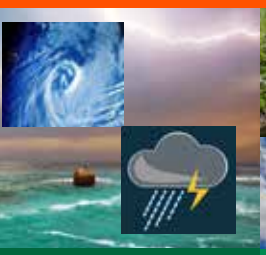
Assessing Progress on Ocean and Climate Action: 2024-2025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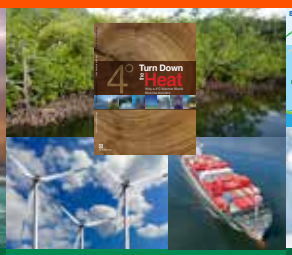

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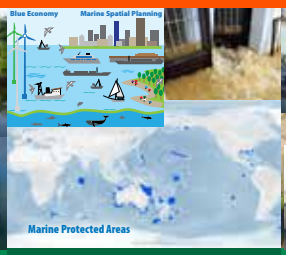

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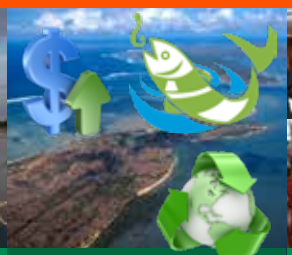
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Assessing Progress on Ocean and Climate Action: 2024-2025

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November 2025

Collaborating Organizations

Foreword

The 2024–2025 edition of the Assessing Progress on Ocean and Climate Action (ROCA) report is a collaborative, multi-organizational effort. This iteration involved 68 authors from 44 organizations, bringing together diverse expertise to provide multidisciplinary updates on sectoral and stakeholder initiatives in science, policy development, financing, and other cross-cutting efforts related to ocean and climate action. A crucial resource for Party negotiators and non-Party stakeholder representatives attending the 30th Conference of the Parties (COP 30) to the UNFCCC, this report offers the latest updates on recent initiatives. It comprehensively takes stock of progress in implementing the ocean and climate agenda at the COP, across other global policy platforms and processes, and through regional and national initiatives. Furthermore, the ROCA report identifies gaps in information and policy that require attention and provides recommendations for future action.

This volume explores the pivotal role of oceans in climate change. It reports on the use of ocean-based mitigation and adaptation approaches, fostering the use of "blue carbon" policies and Nature-based Solutions (NbS) to address climate change challenges; the use of low-carbon Blue Economy; addressing human displacement; and ensuring adequate financial flows and capacity development. Key updates are featured, including, among others, reports on:

- The Ocean and Climate Change Dialogues (2024 and 2025) and Ocean Breakthroughs;
- Two main avenues for countries to produce and trade credits under the Paris Agreement (Article 6.2 and 6.4);
- Integrating ocean-based climate solutions into NDCs;
- 2025 measures to implement decarbonization commitments under the 2023 IMO GHG Strategy ("IMO Net-Zero Framework");
- A regional focus on developments in Latin America (the COP30 host region); and
- Progress in marine areas beyond national jurisdiction (ABNJ), notably, the BBNJ Agreement reaching the 60 ratifications required for entry into force.

This report showcases the successful, continuing cross-sectoral initiatives envisioned by the Global Ocean Forum founding partners to promote sound ocean governance, healthy marine ecosystems, and sustainable development. A cornerstone of this work is maintaining our global network of partners. Issued biennially by the GOF and its partners, this publication continues the legacy of the original Roadmap to Oceans and Climate Action (ROCA) initiative. This report was organized by Miriam Balgos, Catie Mitchell and Peter Ricketts, the report's lead author. In addition to the co-authors, the report benefited from the assistance and contributions of the following collaborators: Alexis Maxwell (Volume Editor), Erinn Bell (2025 Dr. Biliana Cicin-Sain Ocean and Climate Change Intern, Research Assistant), and Kevin McLaughlin (Graphic Designer). The following individuals also provided invaluable insights during the preparation of the report: Joe Appiott, Fernando Cabrera, and Valentina Germani.

Richard Delaney
President, Global Ocean Forum Board of Directors

Executive Summary

Introduction

The 2024-2025 ROCA Report comes at a critical time when ocean health is facing unprecedented stress, and our planet is moving toward key tipping points, namely, the 1.5ºC Paris target. Since the last ROCA Report was presented at COP28 in Dubai, each year (2023 and 2024) has exceeded a global average temperature increase of 1.5ºC above pre-industrial levels. The impacts of human-induced climate change have accelerated as global average temperatures continue to rise, and there are more frequent and intense extreme events. Exceeding the 1.5°C threshold of global warming in the near-term will severely limit climate resilient development. Action must be taken now through international cooperation among governments at all levels and with communities, civil society, academia, media, investors, businesses, youth, and historically marginalized groups. In the face of ongoing climate impacts, there is growing public awareness and international recognition of the ocean as a critical life support system for our planet and as fundamental for climate regulation. Bold and innovative measures are needed to raise ambition on ocean-climate action to protect ocean health, provide sufficient and predictable financing, increase capacity-building, and reduce poverty.

The Impacts of Climate Change on the Ocean Today

- The health of the ocean is deteriorating at an accelerating rate. Recent scientific evidence is alarming, with the following key messages emerging from the 2024-2025 ROCA Report:
    - Annual average sea surface temperatures (SST) over the extra-polar ocean reached a record high of 20.87°C in 2024, while also reaching record values in the North Atlantic, Western Pacific and the Indian Ocean;
    - Annual minimum and maximum extent of Antarctic sea-ice in 2024 were each the second lowest in the observed record (1979 to present), while Arctic sea ice extent reached the fifth lowest monthly extent in the satellite record at its annual minimum in September;
    - In 2024, ocean heat content reached the highest level in the 65-year observational record, the eighth successive year in which a new record has been set for ocean heat content. The rate of ocean warming over the past two decades (2005–2024) is now more than twice that observed over the 45-year period between 1960 and 2005;
    - Global mean sea level (MSL) in 2024 reached a record high in the satellite record (from 1993 to present), and the rate of global MSL rise in the past 10 years (2015–2024) was more than twice the rate in the first decade of the satellite record (1993–2002);
    - The steady decrease of global average ocean surface pH continued in 2023-2024 as it has over the past 29 years, and the 2025 Planetary Health Check Report concludes that the ocean is acidifying to an unsafe degree and assesses that for the first time the ocean acidification boundary has been transgressed;
    - Extreme weather events in 2024 led to the highest number of new displacements recorded in any year since 2008, with tropical cyclones being responsible for many of the highest impact events of 2024. In October 2025, Hurricane Melissa became the strongest hurricane ever to make landfall in Jamaica and one of the strongest ever in the Caribbean;
    - The 2025 Planetary Health Check Report states that ocean health is facing unprecedented stress due to the amount of excess heat absorbed by the ocean since the 1970s, which corresponds to approximately 89-93% of Earth's energy imbalance, and refers to the ocean as "the unsung guardian of planetary health";
    - Once rare, marine heatwaves are becoming more frequent, longer lasting, and more intense and are now devastating vulnerable ecosystems like coral reefs and kelp forests;
    - The ongoing global coral bleaching event, which began in January 2023, is the biggest to date, impacting 84.4% of the world's coral reef area across at least 83 countries. By 2025, records indicate over 80% of the world's coral reefs have been affected by bleaching events;

- Since 1970, the ocean's oxygen content has decreased by 1–3%, resulting in continued reduction of the resilience of the marine biosphere and the expansion of low-oxygen zones (so-called "dead zones"), and it is estimated that the ocean could lose about four times more over the coming centuries, even if greenhouse gas (GHG) emissions stopped today, with severe consequences for marine life; and
- In 2025, roughly one-third of assessed fish stocks are now overfished, with many populations falling below sustainable levels and apex predators disappearing from entire regions, impacting food security and livelihoods in ocean-reliant communities, particularly in low- and middle-income countries.

- With the UN Ocean Decade leading progress toward achieving societal awareness goals, there has been a growing focus on advancing science on the relationship between the ocean and society over the past two years, and numerous initiatives have arisen to support the call for addressing the need for integrating people and their attitudes, values and beliefs into the ocean-climate science-policy arena.

Meeting the Long-term Goals of the Paris Agreement

- According to the World Meteorological Organization (WMO) and other monitoring bodies, annual average global mean near-surface temperature for the single year of 2024 was 1.55°C above pre-industrial levels.
- There is now a 70% chance that average warming over the years 2025-2029 will exceed 1.5ºC, with estimates of current long run warming averaged over multiple years varying between 1.34 and 1.41ºC.
- The United Nations Environment Programme (UNEP) projects that even if all the current Nationally Determined Contributions (NDCs) and net zero pledges were to be met in full, warming would at best be just below 2°C by the end of the century.
- The role and importance of the ocean in global change is increasingly recognized across the broader scientific community, and as pressures compound and amplify each other, marine systems are pushed closer to their tipping points, or conditions beyond which recovery becomes uncertain or impossible.
- The latest predictions from the 2024 Emissions Gap Report put the world on course for a catastrophic rise of 2.6-3.1°C this century unless there are immediate and major cuts to GHG emissions.

The Ocean in the UNFCCC Process

- COP28 saw the largest number of ocean-related events and activities to date, both onsite with the focus being on the Ocean Pavilion and online through the Virtual Ocean Pavilion, and key ocean-related messages and decisions in the outcome statement included:
  - The Ocean Breakthroughs initiative was launched under the Marrakech Partnership for Ocean and Coastal Zones at COP28 with five ocean breakthrough themes being presented: marine conservation, ocean-based transport, aquatic food, coastal tourism, and ocean renewable energy;
  - The ocean and coasts were recognized as some of the strongest allies in the fight against climate change, holding significant mitigation and adaptation potential in addition to multiple co-benefits;
  - Parties were provided with the requested guidance necessary to increase their ambition and strengthen ocean and climate action, especially in the context of their national strategies and options to consider and integrate the ocean and coasts in the Global Stocktake (GST);
  - Building on the momentum generated at COP26 and COP27, the Loss and Damage Fund was finally operationalized, bringing in US$792 million in Parties' pledges; and
  - From 2024 onwards, future Ocean and Climate Change Dialogues will work towards informing national climate goals and the implementation of these goals.
- Although COP29's focus on finance and politics made it challenging to put the ocean on the main agenda, the 2024 Ocean and Climate Change Dialogue's submission was successfully presented and integrated into the final conference outcomes. Key results from COP29 include:
  - Significant setbacks in commitments to reducing climate emissions and to keeping average global temperature rise below the 1.5ºC Paris target, the result of which will be highly detrimental to the oceans;

- Adoption of the Baku Adaptation Plan (BAP), which aims to enhance global adaptation efforts, particularly focusing on the Global Goal on Adaptation (GGA), National Adaptation Plans (NAPs), and the integration of human development considerations into climate resilience strategies; and
- The Baku Workplan, which lays out a roadmap for action in three key areas: promoting knowledge exchange, building capacity for engagement, and integrating diverse knowledge systems into global climate strategies.

- In preparation for COP30, the 2025 Ocean and Climate Change Dialogue focused on three topics: 1) Ocean-based Measures in NDCs; 2) The Ocean under the GGA; and 3) Ocean-Climate-Biodiversity Synergies, plus cross-cutting themes focussing on Means of Implementation (particularly finance) and Ocean Science.
- Key points arising from the Dialogue include:
  - Promoting the urgency of the inclusion of ocean-based mitigation and adaptation measures in the new NDCs to collectively strengthen ocean-based climate ambition;
  - Including ocean-based mitigation and adaptation measures, targets, and policies with 74% of Parties doing so among the 23 new NDCs analyzed between 1 October 2024 and 5 May 2025, with ocean-based adaptation measures featured in 88% and ocean-based mitigation actions included in 41% of the recent NDCs;
  - Highlighting that the ocean should be a cross-cutting priority under the GGA and embedded across all relevant indicators, as it cuts across multiple thematic targets; and

Reaffirming the third United Nations Ocean Conference (UNOC3) outcomes on strengthening international cooperation and urging early ratification of the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement).

- The Ocean Breakthroughs have quickly emerged as a driving force to bring actors together and accelerate ocean–climate action, especially through the Mangroves, Seagrass, and Seaweed and the Coastal Tourism Breakthroughs, moving from high-level ambition to concrete targets now being operationalized with the support of governments, Indigenous Peoples, scientists, and civil society.
- Recognizing the persistent gap in ocean finance, the Ocean Breakthroughs contributed a dedicated appendix to the Ocean Investment Protocol (OIP) at the Blue Economy and Finance Forum in June 2025, and equity and justice have been placed firmly at the heart of the Breakthroughs.

The Interconnectivity of Climate and Biodiversity

- The growing recognition of the ocean is imperative to strengthen the synergies between climate and biodiversity that were noted in the 2022-2023 ROCA Report, and it has continued to gather momentum with the deliberations and outcomes of numerous important fora, such as the 2024 UN Ocean Decade Conference, the 2024 Conferences of the Parties (COP) to the Convention on Biological Diversity (CBD), the 17th round of the Informal Consultations of States-Parties to the 1995 UN Fish Stocks Agreement in 2024, and UNOC3.
- The Nice Action Plan and final declaration statement adopted by more than 170 countries attending UNOC3 is structured around a political declaration, entitled "Our ocean, our future: United for urgent action," and emphasizes the need for urgent action to protect the ocean and its resources, including commitments to conserving the ocean and its ecosystems, promoting sustainable ocean-based economies, and accelerating action.

Central Role of NDCs

As countries submit new and updated NDCs informed by the first GST, the international community enters a new phase, shifting from negotiation to delivery. This moment offers a vital opportunity to scale and embed ocean-based solutions more deeply into NDCs and the overall climate regime.

- Given the mitigation potential of ocean-based climate solutions, their integration into NDCs is still underrepresented. Initiatives such as "bluing the NDCs" provide opportunities to elevate the work of countries that have successfully incorporated ocean-based climate solutions as examples for others to follow.
- The Blue NDC Challenge calls on all countries to place the ocean at the heart of their climate plans ahead of

COP30, with an inaugural group of eight countries committing to include the ocean in their updated climate plans under the Paris Agreement or their accompanying implementation plans.

Mitigation

- The Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) has launched the Blue Carbon Program to help East Asian countries use their coastal blue carbon ecosystems for climate change mitigation. The program will support countries in overcoming challenges like monitoring, policy development, and financing by using public-private partnerships and carbon markets to fully realize the potential of these ecosystems for carbon sequestration and coastal protection.
- Following the 2023 International Maritime Organization (IMO) GHG Strategy, IMO member states have been working on measures to implement decarbonization commitments. Key regulatory measures known as the "IMO Net-Zero Framework" were approved in April 2025 by MEPC 83, but formal adoption was deferred during an extraordinary session of the Committee in October 2025.
- Unproven marine carbon dioxide removal (mCDR) approaches could pose significant risks to biodiversity, global ocean health, and livelihoods. In accordance with the precautionary principle, mCDR should not be considered a viable ocean-based climate solution until its risks are fully understood, regulated, and managed. COP30 must prioritize investment in nature-based, scientifically proven ocean solutions.
- Despite being a minor source of global emissions, the fisheries sector can implement various decarbonization measures to help achieve the 1.5°C climate goal by reducing carbon emissions along the value chain, including improving vessel energy efficiency and utilizing renewable energy sources.
- COP29 provided two main avenues for countries to produce and trade credits under the Paris Agreement: 1) Article 6.2, which provide accounting and reporting guidance for Parties to use internationally transferred mitigation outcomes towards their NDCs; and 2) Article 6.4, which establishes a new UNFCCC mechanism that can be used to trade high-quality carbon credits. Blue carbon activities could produce eligible carbon credits under Article 6.2 or 6.4 of the Paris Agreement as there are no restrictions on the types of eligible emissions reductions and removals.

National Adaptation Plans and the Ocean

- The Sharm Adaptation Agenda (SAA) produced its final report in 2024 and highlighted a number of key ocean developments, including the Ocean Breakthroughs; the UN Global Compact for developing an Ocean Investment Protocol (OIP) aimed at channeling coastal and ocean investments; the launch of the Ocean Resilience and Climate Alliance at COP28 in 2023 to secure US$300 million in funding for ocean cli-mate solutions; and the development of an Ocean Equity Index to integrate equity considerations. The SAA report also introduced an Early Adopter Kit for the High-Quality Blue Carbon Principles and Guidance and highlighted three prioritized outcomes regarding Mangroves, Coral Reefs, and Coastal City Protection.
- The UAE Framework for Global Climate Resilience was adopted at COP28 in Dubai in 2023 to guide the achievement of the GGA and the review of overall progress in achieving it, with a view to reducing the increasing adverse impacts, risks and vulnerabilities associated with climate change, as well as to enhance adaptation action and support.
- At COP29, the SAA was replaced by the Baku Adaptation Roadmap (BAR), which was adopted to provide a strategic path forward for achieving the GGA beyond COP30.
- Linked to the BAR, a significant outcome of COP29 was the Baku to Belém Roadmap. This focuses on scaling up climate finance for developing nations, with the goal of mobilizing at least US$1.3 trillion per year by 2035 from public and private sources.
- The 2024 UNEP Adaptation Gap Report was sub-titled "Come hell and high water" to emphasize the fact that climate change impacts are having increasingly intense and devastating effects on oceans and ocean communities, especially the poorest, as global average temperature rise approaches 1.5°C above pre-industrial levels.

Blue Economy and Ocean Finance

- A collective increase in financial commitments and innovative financing mechanisms for the blue economy from countries, multi-lateral banks, non-profits and private investors since COP28 and COP29 is promising for a shift from conceptualization to operationalization, and continued momentum at COP30 will be critical to fast-track this process.
- Securing sufficient public, private, and innovative funding for ocean and climate action is key for Small Island Developing Sates (SIDS) and ocean-reliant communities under worsening climate change. Current investments fall significantly short of the estimated US$550 billion annually required to secure long-term ocean health and a sustainable blue economy, and investment needs to meet key blue-economy-related targets by 2030 are as high as US$2.5 trillion.
- The NCQG on Climate is a key outcome from COP29, committing to mobilizing at least US$300 billion annually by 2035 for developing nations. This triples the previous US$100 billion target and sets broader ambition to scale up total climate finance to US$1.3 trillion per year from public and private sources.
- Innovative sources of ocean financing such as blue bonds, debt-for-nature swaps, and parametric insurance can deliver measurable climate benefits, support livelihoods, safeguard biodiversity, and strengthen coastal resilience. Financing sources must take a multi-faceted approach, be embedded in national systems, and be supported by development partners to deliver resilient, inclusive, and climate-smart ocean economies.

Population, Displacement and Climate Mobility

- The migration, displacement, and planned relocation of populations in coastal areas is one of the major social dynamics resulting from the impacts of worsening climate change, with approximately 3.3 to 3.6 billion people living in areas that are highly vulnerable to climate change with levels of vulnerability differing among and within regions.
- The number of new displacements due to disasters worldwide has increased to 45.8 million in 2024, and 21st century movements derived from future sea-level rise (SLR) scenarios under different socio-economic pathways could result in the coastal migration of 17-72 million people.
- Policy development on climate mobility has continued to advance, notably through its inclusion in eight negotiation tracks and several high-level segments at COP29, such as the new Fund for Responding to Loss and Damage. Climate mobility has also been amplified through signature initiatives such as the Baku Call for Climate Action and Baku Guiding Principles, Advisory Opinions of the International Court of Justice (ICJ) and Interamerican Court, and national level frameworks *(i.e.* NAPs and NDCs).

Capacity Development

- Empowering youth and civil society in ocean and climate governance is both an environmental and democratic imperative, and it is central to advancing intergenerational justice. This requires equipping communities and younger generations with the knowledge, skills, and mechanisms needed to meaningfully participate in decision-making and drive innovative, context-sensitive strategies.
- The role of communications in the ocean–climate nexus has evolved from showing the ocean solely as a victim of climate change to recognizing it as a critical part of the solution. Moreover, with the rise of misinformation and disinformation, building trust in science, transparency, and critical thinking have now become as important as amplifying scientific findings.
- Strengthening ocean literacy is necessary to ensure citizens are equipped with the tools needed to identify reliable sources, critically assess information, and navigate a rapidly evolving media landscape to mobilize citizens around ocean and climate issues.
- Climate impacts are experienced differently across genders, and climate policies should address the intersectionality between health, socioeconomic and environmental impacts on gender dimensions. As the representation of women in ocean and climate spaces increases, additional research and support is needed to

address data gaps and better understand and recognize the contributions, values, and voices of women and the role that they play in driving transformative environmental initiatives.

Climate and the BBNJ Agreement

- The BBNJ Agreement incorporates climate change considerations through mechanisms like strategic environmental assessments (SEAs) and new institutional arrangements and includes language emphasizing the critical role of the ocean in carbon sequestration, paving the way for potential collaborations between climate and biodiversity initiatives. The Agreement also provides a framework for capacity-building and technology transfer to assist developing countries in implementing its provisions. Now that the Agreement has reached the required threshold of ratifications and will enter into force on 17 January 2026, States and relevant stakeholders must rapidly begin preparation for implementation to unlock the Agreement's full potential for advancing ocean-climate action.

The Way Forward

- In 2024, the world crossed a critical climate threshold, with global temperatures exceeding 1.5°C above pre-industrial levels for the first time. The Global Tipping Points and Planetary Health assessments indicate multiple Earth systems are at or near critical thresholds, and the safe operating space limited by human pressure in seven of nine planetary boundaries has been exceeded. To reverse this trajectory, urgent, coordinated global action is essential. We must accelerate decarbonization, reduce methane and short-lived pollutants, responsibly scale up carbon removal, expand marine and coastal protection, and mobilize finance to undertake large-scale adaptation and ecosystem restoration. Partnership across all levels of government and sectors of society will need to be engaged.
- Key messages from COP30, UNOC3, and the 2025 Dialogue emphasize inclusive climate negotiations involving traditionally underrepresented groups, including youth and historically marginalized voices, scaled up investment in nature-based solutions, alignment of initiatives under the Ocean Breakthroughs framework, and enhanced institutional coordination. Given the urgency and scope of action needed to turn the tide, strong multilateral cooperation and scaled-up financing will be crucial to support adaptation in developing countries and SIDS, as well as to implement the historic BBNJ Agreement, on the threshold of entry into force.
- Looking ahead, a paradigm shift is needed – one that prioritizes collective action and places ocean protection at the heart of climate engagement. This entails scaling up nature-based solutions, securing sustainable finance, strengthening governance, and empowering frontline communities. Science-based decision-making, inclusive leadership, and bold international cooperation must drive this transformation. COP30 represents a crucial opportunity to catalyze collective action – the *Global Mutirão* – by leveraging knowledge, finance, governance, and the resilience of natural systems. As COP30 President André Aranha Corrêa do Lago urges, we must "transform the narrative... from fear to hope" and build a future shaped by cooperation, not catastrophe.

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1. INTRODUCTION

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The Roadmap to Oceans and Climate Action (ROCA) was a multi-stakeholder initiative spanning from 2016 to 2021 which encouraged and mobilized governments, international agencies, NGOs, scientific institutions, private sector, and subnational authorities to advance the ocean and climate agenda (especially in the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations (UN) Ocean Conference, and in other UN fora) in all countries.[1] The ROCA Initiative was first launched at COP22 in Marrakech in 2016, and the 2024-2025 volume will mark the sixth iteration of the report. The 2020-2021 report[2] that was presented at COP26 in Glasgow marked the completion of the original five-year project, and since then the Global Ocean Forum (GOF) has decided to continue to produce ROCA reports on a biennial basis, starting with the 2022-2023 report that was presented at COP28 in the UAE (Dubai) in 2023.[3] Each report builds upon the previous reports, creating a comprehensive and up-to-date assessment of the progress being made on oceans and climate change. This current report covers the years 2024-2025 and provides the latest update on recent initiatives while taking stock of the progress in implementing the ocean and climate agenda at the UNFCCC Conference of the Parties (COP), in other global policy platforms and processes, as well as looking at regional and national initiatives and examples. This ROCA report also attempts to identify gaps in information and policy that need to be addressed and makes recommendations for future action where possible.

For the first time, this ROCA Report includes a detailed section on the region in which the upcoming COP is being held. Annex 1 covers regional developments in oceans and climate change in Latin America. It is anticipated that future reports will include reports on the appropriate region or regions.

1.1 Purpose of the ROCA Report

Since the ROCA initiative was first adopted in 2016, there has been a growing international recognition of the ocean as a fundamental component of our climate system. The initial aim of the ROCA Initiative was to increase the focus on ocean issues at the UNFCCC, and to get oceans formally included and integrated into the UNFCCC negotiations. Up to and including COP25 in 2019, the ROCA reports were presented at the Ocean Action Days organized in the Blue Zone by the GOF and collaborating partners within the framework of the Marrakech Partnership for Global Climate Action. The achievement of the initial aim of the ROCA occurred at COP25 with the Chile/Madrid Time for Action statement[4] in which oceans were included in the formal negotiations with the directive (Article 31) to the Chair of the Subsidiary Body for Scientific and Technological Advice (SBSTA) to hold a formal dialogue on the ocean and climate change and report back to the next COP meeting. Following the hiatus due to the COVID-19 pandemic, this preliminary ocean and climate change dialogue was held virtually in June 2021 at the 55th Session of the SBSTA and the report was incorporated into the text of the COP26 outcome document Glasgow Climate Pact[5] which, among other directives, mandated an annual ocean and climate change dialogue starting at the 56th session of SBSTA in June 2022.

The first ocean and climate change dialogue report was presented to the COP27 meeting held in Egypt in November 2022, and the resulting Sharm el-Sheikh Implementation Plan6 called for the inclusion of technical capacity building and financing to advance the needs of the Parties regarding assessing risk and responding to changing ocean and coastal conditions in the face of ongoing climate change impacts. It also emphasized the need to address gaps in the global climate observing system, particularly in developing countries, and to enhance coordination of systematic observation activities.

The Sharm el-Sheikh Implementation Plan also recognized the growing evidence that the restoration and protection of ocean health is a significant component of both national and global strategies to respond to the impacts of climate change and encouraged Parties to include ocean-based action in the development and implementation of national climate goals, including their nationally determined contributions (NDCs), long-term strategies, and national Adaptation plans (NAPs). This has become a primary focus of a significantly increasing number of events organized around the ocean-climate nexus at UNFCCC COPs and other international fora.

The 2022-2023 ROCA Report recognized that real progress was being made in a number of key areas, including the development and implementation of nature-based solutions (NbS); the growth of the renewable energy sector; the expansion and impact of sustainable fishing practices; and the increasing rate of growth of new scientific findings and technological innovations. However, the report identified that there are many gaps to fill before the ocean and climate are truly integrated in adaptation and mitigation response measures, as well as national and global policies. In particular, the report noted that the results of the first ever Global Stocktake (GST) emphasized the impacts of these gaps on achieving the goals of the Paris Agreement.

The second and third Ocean and Climate Change Dialogues (OCCDs) were held in June 2023[7] and June 2024[8] respectively. At each of these dialogues, two major topics were identified as the foci for discussion and making recommendations to the following COP meetings (COP28 in the UAE and COP29 in Azerbaijan). The two topics discussed at the 2023 dialogue were "coastal ecosystem restoration, including blue carbon" and "fisheries and food security," while the 2024 dialogue focused on "marine biodiversity" and "ocean technology." At the most recent OCCD held in June 2025, three topics were discussed: 1) Ocean-based measures in NDCs; 2) The Ocean under the GCA; and 3) Ocean-Climate Biodiversity Synergies.[9] With each annual June dialogue being preceded (usually in April) by a Virtual Informal Exchange of Views on the Preparation for the OCCD, the process provides for wide input from the global ocean-climate change community. These dialogues are now a continuing, integral part of the UNFCCC negotiation process, ensuring that the directive of COP25 to make the ocean a formal part of the process a reality.

As this 2024-2025 ROCA Report is released, we note that much work has been done to raise public awareness about the importance of the ocean for climate, for biodiversity, for renewable energy, for sustainable food, and as a critical life support system for our planet. However, more action is needed to raise ambition on ocean-climate action and to provide sufficient and predictable financing and capacity-building. Furthermore, since the last ROCA Report, the impacts of climate change have accelerated as global average temperatures continue to increase annually.

In March 2025, the World Meteorological Organization (WMO) released its State of the Global Climate Report 2024,[10] and for the first time in its annual reporting on global climate change, the WMO confirmed that 2024 was the first calendar year in which global mean temperature exceeded the Paris Agreement target of 1.5°C above the 1850-1900 average. This is not good news for the ocean. Heading towards COP30 in Brazil, this increasing stress on the ocean and its fragile marine and coastal ecosystems creates ever increasing gaps between the human ability to adapt and the severity of the bio-physical and socio-economic impacts of our warming planet.

1.2 Progress on the Ocean and Climate Nexus within UNFCCC

Relevance of the ocean under the Convention and the Paris Agreement

The UNFCCC was adopted in 1992 and came into force on 21 March 1994.[11] Today, it has a universal membership, meaning that all States and regional economic integration organizations to which the treaty is open have expressed their consent to be bound by it.[12] Currently, there are 198 Parties (197 States and 1 regional economic integration organization) to the UNFCCC. One reference to the ocean is made in Article 4.1 (d) which refers to promoting the sustainable management, conservation and enhancement of greenhouse gas (GHG) sinks and reservoirs, including "biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems." Also, the definitions in Article 1.3 of the Convention[13] refers to the hydrosphere in its definition of "climate system," which includes the ocean. Article 4(d) of the UNFCCC requires all parties to "promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all greenhouse gases not controlled by the Montreal Protocol". This includes ocean, coastal, and marine ecosystems, forests, and other natural systems that absorb greenhouse gases like carbon dioxide.

Between 2002 and 2019, a concerted effort among Parties and non-Party stakeholders-built momentum to get the ocean fully recognized within the UNFCCC process. The Paris Agreement resulting from COP21 included the ocean in its Preamble, paving the way for the eventual formal incorporation of oceans in the Convention negotiations. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Oceans and the Cryosphere[14] provided the final scientific push to have the ocean-climate nexus formally incorporated by the Convention for its critical importance in the climate change system, which finally occurred in 2019 at COP25 in Madrid. The UNFCCC now has a webpage dedicated to the oceans, which provides information on the status of the oceans under the Convention, ocean outcomes and mandates from the COP meetings, details of the Ocean and Climate Change Dialogues, and ocean action under the UNFCCC.[15]

Today, the ocean is increasingly understood as holding the key to an equitable and sustainable planet. The IPCC 2023 Synthesis report identifies that climate change systems have already caused widespread impacts and related losses and damages on human systems, as well as altered ocean ecosystems worldwide.[16] However, there is an increasing recognition not just of the impact of climate change on the ocean, but also that the ocean is a place where urgent climate action is needed and can provide significant positive potential.

COP28 and CMA5

Held in Dubai, UAE from 30 November to 13 December 2023, COP28, the 5th COP serving as the meeting of the Parties to the Paris Agreement (CMA), received and welcomed the report of the 2023 OCCD. Also, the Ocean Breakthroughs initiative was launched. Five ocean breakthrough themes were presented: marine conservation, ocean-based transport, aquatic food, coastal tourism, and ocean renewable energy (see Figure 1).

The key ocean-related messages emerging from COP28 included:

- Recognition that the ocean and its coasts are some of our strongest allies in the fight against climate change, as they hold significant mitigation and adaptation potential in addition to multiple co-benefits;
- As noted in the Global Stocktake, Parties were encouraged to preserve and restore the ocean and coastal ecosystems and scale up, as appropriate, ocean-based mitigation action, and ocean-based adaptation and resilience measures were explicitly recognized as ecosystem-based approaches that can reduce climate change risks and provide multiple co-benefits;[17]
- Concerns were expressed by many in the oceans community that the oceans were largely absent from the GST, since none of the key messages emerging from the technical dialogues explicitly mentioned the ocean and coastal zones, even though the ocean's potential for mitigation was recognized in the GST outcome to deliver on emissions reductions targets;[18]
- Parties were provided with the requested guidance necessary to increase their ambition and strengthen ocean and climate action, especially in the context of their national strategies and options to consider and integrate the ocean and coasts in the GST;
- After the previous deliberations at COP26 and COP27, the Loss & Damage Fund was finally operationalized bringing in US$792 million in Parties' pledges;
- As noted previously in the Sharm el-Sheikh Implementation Plan, it was agreed that future OCCDs, from 2024 onwards, should work towards informing national climate goals and the implementation of these goals; and
- There was general support from the ocean community for the implementation of the Ocean Breakthroughs as a roadmap to catalyze action and investments to harness the full potential of the ocean. There was widespread support from the ocean community for the implementation of the Ocean Breakthroughs as a roadmap to catalyze action and investments to harness the full potential of the ocean.

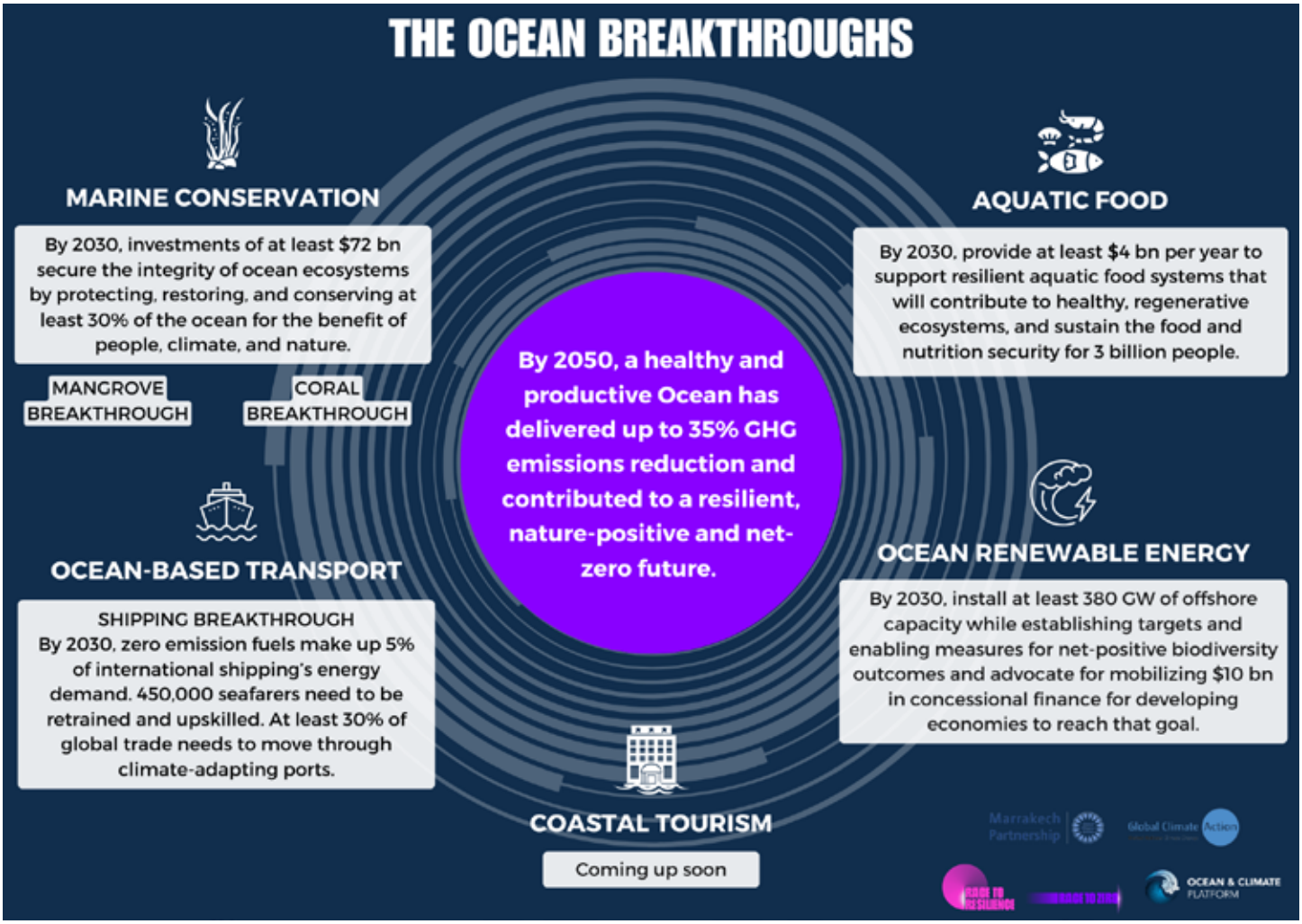

Figure 1. Ocean Breakthrough Themes

The first Sharm el-Sheikh Adaptation Agenda (SAA) implementation report identified increasing recognition of the importance and potential of NbS in coastal and ocean systems, with almost 100 new or updated NDCs including at least one coastal and marine NbS. Also, the report noted that funding was starting to flow on mangrove protection and restoration projects, but overall investments beyond mangroves were falling short of needs, despite a strong economic case for coastal and marine NbS, and in the absence of a global coastal resilience finance tracking mechanism, the total amount committed to coastal and ocean solutions is unclear. The report also noted that collaborations were helping to determine clear near-term solution outcomes beginning with mangroves, and more recently extending to corals and seagrass.[19]

The Ocean and Climate Change Dialogue 2024

The 2024 Ocean and Climate Change Dialogue (OCCD) was held in Bonn from 11 to 12 June 2024 at the 60th session of the SBSTA. Under the direction of the co-facilitators Julio Cordano (Chile) and Niall O'Dea (Canada), the 2024 OCCD focused on two topics: 1) Marine biodiversity conservation and coastal resilience, and 2) Technology needs for ocean-climate action, including finance links.

