



# Synergizing Climate Change and Ocean Regimes: A Comprehensive International Legal Approach for Ocean Acidification Governance

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**Abstract** : Ocean acidification poses a myriad of challenges, particularly to marine environments and ecosystems. Its negative repercussions are equally obvious from a human-centric perspective. Despite efforts to address ocean acidification through various international legal frameworks, current international legal frameworks, such as the United Nations Convention on the Law of the Sea and the United Nations Convention on Climate Change, which represent the climate change regime and the ocean regime, respectively, fall short of adequately addressing ocean acidification challenges. Because of the climate change regime's atmospheric-centered perspective and the ocean regime's pollution-oriented perspective, ocean acidification falls between the cracks and is not a priority for either regime. To adequately address the issues posed by ocean acidification, a concerted effort between the the legal regime addressing climate change and the legal regime regulating maritime affairs is crucial. This effort might be realized by developing a robust governance system that encompasses both of these regimes, which are specifically tailored to tackle ocean acidification. Given the complexity of ocean acidification governance, the distribution of roles for both regimes should be thoroughly examined. Due to its broad reach, the ocean regime might take the lead in directing the trajectory of ocean acidification, while the climate change regime might provide assistance within the context of ocean acidification governance. Active mutual reference and due diligence obligations could be employed in this scenario to bridge the gaps created by both the climate change regime and the ocean regime regarding ocean acidification. The active interaction between these regimes might pave the way for proper ocean acidification governance in order to meet the challenges posed by ocean acidification.

**Key words** : CO<sub>2</sub> emissions reduction, ocean acidification governance, regime complex, the United Nations Framework Convention of Climate Change, the United Nations Convention on the Law of the Sea

## 1. Introduction

Due to the acceleration of global warming, climate change threats are becoming a pressing reality. The adverse effects of climate change also impact the oceans. Since the oceans play a critical role in mitigating Earth's climate change, the relationship between climate change and the oceans carries significant implications. Climate change negatively impacts marine environments and ecosystems, which in turn directly affects the various human dimensions related to it, such as commodities, services, and livelihoods

offered by the oceans. From the climate change-ocean nexus, ocean acidification is a salient example, demonstrating the direct adverse effects of climate change on the oceans.

Ocean acidification is generally understood as the result of the increased absorption of carbon dioxide (CO<sub>2</sub>) into the oceans. Considering the acidity of ocean surface waters has drastically increased since the beginning of the Industrial Revolution, ocean acidification could be seen as the direct outcome of human activities. Now, the consequences of human activities threaten the entire dimension linked to human beings. Despite the serious negative impacts of ocean acidification on the environment, society, and eco-

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nomy, comprehensive countermeasures have yet to be taken.

This absence of effective strategies to combat ocean acidification is also evident in the realm of international law. Although various international legal frameworks address ocean acidification concerns, they just offer fragmented or partial approaches and solutions. Because ocean acidification challenges are closely related to both the climate change regime and the ocean regime, these two regimes are expected to provide substantial solutions to ocean acidification matters. However, neither the climate change regime nor the ocean regime specifically address the adverse effects of ocean acidification. This irony is mainly due to the atmospheric-centric perspective of the climate change regime and the pollution-oriented perspective of the ocean regime. In this context, ocean acidification is not recognized as a pressing issue in either regime. In essence, the all-encompassing approach to mitigating ocean acidification in international law is still at large.

In this context, a paradigm shift is needed to effectively address ocean acidification challenges, with a focus on the interplay between the climate change regime and the ocean regime. For instance, the establishment of a robust governance mechanism that is designed specifically for tackling ocean acidification challenges could be an option for addressing ocean acidification. When it comes to considering the structure of ocean acidification governance, the strengths and weaknesses of the expected constituents of ocean acidification governance should be thoroughly explored. By identifying the possibilities of integrating the climate change regime and the ocean regime and examining the potential difficulties of the interaction between these two regimes, a blueprint for ocean acidification governance could be crystallized.

For the purpose of suggesting the necessity of establishing ocean acidification governance, this study navigates the concerns about ocean acidification. Understanding the multifaceted challenges of ocean acidification is essential for developing effective strategies to address ocean acidification. Also, this study explores the merits and demerits of both the climate change regime and the ocean regime in terms of feasible instruments for preventing ocean acidification. Based on this exploration, an effective strategy to develop ocean acidification governance could be envisaged. Lastly, by stressing the active mutual reference of these two regimes and the usefulness of employing due diligence obligations, this study navigates the effectiveness

of ocean acidification governance. By comprehensively understanding the difficulties driven by ocean acidification, a robust ocean acidification governance based on relevant international legal instruments could be established.

## **2. The Threats of Ocean Acidification and the Lagging Response of International Law**

Although climate change does not cause ocean acidification directly, it is often referred to as its “evil twin” (Hull 2014). Ocean acidification comes from the ocean absorbing atmospheric CO<sub>2</sub>, with human activities accounting for around a third of CO<sub>2</sub> emissions (Arche 2010). Since ocean acidification rapidly lowers the ocean’s pH (Caldeira and Wickett 2003), it endangers marine ecosystems and fisheries, and its impacts extend to communities and economies that rely on these marine resources (Doney et al. 2020). All negative outcomes of ocean acidification might include sea-level rise, deoxygenation, coral bleaching, loss of sea ice, and alterations in the abundance and distribution of various marine species (Pörtner et al. 2019).

Ocean acidification reduces the ocean’s ability to absorb CO<sub>2</sub>, thereby disabling the ocean’s role as a long-term CO<sub>2</sub> sink (Scott 2020). Historically, for nearly 800,000 years, the ocean’s pH has stably remained at roughly 8.2. However, the ocean’s pH began to shift rapidly with the emergence of the Industrial Revolution in the 18<sup>th</sup> century. Rising CO<sub>2</sub> emissions from the Industrial Revolution have impacted ocean pH levels critically. Since the dawn of the industrial age, the ocean has absorbed approximately 525 billion tons of CO<sub>2</sub> from the atmosphere, which is currently about 22 million tons per day. If CO<sub>2</sub> emissions persist at such a pace, the ocean’s pH might drop by a further 120 percent by the end of this century (The Ocean Portal Team 2018). The ocean’s pH is expected to fall to between 7.9 and 7.7 by 2100 if there is no drastic reduction in CO<sub>2</sub> emissions (Turley and Gattuso 2012). The current rate of ocean acidification is considered to be the fastest in at least the last 300 million years (Gao et al. 2019).

