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Climate Change Impacts on the Ocean: A Study with Special Reference to the 1982 UNCLOS, Sea-Level Rise and Maritime Boundaries

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ABSTRACT

The 1982 United Nations Convention on the Law of the Sea was adopted before climate change became a central concern of international environmental law, and it is not a climate treaty. Its provisions on the protection of the marine environment nevertheless supply a working framework for climate-related marine harm, and the 2024 Advisory Opinion of the International Tribunal for the Law of the Sea has strengthened that link by recognizing that anthropogenic greenhouse-gas emissions can constitute pollution of the marine environment within the meaning of the Convention. This paper examines what accelerating sea-level rise means for that framework. It traces the physical drivers of sea-level change, distinguishing global mean rise from local relative change produced by subsidence, sedimentation, tectonic activity and coastal morphology, and sets out the environmental, economic and human consequences, including displacement from low-lying States and the gap in international protection that leaves climate migrants outside existing refugee law. It then turns to the questions that matter most for the law of the sea: whether retreating coastlines and disappearing reef features unsettle baselines, maritime zones and statehood itself. The paper argues that the decisive distinction is between baselines and established boundaries. Baselines follow physical geography; boundaries fixed by agreement or adjudication do not, and the Bay of Bengal arbitration supports their stability. Reconciling physical change with legal certainty is the central task for maritime governance.

Keywords: 1982 UNCLOS, Climate Change, Coastal Communities, Sea-Level Rise

I. INTRODUCTION

Climate change is increasingly transforming the marine and coastal environment through ocean warming, melting glaciers and ice sheets, coastal erosion, ocean acidification and accelerating sea-level rise. These changes have significant environmental, social, economic and legal

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consequences, particularly for low-lying coastal States and Small Island Developing States (SIDS). At the same time, coastal communities face increasing risks to settlements, infrastructure, freshwater resources, fisheries and livelihoods, among others. Moreover, climate-induced geographical changes also raise complex questions concerning maritime baselines, maritime zones, territorial sovereignty and international boundaries.

The 1982 United Nations Convention on the Law of the Sea (UNCLOS) was adopted before climate change became a central issue of international environmental law. It is not a climate change treaty; nevertheless, its broad provisions concerning the protection of the marine environment provide an important legal framework for addressing several consequences of climate change. It is important to note that Part XII of the 1982 UNCLOS, and particularly Articles 192 and 194, establishes obligations upon States to protect and preserve the marine environment and to prevent, reduce and control marine pollution.¹

Furthermore, a major development occurred in 2024 when the International Tribunal for the Law of the Sea (ITLOS), in its Advisory Opinion concerning climate change and international law, recognized that anthropogenic greenhouse-gas emissions can constitute pollution of the marine environment within the meaning of UNCLOS, which significantly strengthens the relationship between the law of the sea and international climate law.²

Sea-level rise presents a particularly difficult legal problem, as the geographical features upon which maritime entitlements are based may change, retreat or disappear, while international law attaches considerable importance to the stability and finality of maritime boundaries. Coral reefs, low-lying islands, beaches and coastal formations may be affected by rising seas, erosion and ocean warming. The resulting tension is between the physical dynamism of the coast and the legal need for certainty and stability, including the grave challenges faced by climate migrants who are environmentally displaced.

The 2014 *Bay of Bengal Maritime Boundary Arbitration* between Bangladesh and India is particularly important in this context.³

This research paper examines the relationship between climate change and the international law of the sea. It focuses on UNCLOS and climate change, protection of the marine environment, shipping emissions, the physical causes and consequences of sea-level rise, reef baselines,

¹ United Nations Convention on the Law of the Sea arts. 192, 194, 197, 204–06, Dec. 10, 1982, 1833 U.N.T.S. 397.

² *Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law*, Advisory Opinion, Case No. 31, ¶¶ 161–79, 385–400, 441 (Int'l Trib. L. Sea May 21, 2024), https://www.itlos.org/fileadmin/itlos/documents/cases/31/Advisory_Opinion/C31_Adv_Op_21.05.2024_orig.pdf.

³ *Bay of Bengal Maritime Boundary Arbitration (Bangladesh v. India)*, Award, PCA Case No. 2010-16, ¶¶ 216–17 (Perm. Ct. Arb. July 7, 2014), 32 R.I.A.A. 1, https://legal.un.org/riaa/cases/vol_XXXII/1-182.pdf.

maritime boundaries, Arctic coastal change and adaptation strategies including seawalls, managed retreat, and floating structures. It argues that the principal challenge for contemporary international law is to reconcile changing physical geography with stable maritime entitlements and peaceful international relations.