On topic 1, the effective management, conservation, and restoration of marine biodiversity was recognized as a multi-purpose solution that can contribute to mitigation and adaptation. Participants stressed the critical need to further mobilize resources, build capacity and enhance partnerships – involving a wide-range of stakeholders. There was a clear call to consider immediate exposure to the coastal impacts of climate change when allocating financial resources (*i.e.* to incorporate a risk-based approach to financial support allocation).[20]

On topic 2, the discussion focused on five areas of technology, namely ocean renewable energy, decarbonized shipping, marine carbon dioxide removal (mCDR), artificial intelligence (AI) and satellite-based technologies. Participants noted the importance of enhancing scientific research, engaging with local actors, and improving access to funding. They also raised the importance of national policy frameworks, including tools such as marine spatial planning (MSP), to prevent adverse impacts of these new technologies on marine and coastal biodiversity.[21]

As stated in the Synthesis Report,[22] the key messages of the 2024 OCCD were:

- The next round of NDCs in February 2025 provides a great opportunity for Parties to enhance their ocean-based mitigation and adaptation efforts – noting that NbS should not be a substitute for drastic emissions reductions;
- Parties are in need of additional guidance on how to fully leverage ocean-based measures in their national strategies, and highlighted the role of the Dialogue in carrying forward the conclusions of the GST and guiding the revision of their NDCs;
- The Dialogue should be following a clear roadmap to be defined for the years ahead in order to progressively address a variety of solutions and continuously take stock of progress made and remaining gaps to fill. It should also consider more focused topics to facilitate concrete action; and
- There is a clear need for increased cooperation and synergies within the UNFCCC and across frameworks, especially the Convention on Biological Diversity (CBD), the Agreement on Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement), and the 2030 Agenda for Sustainable Development. In this context, the third UN Ocean Conference (UNOC3) in June 2025 can act as a lever to accelerate ongoing processes.

The Ocean and Climate Change Dialogue 2025

Held in Bonn from 17 to 18 June 2025 as part of the SB62 meetings, the OCCD 2025 saw new co-facilitators with the appointment of Ambassador Carlos Márcio Bicalho Cozendey (Brazil) and Mr. Ulrik Lenaerts (Belgium). In their information letter dated 30 May 2025, the co-facilitators identified three topics for the 2025 Dialogue:[23]

1. *Ocean-based Measures in NDCs*

   The dialogue will serve as a platform to encourage Parties to scale up ambition through the inclusion of robust ocean-based measures in their new NDCs. The dialogue will also identify the obstacles in implementation of ocean targets, policies, and measures in Parties' NDCs.

   It was noted that there had been an encouraging trend in the recently submitted NDCs, with 74% of Parties including ocean-based mitigation and adaptation measures, targets, and policies in the 23 new NDCs analyzed between 1 October 2024 and 5 May 2025. Ocean-based adaptation measures were featured in 88% of the recent NDCs, and 41% of the Parties included ocean-based mitigation actions in these NDCs.[24]

2. *The Ocean under the GGA*

   The focus of this topic is on the inclusion of the ocean dimension in the implementation and the operationalization of the targets within the UAE Framework for Global Climate Resilience, including implementing and assessing the target on ecosystem-based adaptation (EbA) and NbS. Among the 11 targets under the framework, the target on ecosystems and biodiversity but also the targets on food and infrastructure are particularly relevant for ocean-based adaptation. It emphasizes reducing climate impacts on ecosystems and biodiversity and accelerating the use of EbA and NbS, including through their management, enhancement, restoration and conservation and the protection of terrestrial, inland water, mountain, marine and coastal ecosystems. Other thematic targets - such as water and livelihoods—also have strong interlinkages with ocean systems and the dialogue should consider their ocean dimension.

   Under the UAE–Belém work programme, experts have reviewed indicator submissions from Parties and observers and have compiled 490 indicators across all 11 targets. These indicators offer an entry point for measuring progress in ocean-based adaptation and ensuring its visibility in the GGA framework. As the UAE–Belém work programme moves toward finalizing the indicator set, this dialogue is a timely opportunity to shape how ocean-based adaptation is represented in global adaptation efforts. Additionally, the 2025 dialogue will consider how best to inform the work of the relevant indicators expert groups, whilst also leveraging the 2023-2024 dialogue outcomes on adaptation for coastal and vulnerable communities, Indigenous Peoples and Local Communities

(IPLC), marine technologies, early warning systems, and the scaling up of ecosystem-based approaches.

3. *Ocean-Climate-Biodiversity Synergies*

   Building on the outcome of the first GST, Topic 3 will address the benefits and challenges in promoting a synergistic approach to tackle climate change and biodiversity loss in the context of sustainable development and poverty eradication. The dialogue will respond to the strong convergence expressed during the informal exchange of views on the need to strengthen synergies between the UNFCCC and other UN initiatives and processes, whilst being mindful of the respective mandates.

   The dialogue will consider how Parties can develop more coherent national strategies that enhance coastal resilience and marine conservation. Discussions will consider opportunities for better alignment and coordination among the CBD, its Protocols and its GBF, the UNFCCC and the Paris Agreement, the BBNJ Agreement, and the International Seabed Authority (ISA).

   The dialogue will discuss how Parties can be encouraged to consider integrating their reporting across various frameworks on ocean-related processes. Finally, the dialogue will benefit from technical guidance and case studies offered by various UN agencies during the informal exchange of views, which aim to support Parties in identifying practical ways to enhance synergies across relevant processes.

Additionally, the co-facilitators identified the cross-cutting themes to be Means of Implementation (MOI), particularly finance, and Ocean Science. The dialogue will address the critical role of MOI as a central enabler for the implementation of ocean-based climate solutions. It will serve as a venue to identify actionable financing pathways and explore how ocean finance can be meaningfully integrated into key COP30 processes, including the Baku to Belém Roadmap. The dialogue should assess the extent to which existing climate finance is accessible for ocean-related strategies, as well as highlight innovative financial instruments—such as blue bonds, blended finance models, and climate-smart investment mechanisms—as essential tools for scaling up ocean investments.

The dialogue will also address science as a cross-cutting pillar of ocean-based climate ambition. Discussions will emphasize enhancing access to science, integrating traditional and local knowledge, and building research capacity, particularly in developing countries. The dialogue will share experiences and exchange on sea-level rise monitoring, early warning systems, and data sharing. Discussions will also highlight major UN science-based processes and initiatives, including the Ocean Decade and intergovernmental panels such as IPCC and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

The questions used in the preliminary dialogue discussions[25] are shown in Table 1.

Table 1. Guiding Questions Identified for the 2025 Ocean and Climate Change Dialogue

Topic 1: Ocean-based Measures in NDCs	1. Which opportunities and best practices do you see for integrating sustainable ocean-based actions in Parties' NDCs and how can this support ambition in NDCs? 2. Which obstacles, particularly in terms of MOI (finance, capacity building, and access to technologies) do you see for this integration of sustainable ocean-based action in NDCs and how could they possibly be overcome?
Topic 2: The Ocean under the GGA	3. How can the ocean dimension best be integrated in the indicators as presently considered under the UAE–Belém work programme, particularly to accelerate EbA and advance NbS for coastal resilience? 4. What scope do you see for better alignment between NBSAPs and NAPs, including for monitoring progress?
Topic 3: Ocean-Climate-Biodiversity Synergies	5. How can the outcomes of UNOC best contribute to the ocean-climate-biodiversity nexus under the UNFCCC process? 6. How can the dialogue support Parties in the early ratification and implementation of the BBNJ Agreement in its different sections including the establishment of ABMTs and MPAs?

Cross-cutting Themes	7. What are the key financing instruments and sources for the Parties to implement ocean-based action in the new NDCs? To which extent do you believe existing climate finance is accessible for ocean-related strategies? 8. How to enhance access to ocean science, integrating traditional and local knowledge systems, and strengthening capacity for ocean research, especially in developing countries, for tackling climate change and promoting marine biodiversity conservation and sustainable use? 9. How should a three-to-five-year roadmap for the Ocean and Climate Change Dialogue be structured to facilitate long-term planning and ensure a coherent and progressive addressing of relevant topics over time?

Held in hybrid mode from 17 to 18 June 2025, in conjunction with the sixty-second session of the subsidiary bodies in Bonn, Germany, the OCCD 2025 offered a vital space for enhancing collaboration, understanding and building ocean-based climate action, illustrating needs, opportunities and case studies, as well as highlighting key messages for consideration at COP30.

The Informal Summary Report by the co-facilitators of the OCCD 2025 was published on 30 September 2025.[26] The report includes key messages specifically for informing the discussions and preparation of new NDCs by Parties, and COP30 agenda matters pertaining to the Global Goal on Adaptation, climate finance, and strengthening international cooperation on the ocean-climate-biodiversity interlinkages.

The key messages[27] of the OCCD 2025 report include the following:

Topic 1 - Ocean-based Measures in NDCs: The dialogue underscores the urgency of the inclusion of ocean-based mitigation and adaptation measures in the new NDCs for collectively strengthening ocean-based climate ambition.

- The 2025 NDCs cycle provides a critical opportunity for Parties to enhance ambition and to include sustainable ocean-based measures and implement the outcome of the first GST decision. Ocean-based measures must reflect each country's national circumstances, and there is no one-size-fits-all approach. NDC development must uphold human rights principles and involve IPLC, and coastal communities, and integrate traditional knowledge, knowledge of Indigenous Peoples and local knowledge systems.
- By including the ocean in NDCs, Parties can collectively strengthen climate ambition, while maximizing climate and biodiversity co-benefits.
- A wide range of ocean-based mitigation and adaption measures, targets and policies are available for inclusion in NDCs, that are aligned with the 1.5°C target of the Paris Agreement, including: Integrated Coastal Zone Management (ICZM), NbS, the conservation, restoration, and management of coastal blue carbon ecosystems, climate-smart and resilient fisheries and aquaculture solutions, marine renewable energy technologies, decarbonization of marine transport, MSP, marine protected areas, and ecosystem-based adaptation.
- In line with paragraph 28 of the outcome of the first GST,[28] Parties are encouraged to transition away from fossil fuels in energy systems, including transitioning to marine renewable energy.
- It is essential for Parties to strengthen blue carbon accounting methodologies and tools and Parties must embrace the 2013 Wetlands Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which includes methodologies and guidance to estimate and report on anthropogenic emissions and removals of greenhouse gases from wetlands, including mangrove forests, tidal marshes, and seagrass meadows.
- Blue finance should match ambition for ocean-based climate action in the NDCs and Parties should have quantified targets for their ocean-based measures and include the needs for, or the provision of, ocean-related finance, technologies and capacity-building for implementation of their ocean targets.
- Ocean measures must be grounded in the best available science, with increased investment in research and data collection. Effective integration of ocean in NDCs needs to go hand in hand with investing in robust data systems, measurement, reporting and verification (MRV) processes, science and ocean observations, regional partnerships for joint research and technology sharing, capacity-building, integration and inclusion of IPLC, and coastal communities, whilst integrating their traditional knowledge and ensuring their participation.

- Regional cooperation is encouraged to scale climate action.

Topic 2 - The Ocean Under the Global Goal on Adaptation: The dialogue highlights that ocean should be a cross-cutting priority and embedded across all relevant indicators, as it cuts across multiple thematic targets.

- Oceans should not be limited to a few selected targets and indicators, and alignment of indicators with existing indicators and data systems under multilateral biodiversity frameworks, such as the CBD's Kunming-Montreal Global Biodiversity Framework (GBF), is key for harnessing synergies, minimizing reporting burden, and increasing resource efficiency. Marine-relevant CBD GBF indicators, such as marine protected area (MPA) coverage and ecosystem integrity, can directly inform GGA monitoring to support aligned national and multilateral reporting.
- Indicators should capture ecosystem integrity and connectivity, focusing on holistic ocean system health; and key indicators should be practical, realistic, global, and broadly applicable. Sub-indicators should be context specific and locally applicable to cater for diversity across local communities and countries. A metric to protect small-scale fishers, women, coastal communities, IPLC, and resilience (fisheries, food security and early warning systems) should also be included. Integrating a specific indicator to address maladaptation risks could be beneficial.
- Disaggregation by ecosystem type is needed to reflect differences between coastal, deep-sea, high seas, and other marine systems. Accordingly, include ecosystem-type disaggregated indicators (e.g. mangroves, coral reefs, seagrasses) and MPAs coverage and management effectiveness as adaptation indicators, given their key role in contributing to both biodiversity conservation and climate resilience (carbon sequestration, shoreline protection). Quantitative indicators are needed to scale up EbA and NbS, including measures to track and monitor blue carbon ecosystems.
- Equity in data access and sharing is critical for providing a regional picture of interdependent ecosystems. Strengthening early warning systems and regional ocean observations is important for the development of meaningful indicators. Building and enhancing local capacity, alongside integrating traditional knowledge, knowledge of Indigenous Peoples and local knowledge systems is vital to improve robustness and local relevance of the data systems. Inclusion of metrics on financial flows allocated to ocean action and technology transfer are recommended.
- Coastal and marine ecosystems offer natural entry points for integration, as many adaptation priorities such as MPAs, coastal protection, sustainable fisheries, and blue carbon ecosystems are directly linked to biodiversity conservation. Aligning the planning and reporting processes of NBSAPs and NAPs can improve efficiency, reduce duplication, and foster synergies between climate and biodiversity goals.
- Despite strong interlinkages, NBSAPs, NAPs, and ocean-related policies are often developed under separate ministries impeding coherence. Stronger inter-ministerial coordination and aligned reporting cycles are needed to enhance coherence, reduce administrative burdens, and strengthen efficiency. Financing streams for biodiversity and adaptation remain too often siloed, limiting the response to the multiple opportunities for co-benefits that exist. Greater integration of climate and biodiversity funding mechanisms, including joint programming through GCF, GEF, and related funds, would better support projects that address interconnected challenges.

Topic 3 - Ocean-Climate-Biodiversity Synergies: The dialogue reaffirms the UNOC3 outcomes on strengthening international cooperation, across relevant conventions and multilateral fora, in line with their respective mandates, and urges Parties to ratify the BBNJ Agreement.

- The OCCD 2025 welcomed the reaffirmation of the ocean-climate-biodiversity synergies in the 2025 UNOC3 outcomes declaration and noted the emergence of other initiatives such as the 'Blue NDC Challenge,' spearheaded by Brazil and France during the 2025 UNOC3, and the Ocean Action Panel on "Leveraging Ocean, Climate, and Biodiversity Interlinkages".
- The UNOC3 outcomes must be translated into national level processes and advanced in the context of specific global frameworks, including the UNFCCC and Paris Agreement, CBD, United Nations Convention on the Law of the Sea (UNCLOS), and the BBNJ Agreement. These measures and actions should be embedded in the national climate strategies, to support mitigation, adaptation, and biodiversity objectives, and in line with the GBF, Sustainable Development Goal (SDG) 14 and the Paris Agreement.

- Parties are encouraged to ratify the BBNJ Agreement (which has subsequently occurred) for its early implementation and entry into force and to consider the synergies and co-operation discussions in the Agreement's first COP.
- In line with the OCCD 2024 key message that MPAs and other area-based management tools play a key role in supporting livelihoods, safeguarding marine biodiversity, and increasing resilience to climate change, Parties are strongly encouraged to implement the GBF's 30 by 30 target, along with the other goals and targets, for the effective conservation and management of ocean ecosystems.
- Cross-cutting Themes: the dialogue highlights that science, finance, technology and capacity-building are critical enablers of ocean-based climate action.
- Existing finance mechanisms (GCF, GEF, Adaptation Fund) and MDBs provide some entry points for ocean finance but often lack specific windows to directly finance ocean-based adaptation. The possibility of having dedicated blue finance windows within existing climate funds, to ensure predictable and targeted support for mitigation, adaptation, and resilience-building in marine and coastal systems should be explored
- Capacity gaps limit access to finance for developing countries. A coordinated and streamlined application process, with targeted support for developing countries, especially small island developing states (SIDS) and LDCs, through partnerships and building capacity could help unlock the finance and overcome the fact that currently many SIDS, least developed countries (LDCs), and coastal communities struggle with complex application processes, limited institutional capacity, and insufficient technical support.
- Reframing projects to clearly highlight their adaptation and mitigation co-benefits, alongside blended finance models and risk-sharing mechanisms, can make them more attractive to investors and reduce perception that ocean investments in developing countries are often perceived as high risk, which discourages private sector engagement.
- Exploration of new financing pathways under the UNFCCC process to create a blue finance window, such as Supply Chain Finance (SCF) and Model Wealth Portfolios (MWP), to facilitate predictable, targeted support for mitigation, adaptation, and resilience-building in marine and coastal systems. Such climate funding pipelines could leverage the ocean-climate-biodiversity nexus to promote cross-sectoral projects that deliver tangible co-benefits.
- Strengthen ocean science and knowledge by leveraging the communities of the Research Systematic Observation workstream, integrating coastal communities, IPLCs' traditional knowledge in NAPs, advancing the recent international law developments, and noting the ongoing work on the IPCC seventh assessment report.
- New investments for long-term regional data systems, data collection and research, and partnerships amongst countries are needed to avoid overlaps, identify gaps, and support systemic approaches to science and monitoring.
- Traditional knowledge, knowledge of Indigenous Peoples and local knowledge systems must be respectfully incorporated to inform data and science gaps. Capacity-building is essential to inform the scientific community and policymakers of the traditional knowledge available. Science must be communicated to policymakers in more understandable ways, while respecting the sensitivities around knowledge and data sharing.
- The OCCD 2025 also noted the suggestion to develop a three-to-five-year roadmap for the dialogue. Sequencing priority topics, and alignment with the UNFCCC key cycles, such as the GST and the NDC cycle, and international milestones can ensure continuity, coherence, and technical depth across the ocean-climate agenda.

Finally, the report highlights some key messages for Parties for COP30, which are highlighted below:

- Noting that the 2025 NDC cycle presents a unique and time-bound opportunity for Parties to demonstrate their collective progress to enhance ocean-based climate ambition, all Parties are urged to reflect and implement ambitious ocean-based mitigation and adaptation measures that are aligned with the 1.5°C goal of the Paris Agreement and guided by the outcome of the first GST decision in their NDCs.

- Consider the deliberations of the dialogue when finalizing indicators for ecosystem, biodiversity, and other thematic targets.
- Strengthen international partnerships and collaborations, and cooperation with other international organizations.
- When considering the finance mandates, Parties should consider how they will support the key messages of the dialogue and provide sufficient resources in the 2026-2027 budget for the implementation of mandates related to strengthening ocean-based climate action.

Table 2. Summary of the Key Outcomes of the 2025 Ocean and Climate Change Dialogue from the Final Plenary Session

Guiding Questions	***Summary of Key Points***
1. Opportunities and best practices for integrating sustainable ocean-based actions in NDCs	• Increase inclusion of blue carbon ecosystems in the new NDCs • Restore and protect blue carbon ecosystems • Embed NbS through measurable indicators aligned with the GGA • Link NDCs to NAPs, and NBSAPs • Utilize spatial planning tools and Indigenous Peoples knowledge in policy design • Pilot innovative finance tools (e.g., reef insurance, Nature Bonds, Blue Carbon Plus) • Integrate Indigenous Peoples knowledge • Use science-based tools and guidance (e.g., technical assistance, monitoring frameworks) • Include ocean breakthroughs with sectoral targets as pathways for NDC ambition • Support the Blue NDC Challenge to scale ambition
2. Obstacles and opportunities related to means of implementation - finance (Art. 9), technology (Art. 10), and capacity-building (Art. 11) for the inclusion of ocean in NDCs	**Climate finance: obstacles and opportunities** • Limited access to climate finance for developing countries, especially public finance due to non-market-viability of marine/coastal projects • Create dedicated blue climate finance windows • Simplify climate fund access procedures for SIDS and LDCs, including access to funding from International Financial Institutions (IFIs) • Leverage IFIs finance, including innovative finance such as reef insurance, blue bonds, blended finance, Blue Carbon Plus, and nature bonds • Need for increased resources in climate funds and for dedicated blue climate funding streams with increased funding eligibility for NbS • Proposal to scale up the Baku to Belém Roadmap • Emphasis on transparency, integrity, and inclusiveness in finance design and delivery. **Ocean-based technologies: obstacles and opportunities** • Facilitating access to ocean-based technologies to developing country Parties through collaborative approaches to research and development • Facilitate the safe and responsible research and exploration of mCDR technologies through partnership • Pursuing voluntary cooperation through partnerships to enhanced ocean-based mitigation and adaptation ambition, including through scaling of blue carbon projects such as mangrove restoration.

2. Obstacles and opportunities related to means of implementation - finance (Art. 9), technology (Art. 10), and capacity-building (Art. 11) for the inclusion of ocean in NDCs	**Capacity-building: obstacles and opportunities** • Limited technical capacity for developing countries to implement and monitor ocean-based adaptation and mitigation measures • Knowledge gaps and inequitable access to data, including in the deep sea and transboundary areas. • Strengthening capacity-building of developing countries, especially SIDS and LDCs, to enhance ocean-based climate action, including facilitating technology development, deployment and dissemination, and access to public finance • Strengthening international cooperation, establishing regional research hubs and strengthening local research institutions, for peer learning and fostering country ownership, in particular for developing countries • Integrating traditional knowledge systems, especially from Indigenous Peoples and coastal communities • Supporting open-access data platforms and creating regional data-sharing platforms • Addressing research capacity needs and knowledge gaps through targeted investments and long-term partnerships
3. Integration of the ocean dimension into GGA indicators	• Calls for ecosystem-specific indicators under the GGA, including- early warning systems, ecosystem protection and restoration, livelihood resilience • Metrics for blue carbon ecosystems, marine biodiversity health, storm buffering capacity, reef condition, saltwater intrusion, and mangrove coverage • Indicators should be measurable, gender-responsive, support local adaptation, and be informed by Indigenous Peoples knowledge systems • Align GGA indicators with the GBF and ocean–climate synergies
4. Scope for better alignment between NBSAPs and NAPs (including monitoring progress	• Support for policy coherence across NDCs, NAPs, and NBSAPs • Monitoring systems should track NbS and blue carbon contributions. • Synchronize monitoring frameworks and reporting mechanisms under both UNFCCC and CBD • Use the GGA and GBF as platforms to ensure coherence • Emphasis on equity, co-benefits, and inclusive reporting practices
5. Contribution of UNOC outcomes to the ocean–climate–biodiversity nexus under the UNFCCC process	• UNOC3 outcomes should inform COP30 processes • Support ongoing initiatives like the Blue NDC Challenge and Ocean Breakthroughs • UNOC3 is a key opportunity to enhance ocean-climate-biodiversity synergies, including building coherence across the Rio Conventions • Leverage UNOC3 outcomes to mainstream ocean priorities into the UNFCCC and CBD agendas
6. Dialogue support for BBNJ ratification and implementation (including ABMTs, MPAs)	• Support for the early ratification and operationalization of the BBNJ Agreement • Recognition of the BBNJ's potential to advance ABMTs and MPAs as key tools for adaptation and biodiversity conservation • Need for capacity support, legal assistance, and inclusion of climate considerations for BBNJ Agreement implementation • Emphasis on ensuring that BBNJ Agreement implementation contributes to GGA targets and NDCs
7. Structuring a 3-5-year roadmap for the dialogue	• Transition from ambition to structured implementation • Include annual thematic focus areas, e.g., finance, blue carbon, science-policy integration • Develop a multi-year action plan aligned with COP cycles • Track progress on key initiatives like BBNJ Agreement implementation, and GGA indicators • Support cross-convention coordination

The Plenary Session ended with a call to action, urging participants to:

- Act as ocean ambassadors and foster cross-collaboration, including advocating for the integration of ocean issues within NDCs and working with colleagues to ensure that ocean-related priorities remain visible and central across relevant UNFCCC negotiation agenda items; and
- Help translate the dialogue's collective insights into concrete tracks, initiatives, and proposals, not only within the formal negotiating process but also within the broader climate agenda (including New York Climate Week and pre-COP30) on the road to Belem.

The OCCD 2025 co-facilitators will report back on the outcomes of the dialogue during the COP30 opening plenary

session in Belem and will also convene a UNFCCC side event to present the conclusions and recommendations of the summary report, and to hear from experts and Parties on the way forward.

The report of the OCCD 2025 represents a significant advance from previous dialogues with the inclusion of specific details, proposals, recommendations, and calls to action focusing on greater implementation of the ocean-climate nexus within the UNFCCC and producing tangible results. This reflects the maturation of the OCCD process over the five years in which it has been in place since its establishment at COP25 and the holding of the first preliminary dialogue in 2021. More information and specifics can be found on the OCCD website.[29]

COP29 and CMA6

The 29th COP to the UNFCCC (COP29) took place from 11 to 22 November 2024 in Baku, Azerbaijan. There is little doubt that this was a very challenging COP meeting, not just for the ocean, but also more generally with important Parties such as the United States of America and Argentina calling into question their commitment to the Paris Agreement and the UNFCCC overall.

COP29 was focused on finance and political issues that made it difficult to get the ocean on the agenda. In the past, this would have completely sidelined the ocean agenda, but now that the ocean is formally within the Convention negotiations, the submission from the OCCD was presented as part of the formal deliberations and outcomes. The Azerbaijan presidency did not produce a "cover text" (a front-page document summing up the main outcomes of the summit) for COP29. However, the final communique from the conference reaffirmed the language of COP28's cover text, meaning the ocean was included without being specifically mentioned.

After much discussion and argument, the Parties agreed on a goal of US$300 billion annually by 2035 for the New Collective Quantified Goal on Climate Finance (NCQG), thereby tripling the previous target. However, the process did not allocate significant time to unpacking how much would be allocated to ocean-related (or even nature-related) climate actions. Also, the elimination of wording stating the need to "transition from fossil fuels," and "make polluters pay" was a significant setback for commitments to climate emissions reductions and keeping average global temperature rises below the 1.5ºC Paris targets.

Various initiatives and discussions related to climate change adaptation that emerged from COP29 are broadly referred to as the "Baku Adaptation Plan" (BAP). These initiatives aim to enhance global adaptation efforts, particularly focusing on the Global Goal on Adaptation (GGA), NAPs, and the integration of human development considerations into climate resilience strategies. Among the key components of the BAP are the Baku Adaptation Roadmap (BAR) and the Baku Workplan. The BAR aims to provide a forward-looking pathway for the GGA beyond COP30 and guide the implementation of indicators developed under the UAE–Belém Work Programme.[30] The BAR seeks to address barriers to effective adaptation implementation and support scaling-up adaptation actions. However, modalities, timelines and activities within the BAR were not discussed at COP29, and Parties were invited to submit views on modalities for work under the roadmap via the submission portal by 31 March 2025 to be discussed at the SB62 sessions in Bonn in June 2025.

The Baku Workplan[31] lays out a roadmap for action in three key areas: promoting knowledge exchange, building capacity for engagement, and integrating diverse knowledge systems into global climate strategies. Overall, the BAP contributes to the broader adaptation agenda of the SAA adopted at COP27.

The 2024 Annual Implementation Report of the SAA[32] reported a number of signals of change under the Coastal and Ocean Systems theme, namely:[33]

- *Policy:* Commitments to support the Mangrove Breakthrough from 28 national and subnational governments have been secured and a formal partnership with UAE's Mangrove Alliance for Climate has been established, increasing coverage approximately to 60% of the world's mangroves. The Mangrove Breakthrough also launched its NDC Task Force to transform Mangrove Breakthrough endorsements into mangrove-positive NDC commitments.
- *Finance:* US$300 million in funding has been secured by the Ocean Resilience and Climate Alliance (ORCA) philanthropic initiative for ocean-climate solutions. The Global Fund for Coral Reefs (GFCR), co-founded by the United Nations Capital Development Fund (UNCDF), United Nations Environment Programme (UNEP),

United Nations Development Programme (UNDP), and a public-private coalition, also mobilized an initial $200 million toward the Coral Reef Breakthrough targets in direct investment with additional US$25 million approved in July this year.

- *Partnerships:* The fifth target under the Ocean Breakthroughs – the Coastal Tourism Breakthrough – to be launched and presented at COP29, with a target on seagrass is also being developed by partners.

The prioritized outcomes for the Coastal and Ocean Systems theme include:[34]

- *Mangroves:* Secure the future of 15 million hectares of mangroves globally by mobilizing US$4 billion to halt mangrove loss, restore half of recent losses, double protection, and ensure sustainable finance for mangroves globally to support the resilience of 15 million people and over US$65 billion worth of property annually.
    - *Status:* Despite a lack of comprehensive global data on the status of mangroves, efforts are developing on multiple fronts to tackle mangrove conservation and unlock finance under the Mangrove Breakthrough.
- *Coral reefs:* Secure the future, halt loss, protect and restore 125,000 sqm of shallow-water tropical coral reefs with investments of US$12 billion to support the resilience of more than half a billion people globally.
    - *Status:* Coral reefs remain at risk, demonstrated by a global coral bleaching event this year; efforts to tackle coral conservation and unlock finance are unfolding on multiple fronts.
- *Coastal city protection*: Coastal cities are protected from ocean-based hazards by green, grey and hybrid solutions, increasing the resilience of at least 900 million people worldwide.
    - *Status:* Despite a lack of global data on coastal city protection, initiatives are in place to support cities and finance coastal and ocean NbS (*e.g.*, Coastal 500, Sea'ties initiative, Ocean Risk and Resilience Action Alliance (ORRAA)).

An Ocean Pavilion and a Virtual Ocean Pavilion (VOP) were once again held at COP29, providing on-site and on-line platforms for many ocean-related events, activities, and presentations.

Building momentum towards COP30

COP30 and CMA7 will be held in Belèm, Brazil from 10 to 21 November 2025. Following a disappointing COP for the ocean in Azerbaijan and the prospect of a COP being held in Brazil, where the ocean is of great environmental, economic, and social importance, together with increased energy generated by UNOC3 and the progress towards ratification of the BBNJ Agreement, there is considerable momentum and expectations for the ocean going into COP30.

As with all COPs since 2019, a formal component of the negotiations will be around the outcomes and recommendations of the OCCD.

Progress on societal integration

Over the past two years there has been growing attention to social values as a mechanism for enacting policy and implementing change.[35] [36] [37] [38] We see a new narrative emerging that extends models of understanding the traditional science-policy interface to be inclusive of the contextual role of society, thus situating the science-policy-society framework as the answer for implementation and action.[39] [40]

Numerous initiatives have arisen to support the call for addressing the need for integrating people, and their attitudes, values and beliefs into the ocean-climate science-policy arena. In assessing progress over the past two years, an emphasis on social elements of the ocean climate nexus is clear.

For example, the UN Ocean Decade has led progress toward achieving societal awareness goals. This massive movement has been the catalyst for an immense pressure to develop science and organize around advancing the ocean agenda. Franke *et al.* emphasize the transdisciplinary nature of modern ocean-climate problem solving and assert the role of participation and experimentation in achieving Ocean Decade Goals.[41]

Further, The Venice Declaration for Ocean Literacy in Action posits values related to the implementation of change and signals an impetus to move beyond policymaking and decisions to action.[42] Ocean Literacy

continues to be framed as a capacity building effort that can support action through education and knowledge advancement. McKinley, Burdon, and Shellock (2023) offer ten dimensions of ocean literacy including "knowledge, communication, behavior, awareness, attitudes, activism, emotional connection, access and experience, adaptive capacity and trust and transparency" thus building on traditional information deficit models of literacy to incorporate nuanced social and cultural considerations related to ocean-climate learning.[43]

Similarly, there is an increasing interest in social sciences' role in informing equity realization and shared governance of ocean spaces.[44] Equity and justice are vitally central to modern global ocean-climate decision making. This is evidenced by a focus on loss and damage, as well as a growing pressure for financing to support affected communities. Similarly, youth organizations, including the Early Career for Ocean Professionals (ECOP) group and YOUNGO (the official children and youth constituency of the UNFCCC) continue to push for an equity and justice lens in the application of resource allocation across the UNFCCC. Justice and equity agendas continue to dominate the ocean-climate narrative and there is a resounding call for attention to the most affected communities. Issues of power, authority, and control continue to be a source of legitimate investigation among practitioners and academics alike.

There has been a growing focus on advancing science on the relationship between the ocean and society over the past two years. The marine social science agenda has evolved into numerous pathways of investigation around the nature of ocean, or marine relationships that drive ocean and climate policy and decision-making.[45] The marine citizenship agenda is an example of how place connectivity and participation in place connectedness can be a driver of learning and ultimately impact behavioral outcomes.[46] The Ocean Identity Initiative is an example of the ways individual self-concept is shaped by the emotional relationship one has with the ocean, and hence offers pathways for driving effective ocean policy and behavior.[47] Overall, there is a deepening recognition of the complexity of the ocean science-policy-society interface, and a sociocultural-biophysical systems-based focus on developing solutions across the suite of ocean-climate issues is needed to exhaustively and effectively implement action.[48]

Progress in proceedings

This year marks the initiation of new co-facilitators to the OCCD. In developing a new agenda for the Dialogues, we see a growing interest in more substantive or procedural responses to ocean integration into the climate negotiations, and a shifted focus to a solutions-orientated action agenda that transcends dialogue to enact change. As such, there is a turn in attention to alignment of strategies across UN negotiating bodies, especially in the UNFCCC, CBD, BBNJ, and UNOC. New ideas are emerging in pathways to synergize across decision-making frameworks.[49] As capacity is strained across UN bodies due to resource limitations, parties and leaders are looking for multi-solution actions that address the complexity of ocean climate systems.

Similarly, we see a trend in the development of systems that support synthesis and sharing of data. Policy makers are being inundated by new findings and reports constantly and have become oversaturated with information and guidance. Efforts continue in synthesizing data, sharing findings, and co-developing communication strategies.

The Technical Executive Committee (TEC) Activity C.4.1 Innovative Ocean Climate Solutions group has supported UNFCCC ocean-climate proceeding in a number of ways. The 2023 report of the TEC sets forth guidance on ocean-climate action, stating, "The UNFCCC process presents opportunities to strengthen ocean-based climate action, including through relevant work programs and constituted bodies and the OCCD. In addition, the United Nations Decade of Ocean Science for Sustainable Development 2021–2030, the United Nations Decade on Ecosystem Restoration 2021–2030 and the implementation of the Sendai Framework for Disaster Risk Reduction (DRR) 2015–2030 present opportunities to promote coherence of action within the United Nations."[50] Thus, the report highlights options for advancing alignment and coalescing global ocean-climate action agendas.

In 2024 a TEC brief on innovative approaches to accelerating and scaling up implementation of mature climate technologies emphasized action levers including "engaging stakeholders in climate decisions, attracting private sector climate funding and public–private collaboration."[51] The information note provided by the OCCD Co-facilitators in advance of the 2024 Dialogue further emphasized the technological resources and support of the TEC and CTCN in advancing action agendas across ocean-climate negotiation streams.[52]

1.3 Progress on the Marrakech Partnership on Global Climate Action

The Ocean Breakthroughs, launched in 2023, is the flagship initiative under the Marrakech Partnership for Ocean & Coastal Zones.[53] They have quickly emerged as a driving force to bring actors together and accelerate ocean–climate action. Grounded in science, the Breakthroughs lay out sectoral pathways in five critical areas – marine conservation, renewable energy, shipping, aquatic food, and coastal tourism – where increased action and investments can make a decisive contribution to delivering on the objectives of the Paris Agreement.

Over the last year, the campaign has pursued its shift from vision to implementation. In the realm of marine ecosystems, progress has been particularly striking:

- The Mangrove, Seagrass, and Seaweed Breakthroughs have moved from high-level ambition to concrete targets now being operationalized with the support of governments, Indigenous Peoples, scientists, and civil society. Since its launch at COP27, the Mangrove Breakthrough has secured the endorsement of 40 national and subnational governments, signaling strong political momentum.[54] Since its launch at COP27, the Mangrove Breakthrough has secured the endorsement of 40 national and subnational governments, signaling strong political momentum.[55] To help countries translate their commitments into action, the initiative established an NDC Task Force that provides technical and policy support for integrating mangrove commitments into national climate strategies. A Secretariat has been set up to coordinate delivery and strengthen collaboration among partners. Looking ahead, the initiative will further scale its financial ambition with the launch of the Global Mangrove Finance Facility at COP30, designed to mobilize the US$4 billion goal by 2030. Delivery partners of the Seagrass and the Seaweed Breakthroughs respectively developed an Implementation Action Plan and launched The State of the World's Seaweed report, coordinating efforts and experts' views to ensure the effective conservation of these ecosystems.[56]
- The Coastal Tourism Breakthrough, introduced at COP29, made progress at UNOC3 with the launch of the Ocean Tourism Pact (OTP).[57] Signatories reaffirmed their commitment to accelerate the setting and implementation of global commitments aimed at driving the decarbonization and sustainable transition of the sector. To support these efforts, a working group will be established, serving as a collaborative platform to share knowledge, develop tools, guidelines, and standards that promote resilient coastal tourism.