Marine ecosystems are vulnerable to ocean acidification challenges. Shell-forming species like oysters, mussels, clams, urchins, and starfish have difficulty forming their shells under ocean acidification. A decline in calcifying zooplankton and phytoplankton might be triggered, resulting in disruptions in marine food chains. Coral growth is hindered, and harmful algal blooms become more toxic

and common. Some fish species' sensory systems might malfunction, limiting their ability to evade predators and potentially bringing about a drop in particular fish populations (Pörtner et al. 2019). Furthermore, both the Arctic region and the Antarctic region are particularly vulnerable because CO<sub>2</sub> is absorbed more quickly in colder water (Shadwick et al. 2013; Terhaar et al. 2020). Ocean acidification adversely affects species in these regions because it limits their capabilities to adapt to quickly changing environmental conditions (Thor et al. 2016).

Ocean acidification's consequences are not limited to marine ecosystems. Indeed, ocean acidification could have adverse impacts on human health *per se*. According to Falkenberg (Falkenberg et al. 2020), there are four main ways in which ocean acidification could affect human health: (1) by altering the quality and quantity of food, leading to malnutrition and poisoning; (2) by affecting air quality, resulting in respiratory issues; (3) by changing natural spaces, which can have psychological impacts; and (4) by reducing the chances of developing and accessing medical resources due to biodiversity loss. Furthermore, ocean acidification critically threatens global food security from a human-centric perspective (Lemasson et al. 2019). The oceans are indispensable for the world's food supply. Many people's livelihoods and prosperity are closely associated with the oceans, with 60 percent of the world's population residing in coastal zones. Thus, ocean acidification threatens the lives and livelihoods of the millions of people who depend on the oceans. Ocean acidification has repercussions that go beyond commercial fisheries and shellfish production, potentially compromising protein supply, food security, and livelihoods for millions of the world's poorest people (Elver and Oral 2021).

Grasping the legal and policy implications of ocean acidification is difficult due to the lack of a specialized international legal framework for tackling it. Although fragmented international agreements and initiatives have been addressing ocean acidification issues, no comprehensive international agreement has yet to be adopted to address ocean acidification (González 2012). Owing to the distinctive nature of ocean acidification, it is not subject to the authority of any one of the international agreements. As a result, neither the 1982 United Nations Convention on the Law of the Sea (UNCLOS) nor the 1992 United Nations Framework Convention on Climate Change (UNFCCC) provide all-encompassing answers to ocean

acidification. In this context, ocean acidification could be regarded as a challenge that affects both the climate change regime and the ocean regime (Kim 2012).

The climate change regime could address ocean acidification. However, ocean acidification has not been at the forefront of the regime's concerns. The atmosphere-centric perspective of climate change, which primarily focuses on lowering atmospheric temperatures, explains its relative indifference to ocean acidification concerns (Tiller et al. 2019). Taking the 2015 Paris Agreement (Paris Agreement) as an example, its main objective, as stipulated in Article 2(1)(a), is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. The main focus of the Paris Agreement is the global atmospheric temperature, sidestepping the direct focus on ocean warming.

Despite efforts by various organizations and initiatives to raise awareness about ocean acidification in relation to climate change, it has remained a relatively neglected issue (Engler et al. 2019). Existing international legal frameworks, such as the UNCLOS and the UNFCCC, are not adequately equipped to confront the escalating threat of ocean acidification. In this perspective, the attempts made by various international legal regimes to address ocean acidification are often described as 'lagging' and 'insufficient' (Fennel and VanderZwaag 2016). Put differently, it seems that ocean acidification is slipping through the gaps in both the UNCLOS and the UNFCCC (Oral 2018).

### **3. Comparative Approaches of the Ocean and Climate Change Regimes to Ocean Acidification**

While no overarching global legal regime directly addresses ocean acidification, several legal regimes indirectly tackle its causes by mainly focusing on atmospheric and ocean pollution. Part XII of the UNCLOS, for example, might require States to address ocean pollution. Simultaneously, by concentrating on regulating greenhouse gases (GHG) emissions, the UNFCCC might play a key role in tackling ocean acidification. In this regard, the challenges of ocean acidification could be understood to fall under the 'regime complex'. The regime complex refers to functionally intertwined regimes and institutions that, while not being hierarchical, influence each other's operational

spheres (Alter and Raustiala 2018). For the regime complex to function efficiently, it is essential to forge meaningful ties between the various regimes, establishing a cohesive regulatory network (Scott 2020).

The ocean regime heavily relies on the UNCLOS. It sets basic rules for navigation, maritime zones, resource use, scientific research, and protection of the marine environment, and is equipped with a dispute settlement system for ocean-related issues. Through specific treaties, this regime touches on specific challenges like fisheries, pollution, and regional marine environmental issues. The climate change regime, on the other hand, has evolved around the UNFCCC. The UNFCCC's main focus is to stabilize GHG levels in the atmosphere. The 1997 Kyoto Protocol (Kyoto Protocol) to the UNFCCC specifies how to achieve this objective by setting quantified emission limitation and reduction commitments for developed countries. The Paris Agreement further elaborates on the objectives of the UNFCCC (Guilloux 2019).

How could the ocean regime and the climate change regime collaborate effectively? Either one or both regimes could potentially tackle concerns stemming from the climate change-ocean nexus. For example, the regional fisheries organizations could explore the impact of climate change on fisheries, or it could be approached as an adaptation issue within the context of the climate change regime. The IMO, the climate change regime, or both could address maritime transport emissions. While both regimes might align with their goals, there might be the possibility of conflict. As a result, it might be advantageous to establish a well-balanced task distribution, assigning specific issues to the most suitable regime. Bodansky suggests that by focusing on mitigation within the climate change regime and adaptation within the ocean regime, an orchestrated division of tasks between the two regimes could be established (Bodansky 2021).

