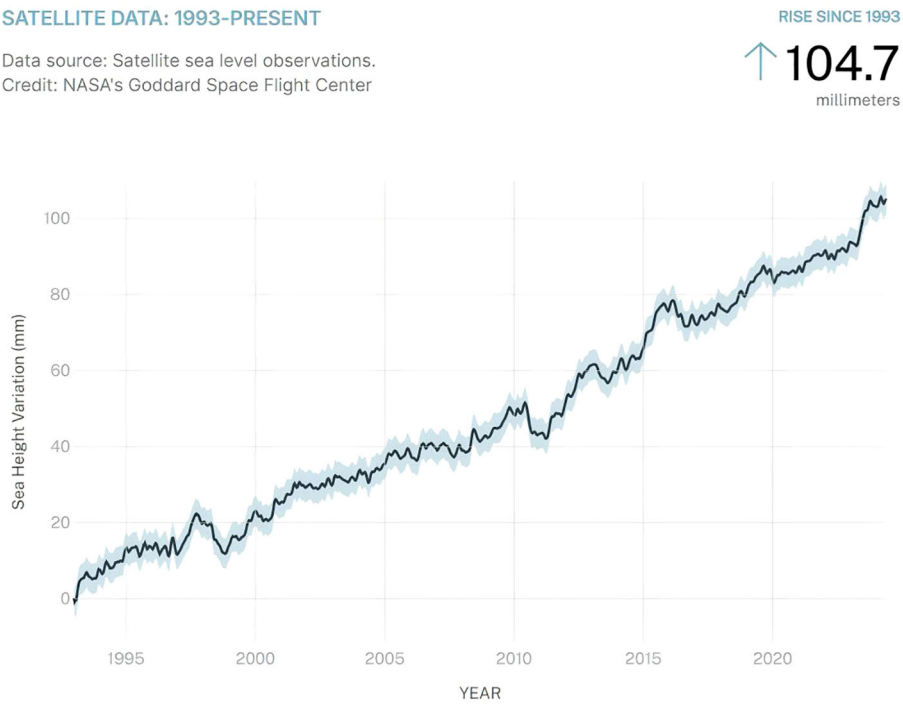

FIGURE 2
Change in global sea level height, 1993–2023. Source: Reproduced from NASA (2023). Not subject to copyright in the United States.

3.4 Problems with the application of dispute settlement procedures in UNCLOS

Part XV of UNCLOS provides a comprehensive framework for the settlement of disputes related to the law of the sea and includes compulsory jurisdiction. This means that parties agree to submit disputes related to UNCLOS matters to international adjudication. If UNCLOS can extend the statutory obligations of the Contracting Parties to include requirements for mitigating the effects of climate change, it would provide a unique opportunity for States heavily impacted by climate change. This would give these countries the right to bring international litigation against major climate polluters to force them to fulfill their climate change obligations under UNCLOS. However, UNCLOS faces several procedural and substantive hurdles to effectively address climate change (Lin, 2020).

3.4.1 Jurisdiction and mandatory dispute settlement procedures

The jurisdictional pathway under Part XV of UNCLOS is established through the interplay of several articles, such as Articles 279, 280, 281, 287, and 288, as shown in Figure 3.

To apply this dispute settlement mechanism to climate change, the issue of jurisdiction must first be addressed. Article 281(1) of UNCLOS outlines the mandatory dispute mechanism in Part XV. This mechanism is only utilized if the parties involved do not reach a dispute settlement in the agreed-upon manner and if the agreement of the parties does not preclude any further extent. It is important to determine whether the dispute is a law of the sea dispute, a climate change dispute, or both (Doelle, 2006). If a plaintiff agrees to settle a dispute over climate change mitigation under the UNFCCC dispute settlement procedure, individual states are not bound by the UNFCCC to take action to prevent harm to the marine environment from greenhouse gas emissions originating in their territory. Similarly, the Kyoto Protocol does not require parties to prevent harm to the marine environment, but rather obliges certain parties to reduce greenhouse gas emissions by 2012, using the same dispute settlement procedures as UNFCCC. Therefore, if the dispute were to be considered a climate change dispute, it would not be resolved. However, a defendant seeking to challenge jurisdiction may argue that a climate change dispute is only marginally, if at all, within UNCLOS (Freestone and McCreath, 2020). They may contend that climate change disputes are essentially related to the UNFCCC, which provides for a different dispute resolution mechanism that precludes