Alongside sectoral progress, the campaign has focused on creating the enabling conditions for scale. Recognizing the persistent gap in ocean finance, the Ocean Breakthroughs contributed a dedicated appendix to the Ocean Investment Protocol (OIP), launched by the UN Global Compact and UNEP-FI at the Blue Economy and Finance Forum in June 2025.[58] By showcasing priority actions and concrete case studies, this annex demonstrates that investable ocean solutions already exist and offers a framework to channel resources toward them. Similarly, equity has been placed firmly at the heart of the Breakthroughs. Through collaboration with the Blue Justice Group, the Ocean Equity Index is being explored across the framework, helping to ensure that global action reduces vulnerabilities and expands opportunities rather than deepening inequalities.[59]

The Ocean Breakthroughs must also serve as a platform for accountability and evidence. Rooted in the Blue Ambition Loop, they highlight the leadership of non-State actors in pushing ambition forward and building the trust needed for governments to strengthen policy and mobilize investment. To monitor and assess progress, the Ocean & Climate Platform and the World Resources Institute's Systems Change Lab are co-developing a global dashboard of indicators, which will provide the first comprehensive view of trends in ocean–climate action since COP21. This tool is set to be launched at COP30 and will mark an important step in enhancing transparency and showcasing that transformative change is underway.

These advances have been amplified by key moments of mobilization. At the UNOC3 in Nice, the Ocean Breakthroughs stood out as a critical piece of the puzzle for implementing the Paris Agreement, not only by highlighting solutions but also by bringing together a wide coalition of governments, private actors, Indigenous leaders, and civil society. To that end, they are well embedded in the Blue NDC Challenge launched by France and Brazil, a political initiative encouraging countries to integrate ocean-based solutions into their national climate strategies. This challenge is already creating new opportunities for alignment between Parties and non-State actors and further anchoring the ocean in the climate negotiations.

Looking ahead, the road to COP30 in Belém, Brazil will be decisive. Taking place on the tenth anniversary of the Paris Agreement and the completion of its first full enhancement cycle, COP30 must serve as a turning point to review national strategies, measure collective progress, and set the tone for the next three years of action until the second GST in 2028.[60] Against this backdrop, the Ocean Breakthroughs are strategically positioned to demonstrate that ocean-based solutions are not only indispensable to achieving climate goals, but also ready to deliver at scale.

At the heart of the COP30 Action Agenda,[61] the Ocean Breakthroughs aim to spark a global *Mutirão for the Ocean* — a collective movement that unites climate, biodiversity, and development agendas to unleash unprecedented ocean action and impact.

1.4 Progress with the mobilization of UNFCCC Friends of the Ocean and Climate and associated actions

The Friends of the Ocean and Climate (FOOC) group, which Ocean Conservancy has been supporting as the Acting Secretariat since 2019, is an informal and inclusive group that provides a space for Parties and civil society organizations to discuss how to advance ocean-climate action in the UNFCCC and how to integrate ocean-climate nexus work across international fora. The FOOC aims to set a global standard for ambitious ocean-climate stewardship and ensure ocean and coastal communities' concerns are integrated into international climate discussions. Since 2017, the FOOC has championed efforts to secure a space for the ocean in the UNFCCC, including the creation of the OCCD. To accomplish this, the group has helped Parties prepare for negotiations at COP, coordinating with non-governmental organizations (NGOs) to support these efforts. Over the last few years, the FOOC has organized events at different venues including the UNFCCC COPs, SBSTA58 OCCD, New York Climate Week, and the UN Ocean Conferences (UNOCs). At each of these events, the FOOC has provided different perspectives to countries interested in implementing ocean-climate actions as part of their climate strategies, as well as encouraging synergies across the various fora.

The original goal of the FOOC was to initiate a dedicated discussion that would lead to inclusive dialogues within the UNFCCC to address the threat that climate change poses to the ocean, as well as to support efforts to maintain a healthy ocean. The FOOC was instrumental in securing the mandate for the OCCD during COP25 in Madrid in 2019 (the "Blue COP") and spearheaded discussions at COP26 and COP27 that led to the Dialogue's evolution into its current format.

Today, the FOOC continues to work in an inclusive manner to support efforts relating to: 1) mobilizing concrete ocean-based climate solutions and their inclusion in NDCs, NAPs, and other climate communications and commitments; 2) supporting efforts for the inclusion of the ocean across UNFCCC processes, such as the GST; 3) creating synergies for the ocean-climate nexus across international fora, including the UN CBD; and 4) identifying and promoting the enabling conditions that support the implementation of such actions (*e.g.* financing, policy gaps).

High-level political engagements hosted by the Friends of the Ocean and Climate Group (2024-2025)

The FOOC has helped mobilize high-level political support for negotiations, encouraged momentum for ocean-climate actions, developed and expanded international leadership on ocean-climate action, and helped integrate the ocean-climate nexus priorities across international fora with events such as high-level dinners hosted at UNFCCC COP28 (Dubai, 2023) and UNFCCC COP29 (Baku, 2024), and planned for UNFCCC COP30 (Belem, 2025), as well as high-level receptions and events held during SBSTA60 and SBSTA62 (Bonn, 2024 and 2025), the U.N. General Assembly High-level Week (New York, 2024), the International Renewable Energy Agency (IRENA) Assembly (Abu Dhabi, 2025), Our Ocean Conference (Korea, 2025), and the UNOC3 (Nice, 2025), supported by partners Oceano Azul Foundation, Ocean & Climate Platform and Ocean Conservancy.

Driving ocean-climate action at the Ocean and Climate Change Dialogue (June 2024 and 2025)

In the lead up to SBSTA60, a series of preparatory meetings with FOOC Parties helped to identify priorities and facilitate coordination ahead of the OCCD, held in June of 2024. These discussions focused on how to make the OCCD a platform to mobilize concrete ocean-climate action around the focal areas identified for the Dialogue by the Dialogue Co-Facilitators, which included marine biodiversity conservation and costal resilience and technology needs for ocean-climate action, including financial links. This discussion elevated opportunities to identify linkages

between the OCCD topics and NDCs, in addition to opportunities for NDCs and national climate plans to integrate ocean-based climate solutions.

In advance of SBSTA62 and the OCCD (Bonn, 2025), a technical analysis of opportunities across the entire UNFCCC (Constituted Bodies and Work Programs) to strengthen the integration of ocean-climate impacts and solutions was shared and presented to FOOC countries in preparation for negotiations at SBSTA62. Using the technical options paper as a starting point, six preparatory meetings of the FOOC were held to discuss and determine policy priorities to advance during SBSTA62. For the first time at an annual SBSTA meeting, the Friends of Ocean and Climate held daily coordination meetings to ensure delegates were more aware of opportunities to advance ocean-climate solutions across relevant negotiations. FOOC parties, and the two Ocean and Climate Change Co-Facilitators, carried the identified ocean-climate priorities, such as the need for adaptation indicators that consider ocean and coastal ecosystems and communities, and the role of ocean-climate solutions in the GST, beyond the room of the OCCD and into key negotiation spaces. This was a crucial step forward towards strengthening integration across UNFCCC agenda items that have the ability to mobilize support and resources for implementation of ocean-based climate solutions. As a result, cohesive policy asks regarding coastal and ocean ecosystems inclusion in adaptation discussions and the importance of ocean-climate finance were reflected in the unofficial outcome document of the Dialogue and delivered directly to negotiators at sessions throughout SBSTA62.

Driving action at COP28 and 29 (Dubai, 2023 and Baku, 2024)

At COP28, FOOC successfully advocated for the inclusion of ocean language in the final decision text of the "UAE Consensus," in addition to supporting the inclusion of ocean language in the final GGA text. Furthermore, FOOC party members were more than doubled, by the addition of: Ghana, Mexico, Palau, Panama, the Republic of Korea, and the European Union (EU) (including Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Romania, Slovakia, Slovenia, and Spain). These new members joined the historical FOOC members of: Canada, Chile, Costa Rica, Fiji, Indonesia, Kenya, Monaco, Norway, Portugal, Sweden, the United Kingdom, and the United States. Although the FOOC is an informal group of Parties, the addition of more active and engaged members working to advance ocean-climate action in the UNFCCC and across international fora serves to elevate key ocean-climate priorities.

In preparation for COP29, the FOOC held meetings to reflect on the key outcomes of the OCCD and launched a discussion to identify ocean-climate nexus priorities that the collective could help advance at COP29. Parties, in collaboration with NGOs, highlighted the importance of working towards better integration of ocean-climate priorities across the UNFCCC and exploring synergies with other international processes including the GBF and the BBNJ Agreement.

During COP29, the dozens of nations that make up the FOOC group coordinated daily to draft and release a powerful joint statement from the floor of the closing plenary of COP29. This statement was delivered by Dr. Sivendra Michael, Fiji's Permanent Representative to the UN, on behalf of the FOOC representing 35 countries, the Alliance of Small Island States (AOSIS), and the African Group of Negotiators on Climate Change (AGN).[62] The shared statement reaffirmed the FOOC's commitment to sustainable ocean-based climate solutions and the urgent need for climate finance to implement them; an important emphasis given the overall disappointing progress on the NCQG achieved at COP29. The FOOC leadership shown at COP29 helped build additional momentum for integrating ocean-climate solutions into climate finance discussions, NDCs, and NAPs, that will be carried on to COP30 in Brazil at the end of 2025.

1.5 Progress in other fora outside of the UNFCCC

United Nations bodies and related mechanisms

In its resolutions on the ocean and the law of the sea, the General Assembly consistently highlights the link between the ocean, climate change and biodiversity, and its serious concern at the current and projected adverse effects of climate change and ocean acidification on the marine environment and marine biodiversity, emphasizing the urgency of addressing these adverse effects, in view of the importance of preserving the role of the ocean as a carbon sink.[63]

The 17th round of the Informal Consultations of States-Parties to the 1995 UN Fish Stocks Agreement in 2024, held

discussions on the topic "Sustainable Fisheries Management in the face of Climate Change."[64] Delegations noted the importance of integrating fisheries into NDCs and NAPs, in view of their importance to food security, nutrition and sustainable development and the need to mobilize action and funding.[65]

The United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea (ICP) focused on "new maritime technologies: challenges and opportunities" in 2023 and addressed "the ocean as a source of sustainable food" in 2024. Climate change aspects are addressed in the context of these topics.[66]

As the inter-agency mechanism to enhance, strengthen and promote coordination, coherence and effectiveness of the activities of the United Nations system and the ISA on ocean and coastal issues, UN-Oceans continues to play an important role in facilitating inter-agency information exchange, including sharing of experiences, best practices, tools and methodologies and lessons learned in ocean-related matters, including in relation to climate change, in particular through side events organized on the sides of multilateral processes, including climate change COPs.

Established by the UN General Assembly, the Regular Process,[67] through its World Ocean Assessments, provides a synthesis of the latest science available on the state of the world's ocean and the social, economic, and cultural activities that take place in relation to the ocean. The third World Ocean Assessment will be delivered to the UN General Assembly towards the end of 2025. It will support the work of the international community on ocean-climate issues, ensuring a robust and integrated understanding of linkages, challenges, and solutions.

The Division for Ocean Affairs and the Law of the Sea (DOALOS), which acts as Secretariat for the above bodies and mechanisms, provides technical assistance and delivers capacity-building activities aimed at strengthening human and institutional capacity that support the effective development and implementation of inclusive and integrated ocean governance frameworks to address, amongst other things, the interlinkages between ocean-climate change-biodiversity action.[68]

Legal issues related to the ocean and climate change have been addressed recently by international courts and tribunals. In its advisory opinion on the Obligations of States in respect of Climate Change issued on 23 July 2025, the International Court of Justice (ICJ) unanimously affirmed that States have binding obligations under international law—including climate change treaties, customary international law, international human rights law and UNCLOS—to ensure the protection of the climate system from anthropogenic GHG emissions.[69] The Court also emphasized that the 1.5°C threshold constituted the primary temperature goal under the Paris Agreement. The Court held that breaching these obligations constitutes an internationally wrongful act, giving rise to State responsibility.[70] In relation to UNCLOS, the Court reiterated the opinion of International Tribunal for the Law of the Sea (ITLOS) (Climate Change, Advisory Opinion, ITLOS Reports 2024) that GHG emissions constitute marine pollution under UNCLOS, and found that States parties have obligations to protect and preserve the marine environment, including from GHG emissions and the adverse effects of climate change, and to co-operate in good faith.[71] In addition, the Court considered that UNCLOS does not require States, in the context of physical changes resulting from climate-change related sea level rise (SLR), to update their charts or lists of geographical co-ordinates that show the baselines and outer limit lines of their maritime zones once they have been duly established in conformity with UNCLOS.[72]

In its advisory opinion on climate change and international law, issued on 21 May 2024, the International Tribunal for the Law of the Sea found that anthropogenic GHG emissions into the atmosphere and excess energy absorbed by the ocean constituted "pollution of the marine environment" under UNCLOS.[73] Furthermore, States have the specific obligation to take all measures necessary to prevent, reduce and control this type of pollution and to cooperate to adopt relevant rules and standards directly or through competent international organizations. The Tribunal also found that, where the marine environment had been degraded, the obligation to protect and preserve the marine environment may call for measures to restore marine habitats and ecosystems, to both maintain the mitigation function of ocean ecosystems as carbon sinks and build the resilience of ecosystems as a form of adaptation.

UN Ocean Decade Conference 2024

The 2024 Ocean Decade Conference was held in Barcelona from 10 to 12 April 2024, bringing together the global Ocean Decade community and partners to celebrate and take stock of progress, and set joint priorities for the future. This important conference covered the full range of Ocean Decade Challenges, including critical issues such as climate change, food security, sustainable management of biodiversity, sustainable ocean economy, pollution, and natural hazards.

As covered in the 2022-2023 ROCA Report, the United Nations Decade of Ocean Science for Sustainable Development (known as the "Ocean Decade") is a once in a lifetime opportunity to deliver a step-change in the generation and use of ocean science.[74] The focus of the Ocean Decade is on solutions-oriented science that fills critical knowledge gaps to inform global and regional policy processes, including processes of the UNFCCC, and to facilitate understanding needed by governments, industry, and resource managers amongst others. It does so by recognizing that the ocean fundamentally influences many aspects of our society and that achieving SDG 14 will have far-reaching positive impacts on the greatest challenges we face today.

Through its Decade Implementation Plan, the Ocean Decade outlines ten Decade Challenges that represent the most immediate and pressing needs over the next decade.[75] Challenge 5 focuses on enhancing the understanding of the ocean-climate nexus and generating knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales. It also recommends improving services for prediction of ocean climate and weather. Working towards the achievement of Challenge 5 is central to addressing the other nine Decade Challenges and the Decade Outcomes.[76]

The Vision 2030 process was launched in the third year of implementation of the Ocean Decade. It is a strategic ambition-setting process to identify a shared measure of success for each of the Ocean Decade Challenges, including Challenge 5, on the road to 2030.[77]

The 2024 Ocean Decade Conference resulted in The Barcelona Statement,[78] which was prepared by the Decade Coordination Unit, housed within United Nations Educational, Scientific and Cultural Organization (UNESCO)'s Intergovernmental Oceanographic Commission (IOC) in its role as coordinating agency of the Ocean Decade, drawing upon the results of the Vision 2030 process, numerous consultations with partners in the lead-up to the 2024 Ocean Decade Conference, and the discussions during the Conference itself.

The Barcelona Statement outlines priority action areas for the Ocean Decade. The conference also focused on accelerating innovation and technology, enabling collaboration, improving ocean science infrastructure, and creating a digital ecosystem for ocean data.

The Conference discussed and identified the following future priorities:

Ocean Knowledge and Science Generation and Uptake – the co-design and co-delivery of science and knowledge to:

- Understand global distribution and human health and ecosystem impacts of marine pollution across the land-sea continuum, including the identification of priority pollutants and consideration of emerging and unregulated pollutants;
- Enhance and scale-up marine and coastal ecosystem-based management approaches, including a focus on better understanding of and solutions for multiple stressors;
- Better understand deep-sea ecosystems, including vulnerability to climate change and new or emerging economic activities;
- Encourage sustainable, resilient, and equitable small-scale fisheries and aquaculture and facilitate sustainable management of industrial fisheries;
- Strengthen sustainable aquatic food production and innovation for new frontiers with a focus on developing countries and strengthened public-private partnerships (PPP);
- Underpin evidence-based Sustainable Ocean Plans (SOPs) at the national level and in relevant transboundary areas;
- Encourage sustainable and climate resilient ocean economy projects, prioritizing those that integrate environmental conservation with socio-economic benefits for local communities.
- Rapidly scale up climate mitigation including through marine renewable energy and management of coastal ecosystems;
- Allow timely understanding of the technical, ecological, and social feasibility, potential impacts of proposed mCDR initiatives and contribute to future policy and regulation development.
- Underpin adaptive governance and management systems and decision support tools for the assessment of vulnerability and risk to coastal communities and marine industries;

- Develop economic models, policies, and innovative financial instruments to diversify and accelerate investment in ocean science, including for enhanced digital representation of the ocean and sustained and sustainable ocean observing and infrastructure;
- Inform knowledge drawn from transdisciplinary social science and ocean literacy research on human-ocean connection, behavior change, and cultural engagement that can be integrated intoOcean Decade digital infrastructure and used to map and measure the impact of ocean literacy initiatives; and
- Increase engagement with the health sector to better understand connections between ocean health and human health.

Ocean Infrastructure Needs – priority needs identified included:

- Marine pollution monitoring;
- Ocean observations;
- Interoperable ocean data; and
- Enhanced use of adapted, innovative technology to underpin the equitable generation, access and use of observations, data, and knowledge across all Ocean Decade Challenges, and by all nations.

Cross-cutting Issues – priority areas identified to ensure that the Ocean Decade is on track for success by 2030 included:

- Strengthening the role of national, regional, and international policy frameworks as drivers of priority science and knowledge generation through the Ocean Decade to ensure relevance and uptake;
- Enhancing the recognition and role of all knowledge systems in the Ocean Decade, including Indigenous and local knowledge;
- Encouraging more meaningful engagement of industry and the innovation sector including in the co-design and co-delivery of ocean science and capacity development initiatives;
- Significantly increasing targeted, expanded, and sustained financing and resourcing for Decade Actions and Decade coordination structures;
- Continuing to enhance diversity, inclusivity and equity in the Ocean Decade and systematically identifying and removing barriers to generational, geographic, and gender diversity;
- Curating strong links between the scientific community and professional communicators to enhance awareness of the importance of ocean science for action across all sectors of society;
- Continuing to expand efforts in ocean literacy to address all sectors of society including policy makers, resource managers, and industry; and
- Further optimizing Ocean Decade coordination for collective impact and ownership.

In addition, a series of major announcements and commitments were made during the Conference as a first step to achieving the above priorities including:

- Launch of new Ocean Decade programs on sustainable ocean planning, and on sustainable ocean management in Africa;
- Commitment by the Barcelona City Council and the Port of Barcelona to develop a Decade Collaborative Centre focusing on sustainable ocean economy;
- Launch of the Ocean Matcher Tool to enhance opportunities for philanthropic funding to Decade Actions – the Ocean Matcher Tool was launched at the UNOC3 in June 2025;
- Launch of new funding opportunities for Africa through the Belmont Forum and SIDS through the Marine Institute, Ireland; and
- Launch of the Sea'ties Initiative led by the Ocean & Platform to enhance the use of science for policy and decision making by coastal cities, including the offer of Qingdao Municipality to host the first Ocean Decade Coastal Cities Conference in 2025.

The Conference also recognized the importance of working collaboratively with other important events (such as the 2025 UNOC3 in Nice, France), and that through such collaboration the global ocean science community has the

possibility to catalyze previously unforeseen levels of action that will indelibly anchor the role of ocean science and knowledge in the achievement of the 2030 Agenda for Sustainable Development.

To fulfill the identified priorities and goals, the Conference issued the following Call to Action to all societal actors, including government, philanthropy, UN entities, industry, and the scientific community to:

- Engage strongly in the Ocean Decade including through the proactive development of partnerships and collaboration for the co-design and co-delivery of transformative Decade Actions that translate the priorities identified during the Conference to tangible action;
- Significantly increase investment of in-kind and financial resources in ocean science, including the development of policies and innovative financial instruments, thus ensuring the sustainability of existing and future Decade Actions, structures, and processes that are collectively working to fill the priorities identified during the Conference; and
- Seize all opportunities to raise awareness and visibility of the Conference outcomes and The Barcelona Statement as an essential guiding framework for global ocean science and knowledge priorities in the lead-up to the 2025 UNOC3.[79] [80]

UN Ocean Conference 2025

Co-hosted by Costa Rica and France, UNOC3 was held from 9 to 13 June 2025 in Nice, France. The conference was attended by 175 UN member States, 64 Heads of State and Government, 28 heads of UN, intergovernmental and international organizations, and more than ten thousand delegates. As the Ocean and Climate Platform states, "From the Blue Zone to the Whale, the city pulsed with the energy of the ocean community, awaiting transformative and concrete actions to finally turn the tide and address the major threats facing the ocean, its ecosystems, and the communities that depend on them."[81]

There was considerable anticipation ahead of UNOC3 given the growing recognition of the importance of the ocean in both the SDG and the UNFCCC processes, and with the anticipation of member States using the venue to advance the ratification of the BBNJ Agreement.

Significant Special Events preceding the Conference, including the One Ocean Science Congress (3–6 June), the Ocean Rise and Coastal Resilience Summit (7 June), the Blue Economy and Finance Forum (7–8 June), and World Ocean Day (8 June) all contributed to building strong momentum. More than a thousand events were held between the Blue Zone and the Green Zone (called the Whale), which welcomed more than 130,000 visitors[82] and was a major attraction in the city to UNOC participants, local residents, and tourists alike. Also, the Virtual Ocean Pavilion for COP30 was formally launched.

Blue Zone events included 10 Ocean Action Panels, each of which was accompanied by a Concept Paper to stimulate discussion.[83] The results of these panels provided inputs into the development of the conference's outcomes statement. Notably, Ocean Action Panel 7 addressed the need to leverage ocean, climate and biodiversity interlinkages, highlighting the central role of the ocean in climate systems and climate solutions.

Important statements were made recognizing the critical links between the ocean, climate, and biodiversity; linking ocean health and climate action; enhanced global action to mitigate climate change and ocean acidification; advancing the protection of marine ecosystems and the 30 by 30 target to protect 30% of the ocean by 2030; supporting strong, open, free science and support for the "Stand Up for Science" movement; increasing the elimination of marine pollution; accelerating the decarbonization of shipping; banning or severely restricting deep sea mining; increasing financing for SDG14 (the lowest financed of the SDGs); and advancing the ratification of the BBNJ Treaty with an additional 19 signatory countries announcing their formal ratification bringing the total to 50, just 10 short of the required 60 ratifications.

These statements and other commitments of the UNOC3 are included in the Nice Action Plan[84] and the final declaration statement,[85] adopted by more than 170 countries attending UNOC3. The plan is structured around a political declaration, entitled "Our ocean, our future: United for urgent action," which emphasizes the need for urgent action to protect the ocean and its resources. The plan includes commitments on conserving the ocean and its ecosystems, promoting sustainable ocean-based economies, and accelerating action. Under the last heading, the

declaration calls for:

- Early ratification and implementation of the BBNJ Agreement;
- Educational and public awareness campaigns to promote understanding of the importance of maintaining a healthy ocean and resilient marine ecosystems;
- The critical need for accounting and mapping of coastal and marine ecosystems, including the deep ocean floor;
- Strengthening regional cooperation and initiatives (such as the UNEP Regional Seas Programme) and establishing coordination mechanisms for integrated management and sustainable development of coastal and marine areas;
- The importance of using the best available science and knowledge (including traditional and Indigenous knowledge); and
- Supporting increased scientific research, data collection, and understanding of the ocean and sustainable science- and knowledge-based mechanisms to support a strong science-policy interface to provide timely, credible and salient scientific and socioeconomic information to inform policies and actions.

The declaration also recognizes that SDG 14 is one of the least funded SDGs and that accelerating ocean action globally requires significant and accessible finance and the fulfilment of existing commitments and obligations under relevant intergovernmental agreements.

The Nice Action Plan aligns with GBF[86] and other international arrangements, such as the Antigua and Barbuda Agenda for SIDS (ABAS) and recognizes the importance of engaging all actors, including SIDS, in the effort to protect the ocean. The Plan also includes a registry of over 800 voluntary commitments from governments, scientists, UN agencies, and civil society to support ocean conservation and sustainable development. The voluntary commitments, which include pledges from various stakeholders, aim to translate ambition into tangible action for ocean conservation and sustainable use.

Voluntary commitments made during the Conference include:

- The European Commission, as part of its Ocean Pact, announced an investment of €1 billion to support ocean conservation, science and sustainable fishing;
- French Polynesia pledged to create the world's largest MPA to safeguard its seas, covering its entire exclusive economic zone (EEZ), approximately 5 million square kilometers (1.93 million square miles);
- New Zealand committed over US$52 million towards supporting enhanced ocean governance, management and science in the Pacific Islands region;
- Germany launched a €100 million immediate action program for the recovery and clearance of legacy munitions in the German Baltic and North Seas – the first of its kind;
- Indonesia, the World Bank and other partners launched a Coral Bond, a groundbreaking financial instrument designed to mobilize private capital to conserve coral reef ecosystems within MPAs in Indonesia;
- Thirty-seven countries, led by Panama and Canada, launched the High Ambition Coalition for a Quiet Ocean — the first high-level political initiative to tackle ocean noise pollution on a global scale;
- Italy committed €6.5 million to strengthen surveillance by the Coast Guard in MPAs and on oil platforms, including through a satellite surveillance system capable of detecting potential oil spills in real time;
- Canada contributed US$9 million to the ORRAA to help SIDs and coastal developing countries increase their resilience to the impacts of climate change through NbS.
- Spain committed to creating five new MPAs that would allow protection of 25% of its marine territory; and
- A collective of United Nations agencies and global partners launched a co-design process for One Ocean Finance — a bold new effort to unlock billions in new financing from ocean-dependent industries and blue economy sectors.[86]

As stated by the Conference Secretary-General, UN Under-Secretary-General for Economic and Social Affairs Li Junhua, "Pledges made this week must be rigorously implemented, tracked, and scaled. The momentum we have generated must carry us forward to COP30, global and regional ocean forums, and national decision-making, and

translate into decisive national action."[87]

The fourth UNOC will be co-hosted by Chile and the Republic of Korea in 2028.

Agreement on Marine Biological Diversity of Areas beyond National Jurisdiction

The Agreement under UNCLOS on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement) was adopted on 19 June 2023 by the Intergovernmental Conference on Marine Biodiversity of Areas beyond National Jurisdiction[88] to be added as an instrument of UNCLOS to protect ocean life in international waters. The BBNJ Agreement will make vital inroads in addressing the triple planetary crisis of climate change, biodiversity loss, and pollution. The Agreement addresses the impacts of climate change and ocean acidification in a variety of ways and recognizes the need to address biological diversity loss and degradation of ocean ecosystems in a coherent and cooperative manner. Climate change impacts on marine ecosystems are wide-ranging and magnified by additional stressors, such as ocean acidification, pollution, and unsustainable use. It is critical to build ecosystem resilience and maintain and restore ecosystem integrity, including carbon cycling services that underpin the role of the ocean in climate. In accordance with the general principles and approaches set out in the draft BBNJ Agreement, its Parties shall be guided by this approach.[89]

Building capacity and transferring technology is a key issue for implementation of the BBNJ Agreement. The project *Capacity Building Initiative for SIDS: Early Ratification and Equitable Implementation of the BBNJ Agreement* is supported by the Bloomberg Ocean Initiative and Arcadia, and it is managed by the University of Wollongong. The project aims to build capacity and support early ratification in SIDS while enhancing ocean equity.[90]

Similarly, cross-sectoral management and governance are major challenges to biodiversity conservation and the sustainable use of marine areas beyond national jurisdiction (ABNJ). The Common Oceans Cross-sectoral Project[91] has been initiated with the aims of building and strengthening regional and national capacity for sectoral and cross-sectoral cooperation and coordination, knowledge management and public awareness of ABNJ. The Cross-sectoral Project sits under the umbrella of FAO's Common Ocean Program,[92] with UNEP as the implementing agency and the GOF as the executing agency for the project, with support from six co-executing partners.[93]

The BBNJ Agreement offers new opportunities to connect the myriad of pressures being faced across the ocean science-policy-society interface. It is a crucial legal instrument to protect marine life, ecosystems, and ocean-reliant communities in the two-thirds of the ocean that lie beyond any country's jurisdiction. As of 7 November 2025, there are 145 signatories and 75 parties to the Agreement, which is set to enter into force on 17 January 2026.

Progress in FAO related fora

Advancing the ocean-climate synergies requires a holistic and coordinated approach to ensure that global efforts are mutually reinforcing. This includes fostering continuity of discussions across key forums beyond the UNFCCC to prevent duplication and enhance policy coherence. In line with this thinking, the FAO Committee on Fisheries (COFI), which is the sole global inter-governmental forum addressing major issues related to aquatic foods, has regularly included climate change as an agenda item for discussion,[94] as well as through its Sub-Committees.[95] Additionally, FAO has established a Strategy on Climate Change,[96] supported by a multi-year action plan.[97] As part of its efforts to contribute to global dialogue, a FAO submission was made to the inform the 17th round of Informal Consultations of States Parties (ICSP-17) of the United Nations (UN) Fish Stocks Agreement held in May 2024 on the topic of "Sustainable fisheries management in the face of climate change".[98] FAO also actively contributed to the 24th meeting of the UN Open-ended ICP-24 in June 2024, on the theme "The ocean as a source of sustainable food", to promote sustainable aquatic food production with minimized climate and environmental footprint.

Progress on ocean acidification undertaken by Global Ocean Acidification Observing Network, IOC, WCO, Ocean Acidification Alliance, and others

International efforts to monitor and address ocean acidification have gained momentum, with increasing alignment between global frameworks and national-level reporting. Notable contributions have come from the Global Ocean Acidification Observing Network (GOA-ON), the Intergovernmental Oceanographic Commission (IOC), the WMO, and the Ocean Acidification Alliance (OA Alliance).

GOA-ON has continued to expand its monitoring and capacity building efforts, as well as solidify actions through the UN Ocean Decade Programme Ocean Acidification for Sustainable Research (OARS) by setting targets for monitoring, ecosystem response assessment and data sharing, and increasing the link with temperature and oxygen datasets to support multi-stressor analysis. The regional hubs of GOA-ON have expanded to include the Southern Ocean, the Caribbean and the Indian Ocean. Regional hubs such as the Pacific Islands and Territories OA Hub (PI-TOA) conducted horizon scanning surveys to identify science-policy gaps, with findings feeding into the Pacific Islands Ocean Conference (Sept–Oct 2025).[99] These efforts are informing national reporting under SDG 14.3 and the UNFCCC. The IOC-UNESCO, through IOCARIBE,[100] continued to support SDG14.3 implementation by coordinating OA monitoring in the Caribbean and Western Pacific. Training workshops emphasizing standardized pH and temperature protocols are creating data that are increasingly used in national biodiversity and climate reports. The SDG14.3.1 ocean acidification indicator now has a data portal that can receive data submissions from around the world.[101] The IOC has received increasing numbers of submissions, with a reported expansion of monitoring stations from 178 in 2021 to 765 in 2025. However, they recognize important gaps in observations and data in many areas, especially in coastal Asia and Africa, and most open ocean areas outside of the North Atlantic Ocean.[102]

The WMO integrated ocean acidification into its Earth System Monitoring framework through its adoption as a Global Climate Indicator in 2018, thus including it in their annual State of Global Climate updates (latest in 2024).[103] This enables countries to link acidification trends with ocean heat content, deoxygenation, and SLR in their national assessments.

The OA Alliance continues to support governments in embedding ocean acidification into national climate adaptation strategies and UNFCCC submissions, with growing uptake across Europe, the Pacific, and Latin America. For example, at the 2025 UNOC3, ten national governments announced new or expanded ocean acidification Action Plans or detailed initiatives to address acidification within their national marine strategies.[104] The USA and France reaffirmed their commitments, aligning their plans with their broader ocean-climate strategy, the GBF and SDG14.3. Mexico and Colombia committed to developing OA Action Plans that feed directly into their Voluntary National Reviews (VNRs) and UNFCCC submissions, linking acidification to fisheries, livelihoods, and biodiversity. Subnational plans were also presented, for instance, from the Cross River State (Nigeria) and the City of Vancouver (Canada). Tribal governments, such as the Makah Tribe and Quileute Nation, announced new OA Actions focused on culturally significant species and traditional knowledge.

Ocean acidification is also increasingly recognized as part of the triple planetary crises of climate change, biodiversity loss, and pollution. For instance, the UK's International Environmental Protection Report (2022-2024)[105] reaffirmed commitments under the Environment Act 2021, including legally binding targets for marine protection, recognizing ocean acidification as a key stressor alongside warming and pollution, and alignment with the GBF. Continued efforts to align ocean acidification with climate change, pollution and biodiversity loss will allow improved uptake into NDCs, NAPs and the SDGs.

Progress on the Kunming-Montreal Global Biodiversity Framework and relevant outcomes of CBD COP16

With only five years left to achieve the targets of the Kunming-Montreal Global Biodiversity Framework (GBF), adopted at the fifteenth meeting of the CBD COP in December 2022,[106] CBD Parties are working to advance its effective and holistic implementation in order to halt and reverse biodiversity loss. Nearly all of the 23 cross-cutting targets of the GBF are relevant for the ocean. In particular, Target 8 aims to minimize the impacts of climate change and ocean acidification on biodiversity and increase its resilience, including through NbS and/or ecosystem-based approaches. Target 11 further aims to restore, maintain and enhance nature's contributions to people, including ecosystem functions and services, and protection from natural disasters, through NbS and/or ecosystem-based approaches. Other targets such as Target 2 on restoring 30% of all degraded ecosystems and Target 3 on conserving 30% of land, waters, and seas are also essential for the ocean-biodiversity-climate nexus, underscoring the importance of integrating climate considerations in their implementation.[107]

At CBD COP 16, Parties updated the monitoring framework[108] that had initially been adopted together with the GBF,[109] and they have been revising their NBSAPs to align with the GBF, developing national targets, and preparing their seventh national reports, due in February 2026.[110] These efforts are critical for the Party-driven global review of collective progress in implementing the GBF, which will be conducted at COP 17 in late 2026. The review will

primarily rely on national reports and a global report on collective progress prepared with the support of an Ad Hoc Scientific and Technical Advisory Group (AHSTAG). Following rounds of peer review, the draft report will be considered at the twenty-eighth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA 28) and the seventh meeting of the Subsidiary Body on Implementation (SBI 7), before its final consideration by COP17, which will be held from 19 to 30 October 2026 in Yerevan, Armenia.[111]

Reflecting the whole-of-government and the whole-of-society approaches of the GBF, Parties have been encouraged to involve all levels of government and all stakeholders in revising NBSAPs.[112] Importantly, Parties have been urged to consider integrating NbS and/or ecosystem-based approaches into their revised NBSAPs and national targets, and promote synergies with other national planning processes related to UNFCCC and the Paris Agreement.[113] Non-state actors have also been invited to submit, on a voluntary basis, commitments contributing to NBSAPs and to the GBF, guided by the agreed core reporting elements.[114]

CBD COP16 further resulted in important outcomes advancing the ocean-climate nexus. A comprehensive decision on biodiversity and climate change reaffirmed past decisions on ocean fertilization and climate-related geoengineering, and gave mandate to explore opportunities to address the ocean-climate-biodiversity nexus in an integrated manner to achieve the GBF.[115] It further requested the Executive Secretary to develop a supplement to the Voluntary Guidelines for the Design and Effective Implementation of Ecosystem-based Approaches to Climate Change Adaptation and DRR providing further guidance on NbS and/or ecosystem-based approaches to climate change mitigation and adaptation, in support of implementing Targets 8 and 11 and other targets. Following consideration by SBSTTA 27, the outcomes of this work are expected to be considered by COP17.

After years of discussions, Parties agreed on a new mechanism to identify new ecologically or biologically significant marine areas (EBSAs) and update existing EBSAs with new scientific information, which can include changes in location or ecological or biological features, such as due to climate change.[116] This landmark decision is particularly important for the effective implementation of Target 3 on area-based conservation in marine and coastal areas, and could be used to inform future proposals for the establishment of area-based management tools (ABMTs), including MPAs, under the BBNJ Agreement. Furthermore, the COP identified priority areas and gaps in need of additional focus under the CBD to support the implementation of the GBF with respect to marine, coastal and island biodiversity, with several of them focusing on climate-related issues, and invited relevant organizations to strengthen their work on these issues.[117] These include: 1) improved knowledge of the impacts of geoengineering on marine and coastal biodiversity, in line with the precautionary approach; 2) increased use of NbS and/or ecosystem-based approaches in coastal and marine ecosystems; 3) mapping, monitoring, restoring, and effective management of marine and coastal ecosystems contributing to climate mitigation and adaptation; 4) conservation and sustainable use of biodiversity associated with sea ice, and improved knowledge of the impacts of sea ice loss on marine and coastal ecosystems; 5) ecological restoration on islands, especially of ecosystems contributing to DRR and resilience; and 6) improved knowledge of the impacts of ocean acidification and warming on island ecosystems, especially when combined with other stressors, and strengthening resilience.

Lastly, COP16 adopted a new Programme of Work on Article 8(j) and other provisions of the CBD related to IPLCs.[118] It includes a specific task for Parties to support IPLC-led initiatives addressing interlinkages between biodiversity and climate change, reflecting the key role of IPLCs in achieving both biodiversity and climate goals.