### **The ocean regime with a focus on marine environmental protection**

The UNCLOS outlines the international community's rights and obligations with regard to the conservation and management of marine ecosystems and resources. The UNCLOS sets comprehensive and enforceable obligations, particularly regarding the adverse impacts of anthropogenic CO<sub>2</sub> emissions on the oceans. Part XII of the UNCLOS, specifically Article 192, provides that "State have the obli-

gation to protect and preserve the marine environment." The Permanent Court of Arbitration (PCA) ruled in *the South China Sea Arbitration* that Article 192 imposes an obligation on States, the content of which is elaborated by the other provisions of Part XII and other applicable rules of international law. According to the PCA, this general obligation set by Article 192 involves both the protection of the marine environment from future damage and its preservation in the sense of maintaining or improving its present condition. Furthermore, the PCA underscores that Article 192 requires both the positive obligation to take active measures to protect and preserve the marine environment and the negative obligation not to degrade the marine environment (PCA 2016, para. 941).

This obligation has redirected the discourse regarding ocean environmental concerns, and it is now recognized as a norm of customary international law binding all States. This obligation goes beyond the conventional focus on pollution found in many Articles of Part XII, stressing the necessity of broadening the scope of Part XII to tackle all forms of harm to the marine environment. By broadening the scope of Part XII, this obligation could encompass both the physical harm and destruction to marine ecosystems and any alterations to the marine environment and its components. This broader interpretation of Article 192 underlines the need for an all-encompassing approach to ocean acidification, aiming not just to preserve the current state of the marine environment but to prevent future damage. Hence, it could be argued that Article 192 requires States to mitigate the causes of ocean acidification, adapt to its consequences, and redress any harm it causes (Harrould-Kolieb 2020).

Other Articles of Part XII, as well as other applicable rules and principles of international law, could provide additional insights on the content of Article 192. In this context, Article 194 holds significant implications. According to Articles 194(1) and (2), States are required to take all necessary measures to prevent, reduce and control marine environmental pollution, irrespective of its source. Moreover, States are required to ensure that activities within their jurisdiction and control do not lead to pollution damage to other States or their environment. The measures taken by States should address all sources of marine pollution under Article 194(3). This encompasses the release of toxic, harmful, or noxious substances, especially persistent ones, whether they originate from

land-based sources, the atmosphere, dumping, vessels, or installations and devices used for seabed activities.

Although Article 194 does not directly mention anthropogenic GHG emissions, they should be considered within the scope of this Article if they have the potential to result in or contribute to marine pollution. This perspective resonates with Article 1(4), which defines marine environmental pollution as the introduction, whether directly or indirectly by human activities, of substances or energy into the marine environment that could have negative repercussions. The range of detrimental consequences includes damage to marine ecosystems, hazards to human health, hindrance to marine activities like fishing and other legitimate uses of the sea, degradation of sea water quality, and reduction of amenities. Taking into account the objective of Article 1, there is a compelling argument in favor of interpreting Article 194 more expansively. Boyle contends that since Article 194 highlights mitigating marine pollution rather than fostering adaptation, this perspective aligns with the intent of Article 194 (Boyle 2021). Consequently, it could be argued that Article 194(2) establishes States' obligations to protect the marine environment, emphasizing the need for States to control and mitigate CO<sub>2</sub> emissions through preventive measures.

The following concerns must be addressed in order to determine whether Article 194 could be applicable to ocean acidification: Can ocean acidification qualify as pollution of the marine environment? According to Article 1(4), human-introduced energy into the marine environment could be classified as marine environment pollution. The heat generated by CO<sub>2</sub> during the global warming process could be understood as human-introduced energy. Therefore, if this energy is reintroduced into the oceans and leads to ocean acidification, it could potentially be addressed within the context of marine environmental pollution, as stipulated in Article 1(4) (Boyle and Ghaleigh 2016). Regarding whether ocean acidification could be classified as marine environmental pollution under the UNCLOS, Harrould-Kolieb contends that the definition of marine environmental pollution under the UNCLOS should be expansively construed to include emerging and unforeseen pollutants, such as CO<sub>2</sub> entering the ocean. Given the devastating effects of ocean acidification on marine ecosystems and human health through altered protein and nutrient quality and availability, as well as the potential reduction in coastal protection by coral reefs, anthropogenic CO<sub>2</sub> in

the marine environment satisfies the criteria set out in Article 1 and should be labeled as a pollutant under the UNCLOS (Harrould-Kolieb 2020).

Frosch argues that measures to tackle ocean acidification should be put into practice to an extent where pollution of the marine environment could be prevented, reduced, regulated, aligned with the no-harm rule (Frosch 2018). Boyle asserts that States should take the necessary measures to prevent or minimize harmful pollution. According to Boyle, such measures might involve conducting an environmental impact assessment, implementing regulation and utilizing the best available technology, and applying the precautionary principle. Furthermore, Boyle underscores that States are required to control and reduce CO<sub>2</sub> emissions, particularly those emanating from sources that jeopardize marine ecosystems and cause harm to other States (Boyle 2016).

Section 5 of Part XII establishes an extensive framework for touching upon marine pollution from diverse sources. Two crucial Articles in this context, Articles 207 and 212, deal specifically with land-based pollution and atmospheric pollution. Their interpretation holds significant implications for discussions on ocean acidification. Boyle posits that a significant amount of marine pollution comes from land-based sources, leading to the atmospheric deposition of these pollutants into the ocean. The UNCLOS has consistently acknowledged these contributors (Boyle 2021). Under Article 207(1), States should consider "internationally agreed rules, standards and recommended practices and procedures". In this context, it is appropriate to consider and integrate the climate change regime, including the UNFCCC, the Kyoto Protocol, and the Paris Agreement, within the framework of the UNCLOS when addressing the mitigation of ocean acidification. This is because the primary objective of the climate change regime is to reduce GHG emissions, including CO<sub>2</sub> emissions, which resonates with the central goal of mitigating ocean acidification.

Although Article 207(1) refers only to pollution from 'rivers, estuaries, pipelines and outfall structures', Boyle contends that, with the support of regional treaties such as the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic and the 1999 Protocol Concerning Pollution from Land-Based Sources and Activities to the Cartagena Convention, the scope of Article 207 could be interpreted broadly enough to include pollution coming from waterborne, airborne, or directly

from the coast. Indeed, these regional treaties expand their scope to include pollution from “point or diffuse inputs from all sources on land,” regardless of whether they are waterborne, airborne, or directly from the coast, in accordance with Agenda 21. Drawing from this interpretation, Boyle suggests that Article 207 could be instrumental in mitigating marine pollution from GHG emissions by regulating coal-fired power stations or other land-based activities (Boyle 2021).