II. 1982 UNITED NATIONS CONVENTION ON THE LAW OF THE SEA (UNCLOS) AND CLIMATE CHANGE

UNCLOS was adopted in 1982, when the scientific and political understanding of anthropogenic climate change was considerably less developed than it is today. The Convention therefore contains no express provisions dealing with greenhouse-gas emissions, climate-induced sea-level rise, ocean acidification, climate-induced migration or the long-term preservation of maritime entitlements affected by geographical change. However, the absence of express climate provisions does not make UNCLOS irrelevant to climate change. Part XII requires States to protect and preserve the marine environment and to take measures to prevent, reduce and control pollution.

Article 192 provides a general obligation to protect and preserve the marine environment, while Article 194 requires States to take all necessary measures to prevent, reduce and control pollution from any source. Articles 197 and 204–206 further emphasize international cooperation, monitoring and environmental assessment.⁴

Climate change illustrates why such a broad obligation is necessary. Ocean warming changes marine ecosystems and species distributions. Ocean acidification threatens organisms that depend upon calcium carbonate structures. Rising temperatures contribute to coral bleaching. Deoxygenation affects marine biodiversity, and sea-level rise increases coastal flooding, erosion and saltwater intrusion.

The principle of due diligence is particularly important here, as climate change creates risks of serious and potentially irreversible harm. States must therefore establish appropriate laws, regulatory systems, monitoring mechanisms and environmental standards to prevent or reduce climate-related marine harm. Climate change can affect not only environmental resources but also territorial integrity, economic survival and access to marine resources. A small island State may depend heavily upon fisheries, tourism and maritime resources while simultaneously facing the possibility of losing coastal land and freshwater resources.

⁴ UNCLOS, *supra* note 1, arts. 192, 194, 197, 204–06.

III. SEA-LEVEL RISE AND ITS DRIVING FORCES

Sea-level change is a complex physical phenomenon resulting from interactions between the ocean, atmosphere, cryosphere and land. It is necessary to distinguish global mean sea-level rise from relative sea-level rise at a particular location.

Relative sea level may be affected by vertical land movement, subsidence, sedimentation, tectonic activity, tides and regional ocean dynamics. Consequently, two coastal locations may experience substantially different rates of relative sea-level change even when global mean sea level is rising at a common rate.

A. Ocean Warming and Thermal Expansion

Ocean warming is one of the major contributors to global sea-level rise. As seawater warms, its density decreases and its volume expands. This process is known as thermal or steric expansion. The oceans absorb most of the excess heat associated with anthropogenic climate change. Thermal expansion therefore contributes significantly to observed sea-level rise and demonstrates that sea level can continue increasing even without additional water from melting land ice.⁵

B. Melting of Glaciers and Ice Sheets

Another major contributor is the addition of water from land-based ice. Glaciers and the Greenland and Antarctic ice sheets lose mass as temperatures rise and contribute additional water to the oceans.

The scale of future sea-level rise will depend substantially upon future greenhouse-gas emissions and the response of ice sheets. Importantly, sea-level rise will continue for centuries to millennia because the ocean and cryosphere respond slowly to changes in global temperature.⁶

C. Anthropogenic and Local Factors

Human activity also influences relative sea level locally. Groundwater and hydrocarbon extraction can cause land subsidence. Dams can reduce sediment delivery to deltas. Coastal reclamation and hard engineering can alter sediment transport and coastal morphology.

Thus, sea-level rise should not be treated as a uniform global process. Global climate change interacts with local geological, hydrological and human factors.

⁵ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS ch. 9 (Valérie Masson-Delmotte et al. eds., Cambridge Univ. Press 2021), <https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-9/>.

⁶ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 5, ch. 9.

D. Spatial and Temporal Variability

Sea level varies spatially and temporally because of ocean circulation, atmospheric pressure, winds, tides, storms and climate variability such as the El Niño–Southern Oscillation.

A relatively modest increase in mean sea level can nevertheless have major consequences for extreme events. Storm surges and high tides occur on top of an already elevated sea level, meaning that previously rare flooding events can become increasingly frequent.⁷

E. IPCC Findings and Acceleration of Sea-Level Rise

The IPCC's *Climate Change 2021: The Physical Science Basis* provides strong evidence of accelerating global mean sea-level rise.