1.6 Regional Developments

1.6.1 Caribbean

Cartagena Convention Secretariat: Ocean and Climate Progress 2024-2025

The Cartagena Convention (adopted in 1983) remains the only legally binding regional agreement for coordinated action on coastal/marine biodiversity protection, pollution control, and oil-spill response in the Wider Caribbean Region. It explicitly recognizes the value of the Caribbean Sea and its "fragile and vulnerable coastal and marine ecosystems." Since its entry into force in 1986, 26 states have acceded. In late 2024 St. Kitts and Nevis became the 19th Party to the Specially Protected Areas and Wildlife (SPAW) Protocol and 16th to the Land-Based Sources (LBS) Protocol, underlining sustained momentum to strengthen legal frameworks for transboundary pollution control and biodiversity conservation. Protection of the Caribbean Sea helps build resilience of the Wider Caribbean Region to

the impacts of climate change while reducing vulnerabilities of coastal populations in mainland countries and SIDS.

Marine Pollution

Under the Convention's LBS and Oil Spills protocols, the Secretariat worked with countries to curb coastal pollution. Notably, St. Kitts and Nevis' 2024 ratification of the LBS Protocol "demonstrates the priority placed on mitigating land-based pollution impacts" in the Caribbean. Throughout 2024–2025 the Secretariat and its Regional Activity Centres led national/regional workshops to bolster pollution monitoring and assessment capacity. For example, technical committees of the LBS and SPAW protocols convened to update a Regional Sargassum Action Plan (to be finalized at COP18, Oct 2025). This initiative recognizes that Caribbean sargassum blooms (37.5 million tons in May 2025) are driven by multiple factors, including climate change, nutrient runoff, and changing currents, and requires coordinated solutions.

Public outreach also increased. The Secretariat marked International Coastal Clean-Up Day 2025 in Kingston to highlight plastic and Styrofoam pollution, and more generally has expanded awareness campaigns on the harm from plastics, agrochemicals, and untreated sewage.

Major technical projects have been deployed with international partners. With the Global Environment Facility (GEF), EU and German funding, UNEP through the Cartagena Convention Secretariat supported integrated water-land-ecosystem management in Caribbean SIDS. For example, the German-funded PROMAR project is reducing plastic litter in coastal environments of Belize, Guyana, Suriname, St. Kitts & Nevis, and Trinidad & Tobago. The five-year GEF IWECo project (Integrating Water, Land & Ecosystems) has bolstered resilience in SIDS by addressing watershed management, biodiversity protection, and land degradation.

A UK–Caribbean Blue Economy Partnership is now advancing marine pollution management in partnership with the Secretariat. In June 2025 in Guyana (and similarly in Jamaica), UK experts from the UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS) and the Secretariat, working with national agencies, launched a project on "Enhancing Water Quality for Sustainable Blue Economy Development." This UK-funded initiative provides technical advice and national workshops to strengthen local capacity for assessing and controlling marine pollution – for example, a two-day Blue Economy & Marine Pollution workshop in Georgetown (June 2025) brought together government, private sector, and community stakeholders to plan priority actions. (In Guyana, the Environmental Protection Agency noted that this collaboration is building "the scientific capacity, institutional strength, and regional alignment" needed to safeguard marine resources).

Cartagena Convention Secretariat-led efforts in 2024–2025 have knit together regional projects on plastics, nutrients, and wastewater, and by generating national pollution inventories, guidelines, and waste-audit programs (with EU/Germany/GEF support), and training resource managers, the region has enhanced its ability to prevent and respond to major pollutants. These pollution controls not only benefit coastal ecosystems but also improve resilience to climate-driven stressors.

Marine Biodiversity

On the conservation side, the SPAW Protocol continues to drive protection of the Caribbean's critical ecosystems (coral reefs, mangroves, seagrasses) and species. SPAW now has 19. The Secretariat worked closely with the SPAW Regional Activity Centre (SPAW-RAC, Guadeloupe) and partners to expand a network of MPAs and enhance ecosystem-based management capacity. For example, the SPAW-listed MPA Network now includes 38 sites across 15 countries, and a region-wide "network of MPA managers" (through the Caribbean Marine Protected Areas Network and Forum (CaMPAM)) has been established for peer learning and joint planning.

In late 2024–2025 the Secretariat, through CaMPAM, rolled out a new Training-of-Trainers course for English-speaking MPA staff, thereby reinforcing MPA management skills in 11 additional countries.

To conserve threatened species, SPAW's technical committees finalized key action plans in 2024 (*e.g.* a revised marine mammals conservation plan) and continue reviewing proposals to list new species and protected areas. In tandem, coordination with international initiatives has broadened their impact. The Secretariat collaborated with the International Coral Reef Initiative (ICRI) and the Global Coral Reef Monitoring Network (GCRMN) Caribbean node to standardize coral reef health monitoring. Under these efforts, countries are generating harmonized reef

datasets that feed into global assessments. In fact, SPAW-RAC coordinated the GCRMN-Caribbean node's work and led preparation of the 2025 GCRMN Report for the Wider Caribbean. These monitoring data will also contribute to the UN's Global Coral Reef Status Report (part of the UN Regular Process for the Marine Environment) and inform progress towards the GBF biodiversity targets.

Recognizing that habitats must be connected and resilient, several regional restoration projects have been launched. The GEF-funded Gulf of Mexico Large Marine Ecosystem (GoM-LME) project (a transboundary US–Mexico program) is implementing ecosystem-based management solutions to "conserve and restore the quality of coastal and marine ecosystems." Its goals include improving water quality, halting overfishing, and "rehabilitating the coastal and marine ecosystems" of the Gulf. Closer to the Caribbean Sea itself, the new UNDP/GEF PROCARIBE+ project (2023–2028) is explicitly designed to "protect, restore and harness the natural coastal and marine capital" of the Caribbean/LBS ecosystems, thereby catalyzing climate-resilient blue-economy investments. PROCARIBE+ activities include region-wide coordination on ocean governance, mangrove and reef restoration, and support for countries to adopt sustainable fisheries and marine management. These large-scale projects complement SPAW's efforts to establish networks of connected MPAs and address shared threats like coral bleaching and invasive species.

Training and Capacity Building

The Secretariat has continued to deliver technical assistance to strengthen national and local marine stewardship. In addition to CaMPAM MPA training, the Secretariat partnered with SPAW-RAC and ICRI to build technical capacity for reef science. Training sessions and mentorship programs have advanced countries' abilities to monitor reef conditions and report in a standardized way (aligned with GBFs).

Another focus is water quality and pollution monitoring: the new UK-CCS/CEFAS project is actively training Guyanese (and Jamaican) officials and scientists on marine water-quality sampling, analysis, and management in support of sustainable blue-economy planning.

The Secretariat continues its behavior-focused training on waste. The 2023 Caribbean workshop on behavior-centered design (see above) now feeds into community projects. In sum, the Secretariat convened dozens of workshops, webinars, and training-of-trainers events during 2024–25, involving government, academic and civil society representatives from multiple countries. These events cover topics ranging from MPA management to pollution economics, thereby pooling expertise across the region and ensuring that small states benefit from shared learning.

Knowledge Management and Communications

Recognizing that policy change requires public support, the Secretariat launched a new Knowledge Management and Communications Strategy (with an accompanying marketing action plan) in 2025. This plan emphasizes stakeholder engagement and behavior change in resource use. It has led to more targeted messaging on marine issues, expanded use of social media, and redevelopment of the Secretariat's newsletter and online info portal.

Overall, these knowledge-management efforts aim to ensure that regional decisions are science-based and that lessons learned in one country are shared widely (for instance, examples of successful reef restoration or plastic reduction campaigns are circulated regionally).

The Cartagena Convention's programs reflect a deeply integrated, transboundary approach, with many initiatives implemented jointly by multiple countries and partner, and active coordination with other conventions (*i.e.* BBNJ) and regional seas (*i.e.* Regional Seas programs).

Looking ahead, the Cartagena Convention Secretariat plans to produce an integrated State of the Convention Area Report (2026) combining marine pollution and biodiversity indicators across the Caribbean. Such a report would synthesize existing data to show regional trends and inform policy.

Meanwhile, work continues under all three Protocols. The region is on track to add more countries as Parties, to extend its protected-area network, and to scale-up solutions like circular economy, green infrastructure, and MSP. Given the Caribbean Sea's outsized importance to tourism, fisheries and climate resilience, these efforts by the Cartagena Convention Secretariat, in partnership with many national, regional, and global actors, are vital.

By strengthening ecosystems and data-sharing, supporting community-led clean-ups and education, and aligning with the GBF, the Secretariat is helping countries of the Wider Caribbean Region build resilience for their coasts and communities against the impacts of climate change.

1.6.2 Latin America

This subsection focuses on regional developments in Latin America concerning climate change from the perspective of coastal and marine sciences, environmental studies, and climate change research. It summarizes a comprehensive report prepared by experts from various institutions across Latin America, which is found in Annex 1. The report highlights Latin America's rich biodiversity and vulnerability to climate change impacts, such as cyclones, hurricanes, floods, droughts, and rising sea levels. These events threaten infrastructure, water supply, food production, and livelihoods, causing significant economic losses. The report discusses the region's diverse geography, including countries with access to both the Pacific and Atlantic coasts and Caribbean island nations, each facing unique climate challenges. It notes the frequency and intensity of tropical systems in both the Atlantic and Pacific Ocean.

Specific regional climate projections are provided for Central America, including rising temperatures, complex precipitation trends, and sea level rise. Ocean acidification and warming in the Mesoamerican Reef region are also addressed. The report reviews the status of ocean accounting in Latin America and the Caribbean, highlighting progress and challenges in data collection and implementation.

The South America section of the report emphasizes the region's vulnerability due to its diverse ecosystems and coastal populations. Sea level rise is noted to be faster than the global average in some areas, threatening coastal cities. The impact of La Niña and El Niño events on weather patterns and droughts is discussed, along with challenges in implementing climate agendas due to scientific gaps, political support, and financial limitations.

Individual country reports are provided, including Argentina, Belize, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Guatemala, Honduras, Uruguay, and Mexico. Each country's specific vulnerabilities, climate impacts, policy responses, and ongoing challenges are detailed. These sections cover issues like rising temperatures, sea level rise, coastal erosion, extreme weather events, ocean acidification, and efforts towards adaptation and mitigation.

Latin America is home to six of the world's most biodiverse countries, which together harbor 70% of all mammals, birds, reptiles, amphibians, plants, and insect species. The region contains 40% of global biodiversity and over 25% of the world's forests, while the Caribbean alone hosts 50% of plant species found nowhere else on Earth. Coastal and marine ecosystems span approximately 16 million kilometers^2 and more than 70,000 kilometers of coastline. Despite contributing only 10% of global greenhouse gas emissions, Latin America and the Caribbean already bear some of the worst impacts of global warming. Cyclones, hurricanes, floods, droughts, rising sea levels, and glacier loss are increasingly triggering migration and endangering millions of lives across urban, rural, and coastal areas. Climate change also threatens basic infrastructure, clean water supply, food production, and electricity generation, jeopardizing livelihoods and basic services. Economic losses and damages from these events can exceed 2% of annual GDP. From 1998 to 2020, climate-related disasters claimed over 312,000 lives and affected more than 277 million people in the region.[119] In 2024, the region experienced significant climate impacts and extreme weather events, including droughts, floods, and wildfires, that disrupted lives, livelihoods, and food supply chains. Coastal communities and ecosystems face particular threats from sea level rise, ocean warming, and acidification in both the Atlantic and Pacific Ocean.[120]

Among the 19 continental Latin American countries, seven have access to both the Pacific and Atlantic coasts, four are exclusively Pacific, and eight are solely Atlantic. All Caribbean island nations and territories lie within Atlantic waters. The size and morphology of each country (especially their longitudinal span) determine their vulnerability to oceanic phenomena and climate variability. The increasing frequency and intensity of tropical, subtropical, and extratropical weather systems have significant consequences for public safety, infrastructure, the economy, and agriculture. From 1991 to 2020, the Atlantic averaged 14 named tropical systems per year (seven hurricanes, three major hurricanes), while the Eastern Pacific averaged 15 (eight hurricanes, four major hurricanes).[121] South American countries are less prone to direct impacts but are not immune, and climate change may shift these patterns. For example, the South Atlantic has seen rare systems such as Catarina (2004), Iba (2019), Raoni (2023), and Akará (2024), which originated as subtropical systems.[122]

The average size of a cyclone, measured as the mean distance from the eye to the outermost closed isobar, is 333 kilometers in the Atlantic and 489 kilometers in the Pacific. "Very large" cyclones can exceed 888 kilometers in radius, with the largest on record being Typhoon Tip (1979), which had a diameter of 2,200 kilometers in the Pacific. Among continental Latin American countries and Cuba, seven (35%) have maximum longitudinal dimensions greater than 1,000 kilometers, while 13 (65%) have extensions of less than 500 kilometers, making them especially vulnerable to cyclonic effects. Caribbean island nations and territories, due to their small size, are even more exposed.

The report concludes by noting the variability in public policy on climate change across Latin America and the need for greater collaboration among society, academia, and governments. It stresses the importance of scientific research, accessible technologies, and the democratization of scientific knowledge to address climate change effectively. The report also calls for improved data collection, international cooperation, and regional networking to strengthen resilience and policymaking.

The scope of public policy on climate change in Latin America and the Caribbean varies depending on the priority assigned by each administration, often slowing progress. However, in a rapidly changing and globalized world, this region faces uncertainty regarding the impacts of climate change, as environmental, cultural, social, and economic damages become increasingly severe and frequent.

Latin America and the Caribbean host key ecosystems for global biodiversity and are a critical area for climate change. Despite possessing an extraordinary proportion of the planet's biodiversity and forests, the region suffers severe climate impacts, even though its contribution to global greenhouse gas emissions is relatively low. Therefore, it is still necessary to promote projects that encourage conservation and sustainable resource management, fostering collaboration among society, academia, and governments. Additionally, raising awareness and re-evaluating the role of biodiversity and forests in the region is essential.

This part of the world is increasingly vulnerable to extreme weather events such as cyclones, hurricanes, floods, droughts, and wildfires, threatening millions of lives, infrastructure, food security, and livelihoods. The economic losses caused by these events exceed 2% of the annual GDP. While the quality of life of the population has been affected, many individuals lack knowledge or adequate tools to adapt and mitigate the effects of climate change in their local environments, both culturally and economically. Therefore, accessible technologies must be developed to enable the implementation of nature-based actions and solutions.

Geographical and morphological characteristics significantly determine countries' vulnerability to climate hazards. Those with extensive coastlines and large longitudinal enlargements may experience different levels of exposure to oceanic phenomena, while small Caribbean islands are particularly susceptible to cyclonic effects due to their limited territorial area. Thus, countries with insular or coastal zones must develop comprehensive marine and coastal management policies, as well as strengthen urban planning based on projections of sea-level rise, coastal erosion, and temperature increases. Additionally, establishing strategies to address the displacement of at-risk populations is crucial, ensuring concrete actions that support adaptation and mitigation in the face of climate challenges.

Changes in tropical cyclone patterns and the emergence of rare meteorological systems highlight modifications in climate dynamics. The presence of subtropical systems in the South Atlantic, along with variations in cyclone size and frequency, underscores the need for continuous monitoring and proactive adaptation. Addressing these challenges requires increased investment in scientific research to develop more efficient, accessible, and rapid meteorological systems, especially in insular and coastal regions. Furthermore, promoting the democratization of scientific knowledge is essential to ensure that all individuals have access to information and tools that allow them to understand and combat climate change effects.

Deficiencies in data collection and uneven coverage hinder effective climate adaptation and mitigation planning. Strengthening international cooperation is crucial to improving climate data gathering, model calibration, and regional information exchange. To this end, fostering the training of young researchers in climate change and creating new academic and governmental positions will help standardize climate data across Latin America and the Caribbean, facilitating evidence-based decision-making and promoting more effective response strategies.

Finally, establishing a regional collaboration network where Latin American experts actively participate in virtual seminars will enhance the dissemination of new findings, the development of joint projects, and academic

exchanges. Coordinated efforts to monitor, analyze, and share data on climate variability and its impacts will strengthen resilience and provide valuable insights for policymaking across the region.

1.6.3 East Asia

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)

In the East Asian Seas (EAS) region, coastal and ocean ecosystems play a particularly vital role in underpinning food security, economic activity, disaster resilience, and cultural identity across some of the world's most densely populated and ecologically diverse coastlines. However, these systems are under increasing threat from climate change, biodiversity loss, and pollution, further complicated by socio-economic and geopolitical challenges, as well as rapid technological advancements.

As PEMSEA prepares for 2030, understanding the status and emerging trends in coastal and ocean systems and governance is important (Figure 2).

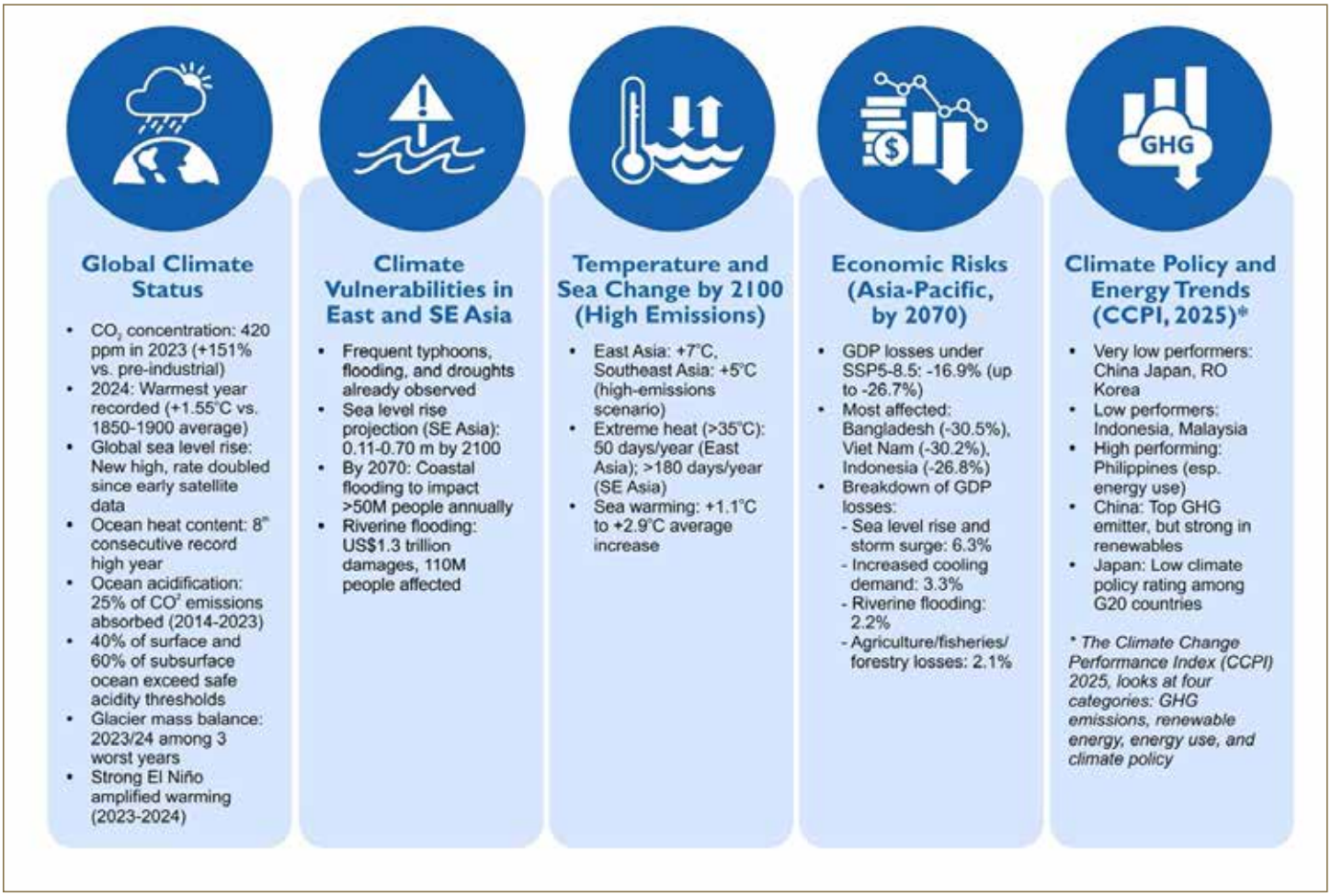

Figure 2. Current Status and Emerging Trends in the Seas of East Asia

The East and Southeast Asian region is home to some of the world's most climate-vulnerable countries and is already experiencing frequent extreme weather events, including typhoons, storm surges, coastal flooding, and prolonged droughts, threatening livelihoods, food security, and economic stability.[123]

Based on the Climate Change Performance Index (CCPI) 2025,[124] which looks at four categories[125] including GHG emissions, renewable energy, energy use, and climate policy, East and Southeast Asian countries, specifically China, Japan, and RO Korea were among the 15 countries out of 67 that received very low performance. While the Philippines is among the high performing countries, Viet Nam and Thailand were ranked medium performing, and Indonesia and Malaysia as low performing. The report noted China as the largest emitter of GHG emissions globally but ranked as one of three best performing G20 countries on renewable energy along with Indonesia and Brazil.

Japan received one of the lower ratings among G20 countries in terms of climate policy. In terms of energy use or consumption, the Philippines was the only country receiving very high performance, while RO Korea was listed in the lower range of rankings.

In a 2024 survey by the ISEAS–Yusof Ishak Institute,[126] 2,931 respondents from 10 ASEAN countries shared views on climate change, policy responses, and regional action. The report reveals that floods (70.3%), heatwaves (51.8%), and landslides triggered by heavy rain (49.8%) are viewed as the most serious climate impacts. Nearly 60% believe their lives will be greatly affected by climate change within the next ten years, with concern rising notably in the Philippines and among higher-income groups. Respondents also reported increasing food insecurity linked to climate-related disasters and policy gaps. National governments are still seen as bearing the most responsibility and cost burden for addressing climate change, though there are varying perceptions in terms of their effectiveness. Businesses are viewed as least active, while support for carbon taxes and cutting fossil fuel subsidies is growing. Solar, hydro, and wind energy were noted as the most favored clean energy options, with increasing interest in hydrogen and nuclear alternatives. Across ASEAN, respondents call for stronger regional cooperation, especially in clean energy infrastructure and financing, to ensure an inclusive and just transition toward a climate-resilient future.

Projected Changes, Impacts and Trends

Climate projections suggest that East and Southeast Asia[127] will face increasing biophysical changes throughout the 21st century, even if global GHG emissions were stopped immediately (ADB, 2024). Severe temperature increases are expected. Under a high-emissions scenario, East Asia may experience average increases of up to 7°C, while Southeast Asia may see increases of nearly 5°C by 2100. East Asia could experience heat extremes of nearly 50 days annually above 35°C, while Southeast Asia may experience extreme heat for over half the year (Climate Tracker Asia, 2024). The surrounding seas are also projected to warm significantly, with average increases between 1.1°C and 2.9°C, further disrupting marine ecosystems and the services they provide.[128]

Rising sea levels exacerbate the threat. Under high emissions, sea levels are projected to rise by around 0.8 meters by 2100 worldwide, though local factors and polar ice instability could worsen the impact.[129] Parts of Asia and the Pacific are already experiencing relative SLR that is twice the global average. In Southeast Asia, especially in coastal areas where the majority of the region's population and infrastructure are concentrated, coastal sea levels could rise by up to 0.70 meters by 2100, intensifying the risk of inundation, saltwater intrusion, and loss of habitable land. Based on satellite altimetry data from 1992–2020, the projection for SLR in Southeast Asia's coastal areas ranges from 0.05–0.33 meters by 2050 and 0.11–0.70 meters by 2100.[130]

By 2100, extreme weather events, such as tropical cyclones and typhoons, are projected to become nearly twice as destructive, while rainfall becomes more intense and erratic, raising the likelihood of both severe flooding and prolonged droughts.[131] [132] Coastal erosion, driven by a combination of rising seas, more powerful storm surges, and altered tidal dynamics, is already changing shorelines, damaging critical infrastructure and exacerbating vulnerability especially in Southeast Asia.[133]

Concerns over declining fisheries in several countries in the region are already being exacerbated by ocean warming and increasing unpredictable weather patterns.[134] Damages to coral reefs and changes in species distribution are expected under the high-emissions scenario of Representative Concentration Pathways (RCP) 8.5, endangering small-scale fisheries, biodiversity and the food security of coastal populations in Southeast Asia. Though changes in biological systems such as plankton biomass and primary production are less noticeable than those in physical and chemical conditions, they remain significant and potentially disruptive.[135]

Food security is another growing concern. Southeast Asians viewed prolonged droughts and heat waves, frequently followed by intense flooding, as major threats to availability and affordability of food.[136] Ocean warming, storm surges, fisheries decline, and saltwater intrusion into farmlands further compound these challenges. Countries such as China, Indonesia, the Philippines, Viet Nam, Malaysia, Singapore, Thailand, Cambodia, Laos, Myanmar, and Timor-Leste are projected to experience reduced crop yields. Human health is also at risk, with rising temperatures expected to reduce labor productivity and increase mortality and health-related risks. Energy demand, particularly for electricity, is projected to rise due to higher cooling needs in East and Southeast Asia.[137]

The economic risks posed by climate change are also projected to be severe. By 2070, coastal and riverine flooding

could affect over 160 million people annually in Asia and the Pacific, resulting in trillions of dollars in damages under a high-end emissions scenario. Sea-level rise, storm surges, and flooding alone could impact more than 50 million people each year, while riverine flooding could cause up to US$1.3 trillion in damages and affect over 110 million people. Increased rainfall variability and extreme storms will increase the risk of landslides, especially in mountainous areas.[138]

Overall, climate change could lead to a loss of up to 16.9% of regional Gross Domestic Product (GDP) in Asia and the Pacific by 2070 under the Shared Socio-Economic Pathways 5-8.5 scenario. Included in the most vulnerable countries are Bangladesh (-30.5%), Viet Nam (-30.2%), and Indonesia (-26.8%). In more extreme projections, regional GDP losses could reach 26.7%. These estimates probably understate the full impact, as they do not account for broader effects on human health, ecosystem services, or social stability. Sea-level rise and storm surges are projected to be the largest contributors to GDP loss (6.3%), followed by increased energy demand for cooling (3.3%), riverine flooding (2.2%), and reductions in natural resources such as agriculture, forestry, and fisheries (2.1%). Even under more moderate scenarios like RCP4.5 and RCP2.6, the Asia Pacific region is expected to face substantial economic losses, underscoring the urgent need for adaptation alongside mitigation efforts (Figure 3).[139]

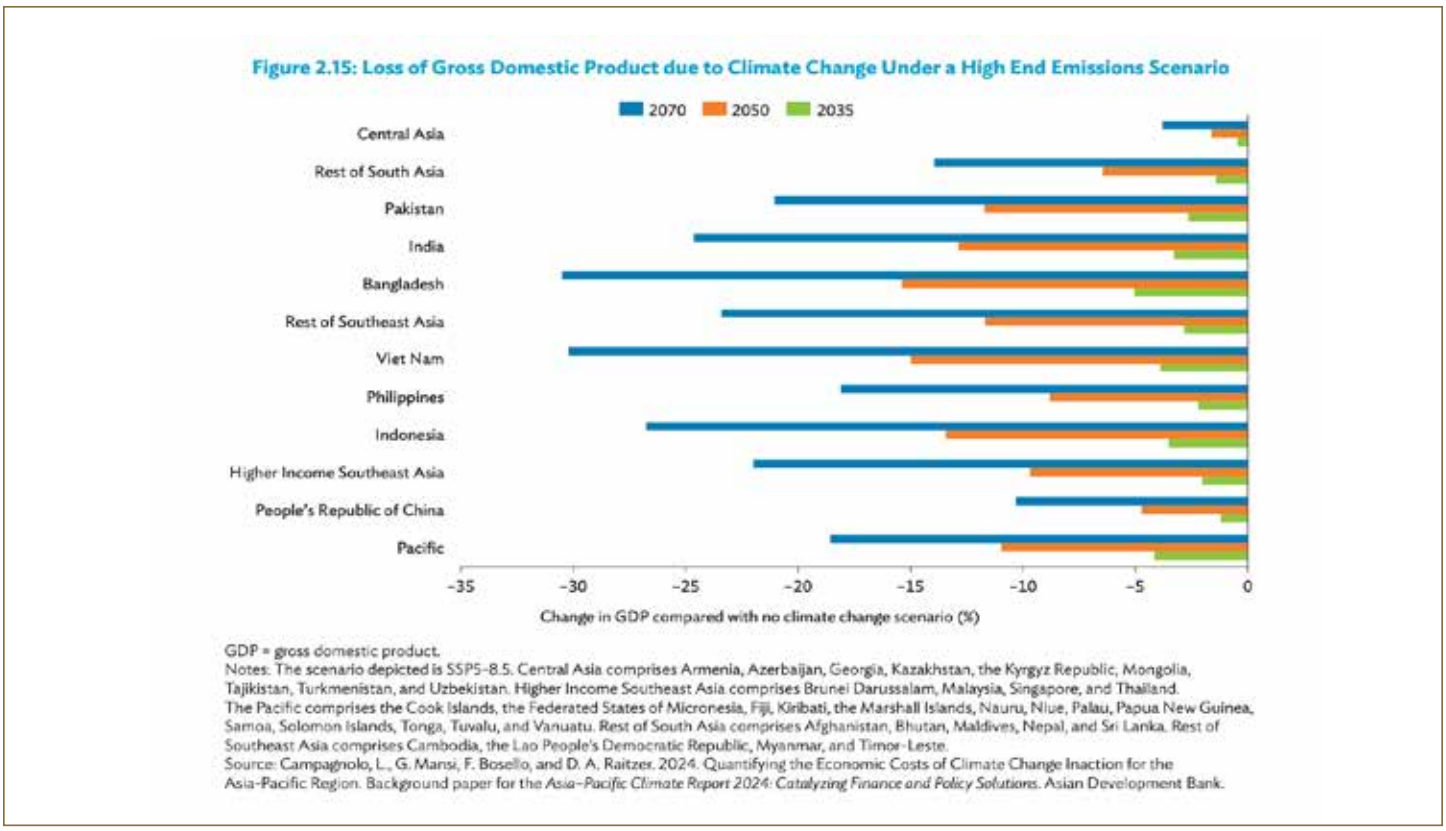

Figure 3. Loss of GDP due to Climate Change Under a High-End Emission Scenario[140]

ATSEA: A New Regional Collaboration in Managing Arafura and Timor Seas Ecosystem

Despite its substantial ecological and economic importance, the Arafura and Timor Seas (ATS) region is confronted with multiple environmental pressures, notably illegal, unregulated, and unreported fishing, marine pollution, coastal habitat degradation, and susceptibility to oil spills. These threats are further compounded by overfishing and the impacts of climate change, which collectively jeopardize the long-term sustainability, productivity, and resilience of the region's coastal and marine ecosystems. Recognizing the ecological and socio-economic value of the ATS coastal and marine ecosystems, the Arafura and Timor Seas Experts Forum (ATSEF) was conceived to promote integrated and ecosystem-based management aimed at the sustainable development of the ATS region. Since its inception in 2003, regional collaboration has advanced through two major project-based initiatives funded by the GEF and implemented by the UNDP: 1) the Arafura and Timor Seas Ecosystem Action Project Phase I (ATSEA-1; 2009–2014); and 2) the ATSEA-2 Project (2019–2024). The experience from the two ATSEA projects has underscored the importance of

establishing a Regional Governance Mechanism as a platform to ensure continuous coordination and deliver more targeted actions toward achieving the 20-year vision of the ATS Strategic Action Programme. The Strategic Action Programme 2024–2033 guides regional action through a framework shaped by participatory processes and scientific approaches. ATSEA's vision is a healthy, resilient, and productive Arafura and Timor Seas that supports both human wellbeing and nature. In addition, the mission of the ATSEA Program is to foster social, ecological, and economic progress through a blue economy–oriented regional partnership in the ATS region.[141] Over the next decade, ATSEA collaboration ill focus on four key priorities:

1. Reducing marine plastic pollution and abandoned, lost, or otherwise discarded fishing gear:
2. Preventing and responding to oil spills;
3. Reducing the incidence of small-scale illegal, unregulated, and unreported fishing; and
4. Increasing the resilience of endangered, threatened, and protected species and critical habitats.

Coordinating Body on the Seas of East Asia (COBSEA)

The Coordinating Body on the Seas of East Asia (COBSEA) is a regional intergovernmental mechanism that brings together nine countries (Cambodia, People's Republic of China, Indonesia, Republic of Korea, Malaysia, the Philippines, Thailand, Singapore and Viet Nam) for the sustainable development and protection of the marine environment and coastal areas of the East Asian Seas.[142] The flagship instrument of COBSEA, the COBSEA Strategic Directions (2023-2027) provides guidance on achieving the 2030 Agenda for Sustainable Development. It focuses on three thematic programs: 1) marine pollution prevention, reduction and control; 2) marine and coastal biodiversity, ecosystem conservation and management; and 3) climate action focusing on nature-based solutions for mitigation and adaptation.[143] COBSEA addresses marine plastic pollution by coordinating action plans, supporting monitoring and data collection, and facilitating regional collaboration among member countries. It implements projects such as the SEA circular initiative with UNEP, focusing on reducing plastic waste leakage, promoting policy development, and encouraging community and private sector engagement across the Seas of East Asia region.[144] Over the past year, several workshops and activities across the three thematic programs were convened in collaboration with international partners to share best practices, bridge gaps, showcase achievements, amplify impactful action and develop practical solutions. Highlighted activities are included below.[145]

- Report on "Towards a Regional Assessment ion Marine Litter in the East Asian Seas" (December 2024)[146]
- Asian Regional Dialogue on Seagrass and Dugong Conservation (February 2025)
- Knowledge Exchange Webinar between Regional Seas Conventions and Action Plans (October 2025)[147]
- Asia-Pacific Workshop on Accelerating the Implementation of the Kunming-Montreal Global Biodiversity Framework through an Integrated and Synergistic Approach (October 2025)[148]

Association of South East Asian States (ASEAN)

As reflected in the ASEAN Joint Statement on Climate Change during COP30 adopted 26 October 2025,[149] ASEAN member states recognise that biodiversity loss and environmental degradation, including from climate change, constitutes one of the most pressing and serious threats to the ability of present and future generations to enjoy fundamental human rights. The statement further emphasized the need to strengthen cooperation in implementing the UNFCCC, the CBD, and other relevant conventions to maximise the resources for achieving the target of climate change and biodiversity.

The ASEAN Socio-Cultural Community (ASCC) Blueprint guides ASEAN cooperation on the environment, among other topics. The latest ASCC Blueprint 2025 identified a series of strategic measures to achieve outcomes relating to the conservation and sustainable management of biodiversity and natural resources as well as sustainable climate, among others. The strategic measures include:[150]

- Promote cooperation for the protection, restoration and sustainable use of coastal and marine environment, response and deal with the risk of pollution and threats to marine ecosystem and coastal environment, in particular with respect to ecologically sensitive areas;
- Enhance policy and capacity development and best practices to conserve, develop and sustainably manage marine, wetlands, peatlands, biodiversity, and land and water resources;

- Promote capacity building in a continuous effort to have sustainable management of ecosystems and natural resources;
- Strengthen human and institutional capacity to implement climate change adaptation and mitigation, especially on vulnerable and marginalized communities; and
- Facilitate the development of comprehensive and coherent responses to climate change challenges, such as but not limited to multi-stakeholder and multi-sectoral approaches.

The ASEAN Working Group on Climate Change Action Plan 2019-2025 supports capacity building and technical exchange covering a broad range of relevant issues, including adaptation and resilience, planning and assessment of NDCs, assistance with GHG emissions, and climate finance.[151] As at the time of writing, the ASEAN is in planning/ developing the ASEAN Climate Change Strategic Action Plan (2025-2030) and the post-2025 ASEAN Strategic Plan on Environment.

During the recent 43rd ASEAN Ministers on Energy Meeting (AMEM) held on 14-17 October 2025, Kuala Lumpur, Malaysia, Ministers endorsed the new ASEAN Plan of Action for Energy Cooperation (APAEC) 2026-2030, which serves as the guiding blueprint for ASEAN's energy agenda. Focused on decarbonization, digitalization and diversification of the regional energy mix, the APAEC adopted new aspirational targets of 40% reduction in energy intensity by 2030 (based on 2005 levels), 30% renewable energy share in Total Primary Energy Supply (TPES) by 2030, and 45% renewable energy share in installed power capacity.[152] As a point of comparison, the previous ASEAN Plan of Action for Energy Cooperation 2016-2025 envisioned a regional achievement of 32% reduction in energy intensity by 2025 (based on 2005 levels) and a 23% share for renewable energy share in the total primary energy supply by 2025. According to the Sixth ASEAN State of the Environment Report, the goal of 32% in energy intensity was on track but the renewable share target still required more efforts.[153] Other outcomes from the AMEM include:

- An enhanced ASEAN Power Grid (APG) Memorandum of Understanding (MOU) to improve policy and regulatory coordination which are key elements in the full build out of the APG;
- Terms of Reference (TOR) for ASEAN Subsea Power Cable Development Framework, notable as the deployment and passage of its subsea power cables through the region's waters is a key milestone towards the implementation of the APG by 2045;
- Work on the ASEAN Renewable Energy Certificate Framework to harmonize certification for and facilitate the cross-border trade of renewable energy in support of the APG; and
- The ASEAN Power Grid Financing Initiative in collaboration with the World Bank and Asian Development Bank, designed to mobilize public and private investments in transmission infrastructure and interconnection projects.