Article 208(1) also requires States to take measures to prevent, reduce and control marine environmental pollution stemming from or in connection with seabed activities. This is especially crucial in light of the possibility for ocean acidification driven by the accumulation of CO<sub>2</sub> in geological formations beneath the seabed. Additionally, the requirement set out in Article 210(1) to prevent, reduce and control pollution of the marine environment by dumping would have substantial implications for tackling ocean acidification. Article 212 could also cover CO<sub>2</sub> emissions from ships and aircraft within the context of pollution from or through the atmosphere. Despite concerns about Article 212’s relevance to GHG emissions, this Article could cover pollutions from ships and aircrafts and pollution from “the air space under States’ sovereignty,” without being tied to a specific source. Through such interpretation, GHG emissions could potentially fall into the scope of Article 212, thereby allowing this Article to be invoked in the fight against ocean acidification (Klerk 2022). Boyle posits that Articles 194, 207, and 212 need to be read together in order to target both airborne and land-based sources of marine pollution that contribute to ocean acidification, particularly those that are emitting CO<sub>2</sub> and other GHG (Boyle 2021).

### **The climate change regime with an emphasis on reducing atmospheric emissions**

The climate change regime, mainly composed of the UNFCCC, the Kyoto Protocol, and the Paris Agreement, focuses on the adverse impacts of atmospheric climate change. While the climate change regime recognizes the climate change-ocean nexus in international climate change dialogues, they primarily concentrate on concerns about atmospheric climate change, failing to give adequate attention to climate change challenges associated with the ocean (Borg 2023). Notwithstanding the fact that the climate change regime does not directly address ocean acidifi-

cation challenges, it could serve as leverage to counteract ocean acidification. This possibility comes mostly from its emphasis on reducing CO<sub>2</sub>-related GHG emissions.

The main objective of the UNFCCC, as outlined in Article 2, is the stabilization of GHG concentrations in the atmosphere and the prevention of dangerous anthropogenic interference with the climate system. Article 4(1)(d) of the UNFCCC requires States to promote sustainable management and cooperation in the conservation and of sinks and reservoirs of all GHG not covered by the Montreal Protocol. As examples of such sinks and reservoirs of all GHG, this Article refers to biomass, forests, oceans, and other terrestrial, coastal and marine ecosystems. According to Article 3(1), States are required to protect the climate system, which is understood to encompass the totality of the atmosphere, hydrosphere, biosphere and geosphere, as well as their interactions under Article 1(3). Thus, if the oceans could be regarded as being included within the climate system, it could be asserted that the UNFCCC could be applicable to ocean-related climate change concerns such as ocean acidification.

Article 2(3) of the Kyoto Protocol requires Annex I Parties to implement and further elaborate policies and measures such as the protection and enhancement of GHG sinks and reservoirs in order to satisfy their quantified emission limitations and reduction commitments under Article 3. Yet, when it comes to protecting and enhancing sinks and reservoirs of GHG, it solely refers to the promotion of sustainable forest management practices, afforestation, and reforestation. This could be read as the Kyoto Protocol’s passive attitude toward ocean acidification. Nonetheless, the Kyoto Protocol’s fundamental commitment to reducing GHG emissions, emphasized in Articles 3(1), 3(7), 4(1), and 5(3), which refer to “anthropogenic carbon dioxide equivalent emissions of the greenhouse gases,” indicates its potential usefulness in the battle against ocean acidification. Even though the Kyoto Protocol’s position on ocean acidification appears to be indirect, the Kyoto Protocol’s dedication to reducing CO<sub>2</sub>-related GHG emissions implies that it could be instrumental in mitigating ocean acidification because ocean acidification comes directly from CO<sub>2</sub>-related GHG emissions.

By referring to the UNFCCC in its preamble, the Paris Agreement serves as an implementing agreement for the UNFCCC. Furthermore, as stipulated in Article 1, the definitions set forth in the UNFCCC apply to the Paris

Agreement. Given its emphasis on maintaining or limiting global atmospheric temperature, the Paris Agreement certainly does not deviate from the basic objective of the climate change regime, which is to counteract atmospheric warming. Nonetheless, the Paris Agreement still holds the potential to address ocean acidification in a way similar to the UNFCCC and the Kyoto Protocol. Notably, in its preamble, the Paris Agreement requires States to “recognize” the importance of the conservation and enhancement of sinks and reservoirs of the GHG referred to in the Convention and “note” the importance of ensuring the integrity of all ecosystems, including oceans. Furthermore, the Paris Agreement could play a role in tackling ocean acidification because it could possibly be perceived as a slow onset event under Article 8(4)(c).

The potential of the climate change regime to address ocean acidification is indeed promising, yet it is critical to explore the inherent difficulties stemming from its capacity to effectively tackle ocean acidification challenges. In fact, the climate change regime’s predominant atmosphere-centric perspective often marginalizes the urgency of directly engaging with ocean acidification challenges. Despite the fact that Article 1 of the UNFCCC refers to the hydrosphere, which covers the ocean within the climate system, there are doubts about the UNFCCC’s capability to address ocean acidification equally due to its atmosphere-centric perspective (Baird et al. 2009). Furthermore, given the UNFCCC’s objective of preventing “dangerous anthropogenic interference with the climate system”, an essential question emerges: Can ocean acidification be identified as such interference? Even if the ocean could be included within the climate system, it remains uncertain whether ocean acidification could be classified as such interference under the UNFCCC (Oral 2018).

In addition, the Kyoto Protocol might not provide a feasible framework for directly countering ocean acidification. The Kyoto Protocol’s goal is relatively limited, aiming for a 5% aggregate reduction in GHG emissions, and this only applies to the Parties listed in Annex I of the UNFCCC and Annex B of the Kyoto Protocol. Furthermore, by focusing on “CO<sub>2</sub> equivalent” emissions reductions rather than CO<sub>2</sub> reductions *per se*, its effectiveness in tackling ocean acidification, directly attributable to CO<sub>2</sub>, looks to be weakened (Kim 2012). Baird, Simons, and Stephens warn that the Kyoto Protocol could potentially allow States to increase their CO<sub>2</sub> emissions if they could offset

it by reducing other equivalent GHG (Baird et al. 2009). As a result, the Kyoto Protocol’s approach inadvertently diverts attention away from the core issue of CO<sub>2</sub>, thereby compromising its ability to counteract ocean acidification effectively (Oral 2018).