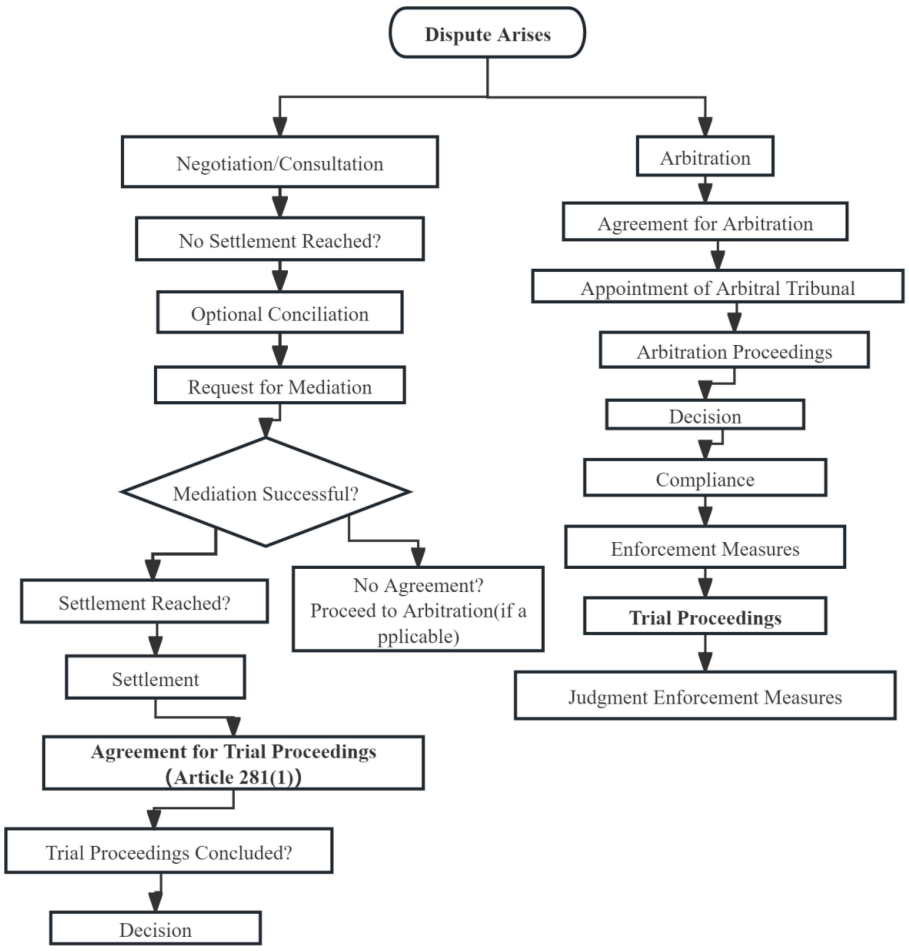

FIGURE 3
Dispute settlement mechanisms in the UNCLOS.

recourse to mandatory awards under Part XV. If the dispute concerns climate change and the UNFCCC, Part XV may be superseded by the UNFCCC's dispute settlement mechanism, resulting in the same outcome as previously mentioned, and the issue remains unresolved. After determining jurisdiction, the next consideration is the choice of dispute settlement procedure. It must be decided whether climate-related disputes should be subject to compulsory procedures or if Parties should have the option to exclude them (Iwatsuki, 2022).