To accelerate a sustainable blue economy in Southeast Asia, ASEAN, Japan, and UNDP launched the Blue Carbon and Finance Profiling Project in May 2025. Building on an earlier ASEAN Blue Economy Innovation Project, this ASEAN-Japan-UNDP collaboration identifies, maps, and values potential carbon credits in marine and freshwater ecosystems, using best available science, satellite technology and field assessments. The project aims to strengthen technical capacity to assess carbon stocks, develop robust blue carbon profiles, and integrate blue carbon strategies into national and regional development plans across ASEAN and Timor Leste. The aim being to unlock innovative financing solutions that drive climate resilience and inclusive economic growth across the region.[154]

Bilateral Initiatives

In addition to the regional initiatives above, some ASEAN member countries have pursued bilateral collaborations on issues within the scope of this report. Such arrangements can offer useful pathfinders for climate-ocean-biodiversity action.

Further to Singapore and Indonesia's Memorandum of Understanding (MOU) Concerning Cooperation on Climate Change and Sustainability (Marvh 2022) that focused on collaboration in carbon markets, carbon credit projects under Article 6 of the Paris Agreement, and nature-based solutions,[155] both countries have since deepened their collaboration through two main MOUs, which are highlighted below.

1. *An MOU on Community Empowerment in Mangrove Ecosystems (April 2024):* This established a bilateral framework to facilitate NGO and stakeholder participation to promote the sustainable use of mangrove resources in

local communities as well as facilitating research on best practices in mangrove restoration in academic and research institutions in Indonesia and Singapore.[156]

2. *MOU on Carbon Capture Storage (June 2025):* This established a joint Working Group to study the components of a legally binding G2G agreement on carbon capture storage, an essential pre-precursor to the implementation of cross-border carbon capture storage projects.

Singapore and Malaysia entered into similar arrangements with MOUs on carbon credits as well as carbon capture and storage in June 2025. Singapore and Malaysia will also jointly pave ways for a credible framework to recognize Renewable Energy Certificates for cross-border electricity trade and have commenced 50 megawatts of renewable electricity under the Energy Exchange Malaysia pilot.[157]

The regional developments are aligned with and reflected in domestic policy in relation to climate-biodiversity policy. For instance, Viet Nam's Prime Minister issued Decision No. 232/QD-TTg in January 2025, approving a project to establish and develop a carbon market for Viet Nam, with a view to spurring financial support for the country's greenhouse gas reduction efforts.[158] Vietnam's 2022 updated NDC highlighted the importance coastal resilience through mangrove restoration and seagrass conservation, enhancing carbon storage while protecting biodiversity, aligning with regional blue carbon initiatives to bolster climate mitigation and adaptation efforts[159]. Thailand's updated Adaptation Plan (2023) emphasized the utilization and preservation of coastal and marine ecosystems.[160] The Philippines National Climate Change Action Plan 2011-2028 adopted ecosystem-based adaptation to enhance coastal resilience with climate goals.[161]

1.7 Future directions: Strategies to strengthen synergies between the Climate and Biodiversity Conventions

There is a growing recognition of the need to strengthen synergies, cooperation mechanisms, and coordinated action between the UNFCCC and CBD processes as a fundamental means to tackle the interconnected crises of biodiversity loss and climate change. Momentum has been growing at the interface between the two conventions, with opportunities for cooperation emerging.[162] Stronger cooperation between the governing bodies of both Conventions can lead to mutually supportive decisions, allowing Parties to develop integrated national policies that maximize co-benefits, minimize trade-offs, and reduce duplication of efforts. Opportunities to enhance synergies include joint scientific and technical work; identification of integrated approaches to the implementation of the Paris Agreement and the GBF; joint capacity-building approaches; improved coordination across the respective COPs and subsidiary bodies of both Conventions; improved collaboration among the national focal points; harmonized approaches to NBSAPs, NDCs, and NAPs; and stronger coordination between the IPCC and IPBES processes[163] and the Conventions' respective financial mechanisms. While some progress has been made in these areas, tangible opportunities remain for further action.

The GBF, strongly interlinked with the Paris Agreement's goals to mitigate and adapt to climate change, stresses the importance of strengthened cooperation and synergies with other conventions, agreements and processes in order to deliver on its goals and targets more effectively and efficiently.[164] Targets 8 and 11 directly link biodiversity action with climate change mitigation and adaptation (through NbS and/or ecosystem-based approaches), with sub-target 19(e) focusing on finance co-benefits and synergies addressing both biodiversity loss and climate change. Together with targets on spatial planning (target 1), restoration (target 2), and area-based conservation (target 3), these provide strong impetus for joint action across both Conventions, other intergovernmental bodies, governments and stakeholders on marine biodiversity and climate change from global to local levels.

Recent UNFCCC developments provide further opportunities for alignment. Building on the CBD's considerable progress of integrating climate-related issues into its work, the UNFCCC has in recent years made important steps to integrate biodiversity elements into its discussions.[165] At COP28, the UAE Framework for Global Climate Resilience under the GGA set a thematic 2030 target on "reducing climate impacts on ecosystems and biodiversity, and accelerating the use of EbA and NbS,"[166] explicitly referencing marine and coastal ecosystems. The associated two-year UAE-Belém work programme on developing indicators to measure progress against those targets provides an opportunity to align with the monitoring framework of the GBF.[167] This could further allow for increased coherence in monitoring, reporting and assessment across the UNFCCC and CBD processes, enabling Parties to utilize the same

data and information where possible. Similarly, the GST under the Paris Agreement emphasized the "importance of conserving, protecting and restoring nature and ecosystems towards achieving the Paris Agreement temperature goal", in line with the GBF, referencing marine ecosystems.[168] A joint statement on climate, nature and people, led by the COP Presidents of all Rio Conventions, further underscored that Paris Agreement and the GBF cannot be achieved unless climate change and biodiversity loss are tackled together.[169]

In parallel, CBD COP16 called upon the Presidents of CBD COP16 and UNFCCC COP29 and COP30 to strengthen multilateral coordination on climate change and biodiversity loss, and adopted a decision on biodiversity and climate change which can help Parties in addressing synergies and enhancing policy coherence.[170] For example, in the context of implementing the GBF, it urges Parties to "identify and maximize potential synergies between biodiversity and climate actions, including by prioritizing the protection, restoration and management of ecosystems and species important for the full carbon cycle and contributing to climate change adaptation."[171] It also encourages to consider both positive and negative impacts of climate change and associated policies on biodiversity when implementing the GBF, and stresses the importance of engagement between CBD and UNFCCC national focal points to ensure coherent national planning processes and implementation.

CBD Parties are now updating their NBSAPs in line with the GBF and developing their national reports, ahead of the 2026 global review on collective progress in its implementation, to be conducted at CBD COP17. Similarly, UNFCCC Parties are updating their NDCs and advancing the assessment of progress under NAPs, expected to conclude at UNFCCC COP30. There is a key momentum to ensure greater alignment across these plans and strategies to strengthen synergistic action on climate and biodiversity, until 2030 and beyond.[172] CBD Parties have been urged to consider integrating NbS and/or ecosystem-based approaches into their revised NBSAPs and national targets, and promote synergies across national planning processes related to UNFCCC and the Paris Agreement.[173]

Institutional cooperation mechanisms and partnerships, such as the Joint Liaison Group of the Rio Conventions, the Bern Process, or the Sustainable Ocean Initiative (SOI) Global Dialogue with Regional Seas Organizations (RSOs) and Regional Fishery Bodies (RFBs), also play a key role in strengthening cooperation and synergies. Building on the CBD COP16's request to continue collaboration with the UNFCCC Secretariat,[174] and to identify opportunities for cooperation including by exploring the potential for a joint programme of work of the Rio Conventions, countries and organizations recently begun exploring concrete options for enhanced policy coherence to support implementation across the Rio Conventions.[175] The Rio Conventions Joint Capacity-Building Programme further works to improve the understanding of the synergies among the Conventions and develop capacities for synergistic national-level implementation.[176] The Bern Process, which brings together representatives of the governing bodies of the biodiversity-related conventions, including both the CBD and UNFCCC, has provided an additional platform to enhance synergies and cooperation. At the Bern III Conference in January 2024, participants identified tangible opportunities to enhance synergies and collaboration among the biodiversity-related conventions in implementing the GBF.[177] Furthermore, the SOI Global Dialogue with RSOs and RFBs, coordinated by the CBD Secretariat, UNEP, and FAO, convenes key global intergovernmental bodies, RSOs, and RFBs, to explore concrete opportunities for cross-sectoral regional cooperation and strengthen their roles in achieving global objectives.[178]

The science-policy interface is another key area of importance for collaboration, and IPCC and IPBES have been making advancements.[179] Recently, the 11th session of the IPBES Plenary decided to organize (subject to the availability of resources) a workshop on biodiversity and climate change, to support the second global assessment of biodiversity and ecosystem services. These efforts are essential to scientifically examine the interlinkages between biodiversity and climate change, while engaging experts across different fields, in support of developing synergistic action.[180]

The interlinkages between the ocean, biodiversity and climate are being increasingly recognized and addressed, as discussed during the OCCD 2025[181] and the UNOC3.[182] The CBD COP16 requested the CBD Executive Secretary, in collaboration with the UNFCCC Secretariat and other UN bodies, to explore opportunities for addressing the ocean-climate-biodiversity nexus in an integrated manner, in support of the GBF.[183] Importantly, Parties identified priority areas and gaps in need of additional focus under the Convention to support the implementation of the GBF in the ocean, and invited relevant organizations to strengthen their work on these issues.[184] They include: 1) improved knowledge of the impacts of geoengineering on marine and coastal biodiversity, in line with the precautionary

approach; 2) increased NbS and/or ecosystem-based approaches in coastal and marine ecosystems; 3) mapping, monitoring, restoring, and effective management of marine and coastal ecosystems contributing to climate mitigation and adaptation; 4) conservation and sustainable use of biodiversity associated with sea ice, and improved knowledge of the impacts of sea ice loss on marine and coastal ecosystems; 5) ecological restoration on islands, especially of ecosystems contributing to DRR and resilience; and 6) improved knowledge of the impacts of ocean acidification and warming on island ecosystems, especially when combined with other stressors, and strengthening resilience. These priority areas provide an opportunity for scientific and technical cooperation to drive effective implementation and to scale up action on the ground.

Moving forward to delivering action across those priority areas will now require the identification of specific entry points, at the national and sub-national policy level, to ensure that ambition materializes. For instance, Sustainable Ocean Planning[185] and climate-smart Marine Spatial Planning (CSMSP)[186] are two key, emergent policy pathways resulting from decades of global MSP policy development, that are set out to address, in particular, targets 1, 2, 8, 11 and 19 of the GBF, as well serving as delivery mechanisms for NBSAPs, NDCs and NAPs . The development of those policies at the national and sub-national level are therefore excellent entry-points for actioning coordinated guidance by the two conventions, helping practitioners and policy makers tackle both the biodiversity crisis and the climate emergency, which many nations already aspire to but where on the ground developments are often still lacking. Coordination and joint delivery of evidence synthesis at the level of the SBSTA/SBSTTA of both conventions and other evidence gathering mechanisms could target the development of specific advice to those policy pathways, provide routes for knowledge sharing between Parties, as well as help identify financing mechanisms to enable Parties to support joint target delivery across the conventions. Marine Spatial Planning policy makers and practitioners have a wealth of knowledge in delivering the type of multiple objective and multiple sectorial governance that are needed to help bring about the transformative changes that both conventions aspire to. The emergence of SOPs and climate-smart Marine Spatial Plans are therefore unique opportunities to bring about action that supports biodiversity, whilst helping prepare for, adapt to and mitigate climate change.

Identification of other specific governance mechanisms that can help bring about these joint objectives is now required to ensure momentum is sustained. Support from science-policy interface networks and workplans, external to the UNFCCC and the CBD, can be important enablers of that change. For instance, the 10 challenges set out as targets of the United Nations Decade of Ocean Action for Sustainable Development can be seen as important enablers helping deliver joint action for both conventions. That is, not only by fostering the setting up of necessary, international scientific collaborations and partnerships for knowledge sharing, but also by helping identify financial support for capacity development of Parties to both conventions that help deliver on their joint objectives. Regional mechanisms, such as regional seas conventions, and important science-policy interface networks (such as the International Council for the Exploration of the Sea) can be valuable supporting mechanisms to help develop and deliver solutions at the interface of the CBD and the UNFCCC. More targeted action between the conventions and those networks could help access that resource.

2. NEW SCIENTIFIC FINDINGS ON THE OCEAN AND CLIMATE, UNDERSCORING THE NEED FOR URGENT ACTION AND APPROPRIATE POLICIES

Co-authors: Peter Ricketts, Acadia University and Global Ocean Forum; Laura Anderson, Stanford Center for Ocean Solutions; Bernadette Snow, Scottish Association for Marine Science; Lisa Levin, Scripps Institution of Oceanography, UC San Diego; Matt Frost, Plymouth Marine Laboratory

This section reviews some recent reports relevant to the ocean-climate interface, as well as latest findings from peer-reviewed research. Among the many scientific developments are the clear indications that the world is moving progressively closer to reaching the 1.5° C increase in global average temperatures that the Paris Agreement seeks to avoid. While we are still below the Paris Target, the rate at which we are closing in on it is alarming. Scientific evidence is also showing that as we near the target, the adverse impacts of climate change are accelerating, and the ocean is sounding the alarm bells as we see record sea-surface temperatures, sea-level rise, ocean acidity, and sea-ice melting (in both polar regions) since measurements have been recorded. As a result, some of the major global systems are getting closer to their predicted tipping points, and most of those involve the ocean.

2.1 Recent reports and research

IPCC

The final Synthesis Report of the IPCC's 6th Assessment Report (AR)[187] was published in March 2023 and the key findings were presented in the 2022-2023 ROCA Report. Since then, the IPCC has been working on the development of the reports that will comprise the 7th Assessment. In a keynote speech to the 17th Session of the Research Dialogue in Bonn, Germany on June 17, 2025, Jim Skea, the Chair of the IPCC Research Dialogue, referenced the very first sentence of the Summary for Policymakers of the AR6 Synthesis Report as a relevant high-level statement: "Human activities, principally through emissions of GHGs, have unequivocally caused global warming. Skea emphasized that we now have high levels of confidence that some type of impacts can be attributed to human activities, noting that we are highly confident that human activities have caused observable increases in hot extremes (Figure 4)), that it is likely that human activities are the main driver of the intensification of heavy precipitation, and likely, but with lower confidence, on the human influence on agricultural and ecological drought**.** One of the tasks of the 7th AR will be to address these lower confidence topics with a view, if it is supported by the evidence, to reach robust conclusions.

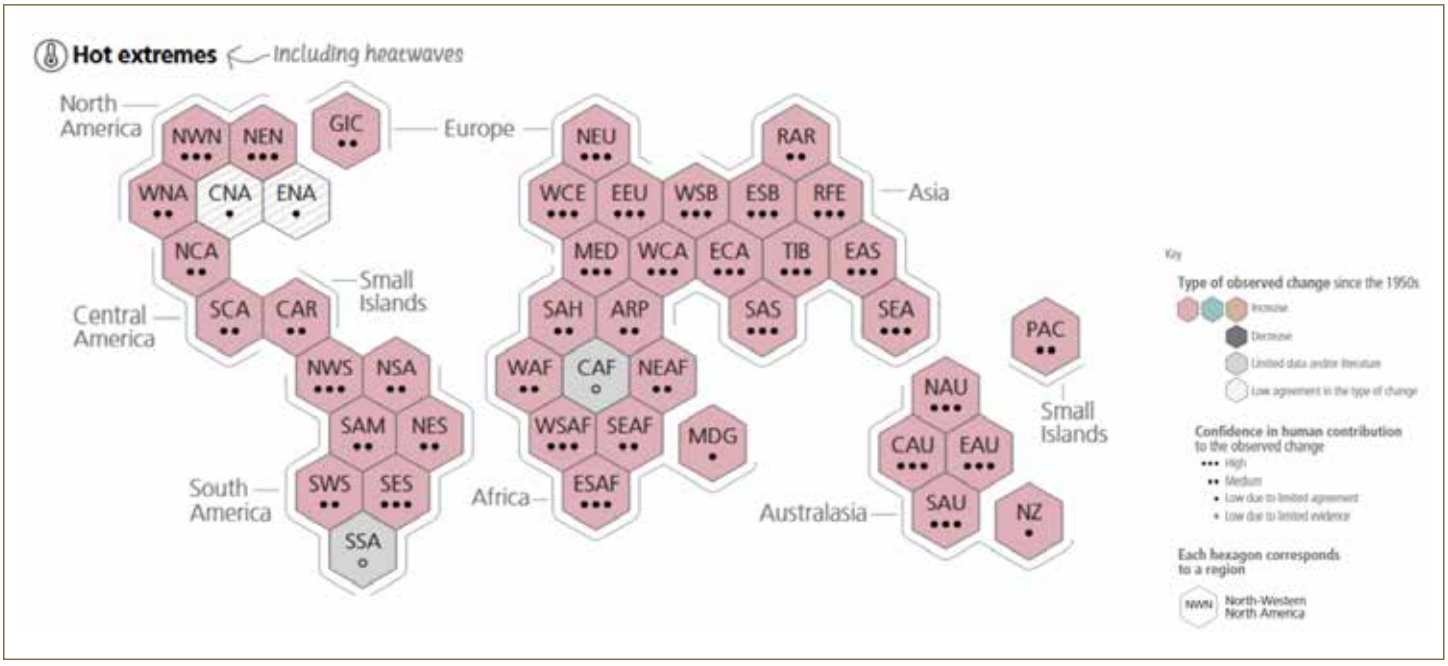

Figure 4. Likelihood that Human Activities are Causing Heat Extremes[188]

Key recent scientific findings referred to in Skea's address include:

- According to the World Meteorological Organization (WMO) and other monitoring bodies, annual average global mean near-surface temperature for the single year of 2024 was 1.55°C above pre-industrial levels. While this does not imply that the 1.5°C warming level mentioned in the Paris long-term temperature goal (which is based on the mid-point of a 20-year long-run average) has been breached, there is now a 70% chance that average warming over the years 2025-2029 will exceed 1.5ºC. Estimates of current long-run warming averaged over multiple years vary between 1.34 and 1.41ºC, but as successive years become warmer than the previous year, the likelihood of exceeding the 1.5°C Paris target by 2030 is increasing; and
- Plausible temperature pathways that can both "exceed" and "limit" warming to 1.5°C remain. Figure 5, based on work by Carbon Brief, shows that a pathway can exceed a given warming level in the short-medium term but still limit warming to that same level by the end of the century.

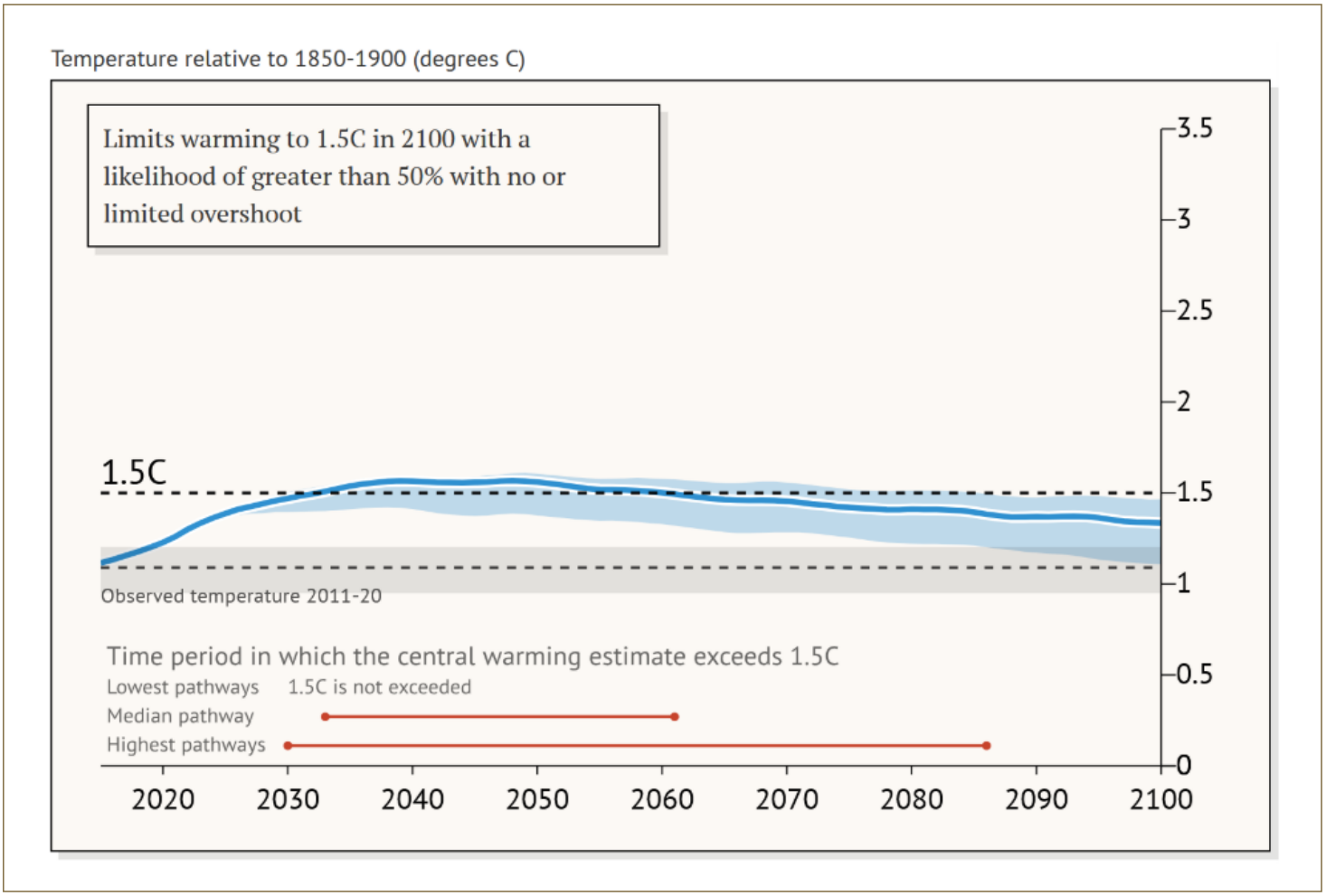

Figure 5. A Plausible Pathway that can both Limit Warming to 1.5°C and Exceed 1.5°C Warming[189]

Skea's conclusions based on recent scientific data and analyses are clear: GHG emissions are still rising, and the global community is not on track to limit warming to 1.5°C. Figure 6 by UNEP shows that, even if all the current National Determined Contributions and net zero pledges were to be met in full, warming would at best be just below 2°C by the end of the century.

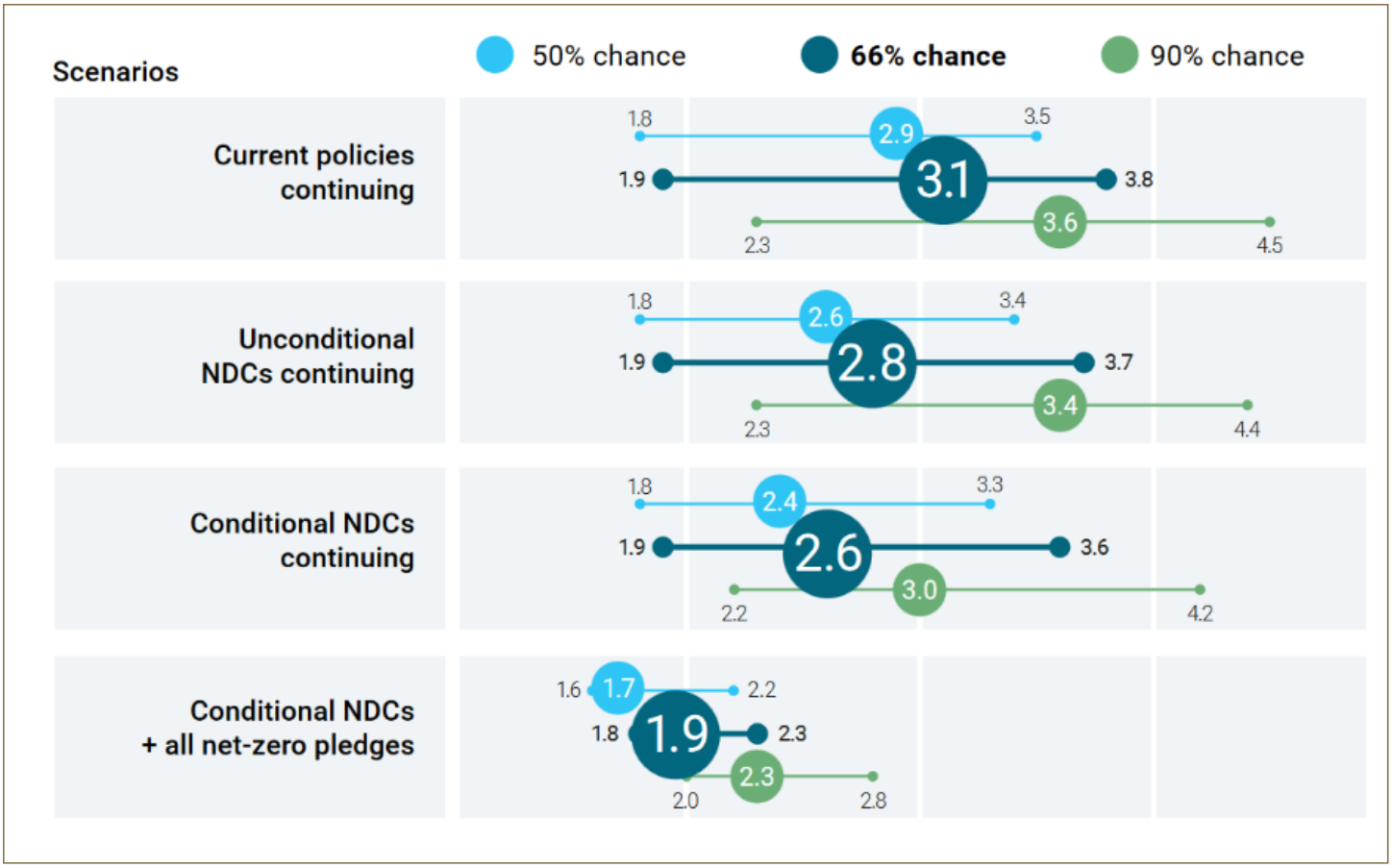

Figure 6. Projections of Peak Global Warming (in °C over the 21st century relative to pre-industrial levels) under NDC Pledge-based Scenarios[190]

Further scientific evidence supported the increase of average global temperatures exceeding the 1.5 °C mark was provided by The Copernicus Institute with its 2024 European State of the Climate Report.[191]

The key messages for sea surface temperatures (SST) in the report are:

- The annual average SST over the extra-polar ocean reached a record high of 20.87°C in 2024;
- The extra-polar SST reached record-high levels for the time of year from January to June 2024, following the streak of monthly records that started in May 2023. From July to December 2024, the SST ranked second warmest, after 2023;
- The residual effects of the strong 2023 El Niño event and a transition towards neutral El Niño Southern Oscillation (ENSO) conditions influenced 2024; and
- Higher than average SSTs were recorded in most ocean basins, reaching record values in the North Atlantic, Western Pacific and the Indian Ocean.

The report states that 2024 saw unprecedented global temperatures, following on from the remarkable warmth of 2023. 2024 also became the first year with an average temperature clearly exceeding 1.5°C above the pre-industrial level threshold set by the Paris Agreement to significantly reduce the risks and impacts of climate change (Table 3). Multiple global records were broken, for GHG levels, and for both air temperature and sea surface temperature, contributing to extreme events, including floods, heatwaves, and wildfires. These data highlight the accelerating impacts of human-caused climate change.

Table 3. Temperature Statistics for 2024[192]

Region	Anomaly (vs 1991–2020)	Actual temperature	Rank (out of 85 years)
Globe	**+0.72°C** (+1.60°C vs pre-industrial)	15.10°C	**1st highest** 2nd - 2023
Europe	**+1.47°C**	10.69°C	**1st highest** 2nd - 2020
Arctic	**+1.34°C**	-11.37°C	**4th highest** 1st - 2016
Extra-polar ocean	**+0.51°C**	20.87°C	**1st highest** 2nd - 2023

The map of extreme surface air temperatures (Figure 7) shows the concentration of excess heat across Earth's ocean, and this is reflected in the increasing sea-surface temperature anomalies between 1980 and 2024 as shown in Figure 8. Anomalies are relative to the average for the 1991–2020 reference period for the corresponding month between 1980 and 2024 (Figure 8)..

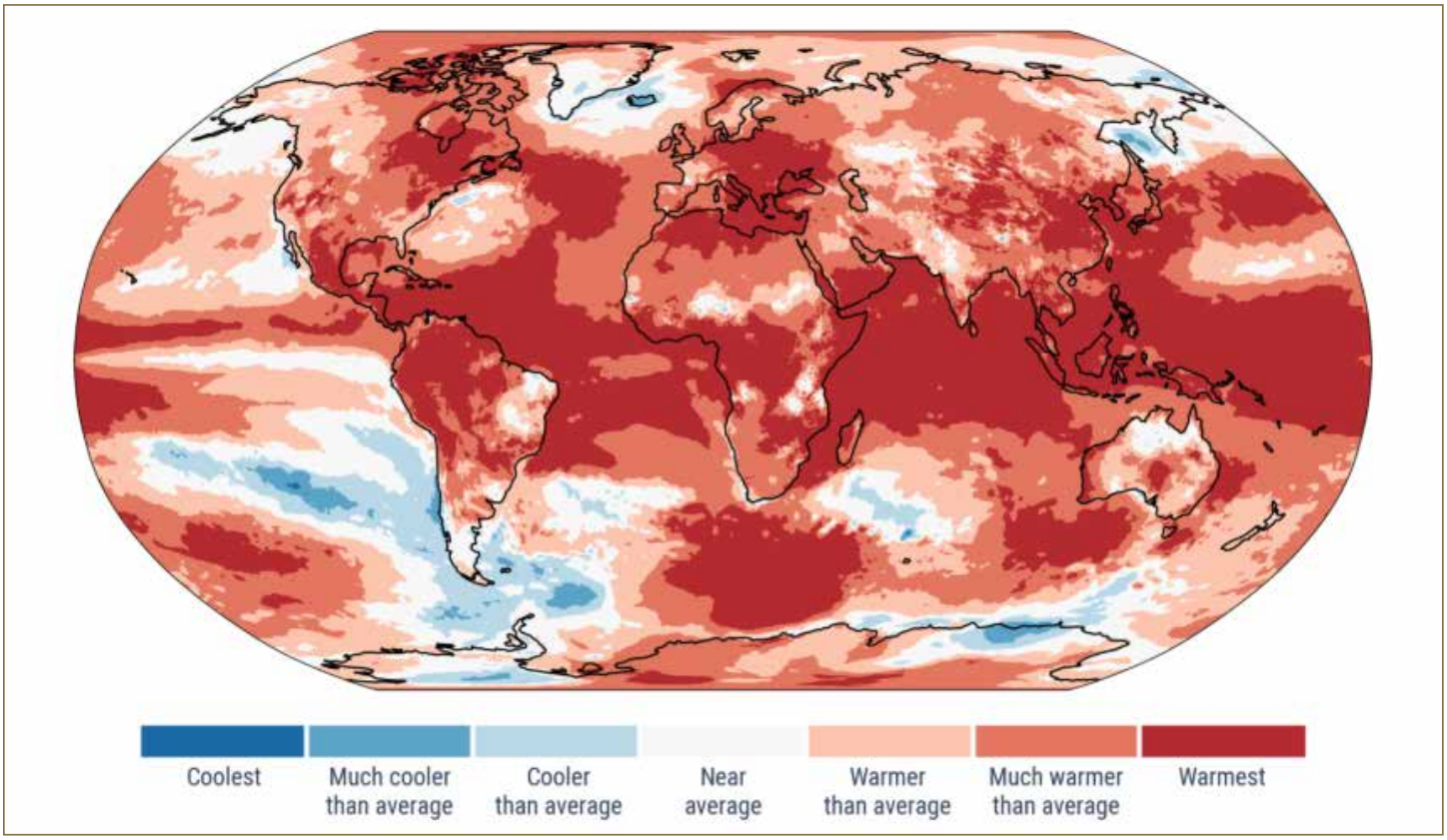

Figure 7. Extremes in Air Surface Temperatures 2024[193]

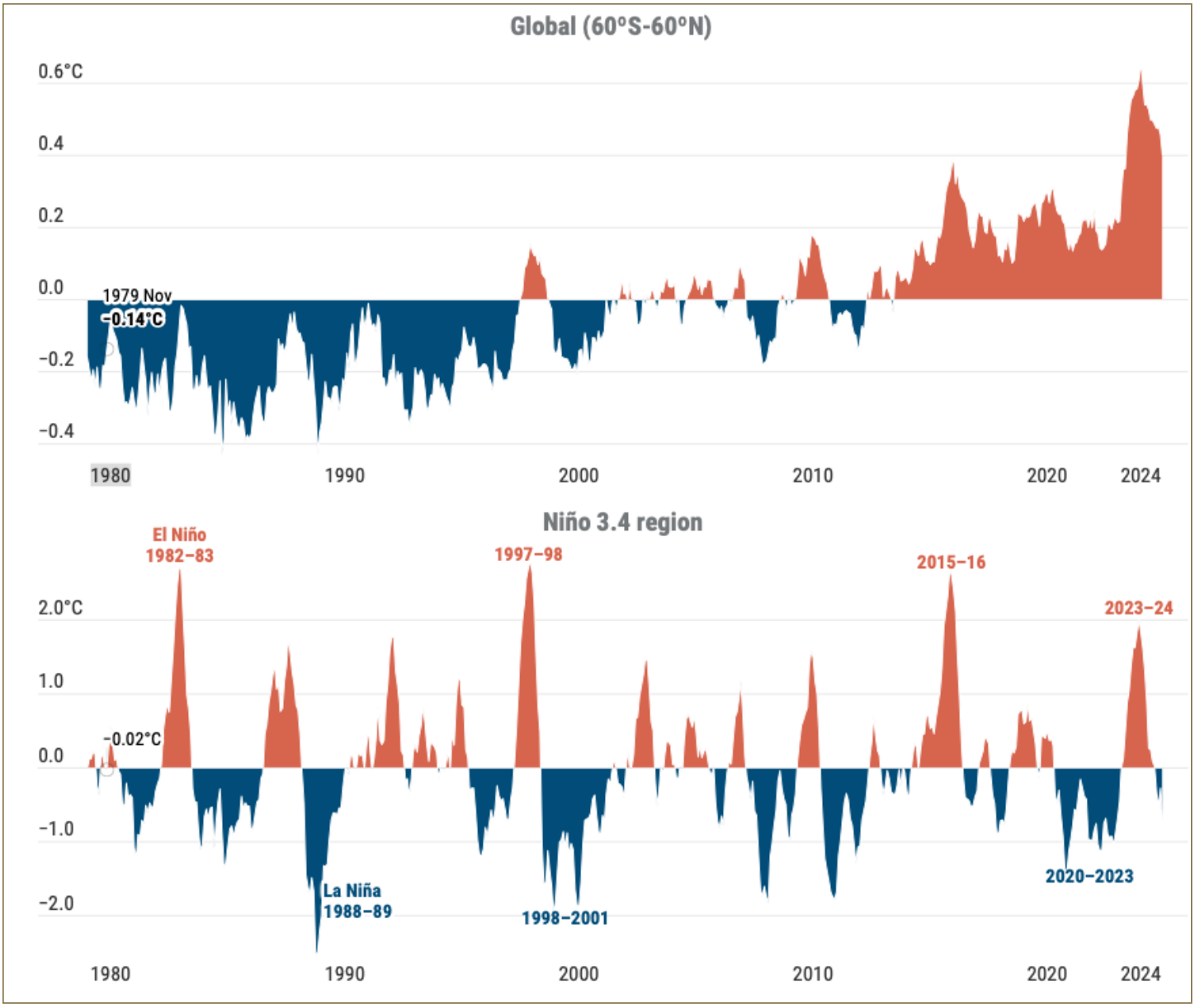

Figure 8. Sea Surface Temperature Anomalies for the Extra-Polar Ocean and the Pacific Ocean El Niño Region 1980-2024[194]

While the El Niño anomalies are relatively constant over time, the extra-Polar anomalies show significant increases beginning at the end of the 1990s and then accelerating after 2010. From January to June 2024, the average SST over the extra-polar ocean (60°S–60°N) reached record-high values for the time of year. The monthly average SST also reached a new record in March, at 21.07°C. These high values extended a streak of records that started in May 2023 and largely coincided with the development, peak and decay of an El Niño event in the equatorial Pacific from mid-2023 to mid-2024. The SST reached record monthly values for 15 consecutive months, from May 2023 to June 2024. The monthly SSTs in 2023 and 2024 were significantly higher when compared to other years, despite the El Niño event not being as strong as the events of 1982–1983, 1997–1998 and 2015–2016.

For 2024, the annual average extra-polar SST was the highest on record, at 20.87°C, 0.51°C above the 1991–2020 average, surpassing the previous records of 2023 (20.80°C) and 2016 (20.61°C). As Figure 9 demonstrates, global SST anomalies broke new records in 2024, despite the 2023–24 El Niño event not being one of the strongest in past decades. Figure 9 demonstrates a comparison between the monthly SST anomalies for the extra-polar ocean (60°S–60°N; vertical axis) and the monthly SST anomalies for the Niño 3.4 region (5°N–5°S, 170°–120°W; horizontal axis). Anomalies are relative to the average for the 1991–2020 reference period for the corresponding month.