The narrative surrounding the Paris Agreement maintains a familiar tone. While ocean acidification has the potential to be categorized as a slow onset event, the Paris Agreement does not have Articles that directly address the primary cause of ocean acidification: CO<sub>2</sub>. While the ambitious global temperature objective of limiting global warming to 1.5°C might indirectly drive reductions in CO<sub>2</sub> emissions, the Paris Agreement is still silent on how much of the individual gases should be mitigated. As a result, there is no guarantee that CO<sub>2</sub> emissions will be lowered to a level sufficient to counteract ocean acidification (Frosch 2018). Given that the Paris Agreement sets out a defined and verifiable objective of global temperature management, it could be seen as more effective than the UNFCCC and the Kyoto Protocol in reducing overall GHG emissions. Nonetheless, despite its potential, the Paris Agreement fall short of satisfying the mitigation requirements of Part XII of the UNCLOS (Boyle 2021).

In essence, the current climate change regime, including the UNFCCC, the Kyoto Protocol, and the Paris Agreement, does not prioritize the climate change-ocean nexus challenges. Since protecting the marine environment is not exactly the primary focus of the climate change regime, requesting that it comprehensively address the adverse impact of climate change on the marine environment, especially CO<sub>2</sub>-related issues on the oceans, might be seen as irrelevant or off-topic. Yet, given that CO<sub>2</sub> is the main contributor to ocean acidification, the success of addressing this issue largely hinges on the climate change regime’s attitude toward the climate change-ocean nexus issues. In this context, the ocean’s relative marginalization, as evidenced by the climate change regime, might exacerbate ocean acidification problems. The fact that the ocean is mainly recognized in the climate change regime as a significant natural sink or reservoir of CO<sub>2</sub> carries significant implications for the climate change regime’s capacity to tackle ocean acidification challenges. This portrayal of the ocean as solely a CO<sub>2</sub> sink or reservoir might lead to an underestimation of its vulnerability to GHG emissions.

In this context, it is necessary to develop a holistic approach that covers both the climate change regime and

the ocean regime in order to tackle ocean acidification challenges more comprehensively. A prospective holistic approach to ocean acidification can take a variety of forms, including an *ad hoc* approach and a robust network of interrelated regimes dealing with various aspects of ocean acidification. However, given the devastating impact of ocean acidification on marine ecosystems and human security, particularly food security, the establishment of an umbrella regime including all regimes associated with concerns about ocean acidification could be suggested as the best option for combating ocean acidification. As a result, the need for establishing a dedicated governance mechanism for ocean acidification, so-called ocean acidification governance, should be seriously explored. Once the ocean acidification governance, which weaves together both the ocean regime and the climate change regime, is in place, the narrative surrounding ocean acidification might be both redirected and furthered. It could be claimed that enhancing this synergy would cause the climate change regime to shift away from simply portraying the ocean as a significant CO<sub>2</sub> sink or reservoir and toward actively protecting the ocean *per se*, which is under threat from CO<sub>2</sub> emissions (Popattanachai and Kirk 2021).

#### **4. Anchoring Ocean Acidification Governance: The Pivotal Role of the Ocean Regime**

Since CO<sub>2</sub> is the principal agent of ocean acidification, reducing CO<sub>2</sub> is indispensable for counteracting ocean acidification challenges. Without a doubt, both the climate change regime and the ocean regime have potential roles in addressing ocean acidification challenges. Although the climate change regime strives to reduce GHG emissions, it does not differentiate CO<sub>2</sub> from other GHG. In other words, the climate change regime does not prioritize CO<sub>2</sub>-driven challenges. The sidelining of CO<sub>2</sub>-driven challenges might undermine the climate change regime's efficacy in battling ocean acidification. The ocean regime, on the other side, might not be completely relevant to immediately address ocean acidification because its focus on ocean acidification is mainly constructed in terms of the protection of the marine environment from a variety of pollutants, including those from land-based sources, vessels, the atmosphere, and dumping. Given this circumstance, neither the climate change regime nor the ocean regime is capable of comprehensively addressing the multifaceted issue of ocean

acidification on their own. In this aspect, the meaningful integration of the climate change regime and the ocean regime is required, and special consideration is needed to solve problems arising from the shortcomings of each of the two regimes concerning ocean acidification. The question then arises: how could these two regimes work together to combat ocean acidification effectively?

#### **The orchestration of two regimes based on active mutual reference**

Given the regime complex, the interplay of two overlapping regimes could range from conflicting to cooperative. If a certain regime shows superiority in handling a particular issue, it should take the lead, while other regimes support and complement its efforts. At first glance, collaboration between the climate change regime and the ocean regime appears uncomplicated, considering their shared concerns about atmospheric pollution and the harmful impacts of CO<sub>2</sub> in general. However, any collaboration between the climate change regime and the ocean regime is fundamentally dependent on finding common ground; without this, convergence might not materialize from the beginning. Furthermore, the nature and outcomes of their cooperation heavily hinge on which regime takes a more critical or dominant role. For instance, if the ocean regime takes the initiative, the outcomes might be different from those obtained if the climate change regime takes the lead.

In this context, an active mutual reference between the climate change regime and the ocean regime is essential to successfully address the complexities arising from the regime complex and to build a robust governance framework for ocean acidification. Although both the climate change regime and the ocean regime have shortcomings in directly addressing ocean acidification challenges, the ocean regime might seem to be more suited as the main player in ocean acidification governance. Although the climate change regime focuses on lowering CO<sub>2</sub> emissions, this does not imply that it is primarily concerned with ocean-related climate change challenges, such as marine environment protection.

There is a compelling reason why the ocean regime must play a prominent role in steering ocean acidification governance in this regard. Furthermore, unlike the climate change regime, the ocean regime has its own dispute settlement system. This indicates that legal aspects of ocean acidification could be scrutinized under specific Articles



of the UNCLOS, leading to definitive legal decisions. Then, what role could the climate change regime be expected to play concerning ocean acidification? As a *lex specialis* in dealing with atmospheric pollution, the climate change regime might supplement and enhance the ocean regime's efforts to fight against ocean acidification by stressing the reduction of GHG emissions, particularly CO<sub>2</sub>.