3.4.2 Collective causation in climate change litigation

Climate change is a global phenomenon caused by the actions of many countries. The harms of climate change are caused by the actions and omissions of many actors, and it is generally not possible to attribute specific climate impacts to individual emitters, making it difficult to trace the contribution of individual states to climate change (Lloyd and Shepherd, 2021). Arguments based on collective causation take various forms and may leave the victims of climate change with nothing. This can marginalize the courts as the relevant institution for climate change governance, leaving individual defendants immune from liability. The issue of collective causation may lead courts to hold that a claim is inadmissible if the defendant State's conduct did not directly affect the plaintiff. It may also be argued that the defendant State has not breached its obligations because nothing the State could have done would have been sufficient to prevent the climate change-related harm (Nedeski and Nollkaemper, 2022). Additionally, it may be argued that the defendant State cannot be ordered to provide reparations because the court is unable to ascertain what portion of the harm was caused by the defendant. Climate change litigation typically involves establishing a causal link between specific activities and their impact on climate change (Verheyen and Franke, 2023). Damages caused by climate change arise from slow-onset events, such as sea level rise or glacial retreat, or from extreme weather events, such as droughts, floods, heat waves, or compound events. These two types of impacts from human-induced climate change differ greatly in terms of time scales, which affects the immediacy and causality of the damage. This adds to the complexity of causality (Otto et al., 2022).

4 Pathways to climate change governance in the UNCLOS

Oceans play two important roles in the climate change story. On the one hand, they have a central role in regulating the extent and scale of climate change. On the other hand, they unfortunately suffer the consequences of climate change. Developing effective ocean policies will help manage the oceans in a way that both mitigates climate change and enables people and communities to adapt to future climate change. One of the "Ten Challenges of the Decade of the Ocean" is to discover ocean solutions to climate change (UNESCO, 2021a; UNESCO, 2021b). The United Nations Decade of Marine Science for Sustainable Development (2021–2030), also known as the Decade of the Oceans, provides a framework for stakeholders worldwide to engage and collaborate beyond their traditional communities (UNESCO, 2021a; UNESCO, 2021b). However, there is currently little international support for rewriting the UNCLOS convention or for making substantive reforms to it (House of Lords, 2022). Therefore, it is necessary to address the issue of climate change within the existing framework of UNCLOS by adapting and supplementing it.

4.1 Development of the agreement relating to the climate change and ocean governance

The UNCLOS has three implementing agreements: the Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea, the Agreement relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and the Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (United Nations, 2023). Of these, the BBNJ Agreement is concerned with the impacts of climate change, but focuses primarily on the impacts of climate change on marine life. However, it should be noted that the impacts of climate change on the oceans are diverse and far-reaching, affecting not only marine life but also oceanic processes, coastal communities, and global weather patterns. The BBNJ Agreement can be utilized as a model for the development of the fourth implementing agreement of the UNCLOS, the Agreement on Climate Change and Oceans Governance, which provides insights into the process of developing the Agreement. Primarily, the BBNJ Agreement explicitly requires that existing legal instruments, frameworks, and institutions not be weakened during the negotiation process (Berry, 2021). This principle is similarly crucial for the development of the Climate Change and Oceans Governance Implementing Agreement. It underscores that the new agreement should be compatible with the existing international legal system, rather than a complete replacement or conflict with it. This contributes to the achievement of a more stable and coherent international legal order. Second, the BBNJ Agreement anticipates the adoption of dispute settlement mechanisms, which may include more specialized judicial bodies, such as the international tribunals (Jiménez Pineda, 2021). The establishment of such a dispute settlement mechanism serves as a valuable reference for the implementation of the agreement on climate change and ocean governance. In the context of complex international disputes, it is evident that a clear and efficient dispute settlement mechanism is essential to safeguard the rights and interests of all parties. Finally, the negotiation process of the BBNJ agreement underscored the significance of interdisciplinary collaboration, necessitating the collective involvement of experts from a multitude of disciplines, including the environment, law, and science (Morgera et al., 2023).

This approach was employed to ensure that the agreement could comprehensively address the pertinent topics. This model of interdisciplinary cooperation is also applicable to the development of an implementing agreement on climate change and ocean governance. Indeed, the issue of climate change itself involves a number of disciplines, including meteorology, ecology, and economics.

In conclusion, the experience and framework provided by the BBNJ Agreement for the conservation and sustainable use of international marine biodiversity can be appropriately adapted and innovated. If there should be a new agreement focusing on climate change and ocean governance that covers the entire oceans, including the areas addressed by the BBNJ, it would need to carefully consider its relationship with the existing BBNJ Agreement. This new agreement should not override the relevant climate change provisions of the BBNJ but rather build upon them, ensuring a cohesive and comprehensive approach to ocean governance.