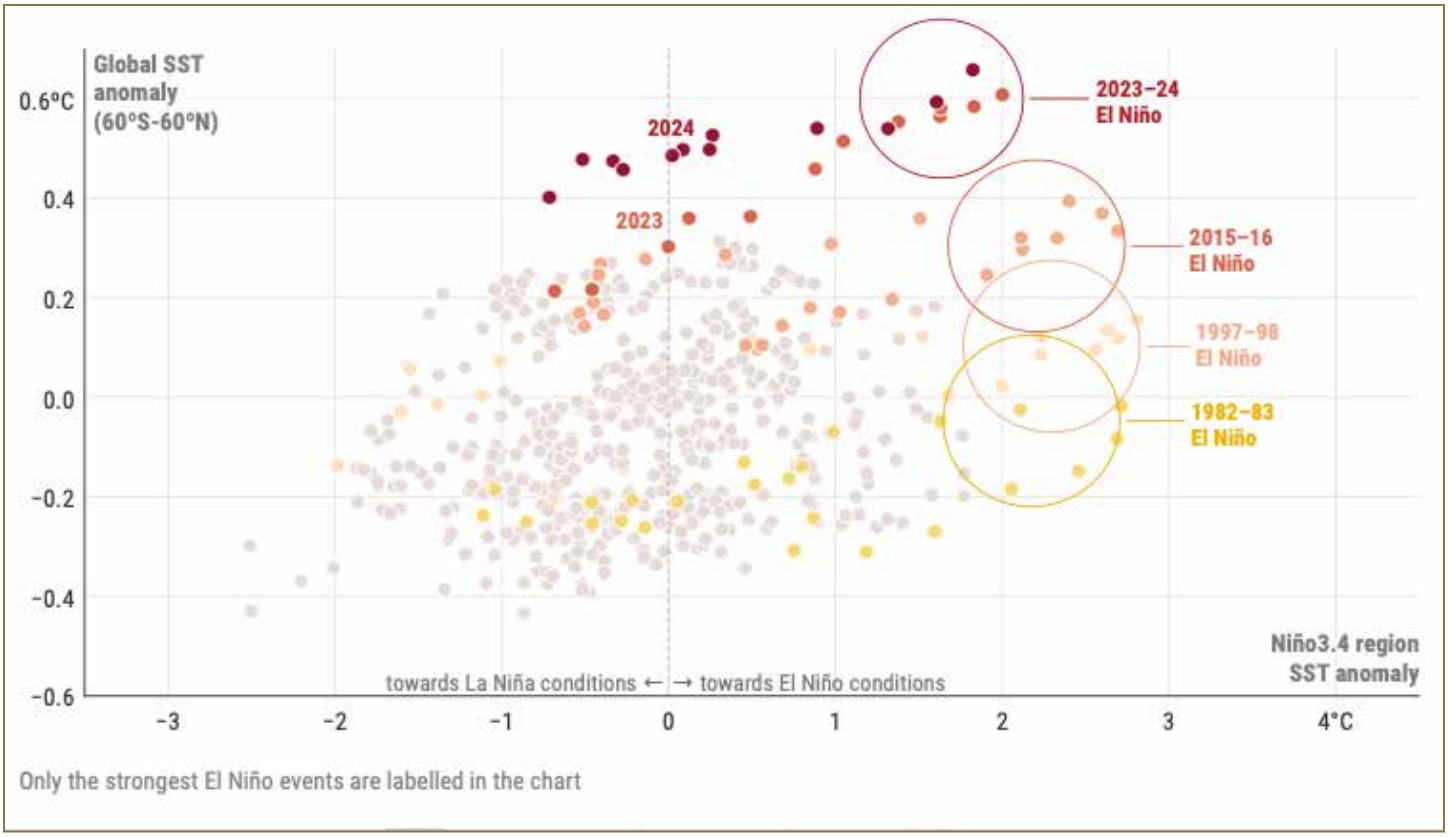

Figure 9. 2024 - A New Record for Global Sea Surface Temperature[195]

The 2024 Copernicus Institute report also provides key messages for sea ice:

- During a large part of 2024, sea ice extent reached historically low values around Antarctica. At its annual minimum in February, the monthly extent ranked third lowest on record. From June onward, the monthly extent ranked either second lowest behind 2023, or lowest (in November).
- In the Arctic, the sea ice extent was relatively close to its 1991–2020 average until June but fell well below average in the following months. At its annual minimum in September, the monthly extent ranked fifth lowest in the satellite record.

In the Antarctic (Figure 10), after reaching record lows for the time of year through most of 2023, the sea ice extent was again well below average during several months of 2024. The annual minimum extent in February was the third lowest in the satellite record. From June to October, the monthly extents were the second lowest for those months, behind 2023, while November set a new record low for the month. In contrast to the pronounced decline in Arctic sea ice since the 1980s, persistent large negative anomalies in Antarctic sea ice extent have only been observed since 2016. Warmer ocean temperatures and atmospheric circulation patterns are likely contributing factors, but research is ongoing.

In the Arctic (Figure 11), sea ice extent was close to its 1991–2020 average until June. This behavior was in line with that often observed since 2021. However, from July 2024 onward, the sea ice extent was significantly below average. At its annual minimum in September, the monthly extent ranked fifth lowest in the satellite record. The year ended with the lowest December extent on record.

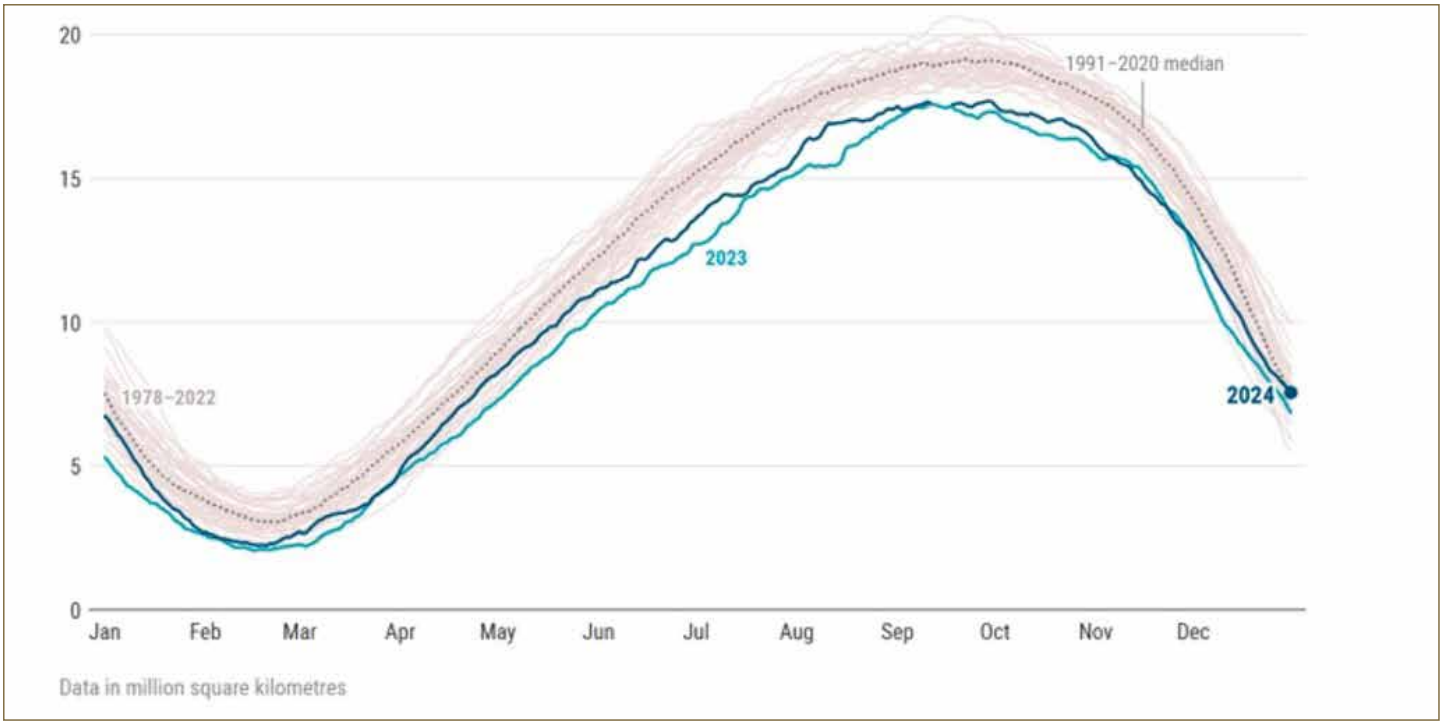

Figure 10. Daily Antarctic Sea Ice Extent 1979 to 31 December 2024[196]

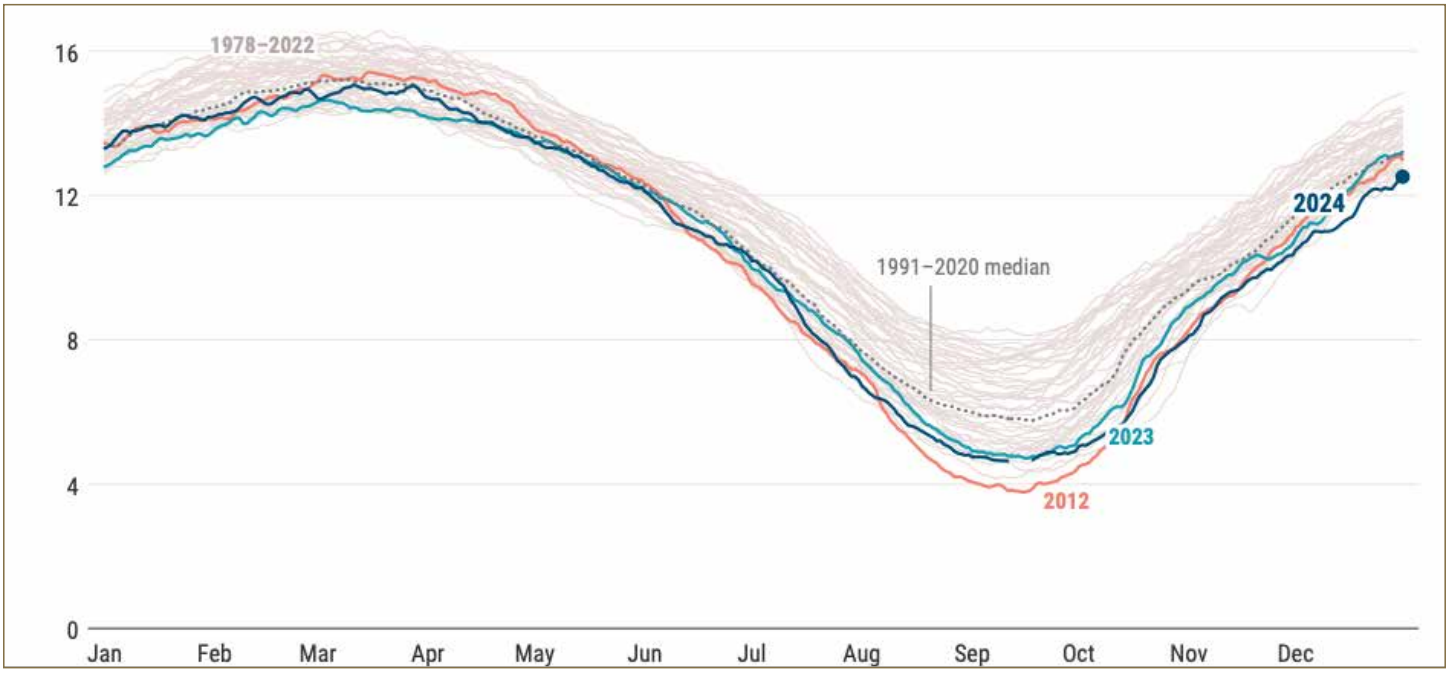

Figure 11. Daily Arctic Sea Ice Extent 1979 to 31 December 2024[197]

In early 2025, the WMO published its 2024 State of the Climate Report.[198] In addition to establishing that for the second successive year, the annual average global mean near-surface temperature for 2024 was 1.55°C above pre-industrial levels, the report also had key findings for the ocean, namely:

- *Ocean Heat Content:*
  - In 2024, ocean heat content reached the highest level in the 65-year observational record, exceeding the previous record high set in 2023;
  - Over the past eight years, each year has set a new record for ocean heat content; and

- The rate of ocean warming over the past two decades, 2005–2024, is more than twice that observed over the period 1960–2005.

- *Global Mean Sea Level:*
  - In 2024, global mean sea level reached a record high in the satellite record (from 1993 to present); and
  - The rate of global mean sea-level rise in the past 10 years (2015–2024) was more than twice the rate of sea-level rise in the first decade of the satellite record (1993–2002).
- *Ocean Acidification (pH):*
  - Acidification of the ocean surface has continued over the past 29 years as shown by the steady decrease of global average ocean surface pH; and
  - Regionally, ocean acidification is not increasing uniformly.
- *Sea-Ice Extent:*
  - The minimum daily extent of Arctic sea ice in 2024 was the seventh lowest in the observed record (1979 to present);
  - The 18 lowest Arctic sea-ice extent minima in the satellite record all occurred in the past 18 years; and
  - The annual minimum and maximum of Antarctic sea-ice extent were each the second lowest in the observed record (1979 to present).
- *El Niño – Southern Oscillation:*
  - The strong 2023/2024 El Niño followed three consecutive years of El Niña from late 2020 to early 2023; and
  - El Niño conditions were established by mid-2023, became strong by the end of 2023 and dissipated by the second quarter of 2024.

A supplemental report addresses High Impact Events that were the result of severe climate and weather conditions in 2024.[199] Extreme weather events in 2024 led to the highest number of new displacements recorded in a year since 2008. Tropical cyclones were responsible for many of the highest-impact events of 2024, including:

- Typhoon Yagi in early September which caused 890 casualties and damage across six countries in Southeast Asia (especially northern Vietnam and southern China);
- Hurricanes Helene in late September and Milton in October both made landfall on the west coast of Florida in the USA, both causing major impacts at landfall, with Helene going on to produce exceptional rainfall and extreme flooding in the interior south-east of the United States. Both hurricanes had economic impacts of tens of billions of dollars, and over 200 deaths were associated with Helene, the most associated with a mainland United States hurricane since Hurricane Katrina in 2005;
- Tropical Cyclone Chido In the southern hemisphere crossed the French Indian Ocean department of Mayotte in December before making landfall in Mozambique and moving onwards to Malawi, with major damage and significant loss of life and population displacement (around 100,000 people in Mozambique alone) in all three countries; and
- Hidaya was the first tropical cyclone to make landfall at cyclone intensity in Tanzania since at least 1952 and brought 316.6mm rain to Kilwa on 4 May, whilst Ialy weakened below cyclone intensity off the Kenyan coast on 22 May, after becoming the first known tropical cyclone in Kenyan waters.

As this report is published, Hurricane Melissa has exceeded record levels as the strongest tropical cyclone to ever make landfall in Jamaica. The Category 5 hurricane came ashore along the south coast of Jamaica on 29 October 2025 and wreaked havoc across the entire island, before losing strength as it moved northeastwards over The Bahamas and Bermuda.[200] Prior to that, Melissa had increased strength over nine days in the Caribbean Sea, causing wind damage and flooding from the storm surges and heavy rainfall in the Dominican Republic and Haiti.[201] At least 49 deaths have been associated with the hurricane to date, and it will likely go down as one of the strongest Caribbean hurricanes on record.[202]

Furthermore, 2025 has seen the impacts of a number of powerful typhoons in the western Pacific Ocean, including Typhoon Kajyki in August and then in September, Typhoon Ragassa became the first super typhoon of the season, eventually reaching Category 5-equivalent status impacting the Philippines, Taiwan, Southern China, Hong Kong, and Vietnam.[203] At the same time Typhoon Neoguri strengthened into an unusually high-latitude Category 4 typhoon near 40°N, making it one of the strongest unusually high-latitude cyclones on record.[204] In early November, Typhoon Kalmaegi developed into a Category 3-equivalent cyclone that devastated portions of the central Philippines and central Vietnam as one of the strongest typhoons on record in the area,[205] and at the time of publication, Typhoon Fung Wong reached 'super typhoon' status with winds over 185 kph as it approached making landfall over Luzon in northern Philippines.

The WMO report[206] also discusses extreme flooding, wildfire, and drought events in 2024, many of which impacted coastal regions and communities around the world, such as wildfires on the west coast of the USA and Chile, severe rainfall and flash flooding in the east coast of Spain and around the Mediterranean, severe monsoon flooding on the east coast of Africa, and severe flooding in May along the south coast of Brazil.

A new scientific report by the Potsdam Institute for Climate Impact Research has found that GHG emissions from the burning of fossil fuels have pushed the acidity of the ocean past a safe threshold, threatening their ability to sustain shellfish and coral reefs.[207] The 2025 Planetary Health Check[208] concludes that Earth's vital signs are flashing red and that seven out of nine Planetary Boundaries (PBs) have been breached. After recent data and methodological updates, the report concludes that the world's ocean is acidifying to an unsafe degree and assesses that for the first time the Ocean Acidification boundary has been transgressed. With ocean acidification being the latest "PB" to be crossed, seven of the nine PBs that are assessed annually have now been crossed. Figure 12 shows the latest PBs Diagram which visually represents the current status of the nine PB processes that the Planetary Boundaries Science (PBScience) project monitors. Each process is quantified by one or more control variables based on observational data, model simulations, and expert opinions.

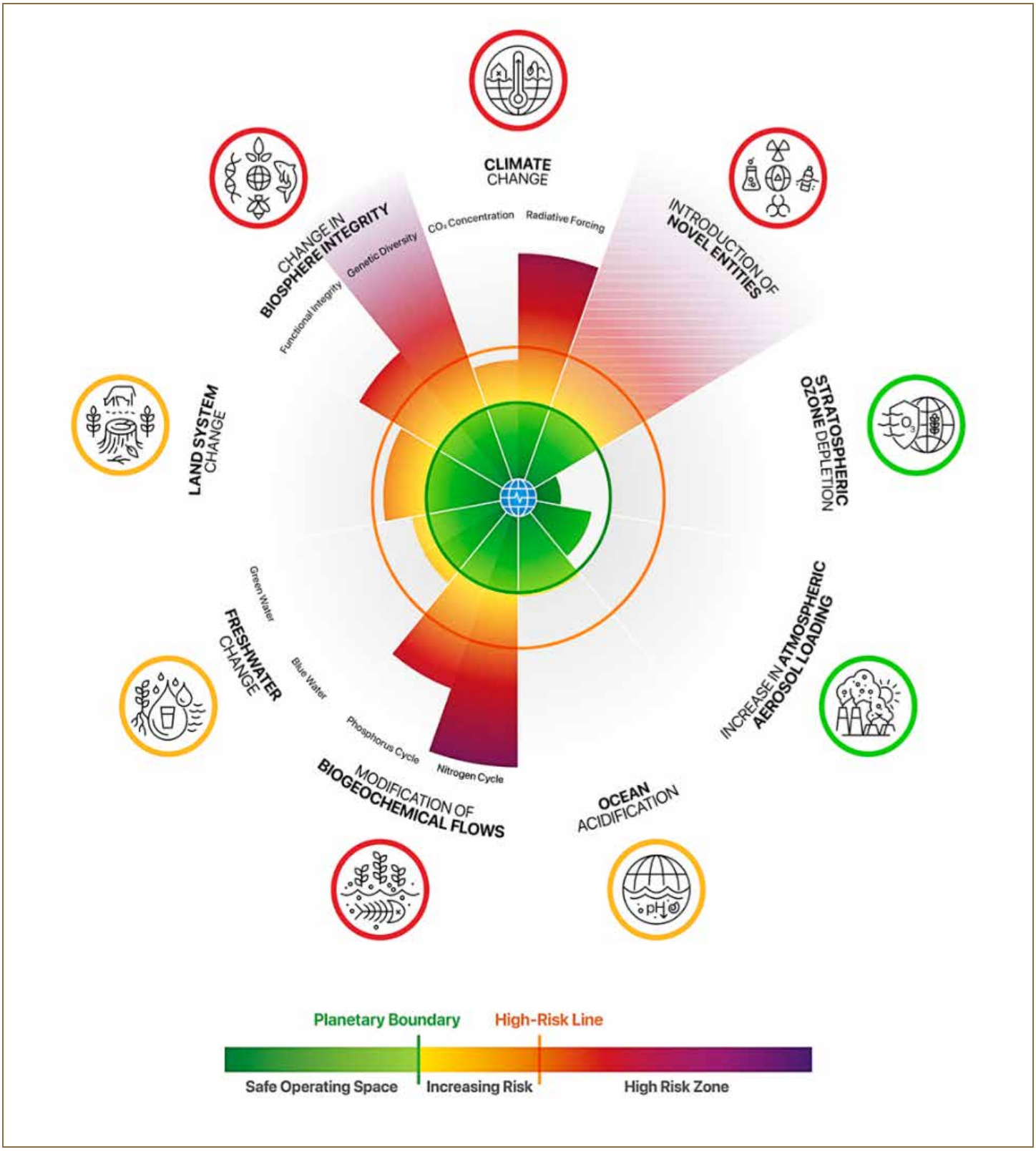

Figure 12. The Planetary Boundaries (PBs) Diagram 2025

Referring to the ocean as "The Unsung Guardian of Planetary Health", the report states that ocean health is facing unprecedented stress from both long-term warming and increasingly frequent and intense extreme events. Due to its vast heat capacity, the ocean has absorbed roughly 256 zettajoules (ZJ) of excess energy generated by heat-trapping GHGs in the atmosphere since the 1970s. This corresponds to approximately 89-93% of Earth's energy imbalance and has likely delayed surface warming due to increased carbon dioxide (CO_2) by more than a decade.

On top of these gradual changes, the report identifies a number of other increasingly critical impacts of climate change on the ocean, which are highlighted below.

- *Marine Heatwaves and Coral Bleaching:* Once rare, these bursts of extreme ocean warming are becoming more frequent, longer lasting, and more intense (Figure 13). They are now devastating vulnerable ecosystems like coral reefs and kelp forests (*e.g.* the 2016 a massive marine heat wave that caused unprecedented bleaching across the Great Barrier Reef) and by 2025 over 80% of the world's coral reefs have been recorded as having been affected by bleaching events.[209] On April 15, 2024, NOAA (in partnership with the International Coral Reef Initiative) confirmed that the world is in the middle of its 4th global coral bleaching event (Figure 14). From 1 January 2023 to 11 September 2025, bleaching-level heat stress has impacted 84.4% of the world's coral reef area and mass coral bleaching has been documented in at least 83 countries and territories.[210] The ongoing global coral bleaching event is the biggest to date, the previous record being during the 3rd global coral bleaching event, which occurred from 2014-2017, when 68.2% of the world›s reef area experienced bleaching-level heat stress. The 1st and 2nd global coral bleaching events occurred in 1998 and 2010, respectively.
- *Historically High SSTs:* In May 2023, scientists observed a sudden and still not fully understood rise in global SSTs.[211] This unexpected warming contributed to the record-breaking air temperatures that followed, making 2023 the first year in which the global average temperature exceeded 1.5°C above pre-industrial levels, Since then, with 2024 also exceeding the 1.5°C level, SSTs have remained at historically high levels in both 2024 and 2025. As waters warm, their capacity to hold oxygen declines, and nutrient runoff from agriculture accelerates algal blooms that increasingly consume oxygen.
- *Deoxygenation:* Since 1970 the ocean's oxygen content has decreased 1–3%. In addition to the oxygen the ocean has already lost, it is estimated that the ocean could lose about four times more over the coming centuries – even if we stopped emitting GHGs today. If emissions are not halted, the ocean is expected to lose even more oxygen, with severe consequences for marine life. Deoxygenation reduces the resilience of the marine biosphere because many species cannot adapt to low oxygen levels. Already today, the expansion of low-oxygen zones, so-called "dead zones", creates conditions hostile to marine animals, e.g. fish and invertebrates, shrinking habitable zones and collapsing food webs.
- *Acidification:* As the ocean continues to absorb CO_2 from the atmosphere, its chemistry is changing. Surface ocean pH has already fallen by approximately 0.1 units since the onset of the industrial era,[212] and this is equivalent to a 30-40% increase in acidity.[213] This change threatens organisms that form calcium carbonate shells or skeletons, such as corals, mollusks, and key plankton species. The decline of these organisms can disrupt food webs and weaken the structure and function of marine ecosystems. Acidification also affects reproductive success, growth rates, and metabolic function across multiple marine groups, weakening both biodiversity and the ocean's long-term ability to regulate carbon.[214]
- *Declining Marine Biodiversity:* Compounding these chemical and thermal threats is the decline in marine biodiversity, much of it driven by overfishing. Roughly one-third of assessed fish stocks are now overfished, with many populations falling below sustainable levels. Apex predators are disappearing from entire regions. As functional and genetic diversity is lost, ecosystems lose their ability to recover from disturbances. In scientific terms, the ocean's ecosystem resilience is being depleted, altering the ocean's capacity to sustain key biogeochemical functions. This loss of ecosystem function impacts food security and livelihoods in coastal communities, particularly in low- and middle-income countries.
- *Proliferation of Pollutants and Novel Entities:* Substances such as synthetic chemicals, plastics, pharmaceuticals, and heavy metals are now found in every part of the ocean, from surface waters to the deep sea. Microplastics are ingested by organisms at all levels of the food chain,[215] which can harm their ability to reproduce, weaken their immune systems, and change how they eat. Persistent organic pollutants accumulate in marine food webs, affecting everything from plankton to whales – and ultimately, human health.
- *Seabed Disturbance:* Beneath the surface, the seabed is also being reshaped and degraded by human activity. Bottom trawling continues to damage habitats on the ocean floor, uproots deep-sea corals, and releases part of the carbon stored in the seabed. Emerging industries like deep-sea mining pose new and largely unquantified threats, disturbing sediment dynamics and releasing plumes of potentially toxic materials. These practices can

fundamentally alter the structure and function of marine ecosystems and are similar in scale and impact to land-use change on land.

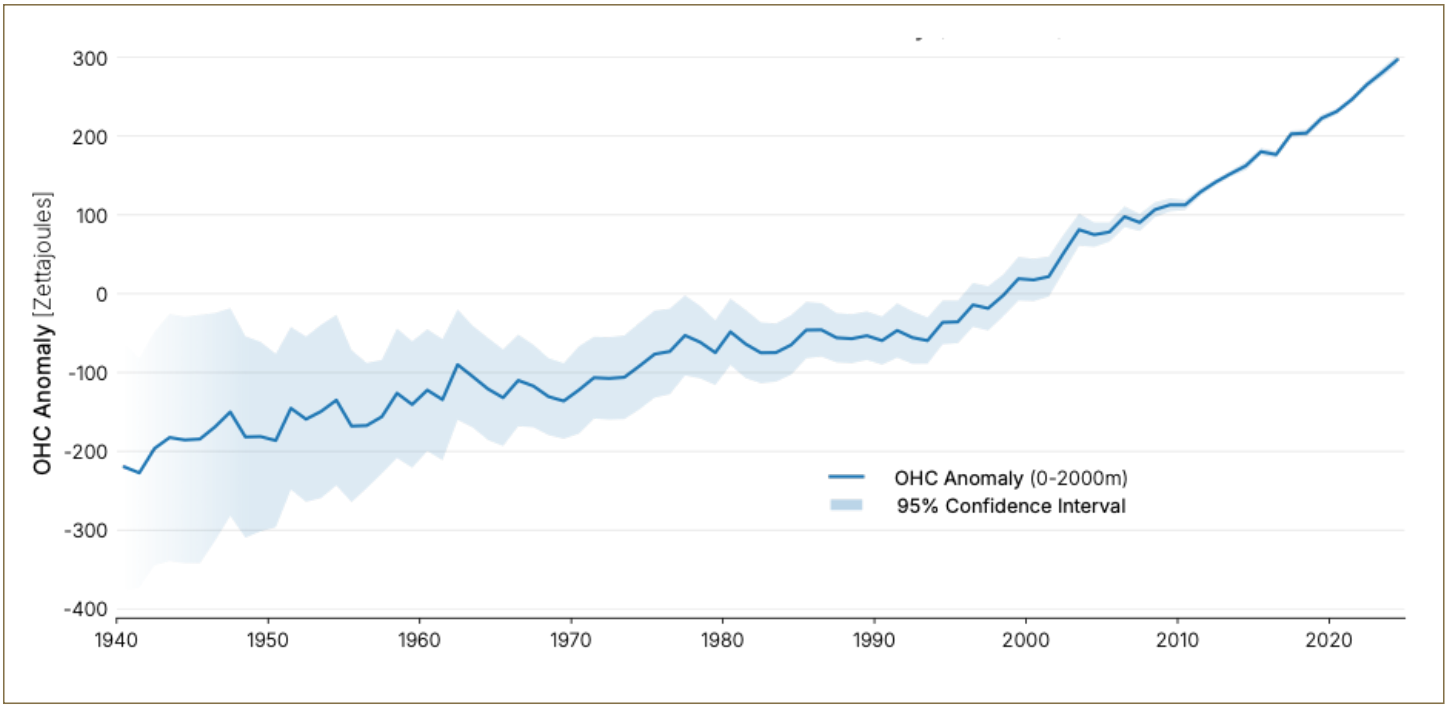

Figure 13. Tracking Ocean Heat Content: 80+ Years of Ocean Warming.[216] This graph shows how the heat stored in the upper 2000 meters of the world's ocean has changed each year from 1940 to 2024. The line represents the amount of extra heat (compared to a baseline period from 1981 to 2010), measured in ZJ. The shaded area around the line shows the uncertainty in the estimates: A wider band means less certainty, and a narrower band means more confidence in the data. Data Source: The data is provided by the Institute of Atmospheric Physics (IAP), Chinese Academy of Sciences, based on in-situ ocean temperature observations (IAP v4 dataset).[217]

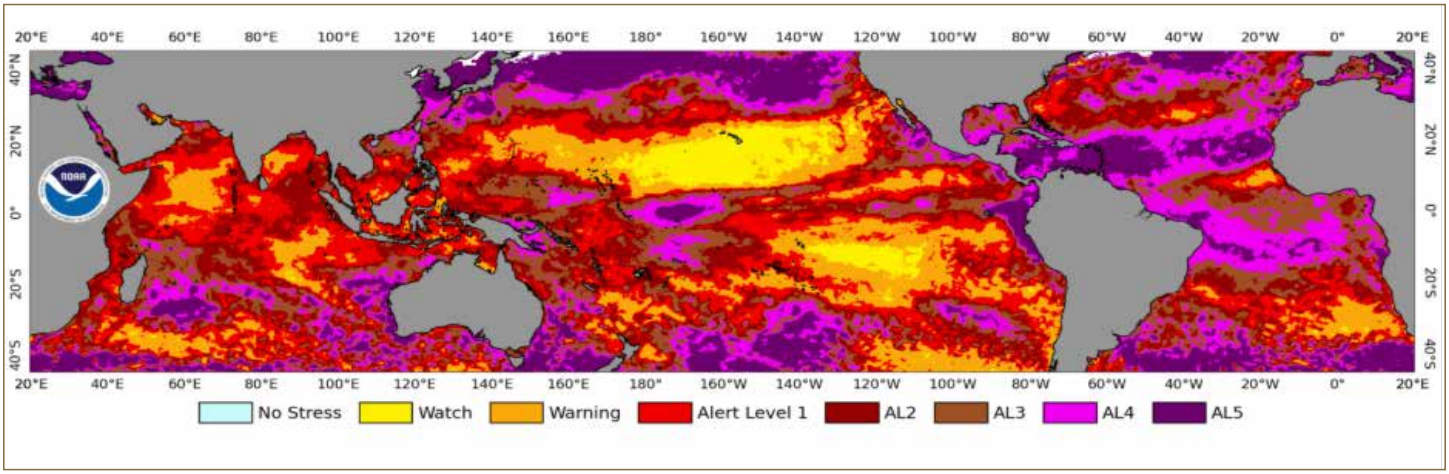

Figure 14. NOAA Coral Reef Watch 5-kilometer Bleaching Alert Area Maximum (v3.1) 1 January 2023 - 20 September 2025. This map displays the maximum accumulated heat stress experienced by coral reefs around the world since January 1, 2023. The dark red/brown areas show the accumulated heat stress capable of causing reef-wide bleaching with mortality of heat-sensitive corals. The light brown (Alert Level 3), pink (Alert Level 4), and dark purple (Alert Level 5) areas on the map indicate locations where the magnitude of extreme heat stress exceeds the Bleaching Alert Level 2 threshold and can lead to multi-species or near complete mortality on a coral reef.

While acidification is the only explicitly recognized marine boundary included in the PBs Project, the ocean also contributes to other boundary areas (see Table 4). Marine Biodiversity is incorporated into the Change in Biosphere Integrity boundary but is not distinguished from terrestrial systems, despite its vital role in carbon cycling, oxygen production, and ecological resilience. Plastic pollution and other synthetic chemicals affecting marine life fall under the Introduction of Novel Entities boundary, but there is no ocean-specific control variable. Similarly, the phosphorus control variable under the Modification of Biogeochemical Flows boundary accounts for ocean impacts like coastal dead zones and excessive algal blooms.

Table 4. Current Representation of Ocean-Related Processes in the Planetary Boundaries Framework[218]

PB process	Ocean inclusion	Control variable (CV) used
Ocean Acidification	Included (only surface acidification)	Aragonite saturation state (Ω_{arag})
Change in Biosphere Integrity: Genetic Diversity	Combined terrestrial & marine extinction rates	Extinction rate (all ecosystems combined, expressed in E/MSY – extinctions per million species-years)
Introduction of Novel Entities	Implicit inclusion of marine plastics (and all other novel entities like PFAS, dioxin, etc.)	None specific to the ocean
Modification of Biogeochemical Flows	Phosphorus threshold partly ocean-based; Nitrogen takes also water quality into account	Global Phosphorus flow to the ocean

The ocean is underrepresented in the PBs Project and its annual reports. For example, there have been recent calls for ocean deoxygenation to be included as a PB in the framework.[219] However, the report recognizes this shortfall and the need to increase the role of ocean processes and thresholds.[220] The ocean section of the report concludes with a strong statement, recognizing the ocean as central to planetary stability through its role as the planet's climate stabilizer, resilience builder, and life-support system.[221]

It is important to see that the role and importance of the ocean in global change is increasingly recognized across the broader scientific community. As pressures compound and amplify each other, pushing marine systems closer to tipping points, or conditions beyond which recovery becomes uncertain or impossible. The PBs Project annual report recognizes that improving the knowledge base around marine processes will be crucial to help anticipate prevent large-scale, potentially irreversible changes in the ocean that could undermine planetary resilience and human well-being.[222]

Global Stocktake and Decade of Ocean Science initiatives

The Global Stocktake (GST) is a Party-driven process, taking place every five years, meant to assess the collective progress of both Parties and non-Party stakeholders in meeting the goals of the Paris Agreement. The first-ever GST concluded at COP28 in 2023. The GST encouraged further strengthening of ocean-based climate action. In addition, resilient food systems and management of inland water, marine, and coastal ecosystems were highlighted as suitable climate solutions in the outcome.

The 2024 OCCD, held at SBSTA60, focused on marine biodiversity conservation and coastal resilience, and technology needs for ocean-climate action, including finance links. The need for more information and guidance to respond to the GST was emphasized throughout the Dialogue. Many Parties called for technical guidelines on how to include ocean-based climate measures in their climate strategies.[223]

As part of the UN Decade of Ocean Science for Sustainable Development Vision 2030 process, a White Paper on Challenge 5 (Unlock ocean-based solutions to climate change) shared key recommendations for a more sustainable and climate-resilient ocean that aligns with the UN SDGs. These recommendations included research into marine

renewable energy, ways of reducing marine pollution, and expanding vegetated coastal ecosystems. They also called for controlled mCDR pilots, improved ocean literacy, adaptive governance, and equity in implementation.[224]

At SBSTA62, the 2025 OCCD aimed to "transform ambition into concrete action" through the lens of the GST. The Dialogue focused on three priority areas: NDCs, the GGA, and synergies across global processes and frameworks. A range of potential ocean-based climate solutions were discussed, including offshore renewable energy, climate-smart and resilient blue foods, decarbonization of the shipping industry, and the conservation, restoration, and management of coastal blue carbon ecosystems. Participants expressed support for a strategic roadmap for future Ocean Dialogues in support of the second GST (2028) and NDC submission cycles (2025 and beyond).[225]

Aquatic / Blue Foods

Climate change poses severe challenges to blue, or aquatic, food systems. Rising atmospheric GHG concentrations affect marine and freshwater production capacities, aquaculture feed supply, and post-production processes. For example, pelagic fisheries face shifts in species distributions, while coral reef fisheries and bivalve production suffer from ocean acidification. Inland fisheries contend with changes in freshwater quality and availability, and fed aquaculture is impacted by terrestrial crop losses affecting feed supply. Small-scale actors, women, Indigenous communities, and other marginalized groups are particularly vulnerable to these climate impacts, especially those communities that rely on aquatic food for sustenance and economic stability.[226] [227] [228]

Blue foods can play roles in reducing GHG emissions from food systems. They generally have a lower carbon footprint than terrestrial animal-source foods, with some, such as bivalves and seaweed, having minimal or neutral GHG emissions.[229] Sustainable management of aquatic food systems offers significant potential for reducing emissions in existing systems, for example by more effectively managing capture fisheries. There is an even bigger opportunity for emission reduction by shifting from high-emission species and practices to lower ones.[230] There is considerable variation in GHG emissions across different species, geographical regions, and farming practices.[231] For instance, the CO_2 emissions from small pelagics are one-eighth those from flatfish, while bivalves emit, on average, one-ninth the CO_2 of farmed shrimp.[232] Targeted investments in sustainable and low-carbon aquatic foods can support low-emission development strategies, addressing both poverty and food and nutrition insecurity.