The effectiveness of the climate change regime in combating ocean acidification critically hinges on its stance toward CO<sub>2</sub> emissions. Specifically, to tackle ocean acidification challenges, the regime should place greater emphasis on the reduction of CO<sub>2</sub> emissions relative to other GHG reductions. Focusing on the scope of the nationally determined contribution (NDC) in the climate change regime has ramifications in this regard. The climate change regime specifies NDC for lowering CO<sub>2</sub> emissions. Significant progress toward mitigating ocean acidification under the climate change regime might be made if the range of NDC to lowering CO<sub>2</sub> emissions could be broadened. Under the climate change regime, there is no textual basis for confining NDC exclusively to a State's territory.

Given the importance of enhancing the interplay between the climate change regime and the ocean regime regarding ocean acidification, expanding the spectrum of mitigation and adaptation measures under the climate change regime is crucial. Throughout this extension, the oceans that are part of a State's exclusive economic zone or even high seas could be included in the scope of protecting natural GHG sinks or reservoirs, which are primary targets of the climate change regime. If this is the case, the resilience of the UNCLOS to ocean acidification could be reinforced by its strategic alliance with the climate change regime (Bodansky 2021). This could be achievable because Article 4(1)(d) of the UNFCCC requires States to promote and cooperate in the conservation and enhancement of sinks and reservoirs, including oceans, coastal, and marine ecosystems.

Under the regime complex, the assignment of roles among competing or cooperating regimes is critical. In this regard, how to contextualize the roles of the climate change regime and the ocean regime in relation to ocean acidification is essential for the successful management of ocean acidification. In other words, how to establish a natural division of labor between the climate change regime and the ocean regime has substantial implications for solving ocean acidification problems. Considering various Articles

of the UNCLOS, it would be possible that this collaboration could materialize. As highlighted in Articles 207 and 212 of the UNCLOS, States are required to take into account "internationally agreed rules, standards and recommended practices and procedures" for the protection and preservation of the marine environment. This requirement appears in various forms throughout numerous Articles of Part XII of the UNCLOS (Harrould-Kolieb 2020). For example, States are required to strive toward the establishment of international rules, standards and recommended practices and procedures for preventing, reducing, and controlling atmospheric pollution under Article 212(3) of the UNCLOS. What are the implications of taking into account international rules, standards and recommended practices and procedures when developing ocean acidification governance?

It could be argued that the climate change regime, including the UNFCCC, the Kyoto Protocol, and the Paris Agreement, could qualify as international rules and standards for the UNCLOS to consider within its efforts to prevent ocean acidification, particularly when it comes to controlling atmospheric pollution. By taking into account the climate change regime, the ocean regime could effectively bridge gaps caused by challenges related to ocean acidification, notably those associated with the reduction of GHG emissions. Since Articles of the UNCLOS do not explicitly address GHG emissions, it becomes challenging to determine whether a State complies with its obligations under the UNCLOS by either implementing or failing to take measures to reduce CO<sub>2</sub> emissions. In this regard, if the UNCLOS is given criteria or standards for determining the compliance of States with their commitment to the reduction of GHG emissions, it could require States to take the necessary measures for reducing GHG emissions. In this context, the climate change regime, especially the Kyoto Protocol, which establishes specific emission reduction targets for industrialized States, might offer the UNCLOS adequate standards of conduct (Stephens 2015).

Without a doubt, while the UNCLOS could improve its capacity to address ocean acidification by taking into account the climate change regime as international rules, standards and recommended practices and procedures, this might not necessarily trigger a meaningful shift in the climate change regime's attitude toward ocean acidification. In other words, this cooperation might be one-sided, primarily within the ocean regime, without a comparable

adjustment in the climate change regime. In this aspect, there is skepticism about the synergy between the climate change regime and the ocean regime in terms of combating ocean acidification. According to Boyle (Boyle 2021), despite the potential for Articles 194 and 207 to be grounds for requiring States to take further actions beyond the scope of the Paris Agreement, this possibility appears infeasible because the legal nature of the commitment that is given to States to the Paris Agreement is somewhat flexible. As a result, demanding additional actions that are not specifically required under the Paris Agreement might appear superfluous.

However, the criticism centered on the legal nature of the Paris Agreement's commitment does not seem compelling. Regardless of the legal nature of the Paris Agreement's commitment, it is evident that the Paris Agreement qualifies as a treaty under the 1969 Vienna Convention of the Law of Treaties. This solidifies its standing as "generally accepted international rules" under Part XII of the UNCLOS. Moreover, the flexible legal nature of the commitment of the Paris Agreement could be readjusted through the ongoing interplay between the climate change regime and the ocean regime. Given the interwoven dynamics of the regime complex, harmonious orchestration could be persistently pursued unless there is an intentional attempt to sever the ties between regimes. In other words, regimes could not avoid mutual influence under the regime complex. Therefore, once the ocean regime spearheads integration with the climate change regime to fight against ocean acidification, the repercussions from the ocean regime's side might catalyze a meaningful change in the attitude of the climate change regime toward ocean acidification.

The climate change regime could lend more specificity to the general obligations set forth in the UNCLOS. By integrating external rules and standards, the UNCLOS could more effectively tackle the complexities or ambiguities inherent in general international agreements. Such synergy could facilitate the development of specific international rules to handle unforeseen scenarios (Redgwell 2016). The construction of the ocean regime is inextricably linked to the orchestration of the UNCLOS with many international agreements dedicated to the protection of the marine environment and the conservation of marine ecosystems. Under this orchestration, the general obligations specified in the UNCLOS could be further elaborated on

in various specific international agreements. For instance, the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL) and the 1978 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter play a pivotal role in providing nuanced insights into the obligations outlined in Part XII of the UNCLOS. Concurrently, the UNCLOS gives guidance for these specific international agreements, as outlined in Article 237, asserting that these agreements should be compatible with the general principles and objectives set forth by the UNCLOS.