The estimated average rates of global mean sea-level rise over successive periods were as follows:

Period	Average GMSL rise
1901–1971	1.3 mm/year
1971–2006	1.9 mm/year
2006–2018	3.7 mm/year

The rate during 2006–2018 was therefore almost three times the rate during 1901–1971.⁸

The IPCC estimated that global mean sea level rose by approximately 0.20 metres between 1901 and 2018 and concluded that twentieth-century sea-level rise was faster than during any preceding century in at least 3,000 years.⁹

Sea-level rise is therefore a long-term legal and governance issue. Even if temperatures eventually stabilize, sea levels will remain elevated for thousands of years. This creates a direct tension with the stability traditionally associated with territorial and maritime arrangements.

F. Impacts of Sea-Level Rise

Sea-level rise produces interconnected environmental, economic, social and legal consequences.

First, it increases coastal flooding and inundation. Areas that historically experienced flooding only during exceptional storms may face recurrent flooding.

⁷ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *CLIMATE CHANGE 2022: IMPACTS, ADAPTATION AND VULNERABILITY* (Hans-Otto Pörtner et al. eds., Cambridge Univ. Press 2022), <https://www.ipcc.ch/report/ar6/wg2/>; INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 5, ch. 9.

⁸ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 5, Summary for Policymakers A.1.7, https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf.

⁹ INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 5, Summary for Policymakers A.1.7, A.2.4.

Second, it increases coastal erosion. Higher water levels allow waves and storm surges to reach farther inland, affecting beaches, dunes, barrier islands and permafrost coastlines.

Third, sea-level rise causes saltwater intrusion into groundwater systems. This is particularly serious for low-lying islands and coastal agricultural regions.

Fourth, coastal ecosystems are threatened. Mangroves, salt marshes, wetlands, seagrass meadows and coral reefs may be damaged by rising seas and changing environmental conditions.

Fifth, ports, airports, roads, pipelines and other infrastructure face increasing risks. Coastal economies are particularly exposed because economic activity is often concentrated close to the sea.

Sixth, sea-level rise can contribute to displacement and relocation. Where adaptation becomes technically or economically impossible, communities may have to move inland or to new locations. Kiribati, Tuvalu and Vanuatu are among the most frequently cited examples of States whose continued habitability is under threat.

Finally, sea-level rise creates important questions concerning maritime baselines and jurisdiction. If coastal features move or disappear, uncertainty may arise concerning the maritime zones measured from them.

IV. CLIMATE-INDUCED MIGRATION AND THE CHALLENGES FACED BY VULNERABLE COASTAL STATES

One of the most significant human consequences of sea-level rise is climate-induced displacement and migration. Rising sea levels, coastal erosion, recurrent flooding, saltwater intrusion, declining freshwater availability and the degradation of fisheries and agricultural land can progressively undermine the conditions necessary for human settlement. Unlike sudden-onset disasters such as cyclones or tsunamis, sea-level rise often produces slow-onset displacement, in which communities may gradually lose habitable land and economic opportunities. Climate-induced mobility may therefore take several forms, including temporary displacement, internal migration, planned relocation and, in extreme circumstances, cross-border migration.

The problem is particularly acute for low-lying Small Island Developing States (SIDS) such as Tuvalu, Kiribati and Vanuatu, as well as highly vulnerable coastal States such as Bangladesh. These States demonstrate different dimensions of the relationship between climate change, human mobility and international law.

A. Climate Migrants and the Protection Gap in International Law

The term “climate migrant” is widely used to describe people who move because environmental changes associated with climate change adversely affect their homes or livelihoods. However, the term does not itself create a specific legal status under international law.

The 1951 Convention Relating to the Status of Refugees generally requires a well-founded fear of persecution on specified grounds. Consequently, a person who leaves Tuvalu, Kiribati, Vanuatu or Bangladesh solely because of sea-level rise will not automatically qualify as a refugee under the Convention.

This creates an important protection gap. A person may be unable to safely return to a severely degraded environment but may nevertheless lack the legal status traditionally associated with refugees. International human-rights law may provide certain forms of protection against removal in circumstances where return would expose an individual to serious risks, but it does not presently establish a comprehensive international legal regime governing all forms of climate-induced migration.

The problem becomes even more complicated where an entire community is gradually displaced. International law has traditionally been structured around individuals crossing international borders rather than the collective relocation of communities whose territory is becoming uninhabitable.

Sea-level rise has become an important issue for the international law of the sea. Changes in coastlines and coastal features may raise questions concerning baselines and maritime zones, while established maritime boundaries require stability and certainty.