Understanding how climate change impacts marine ecosystem biodiversity and global fisheries, the climate-biodiversity-fisheries nexus, is a fundamental element of the UN Ocean Decade. Several Decade-endorsed programs emphasized the importance of considering Challenge 3 (Sustainably nourish the global population) and Challenge 5 (Unlock ocean-based solutions to climate change) together. From a research perspective, there remains a knowledge gap in our understanding of the mechanisms by which climate variability and change impact the structure and function of marine ecosystems and the resources they supply, knowledge that is needed to effectively forecast and manage for climate-driven changes. The programs recommend actions to understand mechanisms by which climate variability, climate extremes, and climate change impact marine ecosystems, as well as improving skill in climate and ecological models related to aquatic foods.[233]

Addressing climate impacts on aquatic food systems and leveraging their potential for climate action requires their integration into national climate strategies and UNFCCC processes.[234] The role of aquatic foods in global food systems is becoming increasingly recognized, especially in providing a source of affordable and accessible nutrition,[235] as well as a priority for climate action. Blue foods are mentioned in the COP28 Presidency's Emirates Declaration on Food and Agriculture, which currently has 160 signatories.[236] The UNFCCC High-Level Champions included resilient aquatic food systems as a 2030 Breakthrough as part of the Marrakech Partnership.[237] The 2023 OCCD featured "fisheries and food security" as one of its two topics, chosen in consultation with Parties and Observers.[238] The role of aquatic food systems in enhancing global food security has also been recognized in the G20 Agriculture Ministers Declaration adopted in 2024.[239]

While climate solutions need to be context-specific, a recent report has mapped high-level pathways to achieve climate-resilient and low-emission aquatic food systems.[240] Key pathways highlighted in the report are included below.

Capture fisheries production:

- Develop sustainable and climate-adaptive fisheries management;
- Reduce emissions from fishing by adopting fuel-efficient and fuel-free technologies; and

- Support climate-adaptive livelihoods and practices for fishers and fishing communities.

Aquaculture production:

- Improve aquaculture feed and feeding management to reduce GHG emissions;
- Transition aquaculture energy inputs to renewables and reduce energy use;
- Promote expansion of low-input, integrated, and/or non-fed aquaculture systems; and
- Support climate-adaptive technologies and practices to increase aquaculture's resilience to climate change.

Blue food supply chains:

- Reduce loss and waste and enhance circularity in blue food supply chains; and
- Reduce emissions from energy use and operations such as storage, processing, and transport of blue foods.

Consumption and diets:

- Integrate sustainable, low-carbon blue foods into food procurement, planning, and assistance programs; and
- Help consumers shift to sustainably produced, low-footprint blue foods.

Blue foods and coastal blue carbon habitats:

- Reduce impact of aquaculture and fisheries on blue carbon habitats; and
- Implement blue carbon habitat management and restoration for carbon storage and adaptation.

The effectiveness of these policy actions can be enabled through additional research and development to reduce uncertainties and stimulate innovation; robust data collection, monitoring, and prediction systems; equitable access to financial services, knowledge, government support, and resources; and collaborative and inclusive management, planning, and decision-making.

2.1.1 Recent peer-reviewed research

Global Warming

2024 was a year of unprecedented atmospheric warming globally with temperatures of 1.55 °C above 1850-1900 average, with CO_2, methane and nitrous oxide (NO_2) reaching the highest levels in the last 800,000 years.[241] Sea-surface temperatures reached record highs in the tropical and North Atlantic, tropical Indian Ocean, parts of the western Pacific and parts of the Southern Ocean, but cooler than average waters were observed along the west coast of South America, with above-average temperatures more evident further west along the equator.[242]

Arctic temperatures have risen approximately four times the global average, leading to upper ocean warming that is twice the global average.[243] Arctic warming is occurring alongside sea ice retreat, freshening and strengthening Atlantic and Pacific inflows to the Arctic. Warming Atlantic inflow to the Arctic plays a dominant role in shaping Arctic Ocean oxygen dynamics, with continued temperature increases leading to major deoxygenation trends.[244] Arctic fish species exhibit high to very high exposure and risk of climate impacts with shallow areas projected to be simultaneously exposed to more intense warming, reduced sea ice coverage, freshening, and acidification relative to the regional averages and species in Beaufort Sea –Amundsen Gulf having particularly low adaptability and high sensitivity to climate hazards.[245]

Continued warming will alter the depth distributions of deep-sea species, generating changes in diversity. Projections of deep-water coral communities in the Gulf of Maine and adjacent continental slope in the Northwest Atlantic, a climate change hotspot, suggest shifts from upper (500-1000m) to deeper bathyal habitat (1500-2000m) for several species, yielding changes in taxonomic and functional diversity.[246]

Fishery species are recognized as vulnerable to warming as well as other related changes in ocean environments. Projections of warming-induced changes in distribution of fish that straddle EEZs and the High Seas (straddling stocks) revealed that irrespective of climate scenario, 37% of 347 straddling stocks (across 67 species), are likely to shift between EEZs and the high seas, by 2030 and 2050, with the majority (22%) moving to the High Seas and many also shifting across Regional Fisheries Management Organizations (RFMOs).[247] McClure *et al*.(2023) applied the National Oceanic and Atmospheric Administration (NOAA) Fisheries Climate Vulnerability Assessment method

to 64 federally managed species in the California Current Large Marine Ecosystem to assess their vulnerability to climate change.[248] They examined vulnerability as a function of environmental change, sensitivity to those changes, finding two thirds of species were moderately or more vulnerable, with the most vulnerable having 1) complex life histories that utilize a wide range of freshwater and marine habitats; 2) habitat specialization, particularly for areas that are likely to experience increased hypoxia; 3) long lifespans and low population growth rates; and/or 4) high commercial value combined with impacts from non-climate stressors.

Advances in modeling, with case studies in the Bay of Bengal suggest that global warming may significantly alter plankton population abundances and interaction dynamics.[249]

Ocean Acidification

Recent research on ocean acidification (OA) has focused on direct and indirect anthropogenic inputs of CO_2, tipping points, and interactions with other stressors. Globally and regionally, OA has crossed its planetary boundary, with new work showing that the subsurface waters are also acidifying rapidly.[250] Studies along the West Coast of North America since 2007 show that anthropogenic carbon accumulation rate increased from 0.8 ± 0.1 µmol/kg/yr in the northern latitudes to 1.1 ± 0.1 µmol/kg/yr further south but decreased to values of about 0.3 µmol/kg.y at depths near 300 meters. The combined effect of this with and respiration in the California Current Ecosystem is to reduce water column pH and aragonite saturation state, resulting in a compression of the overall size of suitable habitat for marine calcifiers and increased probability of shell dissolution.

The addition of excess CO_2 also reduces the amount of biological consumption of oxygen that is required to drop the ecosystem below these thresholds. Bottom trawling can release CO_2, contributing to acidification. Findings by Atwood *et al.* (2024)[251] report that 55-60% of trawling-induced aqueous CO_2 is released to the atmosphere over 7-9 years. Trawling between 1996-2020 could have released up to 0.34-0.37 Pg CO_2 yr-1 globally to the atmosphere, and locally altered water pH in some semi-enclosed and heavily trawled seas. Research on OA tipping points suggests that they usually occur at locations with naturally elevated mean pCO_2 concentrations of 500 µatm or more, which is just below the concentration where the direct physiological impacts of ocean acidification are detectable in the most sensitive taxa in laboratory research (coralline algae and corals). OA will most likely cause ecological change in the near future in most benthic marine ecosystems, with tipping points in some ecosystems as low as 500 µatm pCO_2.[252]

Meta analysis by Hu *et al*. (2024)[253] of controlled experiments including both OA and ocean warming factors revealed that synergistic interactions are less common (16%) than additive (40%) and antagonistic (44%) interactions overall and their proportion decreases with increasing trophic level, with predators being the most tolerant trophic level to both individual and combined effects. Interactive effects of OA and warming range from synergistic in temperate regions to compensatory in subtropical regions, to positive in tropical regions.

Ocean Deoxygenation

Atlantic waters enter the Arctic through Fram Strait and Barents Sea Opening, with an inflow of approximately 6.3 Sverdrup (1 Sverdrup = 106 m3 s–1), occupying waters mainly below 300m. This is causing accelerated oxygen loss within the mid-layer of the Arctic Ocean that greatly exceeds those in other ocean basins. This subsurface deoxygenation in the Arctic is attributed to the amplified warming-induced solubility decrease at the Atlantic gateways, followed by the rapid subduction and spread of deoxygenated Atlantic inflow waters throughout the Arctic.[254] These combined effects result in the fastest regional global deoxygenation rate and sustained accelerated oxygen loss across extensive distances and timescales spanning years to decades.[255] Notably, Arctic deoxygenation coincides with warming and acidification that together place Arctic ecosystems under extreme stress.

Oxygen production in the deep sea associated with polymetallic nodules is a novel finding by Sweetman *et al*. (2024),[256] which raises questions about unexpected consequences of deep seabed nodule mining.

Projections for the mesopelagic zone of the California Current Ecosystems based on changes in light and oxygen under a high emissions scenario, indicate that the livable portion may compress vertically by approximately40m or approximately 39% by the end of the century, with complete horizontal habitat loss at 300 m. (Iglesias and Feichter 2025). Otolith records fishes in the Mediterranean link deoxygenation to mesopelagic fish decline 7-10,000 years ago.[257] Given the critical importance of the mesopelagic to the carbon cycle[258] [259] and carbon export[260] there

is concern about changing carbon sequestration under deoxygenation. Consequences include altered food-web interactions, with increased vulnerability of mesopelagic biota to top predators.

The potential for positive feedback between warming-enhanced deoxygenation and the emissions of N_2O, a key GHG is documented within the Humboldt Current System off Central Chile, with a trend of increasing N2O outgassing that is correlated with upwelling intensity.

Studies of coral resistance to ocean deoxygenation suggest species-specific vulnerabilities with some corals exhibiting metabolic plasticity that allow them to tolerate low oxygen conditions and avoid bleaching or mortality.[261]

Ocean deoxygenation has been proposed for consideration as a new planetary boundary, linking terrestrial, aquatic and marine systems, alongside ocean acidification and warming.[262] Oxygen has declined precipitously in aquatic ecosystems, interacts with other PBs and has capacity for global negative impacts, including fish kills, harmful algal blooms and lost tourism, and ultimately mass extinctions.[263] Emergence of new proxies for oxygenation in the paleo record (benthic and pelagic) offer promise for expanding the contribution of past records to climate science and projections.[264]

Sea-Level Rise (SLR)

The World Economic Forum reported in 2025 that SLR is the third-biggest threat to the world in the coming decade.[265] The rate of global SLR has doubled during the past three decades from approximately 2.1 millimeters per year in 1993 to approximately 4.5 millimeters per year in 2023.[266] There are also areas where Sea Level is rising faster than the global average, such as the United Kingdom (UK), where recent reports show that over the past 32 years, (1993–2024) UK sea level has risen by 13.4 centimeters, which is higher than the global estimate of 10.6 centimeters. [267] Kendon et al (2025) also note the large uncertainties in SLR estimates for the UK.[268] Impacts of SLR on coastal infrastructure, ecosystems, and local communities depend on a variety of factors. In India, where about 250 million people live along an extensive coastline, SLR is considered by the government a top concern due to its projected impacts including on livelihoods and communities through coastal erosion, saltwater intrusion, impacts on tourism and coastal infrastructure and risks to water and food security.[269] These sorts of impacts are increasingly being studied at regional levels such as the Global SLR driving severe coastal erosion across SE Asia.[270] Zamrsky *et al.* (2024)[271] modelled the impact of SLR on fresh groundwater across 1,200 coastal regions and showed nearly 60 million people could lose more than five percent of this resource.

A special International Conference on the Effects of Climate Change on the World's Ocean in 2023 showed widespread impacts of climate change on fisheries across the globe but with a need to develop good practice by engaging beyond traditional sectors when looking at adaptation options.[272] As for the issue of SLR, there is also a greater focus being placed mapping climate impacts at a regional scale so for example the Mediterranean Sea is predicted to be at higher risk than other areas due to higher observed and projected rates of climate change when compared with global trends.[273]

Seaweed Aquaculture

Increasing climate impacts such as ocean warming are negatively impacting both wild and farmed seaweed populations, with increased heat stress and introduction of diseases.[274] In support of the FAOs 2022-2025 strategic framework, Blue Transformations Programme Priority Area, OneHealth and SDGs the Progressive Management Pathway for Aquaculture Biosecurity (PMP/AM) has been developed.[275] Specific Seaweed PMPs with stakeholders in Southeast Asia will be developed through a series of workshops.[276] Asia is the largest producer of seaweed globally. The Seaweed Breakthrough is an opportunity to protect seaweeds and seaweed habitats, through the United Nations breakthrough Agenda's conservation initiative.[277] A report is available on the "State of the Worlds Seaweeds 2025 [data]".[278] The report includes identification of knowledge gaps and the development of high-level targets that will support the breakthrough through expert-led workshops.[279] The UN Global Seaweed Initiative is aligned with the Paris agreement, supports SDGs (2, 5, 9, 10, 13, 14 & 15) to be launched officially September 2025.[280]

Emerging Themes

Extreme events in temperature, oxygen and acidity are becoming more frequent as are compound events, where multiple extreme conditions occur simultaneously with potentially severe ecosystem impacts. Le Grix *et al.* (2025)[281] report that extreme conditions in high temperature, low oxygen and high acidity frequently coincide throughout

the water column and are particularly frequent in regions where vertical gradients in the stressors align, such as in the tropical Atlantic at 600 m depth. Vertical displacements of water masses act as potential drivers of subsurface compound events; the frequency of compound events is projected to strongly increase throughout the water column.

This year has seen rising concerns over ENSO and the Atlantic Meridional Overturning Circulation (AMOC) in the context of unprecedented ocean warming due to their profound influence on global climate variability and their critical roles in modulating weather extremes. ENSO is an ocean-atmospheric phenomenon primarily occurring in the central and eastern Pacific Ocean, influencing global weather patterns. New research shows the economic costs of ENSO events are orders of magnitude larger than previously thought, in the range of US$2.1-5.7 trillion globally per event. The AMOC is a system of ocean currents in the Atlantic Ocean, crucial for redistributing heat and regulating Climate. New findings suggest its slowdown or collapse may occur at much lower warming thresholds than previously believed, possibly before the end of the century. For both ENSO and AMOC there is an urgent need to close the gap between observations and models to constrain uncertainty in the next few decades.[282]

Science Gaps

The formal uncertainty language adopted by the IPCC AR can help identify science gaps in climate science. Many low-certainty topics result from lack of studies or lack of agreement are of importance but are not elevated to executive summaries and short summaries for policymakers. A review of low certainty topics and identified gaps for deep-sea science in six selected AR6 reports[283] revealed 219 major science gaps. Half are biological, surrounding changes in ocean ecosystems, fisheries, and primary productivity, and others are related to uncertainties in the physical (32%) and biogeochemical (15%) ocean states and processes. Key research priorities identified include meridional overturning circulation, the ocean carbon cycle, primary production and food supply, ocean deoxygenation and acidification, climate change impacts on ocean ecosystems and on fisheries, and ocean-based climate interventions.

3. THE CENTRAL ROLE OF NATIONALLY DETERMINED CONTRIBUTIONS AND OTHER NATIONAL TOOLS FOR OCEAN-CLIMATE ACTION

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As in previous ROCA Reports, this section takes an in-depth look at the current ocean content in NDCs to determine trends in the inclusion of ocean-relevant references. It also notes trends over time in the role that the ocean plays in NDCs.[284] Suggestions are made for further improvement of ocean content in NDCs.

An NDC is a climate pledge developed by a country detailing its efforts to reduce national emissions and adapt to the impacts of climate change. NDCs are the main tool Parties use to report on their actions and progress towards achieving the global 1.5°C goal under the Paris Agreement. The promise of the Agreement is that it created a first set of commitments, followed by a "ratchet" cycle, in which countries submit updated NDCs every five years. The outcomes of the GST, a process created to assess the progress of the global collective towards achieving the goals set by the Paris Agreement every five years, informed COP29 on the degree of preparation for the next round of NDC submissions due by COP30 and helped to drive increased ambition.

Despite the clear interrelationship between climate change and the ocean, the ocean-climate nexus has been sorely underrepresented in these important UNFCCC processes. In referencing the Ocean Conservancy's 2023 update to its 'NDC Tracker', the 2022-2023 ROCA Report noted that while many Parties had made at least one reference to the ocean in their first round of NDCs, only a small number had discussed ocean actions as a climate solution. It was noted that the ocean must be a key element of the climate change response toolkit if we are to keep the 1.5° C goal alive and avoid the worst consequences of climate change, many of which are now starting to hit hard in many parts of the global ocean system as see in Chapter 2. As the 2025 OCCD states, it is high time that countries match their commitments with robust means of implementation and clear, measurable targets to ensure effective delivery on the ground.

With NDCs due by COP30 in November 2025, there is a critical window of opportunity to correct course and steer our climate trajectory back on track, with initiatives like the "Blue NDC Challenge" aimed at integrating ocean-based climate measures and increasing ocean ambition in NDCs. This section will explore if there have been improvements since 2023 and look at other tools that are being used to enhance the integration of ocean-climate action.

3.1 Actions to further improve ocean content of NDCs

The year 2025 is a pivotal moment for climate ambition and implementation. It marks the tenth anniversary of the Paris Agreement and the completion of its first full enhancement cycle. As countries submit new and updated NDCs informed by the first GST, the international community enters a new phase, shifting from negotiation to delivery. This moment offers a vital opportunity to scale and embed ocean-based solutions more deeply into NDCs and the overall climate regime.

Scientific evidence underscores the opportunity. Research commissioned by the High-Level Panel for Sustainable Ocean Economy showed that ocean-based solutions could deliver up to 35% of the emissions reductions needed by 2050, while also enhancing resilience, conserving biodiversity, and supporting sustainable development. The ocean has not only been affected by the impacts of climate change but is also one of the most powerful tools available to address it.

Trends in ocean-based solutions in NDCs

The integration of ocean-based climate solutions into NDCs has grown since their first submission in 2015 but still remains underrepresented given its mitigation potential. In the NDC cycle (2015), around 62-70% of submissions included at least once ocean reference,[285] though these were mostly focused on threats such as coastline impacts, fisheries vulnerability, and ocean warming, rather than on actionable measures. By the second enhancement cycle (2020), more than 70% of updated NDCs included at least one ocean-based action, showing a notable shift in positioning the ocean as part of the solution to combating climate change impacts.[286]

In 2025, early data suggest that 74% of the 23 new NDCs submitted between October 2024 and May 2025 include ocean-based climate measures, with ocean adaptation appearing in 88% and mitigation actions appearing in 41% of submissions.[287] These figures are encouraging, but much more remains to be done to unlock the full potential of ocean action through ambitious policies, greater investments, and cross-sectoral integration.

Ahead of COP30 and the submission of NDCs 3.0, there have been increased efforts to build momentum for "bluing the NDCs" and elevate the work of countries who have included ocean-based climate solutions in their NDCs as an example for others. At the UNOC3 held in June 2025 in Nice, France, Brazil and France launched a landmark international initiative to dramatically scale up ocean-focused climate action. The Blue NDC Challenge calls on all countries to place the ocean at the heart of their climate plans ahead of COP30, which Brazil will host in November 2025. In addition, an inaugural group of eight countries including Australia, Fiji, Kenya, Mexico, Palau, and the Republic of Seychelles, have already joined the initiative, committing to include the ocean in their updated climate plans under the Paris Agreement or their accompanying implementation plans. These plans represent the centerpiece of each country's efforts to reduce emissions and limit warming to 1.5°C and build resilience and represent the highest level of political will under the UNFCCC.

Sector-specific efforts to integrate NDCs are highlighted below.

- *Coastal ecosystems:* Mangroves, seagrasses, and salt marshes are increasingly included in NDCs, but fewer than half of countries specify measurable targets (*e.g.,* hectares to restore/protect).[288] Examples include Belize's commitment to protect 6,000 hectares and restore 2,000 hectares of mangroves by 2030.
- *Renewable energy:* Offshore wind is now referenced in Brazil, the UK, and the UAE NDCs, but overall inclusion remains limited to high-income countries. Furthermore, a number of countries are members of the Global Offshore Wind Alliance and have committed to developing marine renewable energy, however they do not include these plans in their NDCs.
- *Shipping:* several countries (*e.g.,* Marshall Islands, Singapore, Canada) reference plans for green maritime fuels or domestic decarbonization targets.
- *Fisheries and Agriculture:* Nine NDCs included mitigation such as improving fleet efficiency or promoting sustainable aquaculture.
- *Tourism:* References are few and mainly address adaptation of coastal infrastructure.

Key Gaps and Challenges

Despite progress, several gaps persist, including:

- Ocean-based mitigation is underutilized compared to adaptation;
- Many commitments remain vague, lacking numerical targets or timelines;
- Equity and livelihoods dimensions are often overlooked;
- Financing for ocean action remains minimal, with less than one percent of global climate finance directed to the ocean; and
- Alignment with other national strategies (NAPs, NBSAPs, SOPs) remains inconsistent.

Recommendations for Strengthening Ocean Content

To unlock the full potential of ocean-based action, countries can undertake actions in alignment with the steps highlighted below.

1. *Set quantifiable targets:* Move from narrative pledges to measurable commitments (e.g., hectares of mangroves conserved and restored, MW of offshore wind installed).
2. *Balance adaptation and mitigation:* Expand mitigation by integrating shipping decarbonization (green shipping), aquaculture efficiency, and sustainable marine renewable energy.
3. *Embed equity and livelihoods:* Ensure NDCs include specific provisions for small-scale fishers, Indigenous peoples, and vulnerable coastal communities.
4. *Leverage finance and innovation:* Link NDC commitments to financing mechanisms.

5. *Integrate across frameworks:* Align NDCs with NBSAPs, NAPs, and SOPs to maximize synergies and avoid duplication.
6. *Enhance monitoring and MRV:* Use tools like Global Mangrove Watch and the Blue Carbon Initiative's guidelines to track implementation and unlock results-based finance.

Momentum is growing, and more countries are embracing ocean-based solutions as essential components of climate action. However, this progress must be deepened and broadened. COP30 presents a critical opportunity to consolidate the role of the ocean in national climate commitments, transforming the ocean from a "victim" narrative into a driver of mitigation, adaptation, and resilience.

3.2 National Ocean Policies as a tool for further integrating ocean and climate action

As climate change accelerates, National Ocean Policies offer a strategic framework for countries to align marine conservation with climate resilience. These policies enable governments to coordinate efforts across sectors, fisheries, energy, transport, and coastal development—while embedding climate goals into ocean governance.

By prioritizing blue carbon ecosystems, MSP, and ocean-based renewable energy, such policies help nations reduce emissions, protect biodiversity, and adapt to rising seas. They also facilitate international cooperation, allowing countries to contribute meaningfully to global agreements like the Paris Accord and the High Seas Treaty.

Indian Ocean

In South Asia, India is emerging as a leader in aligning ocean-related climate policies with its broader environmental and SDGs. The National Action Plan on Climate Change (NAPCC), the National Adaptation Fund for Climate Change (NAFCC), and the Deep Ocean Mission, all support coastal resilience in the face of climate change. The Deep Ocean Mission integrates climate science with ocean exploration, aiming to understand oceanic processes that influence monsoons, sea-level rise, and carbon cycling.

At the 2024 UNOC in Nice, India unveiled a Six-Point Ocean Action Plan that underscores its commitment to integrating ocean health with climate resilience. Among the most transformative elements of this plan is the promotion of ocean-based climate solutions, a strategy that leverages the ocean's natural systems and technological innovations to combat climate change. Key elements of this plan under implementation are highlighted below.

- *Investing in ocean renewable energy*: Offshore wind, tidal, and wave energy all present opportunities for investment in ocean renewable energy. Pilot projects along the Gujarat and Tamil Nadu coasts aim to diversify the nation's energy mix while reducing GHG emissions. These efforts are supported by climate-resilient infrastructure initiatives under the Sagar Mala program, which incorporate risk assessments and nature-based defenses like artificial reefs and dune restoration.
- *Identifying and investing in NbS:* Restoration efforts of blue carbon ecosystems such as mangroves, seagrasses, and salt marshes would benefit from increased investment. Over the past year, India has restored over 10,000 hectares of mangroves, enhancing both carbon sequestration and coastal protection.
- *Expanding ocean observation networks:* Increased observation will allow for better monitoring of SLR, ocean warming, and acidification, and the resulting data will be critical for climate modeling and disaster preparedness.

East Asian Seas Regions

Several global and regional programs are aligning climate action with sustainable development and resilience goals. By incorporating climate goals into economic development, The World Bank Group's (WBG) Climate Change Action Plan (2021–2025) advances a Green, Resilient, and Inclusive Development (GRID) approach.[289] It focuses on high-emission sectors for mitigation, scales adaptation, and emphasizes gender-sensitive climate strategies to ensure equitable benefits. Similarly, the Global Green Growth Institute's Asia Regional Strategy (2021–2025) supports post-COVID green recovery by promoting renewable energy, circular economy systems, and coastal resilience while leveraging private capital for NbS and measurable GHG reductions.[290]

At the regional level, the ASEAN Climate Change Strategic Action Plan (ACCSAP) 2025–2030[291] builds on earlier efforts to implement NDCs, enhance finance and technology support, and foster ASEAN-wide coordination through

initiatives such as the ASEAN Climate Change Centre. Complementing these efforts, green finance mechanisms led by ADB and ASEAN, including green bonds, are catalyzing investments in climate-resilient projects. Another initiative is PEMSEA's Blue Carbon Program, supported by a Technical Working Group, which aims to contribute to improving carbon sequestration and coastal resilience by conserving and restoring coastal ecosystems, such as mangroves, seagrasses, and tidal marshes. The program integrates science and policy through the conduct of regional studies (*i.e.* Assessing the Supply Side of Blue Carbon in ICM and other local sites in the EAS Region and Harmonizing Blue Carbon Accounting Protocols for Coastal Ecosystems in the EAS Region) toward the development of a regional blue carbon accounting protocol, standardized monitoring and certification systems, supports capacity-building via regional trainings, and advances the inclusion of blue carbon in national policies and carbon finance mechanisms.

Most countries in the Asia and Pacific region have prepared NAPs and included adaptation priorities in their NDCs as part of their commitments under the Paris Agreement (see the UNFCCC Secretariat's 2025 report on the progress in the process to formulate and implement national adaptation plans[292]). Of the 44 economies that ratified the Paris Agreement, 36 have announced or adopted net zero targets. However, there is a recognized need for concrete roadmaps and to better integrate adaptation into medium-term development plans and expenditure frameworks.[293]

In East Asian countries, the plans summarized in Table 5 were adopted in support of Climate Change Adaptation.

Table 5. Climate Change Adaptation from Mid-term Review of PEMSEA's SDS-SEA Implementation Plan 2023-2027[294]

Country	Key CCA-Related Plans
Cambodia	Climate Change Strategic Plan (CCCSP) 2024-2033
China	National Climate Change Adaptation Strategy to 2035
Indonesia	National Action Plan for Climate Change Adaptation (RAN-API)
Japan	National Plan for Global Warming Prevention (revised in 2025)
Lao PDR	National Strategy on Climate Change of the Lao PDR Vision to the year 2050, Strategy and Programs of Actions to the year 2030
Philippines	National Adaptation Plan (NAP) of the Philippines 2023-2050; Nationally Determined Contribution Implementation Plan 2023-2030
RO Korea	Third National Action Plan (for 2021–2025)
Singapore	National Climate Change Strategy (2012); Climate Action Plan (strategies to achieve 2030 pledge); Long-term Low Emissions Development Strategy (LEDS)
Timor-Leste	First National Adaptation Plan (NAP); National Mitigation Plan (development ongoing)
Viet Nam	National Adaptation Plan (NAP) for the period 2021-2030, with a vision to 2050

To address coastal erosion and protect coastlines, countries in Southeast Asia are using a combination of hard and soft approaches. For instance, Viet Nam has deployed geotube seawalls and reinforced sea dikes with concrete revetments, while Thailand uses stepped rock and concrete revetments that also support tourism and vegetation. Singapore has fortified 70-80% of its coastline with hard walls and embankments. Nature-based soft measures are also becoming popular as low-cost, sustainable solutions. Some examples are Viet Nam's Mekong Delta bamboo fences and geotube breakwaters to reduce wave energy and enhance sedimentation, and Indonesia's permeable dams, among others.[295]

In terms of technological innovations, one emerging field to monitor and address climate change is Blue Technology (Blue Tech), where startups are creating innovative solutions at the ocean-climate nexus to address issues like climate change, pollution, and biodiversity loss. Underwater robots for data collection and maritime security, mCDR to extract CO_2 from seawater, energy-efficient industrial technologies for shipping and wastewater are some of the innovations. Ocean sensors aid in scientific research and naval operations, while enhanced aquaculture methods aim to produce seafood more sustainably. The sector is attracting increasing investment, with most funding going

to the industrial and aquaculture sectors.[296] AI and climate technology advancements are also helping to address climate change, particularly through carbon capture and intelligent systems that optimize energy use, forecast climate risks, and streamline sustainability planning across sectors. (*e.g.,* technologies like Direct Air Capture (DAC) and Bioenergy with Carbon Capture and Storage (BECCS), and AI-powered tools such as IBM's emissions monitoring systems and Carbon Trail's AI Copilot).[297]

Key Recommendations Identified from Existing Studies

The following compilation synthesizes key recommendations drawn from various climate-related studies.

- Policy and Strategic Frameworks:
  - Enhance integration of NAPs and NDCs into medium-term development plans and budgets;
  - Develop concrete sector-specific roadmaps to support net-zero targets;
  - Mainstream climate adaptation and mitigation, as well as disaster management, in ocean governance and policies; and
  - Develop financial incentives (e.g., clean energy fund).
- Adaptation Measures and Initiatives:
  - Expand soft and hard solutions to strengthen coastal resilience and protection
  - Advance community-level adaptation and planning;
  - Promote market reforms that can help build adaptive capacity *(e.g.*, eliminate harmful resource subsidies);
  - Conduct assessments or reassessments and communicate results to inform planning and decision-making; and
  - Promote interdisciplinary research.
- Mitigation Efforts and Energy Transition:
  - Promote decarbonization through renewable energy and energy efficiency;
  - Reallocate and rationalize fossil fuel subsidies toward social and green transition programs;
  - Implement carbon taxes and emissions trading systems; and
  - Engage in international carbon markets with robust national strategies.
- Technological Innovations and Approaches:
  - Develop data sharing protocols and systems, support R&D, strengthen use of AI or digital tools, and promote blue technology solutions to support data analysis, monitoring, and forecasting.
- Public Engagement, Capacity Building and Awareness
  - Enhance climate education and communication to promote behavior change and make climate data more understandable, accessible and actionable;
  - Ensure inclusive participation by involving indigenous and local knowledge systems in planning and decision-making processes; and
  - Invest in skills, infrastructure, funding, and access to information.

4. MITIGATION

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This section focuses on mitigation measures and follows the recommendations from the initial ROCA initiative to further develop and apply mitigation measures using the ocean, such as implementing "Blue Carbon Policies," reducing CO_2 emissions from ships, developing ocean-based renewable energy, and considering (long-term no-harm) ocean-based carbon capture and storage.

It is well known that the ocean has the capacity of delivering up to 35% of the emissions reduction needed by 2050 if we are to keep below the Paris Agreement targets, while also enhancing climate resilience, biodiversity conservation, and sustainable development. Indeed, the ocean may be our only hope of limiting emissions below the 2º C level, given the pace at which we are already moving towards the 1.5º level. Given the current lack of action on mitigation and with the world's largest economy abandoning climate change targets and policies, holding to the 1.5 C level may be the most optimistic future facing the world at present.

4.1 Implementing blue carbon policies and nature-based solutions

The East Asian Seas region is a major contributor to global warming and one of the most vulnerable regions to climate change challenges, exhibiting a significant need for blue carbon solutions. Mangroves, peat marshes, seagrasses and marine organisms, all identified as a rich source of blue carbon, offer vital benefits such as carbon sequestration, coastal protection, and sustainable marine life habitats that can be the lifeblood of the surrounding coastal communities.

Despite these significant opportunities, several challenges must be addressed to harness the full potential of blue carbon ecosystems (BCE). These include the need for advanced monitoring systems, standardized methodologies for carbon sequestration measurement, policy support, and financing for restoration and conservation efforts. Funding models such as PPP, carbon markets, green bonds, and impact investments are crucial to supporting blue carbon initiatives. Examples of successful blue carbon projects across various countries in the region demonstrate the importance of ecosystem conservation, restoration, and community involvement in carbon offsetting and sustainable development.

The demand for blue carbon worldwide is projected to grow significantly over the next five to ten years, driven by market demand, improvements in carbon sequestration accounting and verification, and future projections as the potential for blue carbon financing within the voluntary carbon market presents lucrative financial short- and long-term opportunities.

PEMSEA established a regional blue carbon program which is a regional approach to blue carbon management that aims to support PEMSEA country partners' NDCs while enhancing the condition of blue carbon ecosystems, recognizing their diverse ecosystem services and role in increasing coastal community resilience. The program has two main objectives: 1) to support the conservation and enhancement of coastal blue carbon ecosystems to optimize their contributions to GHG emissions reduction and coastal resilience to climate change; and 2) to improve local government and community access to financial mechanisms that support the scaling up of blue carbon ecosystem management.

This initiative is especially significant as the East Asian Seas region hosts some of the world's largest blue carbon ecosystems. There is increasing recognition that blue carbon conservation and restoration can directly support countries in meeting their national commitments under the Paris Agreement and the 30 by 30 framework. Specifically, the integration of blue carbon into NDCs provides countries with a concrete pathway to implement NbS that not only help achieve their climate mitigation targets but also deliver substantial co-benefits for climate adaptation and ecosystem resilience.

To support its implementation, PEMSEA developed a Roadmap for the Blue Carbon Program in 2023, outlining immediate actions and a phased approach toward establishing a voluntary certification system and regional blue carbon accounting protocol regional blue carbon accounting protocol (Figure 15).

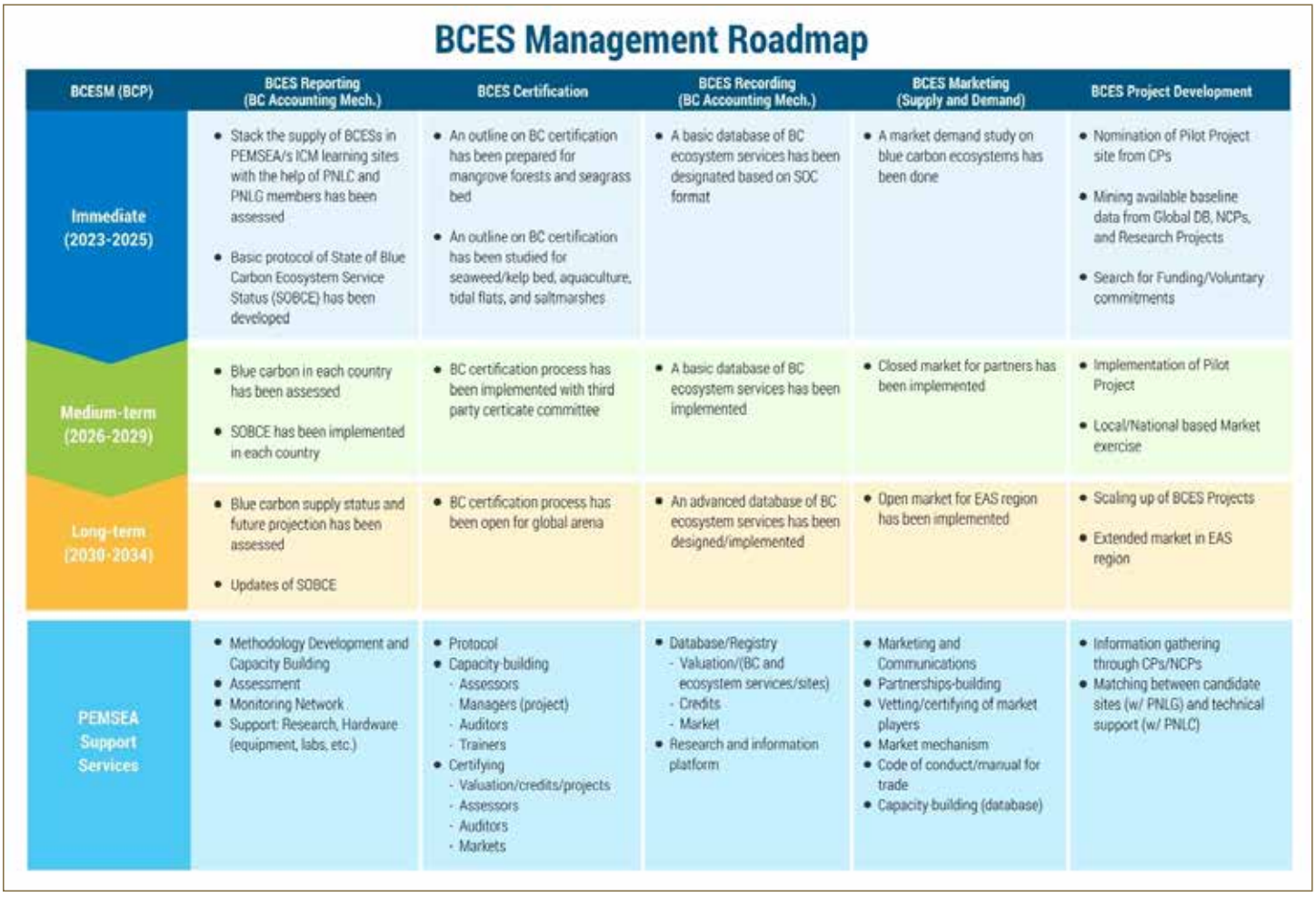

Figure 15. PEMSEA Blue Carbon Program Roadmap

The work is guided by a Blue Carbon Technical Working Group comprised of blue carbon experts and representatives from PEMSEA country- and non-country partners. So far, the regional blue carbon program has produced the following documents and organized technical and capacity development activities:[298]

- Conducted baseline studies assessing blue carbon supply and demand across ICM and other coastal sites in the East Asian Seas (EAS) region (Assessing the supply side of blue carbon in ICM and other local sites in the EAS Region);
- Commissioned a regional review entitled "Harmonizing Blue Carbon Accounting Protocols for Coastal Ecosystems in the East Asian Seas Region", which examined accounting methodologies in selected EAS countries; and
- Developed standardized guidance on blue carbon accounting protocol, which is currently underway for review by the EAS Partnership Council.