There is no compelling reason to suppose that a similar dynamic could not be echoed in the interaction between the climate change regime and the ocean regime, especially when it comes to tackling ocean acidification. By focusing on CO<sub>2</sub> emissions reduction, the climate change regime could be employed to refine the general obligations of the UNCLOS in relation to ocean acidification. It is crucial that any efforts made within the climate change regime should align with the general principles and objectives of the UNCLOS. In essence, in conformity with the UNCLOS, the climate change regime could play a supporting role in preventing ocean acidification. Without a doubt, the climate change regime itself could not require States to address ocean acidification directly. Yet, compliance with the UNCLOS must be maintained if the climate change regime plays a complementary role in resolving ocean acidification concerns alongside the UNCLOS. The UNCLOS might require States to address ocean acidification as part of their climate change mitigation efforts, highlighting the need to reduce CO<sub>2</sub> emissions in order to prevent its adverse effects on the oceans (Harrison 2017).

#### **Requiring more actions for states through due diligence obligations**

Paving the road to constructing ocean acidification governance, which is mainly driven by the ocean regime, could be facilitated by the principle of due diligence. States could be required to take necessary measures even in the absence of agreement on more detailed and specific international rules and standards under the direction of due diligence obligations (Boyle 2021). Due diligence obligations could materialize the potential relevance of the climate change regime within ocean acidification governance. The obligations set out in Part XII of the UNCLOS are widely understood to reflect the principle of due diligence.

Generally, an obligation of due diligence is interpreted as an obligation of conduct. An obligation of result necessitates a State to fulfill a particular action, while an obligation of conduct requires a State to exert its maximum efforts (Longobardo 2020). In *the Responsibilities and obligations of States sponsoring persons and entities with respect to activities in the Area case*, the International Tribunal for the Law of the Sea (ITLOS) stated that States are required to “deploy adequate means, to exercise best possible efforts, to do the utmost, to obtain this result”. The term “to ensure” in Article 194(2) was construed by the ITLOS as a manifestation of an obligation of due diligence (ITLOS 2011, paras. 110–112).

In terms of the precise meaning and scope of due diligence obligations, the ITLOS posits that the concept of due diligence remains dynamic, and its substance might not be easy to define in precise terms (ITLOS 2011, para. 117). The position of the ITLOS is not difficult to understand because it is widely believed that the legal character of an obligation of due diligence is an obligation of conduct. Since an obligation of due diligence is not an obligation of result, it might be argued that due diligence obligations could not play a substantial role in requiring specific actions of States. To put it another way, even though the UNCLOS emphasizes the importance of due diligence obligations in protecting the marine environment and preserving marine ecosystems, it might not require States to undertake specific actions or measures to achieve specific results because of the inherent legal nature of these obligations. Nonetheless, the complexities associated with due diligence obligations in Articles of the UNCLOS present an opportunity for the climate change regime to bolster ocean acidification governance.

An obligation of due diligence is echoed in Articles 192, 194, 207, and 212 of the UNCLOS, however, the wording and scope of application differ across each Article (Klerk 2022). For instance, Article 192 emphasizes the protection of the marine environment from all of the harmful effects of climate change; Article 194 particularly targets pollution in the marine environment; and Articles 207 and 212 focus on specific sources of pollutants, such as land-based and atmospheric pollution. Taken together, these Articles demonstrate an obligation of due diligence to protect and preserve the marine environment from the detrimental effects of GHG emissions, irrespective of their origin. According to Stephens (Stephens 2015), Articles

192, 194, 207, and 212 of the UNCLOS, in conjunction with Article 1(1)(4), which broadly categorizes pollution to include both substance and energy, require States to undertake due diligence obligations in reducing GHG emissions that adversely impact the marine environment.

Despite the widespread reference to obligations of due diligence in Articles of the UNCLOS, the following question may arise: what exactly is the meaning and scope of due diligence obligations? According to Klerk (Klerk 2022), within the context of the interpretation of treaties, the climate change regime could potentially clarify the substance of due diligence obligations set forth in the UNCLOS. Any relevant international law rules applicable to States should be considered for interpreting treaty provisions, according to Article 31(3)(c) of the VCLT. As a result, when it comes to difficulties concerning the interpretation of due diligence obligations specified in Articles of the UNCLOS, the climate change regime could be considered for solving such difficulties. In essence, when interpreting the due diligence obligations in Articles 192, 194, 207, and 212, these obligations could be relevantly construed via the prism of the climate change regime, particularly the Paris Agreement. This perspective resonates with the decisions of international tribunals. In *the South China Sea Arbitration*, the PCA opined that the content of Article 192 could be further clarified by referencing specific obligations of other international agreements (PCA 2016, para. 942).

There is a concern that simply meeting the UNFCCC’s commitments, unless those commitments specifically mention ocean acidification, might not fully satisfy due diligence obligations outlined in the UNCLOS to prevent, control, and reduce pollution of the marine environment from ocean acidification. Put differently, implicit in this concern is a suggestion that the UNFCCC’s commitments might fall short in counteracting ocean acidification (Scott 2020). This underlines the need for a comprehensive reexamination of the effectiveness of the UNFCCC’s commitments from the perspective of the ocean regime regarding ocean acidification.

The ongoing dialogue between the climate change regime and the ocean regime could lead to both refining the UNFCCC’s commitments and crystalizing due diligence obligations in the UNCLOS. In essence, the detailed interpretation of due diligence obligations in the UNCLOS hinges on the dynamic interaction of the climate change

regime and the ocean regime. The Paris Agreement undoubtedly offers the criteria for due diligence obligations, requiring States to align with Part XII of the UNCLOS regarding marine pollution from GHG emissions, notably CO<sub>2</sub> emissions. Indeed, the Paris Agreement establishes an obligation of due diligence to develop necessary measures. Key commitments within the Paris Agreement, such as the 2°C temperature goal and the principle of progression, could serve as the standard of conduct within the UNCLOS (Klerk 2022).

Furthermore, it is crucial to explore the nature and extent of harm caused by States in circumstances where due diligence obligations do not exist. The absence of due diligence obligations does not necessarily imply that States have *carte blanche* in their activities. Rather, activities involving higher risks, according to the ITLOS (ITLOS 2011, para. 117), necessitate a more stringent threshold of due diligence. From this perspective, the precautionary principle, which is seen as an essential component of due diligence obligations, could have a significant ramification when it comes to addressing ocean acidification challenges. According to Rio Declaration Principle 15, the precautionary approach asserts that cost-benefit measures to prevent environmental degradation should not be postponed due to the lack of complete scientific certainty, especially when confronted with threats of serious or irreversible damage (UNGA, 1992). This perspective is supported by the ITLOS. The ITLOS found that “the precautionary approach is also an integral part of the general obligation of due diligence” (ITLOS 2011, para. 131).