India’s experience also demonstrates that climate change should not be treated solely as an environmental problem. Mumbai, Kolkata, Chennai, Gujarat and the Sundarbans show that sea-level rise can affect territory, infrastructure, economic activity, livelihoods, migration and maritime interests simultaneously.^{10,11}

Accordingly, India’s experience supports the argument that international law should preserve established maritime boundaries while encouraging climate-resilient coastal planning, scientific monitoring, ecosystem protection and international cooperation.

¹⁰ WORLD BANK GROUP, TOWARDS RESILIENT AND PROSPEROUS CITIES IN INDIA (2025), <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099052225091510119>.

¹¹ Rabin Chakraborty et al., *Impact of Climate Change Scenario on Sea Level Rise and Future Coastal Flooding in Major Coastal Cities of India*, 15 SCI. REP. 28689 (2025), <https://doi.org/10.1038/s41598-025-13394-5>.

V. STATEHOOD, SOVEREIGNTY AND MARITIME ENTITLEMENTS

Traditional concepts of statehood are generally associated with territory, population, government and capacity to enter into international relations. Sea-level rise raises the possibility that a State could lose significant portions of its habitable territory while its population, government and international identity continue to exist.

This creates an unprecedented legal question. If a low-lying island becomes permanently submerged or uninhabitable, should its people lose their nationality, its government lose its international personality, and its maritime zones disappear automatically?

There is increasing international support for the proposition that climate-induced physical changes should not automatically extinguish previously established maritime entitlements. The work of the International Law Association and subsequent developments in international law support greater stability and predictability concerning maritime zones affected by sea-level rise. The 2014 Bangladesh–India arbitration is also significant because the Tribunal rejected the idea that climate change should undermine an already established maritime boundary.

The issue is particularly important for SIDS because maritime zones can be many times larger than their land territory. Exclusive economic zones provide access to fisheries, seabed resources and other economic opportunities. Losing maritime entitlements because of climate-induced physical changes could therefore compound the economic consequences of territorial loss.

VI. CLIMATE MIGRATION AND INTERNATIONAL RESPONSIBILITY

The experiences of Tuvalu, Kiribati, Vanuatu and Bangladesh also raise questions of international equity. States that are highly vulnerable to sea-level rise are often not responsible for a proportionate share of historical greenhouse-gas emissions. Nevertheless, they may face substantial costs associated with adaptation, displacement, relocation and loss of territory.

The principle of international cooperation is therefore particularly important. Climate finance, technology transfer, disaster-risk reduction, capacity building and planned migration pathways can assist vulnerable States in responding to climate impacts.

VII. CORAL REEFS AND MARITIME BASELINES

Coral reefs raise some of the most difficult legal questions concerning climate change and maritime entitlements.

Article 6 of the 1982 UNCLOS provides that, in the case of islands situated on atolls or islands having fringing reefs, the baseline for measuring the breadth of the territorial sea is the seaward low-water line of the reef.¹²

This provision is particularly significant for island States whose maritime zones depend upon reef systems. Climate change threatens coral reefs through ocean warming, acidification and sea-level rise. Coral bleaching and reduced calcification can undermine reef structures.

Two questions therefore arise. First, can coral reefs continue growing sufficiently quickly to keep pace with sea-level rise? Second, if a reef becomes submerged or significantly changes, should the baseline move with it?

UNCLOS does not provide a comprehensive answer. Article 5 defines the normal baseline by reference to the low-water line, suggesting an ambulatory physical relationship. However, the Convention does not expressly state whether a baseline that has already been established and publicised must continuously be recalculated.

The International Law Association's 2018 work on sea-level rise recommended that properly established baselines and maritime-zone limits should not necessarily have to be recalculated merely because subsequent sea-level change alters the geographical reality.¹³

This approach attempts to reconcile geographical reality with legal stability. It is particularly important for SIDS because the disappearance of reef-based features could otherwise result in a significant loss of maritime jurisdiction and resources.

VIII. MARITIME BOUNDARIES AND THE PRINCIPLE OF STABILITY

The most significant legal issue is whether an established maritime boundary should change when the physical coast changes. International law places considerable importance on the stability and finality of boundaries. Article 62(2)(a) of the Vienna Convention on the Law of Treaties provides that fundamental change of circumstances cannot generally be invoked to terminate or withdraw from a treaty establishing a boundary.¹⁴

Although the provision principally concerns treaty-based boundaries, it reflects a wider principle of stability in territorial arrangements. The distinction between a baseline and a maritime boundary is therefore crucial. A baseline may potentially be affected by changing

¹² UNCLOS, *supra* note 1, art. 6.