To effectively adapt and integrate the new agreement into the existing framework, several innovations and adjustments can be considered:

a. Integrated Climate-Ocean Governance: Develop a unified framework that seamlessly integrates climate change mitigation and adaptation measures with ocean governance (Borg, 2023). This would involve aligning the objectives and provisions of the new agreement with those of the BBNJ, ensuring that both climate and marine biodiversity goals are met without conflict.

b. Enhanced Legal Mechanisms: Strengthen legal mechanisms to address emerging climate-related challenges in ocean governance. This could involve incorporating more robust enforcement provisions, dispute resolution mechanisms, and compliance monitoring systems, drawing from the successful aspects of the BBNJ Agreement.

c. Adaptive Management Strategies: Implement adaptive management strategies that allow for flexibility and responsiveness to new scientific information and changing environmental conditions (Morgera et al., 2023). This could be achieved by incorporating regular review processes and feedback loops that enable continuous improvement and adjustment of policies and measures.

d. Capacity Building and Technology Transfer: Prioritize capacity building and technology transfer to support developing countries in implementing the new agreement. This could involve providing technical assistance, financial resources, and access to advanced technologies, ensuring that all countries can effectively contribute to and benefit from improved ocean governance (Young, 2023).

By incorporating these innovations and adjustments, the new agreement can enhance and complement the existing BBNJ framework, contributing to the improvement and development of the global ocean governance system in a manner that addresses the pressing challenges of climate change.

4.2 Interpreting UNCLOS in light of the Paris Agreement

UNCLOS is a dynamic document with many of its key provisions being subject to interpretation. Two compatibility clauses, Articles 237 and 311, determine its relationship with other documents. Article 237 of UNCLOS establishes the interrelationship between the obligations set out in Part XII and those set out in the more specialized agreements. In this way, those more specialized obligations will continue to exist as long as they are not in conflict with the Convention. This function of Article 237 of UNCLOS is further reinforced by Article 311, which sets out the relationship of the other agreements relevant to the Convention as a whole.

The fact that the Paris Agreements, although not agreements concluded exclusively for the protection and preservation of the marine environment, the principle of the protection and preservation of the marine environment as a general principle of UNCLOS implies that the general applicability of article 237 of UNCLOS is not limited to agreements concluded exclusively for the purpose of protecting the environment, and that it is subject to an extended interpretation (Stephens, 2020). Furthermore, UNCLOS is not a self-contained regime; its obligations can be concretized by the development of more specific rules in other instruments. It is therefore proposed that this explicitly recognizes that UNCLOS can be interpreted by way of its external rules, which include the Paris Agreement. Ultimately, compatibility between the United Nations Convention on the Law of the Sea and the Paris Agreement was ensured. Although the Paris Agreement does not specifically address the protection and preservation of the marine environment, its obligations are relevant to it. Anthropogenic greenhouse gas emissions have a significant impact on the marine environment, leading to ocean acidification, sea level rise, and a decline in biodiversity (European Environment Agency, 2023). One of the objectives of the Paris Agreement is to mitigate greenhouse gas emissions, which is relevant to the protection of the marine environment. UNCLOS Parties are required to fulfill their obligations under the Paris Agreement in a manner consistent with the general principles and objectives of UNCLOS (Klerk, 2023). This provision ensures a uniform standard for safeguarding the marine environment. The fundamental premise of the Paris Agreement is the submission of emission reduction targets by states, commonly referred to as nationally determined contributions. If incorporated into the obligations for marine environmental protection under UNCLOS, these targets would not only quantify the obligations of states but also motivate them to strive to achieve their emission reduction targets. Nations with a vested interest in both marine environmental protection and climate change mitigation, such as island nations and coastal states, are likely to support the inclusion of emission reduction targets within UNCLOS. For instance, countries like the Maldives, Fiji, and other members of the Alliance of Small Island States (AOSIS) have been vocal advocates for stronger climate action due to their vulnerability to sea level rise and environmental degradation. Additionally, the European Union has demonstrated

a commitment to integrating climate action across various policy areas, including marine governance.