The precautionary principle seeks to offer effective environmental protection by advocating proactive responses to potential environmental threats in the face of scientific uncertainties (Jaeckel 2017). Within the ocean regime, the precautionary principle is generally used to navigate issues like marine pollution control and fisheries in the broader realm of international marine environmental protection (Gullett 2021). The harmful effects of ocean acidification on fisheries, in particular, highlight the significance of utilizing the precautionary principle in the context of regional fisheries management organizations (Rayfuse 2021). Since the detrimental impacts of climate change are so tangible, it might be argued that the precautionary principle could not be the most effective tool in tackling the challenges posed by climate change (Heinzerling 2007). Nonetheless, given the significant scientific uncertainty about

the long-term cumulative effects of climate change (Klerk, 2022), it is critical to apply the precautionary principle, especially when tackling the challenges of the climate change-ocean nexus within the governance of ocean acidification.

Given that Articles in Part XII of the UNCLOS articulate due diligence obligations, it is reasonable to argue that States should take into account the precautionary principle when taking necessary measures to comply with their due diligence obligations. Crucially, when contextualized within due diligence obligations, the precautionary principle requires States to take even minimal yet necessary measures to protect the environment. When applied to ocean acidification governance, this rationale could serve as a compelling ground for States to at the very least comply with the Paris Agreement, with a focus on reducing GHG emissions, notably CO<sub>2</sub> emissions. In fact, the precautionary principle in the context of due diligence obligations could bridge the gaps created by both the climate change regime and the ocean regime. In simpler terms, the application of the precautionary principle could answer the question of whether the climate change regime, including the UNFCCC, the Kyoto Protocol, and the Paris Agreement, should comply with due diligence obligations in Articles of Part XII of the UNCLOS, which are beyond the climate change regime’s own domain.

Given the difference between the obligations of the Paris Agreement and those of Part XII of the UNCLOS, the significance of the precautionary principle is accentuated. The difference in obligations between the climate change regime and the ocean regime is the main source of a prevailing concern that full compliance with the Paris Agreement alone could not guarantee comprehensive protection of the marine environment. To rephrase, even with full compliance with the Paris Agreement, States might fall short of fulfilling their due diligence obligations under the UNCLOS. This underscores the precautionary principle’s pivotal role in requiring States to take necessary measures that might go beyond the requirements of the climate change regime. In essence, applying the precautionary principle would underline the necessity for States to scrutinize the negative repercussions of climate change on the marine environment and comply with their due diligence obligations under Part XII of the UNCLOS. Article 207(5) of the UNCLOS suggests the feasibility of introducing a more stringent standard of conduct regarding

the release of persistent harmful substances, including CO<sub>2</sub>. Drawing from this Article, it could be claimed that the UNCLOS could impose a more rigorous standard of conduct, requiring States to undertake specific measures that go beyond their commitments under the Paris Agreement, particularly when channeling the precautionary principle towards reducing GHG emissions, including those of CO<sub>2</sub>.

## 5. Conclusion

While climate change does not directly cause ocean acidification, the two are indisputably related. The widespread effects of ocean acidification on marine environments, ecosystems, and even humans highlight the critical need for multifaceted efforts to prevent and mitigate ocean acidification. As an issue that spans both the climate change regime and the ocean regime, it stands to reason that these two regimes will take the lead in tackling the concerns of ocean acidification. Yet, neither the climate change regime nor the ocean regime prioritizes ocean acidification difficulties; as a result, neither regime provides appropriate answers to ocean acidification problems.

The lack of an international law specifically addressing ocean acidification might explain the apparent silence of international law on the difficulties of ocean acidification. Consequently, a fundamental question could arise: How should international legal efforts be directed to adequately address ocean acidification? The simplest way is to make a new international law dedicated to ocean acidification. However, given the time-consuming issues associated with international law-making, this might not be a viable option. In this scenario, it appears more feasible to build a governance framework based on existing international laws. To effectively address the difficulties of ocean acidification, ocean acidification governance should be founded on a thorough understanding of the strengths and shortcomings of its primary constituent regimes.

While the climate change regime aims to reduce GHG emissions, CO<sub>2</sub> emission reductions are not given top priority. As a result, to become an integral part of ocean acidification governance, the climate change regime should take a more serious stance toward CO<sub>2</sub> emission reductions. The ocean regime, on the other hand, mainly explores ocean acidification challenges in light of the pollution-oriented perspective. The ocean regime's stance toward

ocean acidification in this way might undermine its efficacy in ocean acidification governance. Additionally, when tackling the challenges of ocean acidification, it is important to thoroughly examine the potential challenges that both the climate change regime and the ocean regime might pose within the context of the regime complex.

In this context, an active mutual reference between the climate change regime and the ocean regime in terms of ocean acidification governance is critical, especially given the lack of a dedicated international legal framework tackling concerns about ocean acidification. Through active mutual reference, both the climate change regime and the ocean regime could require States to take necessary measures that might be challenging to advocate within their respective regimes. Furthermore, the potential significance of due diligence obligations should be highlighted. Various Articles in Part XII of the UNCLOS represent due diligence obligations, and these obligations could be used to address ocean acidification. However, the contents of due diligence obligations under these Articles require clarity. In this context, support from the climate change regime is indispensable for elaborating on the contents of due diligence obligations. Through this interaction, ocean acidification governance could enhance its capability to combat ocean acidification more effectively.

More crucially, a whole different approach to combating ocean acidification is required in the field of international law. In essence, ocean acidification, which is closely linked to global warming, has its roots in human activity, particularly since the beginning of the Industrial Revolution. Current harsh criticisms of international law highlight the injustice to the environment that the Anthropocene has brought about. In this regard, there are growing voices advocating that international law should play a critical role in ushering in the post-Anthropocene era, which prioritizes the protection of Earth's environment as a whole, which has been threatened by human activity. If the problems related to ocean acidification could be properly addressed by international law, international law might be deemed the key contributor to the start of the post-Anthropocene epoch. International law in the Anthropocene era is currently confronting a formidable foe from both the atmosphere and the oceans. Failure to address ocean acidification implies the complete oxidation of international law *per se*.

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