¹³ INTERNATIONAL LAW ASSOCIATION, INTERNATIONAL LAW AND SEA LEVEL RISE: REPORT OF THE COMMITTEE ON INTERNATIONAL LAW AND SEA LEVEL RISE (2018); INT'L LAW ASSOCIATION, Res. 5/2018, International Law and Sea Level Rise (2018), https://www.ila-hq.org/en_GB/documents/conference-resolution-sydney-2018-english-2.

¹⁴ Vienna Convention on the Law of Treaties art. 62(2)(a), May 23, 1969, 1155 U.N.T.S. 331.

geography, whereas a maritime boundary established by agreement or adjudication may enjoy a much stronger claim to permanence.

A. *Bangladesh v. India* Arbitration

The *Bay of Bengal Maritime Boundary Arbitration* between Bangladesh and India provides particularly important authority.

In its 2014 Award, the Tribunal emphasized the need for maritime boundaries to be stable and definitive. It also expressly considered climate change and concluded that neither the prospect of climate change nor its possible effects should jeopardize settled maritime boundaries.¹⁵

The Award supports a three-part distinction:

1. Physical coastline: may change because of erosion, accretion and sea-level rise.
2. Baseline: may raise questions concerning whether it is ambulatory or fixed.
3. Established maritime boundary: should generally remain stable once lawfully determined.

This distinction is extremely important. A State could potentially experience substantial physical territorial loss while retaining a maritime boundary established through agreement or adjudication. The principle of stability serves important purposes. Maritime boundaries determine access to fisheries, hydrocarbons, minerals, seabed resources and other economic activities, and constantly shifting boundaries could create uncertainty and increase the likelihood of international disputes. A State that loses substantial territory because of sea-level rise may retain maritime rights even after the physical features supporting the original entitlement have disappeared. This demonstrates the need for international cooperation and clear legal rules.

IX. A NEED FOR LEGAL AND POLICY CHALLENGES

The central challenge for international law is to reconcile two apparently competing objectives: accommodating physical change and preserving legal certainty.

The first requirement is legal stability. Properly established maritime boundaries should generally remain stable so that States can rely upon them.

The second requirement is environmental protection. States must prevent and reduce climate-related harm to the marine environment under UNCLOS.

¹⁵ *Bay of Bengal Maritime Boundary Arbitration (Bangladesh v. India)*, *supra* note 3, ¶¶ 216–17.

The third requirement is scientific monitoring. Changes in coastlines, reefs, sea levels and marine ecosystems must be continuously observed.

The fourth requirement is international cooperation. No State can address sea-level rise entirely through unilateral action. Coastal processes frequently affect neighbouring States, while greenhouse-gas emissions have global consequences.

Finally, international law must address the special vulnerability of SIDS and low-lying coastal States.

X. CONCLUSION

Climate change is testing the capacity of international law to reconcile stable legal arrangements with rapidly changing physical geography. Although UNCLOS was adopted in 1982 and was not drafted as a climate treaty, its environmental provisions provide a strong legal foundation for addressing climate-related marine harm.

The 2024 ITLOS Advisory Opinion represents a major development, and by recognizing that anthropogenic greenhouse-gas emissions can constitute pollution of the marine environment, ITLOS strengthened the connection between UNCLOS and international climate governance. Articles 192 and 194 consequently have considerable importance in responding to climate-related marine environmental harm.^{16,17}

Sea-level rise creates equally significant challenges. It results from thermal expansion, melting land ice and other processes, while local relative sea-level change is influenced by subsidence, sedimentation, tectonic activity and coastal morphology. Its consequences include flooding, erosion, saltwater intrusion, ecosystem degradation, infrastructure damage and human displacement.

The most difficult legal question concerns the relationship between changing coastlines and stable maritime entitlements. Coral reefs, low-lying islands and coastal features may change or disappear, potentially affecting baselines. However, the 2014 Bangladesh–India arbitration strongly supports the stability of established maritime boundaries. This distinction between physical geography, baselines and established boundaries provides an important foundation for future international legal development.¹⁸

¹⁶ *Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law*, *supra* note 2, ¶¶ 161–79, 385–400, 441.

¹⁷ UNCLOS, *supra* note 1, arts. 192, 194, 197, 204–06.

¹⁸ *Bay of Bengal Maritime Boundary Arbitration (Bangladesh v. India)*, *supra* note 3, ¶¶ 216–17.

Ultimately, sea-level rise is not merely an environmental or engineering problem. It is a question of sovereignty, jurisdiction, environmental protection, human security, economic survival and the stability of the international legal order. The future of maritime governance will depend upon maintaining a careful balance between physical change and legal certainty, supported by UNCLOS, specialized treaties, international adjudication, scientific evidence and international cooperation.