Furthermore, UNCLOS Part XII includes provisions for protecting and preserving the marine environment. These obligations fall under the category of "due diligence" from both a case law and specific provision perspective (Nguyen, 2021). For example, article 194 requires States to take all necessary measures, individually or jointly, in accordance with the Convention to prevent, reduce, and control pollution of the marine environment from any source. Although UNCLOS does not use the term "due diligence", the provisions of Part XII are closely related to it. Part XII emphasizes that the protection and preservation of the marine environment can only be achieved through the control of activities in the oceans and relies on the "duty of care". This duty requires States to adopt laws and regulations, use their best endeavors, and take measures, as addressed in articles 207, 208, and 212. These provisions reflect the duty of due diligence to protect and preserve the marine environment from the harmful effects of greenhouse gases from all sources.

4.3 Reinterpretation of the relevant provisions on sea-level rise and maritime boundaries

During the negotiation of UNCLOS, sea level rise and its impacts were not recognized as issues to be addressed in the Convention. Article 312 of UNCLOS stipulates that the provisions of UNCLOS can be amended. This implies that existing provisions can be modified to better adapt to new circumstances arising from sea level rise. One potential avenue for adaptation is the specification of new types of baselines in UNCLOS. These could include "dynamic baselines" or "fixed baselines," which would enable the impact of sea level change to be reflected. Dynamic baselines should be able to reflect current geographic and environmental conditions while providing some flexibility to adapt to possible future changes. For example, a set of flexible adjustment mechanisms could be added to UNCLOS to cope with changes in maritime boundaries due to sea-level rise. These mechanisms could include the need for periodic review and reassessment of maritime boundaries, as well as allowing States to apply for adjustments to their maritime boundaries under certain conditions. A "fixed baseline" would stabilize and define maritime boundaries. Article 7(2) "in cases where the coastline is highly unstable due to natural conditions such as deltas, it is permissible to extend the coastline to the maximum level of the sea along the low-tide line. In situations where the coastline is highly unstable due to deltas and other natural conditions, suitable points may be chosen as far seaward as possible along the low-tide line. The straight baseline will remain in effect despite any subsequent retreat of the low-tide line until it is changed by the coastal State in accordance with the present Convention". The article mentions "other natural conditions" and the "recession of the low-water line", which could be interpreted to include sea-level rise. Therefore, even if the coastline is highly unstable due to sea-level rise, the baseline may remain unchanged even if the low-tide line retreats in the future (Sefrioui, 2017). The maritime zones and their associated rights and entitlements will remain in force and will not be reduced, regardless of any physical changes caused by sea-level rise resulting from climate change. Furthermore, the adaptability of UNCLOS could be enhanced through an evolutionary interpretation approach, thereby enabling it to address the diverse legal concerns that arise in practice (Starita, 2022). For instance, when international judicial bodies employ evolutionary interpretation of UNCLOS provisions in specific contexts, they may refer to the practices and principles of the International Court of Justice and arbitration institutions in addressing analogous maritime boundary disputes (Anggadi, 2022). This could include the principle of equitable settlement exemplified in the Gris Pardana case, which could provide a legal basis and an operational framework for revising the Convention.

Currently, UNCLOS does not recognize dynamic baselines, and this discussion is indeed a hypothetical exploration of potential adaptations in response to climate change. The relevance of considering these scenarios lies in the proactive approach to future-proofing the Convention against evolving environmental challenges. By examining potential amendments and adaptations, we can better prepare for the impacts of sea level rise, ensuring that the legal framework remains robust and effective. The aforementioned steps can effectively resolve the problem of uncertainty in the fixing of existing maritime boundaries while simultaneously enhancing the adaptability and practicality of the UNCLOS. By addressing hypothetical scenarios and considering proactive measures, the international community can ensure that UNCLOS remains a relevant and dynamic instrument in the face of climate change.

4.4 Harmonizing regulatory rules for ocean fertilization activities

Ocean fertilization should be regulated in a specific instrument. According to UNCLOS, ocean fertilization is not considered dumping. The use of ocean fertilization as an instrument is consistent with the obligation embodied in Part XII of UNCLOS to protect and preserve the marine environment by limiting the emission of greenhouse gases and mitigating their negative impacts on the marine environment. However, the assumption that ocean fertilization is an environmentally friendly tool has been questioned due to the potential negative impacts of adding nutrients to the marine environment (Johansen, 2020a; Johansen, 2020b). If an activity is close to the threshold of harm, it may be considered a form of pollution.

To develop ocean fertilization technology as a tool for combating climate change, a coordinated framework for designing management structures to study ocean fertilization is necessary. This should include assessing the environmental impacts of geoengineering activities, which should be carried out in parallel with the environmental impact assessment process. Additionally, close monitoring and regulation of ocean fertilization activities is necessary. Ocean fertilization technology is still in its early stages and requires more scientific experimental data to support it. Such data is essential for tests, environmental or otherwise, that may have

damaging effects. Therefore, it is wise to act on the precautionary principle, which advocates caution and environmental protection rather than "miracle" solutions with unknown side effects. For activities such as ocean fertilization, it is necessary to take a precautionary approach when there is insufficient scientific evidence to determine whether the technology will sequester carbon or have widespread harmful effects on the environment.

4.5 Using framework agreements to regulate ocean acidification

UNCLOS is relevant to the governance of ocean acidification in two ways. Firstly, it includes obligations in Part XII that focus on the protection and preservation of the marine environment. Secondly, it includes obligations in the relevant regional parts of the Convention that focus on the conservation of living resources (Harrould-Kolieb, 2020). It is widely recognized that the introduction of carbon dioxide into the marine environment can cause harm to living marine resources and life due to changes in ocean chemistry and its effects (Schulz and Maher, 2023). Ocean acidification has the potential to harm human health by altering the quality and quantity of proteins and nutrients (Falkenberg, 2020). Additionally, it may reduce the coastal protection provided by coral reefs. Carbon dioxide in the marine environment, which is the upstream cause of ocean acidification, is considered a pollutant under UNCLOS due to its impacts (Bai, 2021). States must address all sources of marine pollution, including pollution from land-based sources (Article 207), dumping (Article 210), vessels (Article 211), and the atmosphere (Article 212). Taken together, these articles cover all sources of carbon dioxide to the marine environment. The reduction of these sources is an important way of mitigating ocean acidification on a global scale, as required by article 192. Article 61 of UNCLOS deals with the protection of living resources within the exclusive economic zones of States. "Within these zones, States must establish catch limits for living resources and consider the best scientific evidence available when conserving and managing living resources within their jurisdiction". UNCLOS requires that ocean acidification be taken into account in the development of conservation measures and allowable catch limits, considering its potential contribution to the decline in maximum sustainable yield of certain stocks. Therefore, control measures should consider the impacts of ocean acidification.

UNCLOS has a broad mandate to manage ocean acidification comprehensively, as revealed by the relevant provisions of Part XII and the conservation-related provisions in other parts of the treaty discussed above. States are obliged to address the harms caused by ocean acidification to the marine environment. However, UNCLOS does not provide a methodology or criteria for implementing this framework. The methodology and criteria are to be established through provisions in the framework agreement and other external agreements. One way to address ocean acidification is by regulating carbon dioxide emissions through an implementing agreement on land-based sources of marine pollution. This can establish detailed pollution standards that identify the risks of ocean acidification and require that it be addressed through pollution reduction. For example, the BBNJ negotiations provide a more positive way to address ocean acidification provisions in UNCLOS (Craig, 2017). This is because ocean acidification is recognized as one of the greatest emerging threats to marine biodiversity and could affect new species found in the oceans (NOAA Fisheries, 2019). Secondly, including ocean acidification in existing implementing agreements, such as the United Nations Fish Stocks Agreement, provides a way forward for addressing the impact of ocean acidification on straddling and highly migratory fish stocks. Third, regulation through international rules and standards is intended to fill the gaps left by general agreements, so that more details of ocean acidification can be negotiated as needed and rules can be developed for unforeseen circumstances. This is achieved through the cooperative development and refinement of international rules, standards, and recommendations for the governance of ocean acidification. States can address ocean acidification by taking measures domestically and supporting international initiatives aimed at mitigating the phenomenon (Turner et al., 2021). In addition, international efforts to address ocean acidification can be complemented by regional agreements between states sharing a common marine environment. Such agreements could include provisions for monitoring, research, mitigation measures, and capacity-building, tailored to the specific needs and challenges of a given region. By utilizing these mechanisms, states can translate their domestic laws and agreements to address ocean acidification into international law or incorporate them into the UNCLOS. This process requires cooperation, negotiation, and commitment among states to effectively address the global challenge of ocean acidification.

4.6 Remedying the causation proof gap through the scientific theory of attribution and the due diligence obligation

Barriers to proving causation in climate change litigation prevent courts from finding greenhouse gas emitters liable for climate damage. In recent years, judicial decisions have been crucial in addressing the issue of causation in climate litigation. According to a research project at the University of Oxford, the evidence presented and cited in climate change litigation cases lags considerably behind recent developments in climate science (Stuart-Smith, 2021). This hinders causation claims and argues for a greater understanding and use of existing methodologies in the science of attribution to address barriers to causation in climate litigation (Stuart-Smith, 2021). Currently, climate attribution research is primarily relevant to domestic climate litigation. However, with the trend towards global warming and an increase in extreme weather events, attribution is likely to become a crucial aspect of future international climate loss and damage discussions. Attribution studies typically involve selecting an event to study, identifying a trend in the observed historical climate record, simulating this trend through a trial-order climate model, comparing simulations using all natural and anthropogenic climate drivers with simulations using only natural drivers, and estimating statistical confidence (Otto, 2023). At the practical level, attribution studies can confirm the link between global greenhouse

gas emissions and climate change-related hazards, such as extreme weather events (heat waves, storms, or floods), as well as slow-onset impacts (such as sea-level rise or ocean acidification) (Cho, 2021). For instance, studies have found that human-induced climate change increased the probability of a heat wave in Argentina in 2013–2014 by 400% (Chesini et al., 2022). In addition, attribution studies have produced methods capable of quantifying the marginal contribution of individual emitters to extreme weather events and slow-onset changes (Stuart-Smith, 2021). This allows the Court to consider the extent to which individual country contributions increase the severity or probability of particular climate change-related events. For instance, emissions from EU member states were responsible for 37% of the total increase in the likelihood of a heat wave in Argentina during 2013–2014 (Wehner, 2022).

5 Conclusions

UNCLOS is often referred to as the "constitution of the oceans" as it provides a comprehensive legal framework for all activities in the oceans and seas (Pyć, 2016). However, the adaptability of UNCLOS is being tested with the emergence of uncertainties such as climate change. This study highlights the critical relationship between ocean governance and climate change governance. These two governance systems are grounded, respectively, in the UNCLOS and the UNFCCC. Despite their shared objective of environmental stewardship, a noticeable lack of interaction exists between these legal systems. This lack of interaction stems from distinct negotiation backgrounds, legal scopes, and objectives. The oceans, which play a pivotal role in regulating the Earth's climate system, are underrepresented within the UNFCCC. This study aims to bridge this gap by analyzing the effectiveness of UNCLOS in addressing climate change. Through a comprehensive examination, which includes an examination of climate change impacts and logical structuring, the study identifies UNCLOS's limitations, particularly in regulating sea level rise, ocean acidification, and ocean fertilization. The study proposes a governance pathway grounded in UNCLOS and advocates for the development of the Agreement relating to the climate change and ocean governance, and reinterpretation of UNCLOS in alignment with the Paris Agreement. This reinterpretation calls for greater flexibility in content to meet current climate challenges, reevaluation of provisions related to sea-level rise and maritime boundaries, and development of coordinated regulatory rules and framework agreements to address ocean fertilization and acidification. Furthermore, the study proposes the implementation of scientific theories and due diligence obligations to address gaps in proof of causation. By adopting these measures, states can pursue an effective ocean law governance pathway to confront the challenges of climate change, ensuring comprehensive protection of the marine environment and sustainable management of ocean resources.

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

WZ: Writing – review & editing, Writing – original draft. GW: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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