When implemented, the harmonized blue carbon accounting protocol has the potential to improve MRV of GHG emissions and removals from blue carbon ecosystems, specifically mangroves, tidal marshes, and seagrasses. Aligned with the IPCC 2013 Wetlands Supplement, it adopts a tiered methodology framework, ranging from Tier 1 (default values) to Tier 3 (site-specific data), to accommodate varying national capacities and contexts. The protocol accounts for key carbon pools, including soil organic carbon, and offers practical directions on activity data collection and emission factor application. Designed to inform national GHG inventories, voluntary markets, and compliance mechanisms, it also lays the groundwork for integrating broader ecosystem services and co-benefits in future crediting systems.

4.2 Reducing CO_2 emissions from ships

International shipping is the main pillar of global commerce. As a global network connecting States, shipping has a key role to play in the development of a sustainable economy. The International Maritime Organization (IMO) is a specialized UN agency and the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted, and universally implemented.

In July 2023, at the 80th session of the Marine Environment Protection Committee (MEPC 80), IMO Member States unanimously adopted resolution MEPC.377(80) on the *2023 IMO Strategy on reduction of GHG emissions from ships* (2023 IMO GHG Strategy),[299] enhancing IMO's contribution to global efforts by addressing GHG emissions from international shipping and establishing timelines for the development of regulatory measures to effectively transpose the GHG reduction commitments into mandatory requirements. The enhanced levels of ambition in the 2023 IMO GHG Strategy include:

- A confirmation of the ambition to reduce CO_2 emissions per transport work (carbon intensity) as an average across international shipping, by at least 40% by 2030, compared to 2008;
- To reach at least 5%, striving for 10%, of the energy used by international shipping to be zero or near-zero GHG emission technologies, fuels and/or energy sources by 2030;
- To reach net-zero GHG emissions by or around 2050, taking into account different national circumstances, whilst pursuing efforts towards phasing them out as called for in the Vision of the Strategy, consistent with the long-term temperature goal set out in Article 2 of the Paris Agreement; and
- Indicative checkpoints to reach net-zero GHG emissions, which include reducing the total annual GHG emissions from international shipping by at least 20%, striving for 30%, by 2030, and by at least 70%, striving for 80%, by 2040, compared to 2008.

Since the adoption of the 2023 IMO GHG Strategy, IMO Member States have been actively developing the regulatory measures required to implement the Organization's decarbonization commitments. The final draft of these measures, referred to as the 'IMO Net-Zero Framework', was approved by MEPC 83 in April 2025, with a view to adoption in October 2025 at an extraordinary session of the Committee, in line with the timelines set out in the 2023 IMO GHG Strategy. However, the extraordinary session of the Committee in October 2025 decided to defer adoption due to push back from certain Member States.

Development and approval of a basket of mid-term GHG reduction measures: the 'IMO Net-Zero Framework'

MEPC and the Intersessional Working Group on Reduction of GHG emissions from ships (ISWG-GHG) have been developing a "basket of mid-term GHG reduction measures" aimed at delivering on the reduction targets of the 2023 IMO GHG Strategy. The measures are comprised of a technical element, namely a global marine fuel standard regulating the phased reduction of a marine fuel's GHG intensity; and an economic element, on the basis of a maritime GHG emissions pricing mechanism.

A comprehensive impact assessment of the potential impacts of the candidate mid-term measures on the world fleet and on States, in particular LDCs and small islands developing States (SIDS), was initiated by MEPC 80 (July 2023).[300] MEPC 82 (September/October 2024) noted the outcome of this assessment and agreed to take them into account, as appropriate, in the further development of the measures; and also agreed to further assess the potential impacts of the measures on food security. Following consideration of the review and additional information provided by the Secretariat, MEPC 83 (April 2025) agreed that the impacts on food security are to be taken into account and addressed, as appropriate, in the further development of the measures; and to keep the future potential impacts on food security under continuous review, so that any necessary adjustments may be made.[301]

Based on the various proposals on the architecture of the mid-term GHG reduction measures, set out as possible amendments to Annex VI (Prevention of air pollution from ships) of the International Convention for the Prevention of Pollution from Ships (MARPOL), MEPC 82 (September/October 2024) produced a draft legal text (the draft 'IMO Net-Zero Framework'). This draft text was further developed during the ISWGGHG meetings ISWG-GHG 18 and ISWG-GHG 19 and finalized by the GHG Working Group at MEPC 83 (April 2025). Following a roll-call vote,

MEPC 83 approved the draft amendments to MARPOL Annex VI on the IMO Net-Zero Framework.

As requested by the Committee, the Secretary-General circulated a draft 2025 Revised MARPOL Annex VI (Circular Letter No. 5005),[302] including the amendments on the IMO Net-Zero Framework, to all IMO Member States with view to adoption at an extraordinary session of MEPC (MEPC/ES.2) in October 2025. During this MEPC extraordinary session, the Committee agreed to adjourn the meeting for a period of one year to address outstanding concerns from Member States and industry whilst continuing in parallel the development of relevant implementing provisions.

Key elements of the draft 'IMO Net-Zero Framework'

The goal of the IMO Net-Zero Framework is to achieve the climate targets set out in the 2023 IMO GHG Strategy; accelerate the introduction of zero and near-zero GHG fuels, technologies and energy sources by providing regulatory certainty to the industry and fuel providers; and support a just and equitable transition.

When adopted, the IMO Net-Zero Framework will be included in a new Chapter 5 of MARPOL Annex VI and will apply to ships of 5,000 gross tonnage and above. Under the draft regulations, ships will be required to comply with a:

- *Global fuel standard:* Ships will be required to reduce, over time, their annual GHG fuel intensity (GFI), (*i.e.* how much GHG is emitted for each unit of energy used), on the basis of a 'well-to-wake' emissions approach and using the IMO *Guidelines on Life cycle GHG intensity of marine fuels* (LCA Guidelines);[303] and
- *Global economic measure:* Ships emitting above GFI thresholds will have to balance their compliance deficit by acquiring remedial units by means of pricing contributions to the IMO Net-Zero Fund; while over-compliant ships will generate surplus units; and those using zero or near-zero GHG technologies will be eligible for financial rewards disbursed by the IMO Net-Zero Fund.

The GFI reduction factors will be set annually and will be based on a two-tier compliance approach: a direct compliance target and a base target. Ships emitting above the set thresholds will balance their compliance deficit by acquiring remedial units through pricing contributions to the IMO Net-Zero Fund; while for emissions above the base target thresholds the deficit can also be balanced by using surplus units banked from previous reporting periods or surplus units transferred from other ships.

An IMO GFI Registry will be established and administered by the IMO Secretariat to ensure compliance and facilitate the implementation of the IMO Net-Zero Framework, by recording all actions (banking, cancellations, credit, etc.) and transfers of units in each ship's account in the Registry. For each ship and reporting period, an annual ship account statement will be issued by the Registry, reflecting how the ship complied with the requirements and its potential eligibility to receive rewards for the use of zero or near-zero GHG emission technologies, fuels and/or energy sources.

An IMO Net-Zero Fund will be established to collect, manage and disburse generated revenues through the acquisition of remedial units. The Fund will operate in accordance with governing provisions to be developed by MEPC. The day-to-day operation of the Fund will be overseen by a Governing Board, appointed by the Committee ensuring a gender and geographically balanced composition and adequate representation of developing countries, in particular SIDS and LDCs.

The revenue will be disbursed to reward ships for the use of zero or near-zero, in the context of the implementation of the IMO Net-Zero Framework, promote a just and equitable transition in States by facilitating environmental and climate protection, adaptation and resilience-building within the boundaries of the energy transition in shipping, paying particular attention to the needs of developing countries, in particular LDCs and SIDS.

The IMO Net-Zero Framework also introduces a framework for certification of sustainable fuels to certify the ship's attained annual GFI; enhances the assessment of possible impacts of the measures on food security by inviting the Committee to keep under review the potential impacts of the new chapter on food security; and explicitly supports the promotion of technical cooperation and transfer of technology by inviting Administrations to cooperate amongst them, as well as with the Organization and other international organizations in respect of the implementation of the new measures.

IMO action to promote the uptake of alternative low-carbon and zero-carbon maritime fuels

Life cycle GHG intensity assessment (LCA) of marine fuels

MEPC 80 adopted LCA Guidelines, allowing for a Well-to-Wake calculation, including Well-to-Tank and Tank-to-Wake emission factors, of total GHG emissions related to the production and on-board use of marine fuels. The LCA Guidelines are a key implementation instrument for the IMO Net-Zero Framework as they provide a robust international framework to assess the GHG intensity and sustainability of marine fuels with the overall objective of reducing GHG emissions within the boundaries of the energy system of international shipping and preventing a shift of emissions to other sectors.

The IMO Net-Zero Framework introduces the fuel lifecycle label (FLL) as a technical tool to convey information relevant for the life cycle assessment of a marine fuel. This will be an important tool to document a fuel's sustainability across the fuel value chain. Details on the operationalization of the FLL will need to be provided in guidelines to be developed. The IMO Net-Zero Framework also envisages recognition by the Committee of Sustainable Fuel Certification Schemes (SFCS) to certify, as appropriate, GHG emission factors and sustainability themes or aspects of a marine fuel.

MEPC 83 adopted, by resolution MEPC.402(83), Guidelines for testbed and onboard measurements of methane (CH_4) and/or NO_2 emissions from marine diesel engines. These Guidelines provide an emission measurement protocol and procedures for documentation and verification of emission values, based on the well-established methodologies of IMO's NOx Technical Code 2008.

MEPC 83 approved a Work Plan on the development of a regulatory framework for the use of onboard carbon capture and storage (OCCS), in order to reduce net GHG emissions from ships without negatively affecting the environment, and re-established a Correspondence Group to advance regulatory developments on these issues.

Future Fuels and Technology project (FFT)

The IMO Future Fuels and Technology project (FFT), funded by the Republic of Korea, was launched in 2022 to support regulatory decision-making at MEPC and its subsidiary bodies, notably on GHG relevant issues. So far it has conducted a *Study on the readiness and availability of low- and zero-carbon ship technology and marine fuels* (Spring 2023)[304] and a *Review of existing practices on sustainability issues for marine fuels* (Autumn 2023).[305]

The IMO Future Fuels Portal,[306] launched in March 2024, provides easy and free-of-charge access to the latest information on zero and near-zero GHG emission marine fuels and technologies through a dedicated online portal; and promotes communication and knowledge sharing to foster cooperation and collaboration among stakeholders to achieve the targets of the 2023 IMO GHG Strategy.

The FFT Project organized a Technical Seminar[307] on OCCS Systems, taking place in September 2025, to enhance the understanding of the latest developments in OCCS technology, infrastructure readiness and relevant environmental, safety and human element perspectives.

Implementation and review of the short-term GHG reduction measure

Following the adoption by MEPC 80 (July 2023) of the Review plan of the short-term GHG reduction measure, to be completed by 1 January 2026, MEPC 82 continued its work to review the short-term measure currently in force to reduce GHG emissions from ships by enhancing the energy efficiency of the global fleet. These regulations, adopted in 2021 and effective since 1 January 2023, require existing ships to measure their energy efficiency by calculating their attained Energy Efficiency Existing Ship Index (EEXI) and to continuously improve their annual operational carbon intensity indicator (CII) rating.

MEPC 82 agreed on a two-phase approach to address a number of key challenges or gaps identified in the implementation of the short-term measures over the past years, ranging from CII impact on individual ships assessments or operational energy efficiency performance and potential penalization of ships on short voyages to the lack of incentivization for port call efficiency and just-in-time arrival of ships. The timeframe foresees addressing some challenges and gaps before 1 January 2026 (Phase 1), while others will be addressed after 1 January 2026 (Phase 2).

MEPC 83 finalized Phase 1 by adopting amendments to the 2021 Guidelines on the operational carbon intensity reduction factors relative to reference lines (resolution MEPC.400(83)) and defining new CII reduction factors for 2027 to 2030, resulting in a 21.5% reduction in 2030 compared to 2019.

MEPC 83 also approved a Work Plan for Phase 2 of the review of the short-term GHG reduction measure (2026 to 2028) including the following work streams: enhancing the Ship Energy Efficiency Management Plan (SEEMP) framework; further developing CII metrics; and considering synergies between IMO carbon intensity/energy efficiency framework and the IMO Net-Zero Framework.

4.3 Considering ocean-based carbon capture and storage

Carbon Capture in sub-seabed geological formations

In 2006, Annex I to the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol) was amended (resolution LP.1(1)) to allow Carbon Capture and Sequestration (CCS) in sub-seabed geological formations when deemed "safe" and to regulate the injection of CO2 waste streams into sub-seabed geological formations for permanent isolation. These amendments entered into force in 2007 and created a legal basis in international environmental law to regulate the injection of CO2 waste streams into sub-seabed geological formations for permanent isolation.

Under the London Protocol, CCS in sub-seabed geological formations is thus subject to the licensing arrangements contained in the instrument as well as a mandatory impact assessment. To facilitate the licensing process, the Contracting Parties adopted, in 2012, a *"Risk Assessment and Management Framework for CO_2 Sequestration in Sub-Seabed Geological Structures"* and the "*Specific Guidelines on Assessment of CO_2 Streams for Disposal into a Sub-Seabed Geological Formations*." These documents provide advice on how to capture and sequester CO_2 in a manner that meets all the requirements of the London Protocol and is safe for the environment, both marine and atmospheric, for the short- and long-term.

In 2009 the Parties further amended the LP (resolution LP.3(4)) to enable Parties to share transboundary sub-seabed geological formations for CCS projects (provided that the protection standards of all other LP requirements have been met). However, this amendment has not yet entered into force. Therefore, in 2019, as an interim solution, LP Parties adopted a resolution (LP.5(14)) to allow provisional application of the 2009 amendment enabling countries to export and receive CO2 for offshore geological storage, pending its entry into force by those Contracting Parties which have deposited a declaration to this effect. The number of Parties to the 2009 amendment, and those declaring provisional application of the amendment, continue to grow as CCS is quickly maturing as an accepted climate change mitigation technology. As of 3 October 2025, there are 15 Contracting Parties having accepted the 2009 amendments, and 15 Contracting Parties have also deposited declarations of provisional application of the 2009 amendment.

Under the 2009 amendments to the London Protocol, Contracting Parties entering into an agreement or arrangement for export of CO2 for the purposes of CCS in sub-seabed geological formations, must notify the IMO Secretariat. To date, a total of nine such arrangements/agreements have been reported to the Secretariat.

4.4 Marine carbon dioxide removal

Marine carbon dioxide removal (mCDR) involves the process of removing CO_2 from the atmosphere and storing it in the ocean. Enhancement of natural processes or the introduction of human-engineered solutions are both considered potential mCDR pathways. As a relatively new field of research, there is uncertainty about the efficacy and potential environmental impacts of mCDR techniques. This section provides an overview of the current status of mCDR development and potential pathways to its more widespread adoption.

The suite of approaches proposed to remove CO_2 using the ocean has been categorized with biological, chemical and physical approaches. Carbon may be removed from the air and deposited in the ocean (subsurface CO_2 disposal, removed from ocean surface waters followed by re-equilibration of CO_2 from the air (ocean alkalinity enhancement (OAE)), direct ocean carbon capture (DOCC), phytoplankton stimulation, downwelling, sequestration in coastal sediments (blue carbon), or exported and sunk into the deep ocean (phytoplankton, macroalgae, crop waste, wood waste).

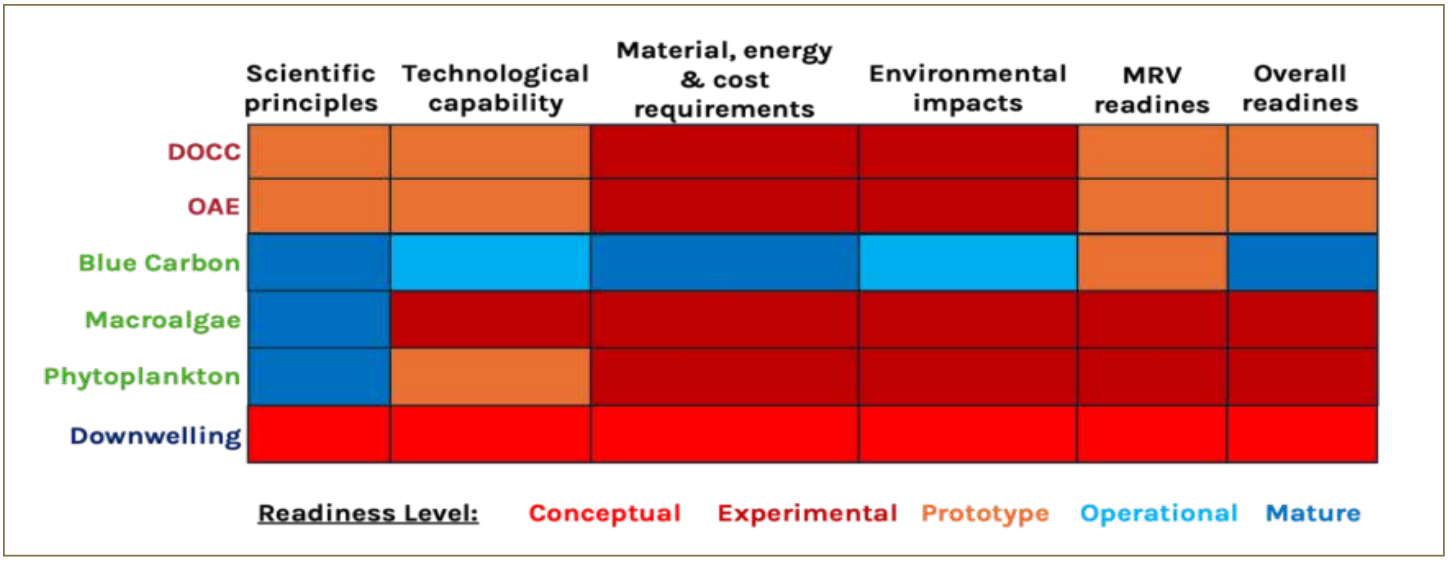

Figure 16. Readiness of mCDR technologies based on multiple criteria. Adapted from Doney et al. (2025)[308]

Assessment of readiness suggests that all approaches are in the early stages of development, with the chemical approaches slightly ahead of the biological and physical approaches (Figure 16). The one exception is coastal blue carbon, the restoration and enhancement of mangroves and seagrasses, which is relatively well constrained, but has limited scalability for carbon sequestration. Development of mCDR is increasingly addressing social acceptance, MRV processes, and environmental risk. Most of the approaches when applied at a large scale will alter the chemistry and biology of marine ecosystems. Biological mCDR techniques can cause nutrient robbing, changes in subsurface light, seawater oxygen, turbidity, and altered water column and seafloor chemistry both at and beyond the site of mCDR activity. OAE by enhanced weathering can introduce ground particles that contain harmful trace minerals; Electrochemical OAE and DOCC will entrain large amounts of water as well as discharge water back into the marine environment consisting of altered seawater chemistry, both of which could impact marine species in the vicinity of the operations. Coastal chemical approaches may have more accurate MRV (measuring CO_2 removal) than open ocean and/or biological applications, however the methods and technology to conduct any MRV are still being developed. The potential for implementation of all mCDR technologies at climatically relevant scales is highly uncertain. To propel mCDR towards implementation will require significant advances in technological capabilities and scientific knowledge of efficiency, environmental implications and monitoring requirements, alongside development of appropriate governance structures, financing mechanisms and societal engagement.[309] This requires open and transparent research and funding support.

Governance of mCDR is relatively weak and there is no globally applicable, international framework. However, international regimes relevant to ocean protection and climate that have addressed mCDR include UN Convention on the Law of the Sea, the BBNJ Agreement, the London Convention and London Protocol, the CBD, and the UN Framework Convention on Climate Change and Paris Agreement. Few countries have domestic laws specifically addressing mCDR activities; rather mCDR activities are regulated under general environmental laws. Public familiarity with and acceptance of mCDR is limited, with natural approaches and enclosed engineering methods somewhat more favored, but large-scale applications are not yet being considered.

Natural Analogs

Understanding the consequences of marine climate interventions for physical, biogeochemical and biological processes in the ocean is challenging. A growing body of literature looks to natural analogs to aid assessment of mCDR technologies, improve MRV, and predictions of environmental consequences. Some of the advantages of natural analogs include the absence of cost to generate the effects, permitting requirements, and social license; the potential for large-scale natural experiments with unperturbed conditions (in space or time); and the potential for replicated research via multiple occurrences.[310] However, they also offer real-world complexity that can sometimes make causation difficult to establish.[311] Natural analogues proposed for Ocean Alkalinity enhancement can include

long past events gleaned from the geologic record such as a deglacial pulse of neutralized carbon involving alkalinity release at the end of the last ice age;[312] modern inputs of rivers and their plumes such as the high-alkalinity Mississippi R., glacial flour inputs to fjords or restricted basins that can inform on mineral dissolution or precipitation, particle dynamics, and plume evolution, whiting events consisting of plumes of suspended, fine-grained CaCO3 appear as in the Bahamas, high-alkalinity basinal seas such as the Mediterranean, Red Sea and Black Sea; alkaline serpentinite vents in the deep sea, such as found at Lost City in the Atlantic or Chamorro Seamount in the Marianas region; black sand and olivine beaches whose minerals mimic the feedstock for OAE, seafloor weathering and borehole chemistry.[313]

For biomass sinking, natural kelp falls, sinking of pelagic *Sargassum* rafts, and natural wood falls, all offer potential analogs. In most cases, the natural falls are notably smaller in scale than would be required for climate intervention. Natural analogs for iron fertilization and artificial upwelling that cause hotspot CO_2 sinks can be found in regions such as Crozet and Kerguelen in the Southern Indian Ocean where iron inputs stimulate seasonal booms, near shallow hydrothermal vents such as along the Tonga volcanic arc[314] elevating primary production; downwind of Australia during the 2019/2020 fire season[315] and from African dust deposited off NW Africa in the Atlantic[316] and in the Southeast Madagascar Sea,[317] during volcanic eruptions spewing nutrient and iron-rich ash such as the recent Hunga Tonga-Hunga Ha'apai, although these latter examples are short-term, single episode events that may not replicate the extended fertilization required for climate modification. There are few natural analogs for DOCC that would mimic environmental impacts, although intense phytoplankton blooms can strip DIC from seawater, leaving alkaline conditions whose consequences might provide natural analogs for both DOCC and OAE.[318] Analogs for CO_2 injection might include natural CO_2 vents, which generate hypercapnic conditions and have been considered as analogs for ocean acidification.[319]

Notably, although many natural analogs have been identified, with the possible exception of iron fertilization, there have been few synthetic efforts to assess the analog implications for ecosystem-scale responses to mCDR, especially for the deep ocean.[320]

Deep-sea considerations

The deep sea is the targeted carbon repository for multiple ocean-based climate interventions, including iron fertilization, artificial upwelling, artificial downwelling, macroalgal culture and sinking, crop and wood waste sinking, because carbon deposited below 500 or 1000m remains out of the atmosphere for extended periods of time (typically 50-100 years or more). The carbon takes the form of increased phytodetrital input, baled algae or agricultural waste, or liquid CO_2 injection. Although most discussions of these approaches depict the deep sea as an isolated barren space, it is increasingly recognized as hosting multiple, complex, highly interconnected ecosystems that also interact with coastal waters. Because both climate change itself, and climate mitigation measures that dispose of carbon in deep water, can negatively impact deep-sea ecosystems, an accurate accounting of environmental impacts is required to assess the costs and benefits of climate interventions.[321] A host of approaches are available to assess environmental responses including laboratory experiments, field mesocosms, field experiments, and natural system analogs and modeling,[322] but there are relatively few studies that have applied these to climate interventions in the deep ocean.[323] Key deep-sea features requiring consideration in assessing responses and environmental risk include:

- The heterogeneity of habitats and ecosystems likely to be affected (*e.g.*, abyssal plains, seamounts, mid ocean ridges, canyons, basins, fjords, slopes, trenches, hydrothermal vents, methane seeps, mesopelagic, bathypelagic, and abyssopelagic) each of which may respond to carbon inputs differently;
- Strong organism and ecosystem adaptation to fixed geochemical and hydrographic conditions that may be perturbed;
- Long lifespans, slow growth and late maturation and low fecundity which can delay or limit recovery;
- Largely undescribed biodiversity and many rare species;
- Foundation species and highly developed mutualistic interactions, such that harm to one species may affect many others; and
- Access that is remote, costly and technology intensive, contributing to data limitation.

These give rise to social and governance challenges in which climate intervention decisions are made under great uncertainty (invoking the precautionary principle), inequities exist in scientific information needed for decision making, developed economies are favored over developing economies, actions involve intergenerational consequences, global commons may be involved (for 60% of the ocean), and rights-based groups (indigenous people) often lack a voice.[324] A recent review of climate science gaps for the deep ocean based on 6 IPCC AR6 Reports calls out ocean-based climate interventions as one of seven major areas of uncertainty and calls for research on deep-ocean processes, altered functions, unintended consequences, and feedbacks to mCDR.[325]

Biophysical and sociocultural risk considerations

mCDR strategies are dominating the discussion surrounding mitigation of anthropogenic emissions. The IPCC Sixth AR features mCDR strategies attaining 1.5˚C compatibility with high overshoot pathways giving a new hope and area of prospect for public and private sectors alike. Many mCDR strategies, both nature-based and technological, are being tested through theoretical, lab-based, and small-scale approaches. However, uncertainty remains around large-scale deployment of mCDR strategies that can attend to the mitigation needs of a fossil fueled society. Further, there is growing concern over scalability of mCDR options that can be deployed within social and physical risk thresholds. As such, the risks and related policy responses, associated with large-scale mCDR are still being investigated.

While biophysical assessments of mCDR applications are being explored by private companies, financial institutions, and research organizations around the world, sociocultural risks associated with mCDR are still under-investigated. Nutrient fertilization, artificial upwelling and downwelling, seaweed cultivation, recovery of marine ecosystems, ocean alkalinity enhancement, and electrochemical engineering approaches all have social and cultural attributes that relate to applicability, scalability, and sustainability.[326] [327] [328]

Biophysically speaking, risks associated with certain approaches are well known, while others remain uncertain and demonstrate high levels of risk to various ecosystem attributes.[329] Numerous complexities and aspects of the ocean climate system are considered in the deployment of these approaches, which makes for a unique area of marine policy, especially as efforts to explore even more novel mCDR approaches persist. Scientists are urging caution in the deployment of novel strategies to avoid direct and indirect social and physical risks.[330]

Socio-culturally speaking, there are many issues emerging around mCDR implementation including: conflicts over space and access, issues of resource allocation and prioritization, and a general concern over the precautionary principle not being employed.[331] Further, there is a lack of knowledge and awareness with regard to these strategies from a public perspective, which is driving skepticism and manifesting distrust among communities affected by mCDR deployment.[332]

The National Academies of Sciences, Engineering, and Medicine (2022) report indicates mCDR social risks exist related to legality of implementation and governance complexities, potential impacts on local and indigenous communities and food systems, and a lack of ethical guidance that reflects sustainability goals.[333] [334] [335] Further, there is growing conflict over ocean space uses in association with massive blue economic growth at the global scale.[336] Röschel and Neumann (2022) explain that "foresight-oriented and adaptive governance" approaches are needed to bridge gaps resulting from extensive uncertainties and unknowns linked to mCDR deployment. [337] These findings reflect a scientific position of precaution when integrating mCDR strategies into emission reduction plans with a focus on reducing conflict and engaging innovative governance structures.

Each of the various mCDR strategies carries social and environmental risks. For example, the nature-based solution (NbS) of mass seaweed cultivation raises concerns about physical changes to ecosystems from concentrating abundant species in limited areas, while access to leases and growing rights can create conflicts within communities seeking to benefit from these resources.

UNEP (2023) defines several threats have been identified for seaweed farming, noting that "rapid upscaling of seaweed commercial use pathways for carbon sequestration and GHG emissions reduction could have unforeseen environmental and social risks." [338] The social risks related to food security, environmental and chemical exposure, and exploitation of unjust labor regimes are being considered. Further access to seaweed beds and areas to grow seaweed require governance and oversight to ensure sustainable use.[339]

On the other end of the spectrum, in the technological realm, social risks related to ocean alkalinity enhancement are characterized by concerns over the offshore nature of implementation and impacts to fishing communities and food systems. Further, offshore application requires a sophisticated and resourced approach that may not be feasible for many countries already lacking capacity in accessing offshore areas of the territorial sea. This can result in uneven distribution in areas that have stronger economic standing.[340]

In the end, many efforts are underway to better understand social and biophysical risks associated with various mCDR technologies. Concerns over resource biophysics, allocation and access, food system impacts, development challenges, and ethical considerations remain critical areas of research for the responsible deployment of mCDR strategies.

4.5 Mitigation measures in fisheries and aquaculture

Despite being a minor contributor to global carbon emissions, fisheries can adopt decarbonization measures along the value chain to contribute to the 1.5°C climate goal. Key measures include the use of renewable energy, enhancing vessels energy efficiency through practices such as reducing trawling speed, fishing gear modifications (lighter ground gear and trawl doors, different mesh sizes, lighter netting materials and other trawl components), hull modifications, timely cleaning of the hull bottom from fouling and timely servicing the engine. To promote the uptake of these practices, in 2022-2023, FAO, in close collaboration with the Bay of Bengal Programme – Intergovernmental Organization (BOBP-IGO), has been promoting simple fuel-saving measures in Sri Lanka and India using a technical manual.[341]

Meanwhile, electrification of the industrial fishing fleet is going slow. It involves equipping vessels with lithium-ion batteries, hydrogen fuel cells, and/or solar power. Tests are ongoing in a few places with governmental support to overcome hesitations of early adaptors and innovators among the vessel owners to invest in electrification. Several hybrid solutions are also being tested, such as vessels equipped with battery packs and a diesel engine that power the vessel together for a full day of operation.[342]

Similar to fishing operations, aquaculture production is also a minor GHG emitter. The total GHG emissions for global shellfish and finfish aquaculture production from "cradle to farm-gate" is estimated to have been 263 megatonnes of CO_2 equivalent (CO_2e) in 2017, about 0.49% of the total global GHG emissions that year.[343] Compared with terrestrial livestock, aquaculture exhibits lower carbon intensity, primarily due to the absence of enteric methane emissions. Feed production represents the largest share of aquaculture's emissions (57%), followed by aquatic NO_2 emissions from nitrification and denitrification processes, and on-farm energy use, which includes pumping, lighting, and powering vehicles. Among aquaculture systems, the production of bivalves generally has a lower carbon footprint than shrimps and prawns, although there can be considerable variability around GHG emissions per unit production across different geographical regions or farming sites depending on production efficiency.[344] GHG emissions from seaweed farming are reported to be less than bivalve aquaculture and considerably lower than emissions from fed finfish and crustacean mariculture.[345]

There is ample room for decarbonizing aquaculture production to supply low-carbon and high-quality nutrition. Modelling suggests that a reduction of 21% in CO_2e emissions per tonne of fish production can be achieved by combining approaches of improving efficiency of input use (*e.g.* water, feed, energy, fertilizers), shifting energy support from fossil fuel to renewable, adopting best practices to improve feed conversion rates, and replacing fishmeal and fish oil with crop-based ingredients, terrestrial animal by-products and non-conventional protein ingredients such as insects, yeast and microalgae.[346] [347] Moreover, boosting production of lower trophic species such as algae and bivalves, and integrated multitrophic aquaculture (IMTA) such as shrimp-mangrove cultivation, can result in a substantial reduction of overall GHG emissions from aquaculture production systems.[348] The farming of bivalves (such as mussels and oysters) and algae, which do not need external feeds, can also provide additional ecosystem services, including biological absorption of nutrients to control coastal eutrophication.[349]

Beyond production, post-harvest activities can optimize operations by using renewable energy and climate-smart technologies, such as solar dryers or biodigesters. These practices are supported by field projects targeting women and fostering access to more efficient ovens for fish smoking.[350] An FAO publication has identified opportunities for renewable energy interventions along the small-scale fish value chains and discussed challenges associated with cost and financing, policy environment and local capacity, awareness.[351]

Finally, there are also opportunities for fisheries to contribute to carbon sequestration and blue carbon ecosystems through holistic fisheries management with measures such as mangrove preservation and restoration. Estuaries and nearshore canyons serve as valuable habitats for multiple species and actively sequester carbon. With support from the Norwegian Agency for Development Cooperation (NORAD), FAO supported the development of a climate smart Small Pelagic Fisheries Management Plan in the Philippines, which includes coastal and marine ecosystems restoration. The project is expected to improve fisheries governance, restore coastal habitats, and protect critical ecosystems, hence alleviating climate change impacts on ecosystems.

4.6 Carbon trading and blue carbon initiatives

Key outcomes from COP29 related to carbon trading

There are two main avenues for countries to produce and trade credits under the Paris Agreement: Article 6.2 and Article 6.4. Article 6.2 sets out very broad guidelines for eligible credits, and countries can use whichever methodologies they like, as long as the overall guidelines are met. Article 6.4 created a Supervisory Body, which will approve specific methodologies for trade.

COP29 marked a historic milestone for Article 6 as countries finalized most of the remaining building blocks of carbon markets under the Paris Agreement. The conclusion of the Article 6 negotiations after nearly a decade sends a clear and decisive message: The rules, imperfect as some may be, are now established, providing much-needed certainty for countries, investors, and stakeholders to advance their Article 6 trading.

There are no restrictions on the types of emissions reductions and removals that can be eligible under Article 6.2 or Article 6.4, meaning that blue carbon activities could produce eligible carbon credits under either approach.[352] However, the specifics and timeline will vary. While the agreement reached at COP29 provides a framework for carbon markets under the Paris Agreement, most decisions around implementation are left to national governments. Key decisions, such as what will be traded, how trades will be operationalized, and who will oversee the markets, need to be addressed domestically before trading starts to take off. That means some countries may approve the sale of blue carbon credits and others may not.

Article 6.2

Despite some uncertainty from ongoing negotiations, Article 6.2 has been operational since 2021, and momentum has only grown in the past years. Dozens of bilateral deals have been signed, with increasing participation from both buyer and seller countries. At least 30 projects have also received host country authorization to trade Article 6 units. However, only one Article 6 trade has been completed so far, highlighting the challenges that remain in *implementing* Article 6.2. Specifically, the biggest challenge lies in countries developing their domestic frameworks to participate in Article 6: this includes defining institutional arrangements to authorize Internationally Transferred Mitigation Outcomes (ITMOs), aligning Article 6 strategies with broader national climate targets, and establishing processes to comply with reporting requirements. Even when these frameworks are in place, countries face a more complex issue: deciding what sectors to trade from, how many units to transfer, and at what minimum price (if any), all while ensuring these trades do not compromise their NDCs. So far, no pilots with blue carbon activities have been signed, but that could change as long as there is supplier country willing to sell these credits.

Article 6.4

In October 2024, the Article 6.4 Supervisory Body adopted important guidance on methodologies and removals, critical areas still needed for the full operationalization of Article 6.4. This guidance shifted status from "recommendations" to "standards," allowing the Supervisory Body to adopt them directly without needing further approval from countries at COP29. Nonetheless, the CMA endorsed both the removals[353] and methodologies[354] standards on Day 1 of COP29. It was unusual to have a decision right at the beginning of COP, but it was a "win" needed by the COP Presidency to build momentum for the remaining two weeks of negotiations.

While this was a crucial milestone, the hard work for the Supervisory Body is just beginning. There are no approved methodologies, and without them, no new projects can be registered under Article 6.4. The Supervisory Body is now reviewing and approving methodologies, but this process can be lengthy. For example, under the Clean

Development Mechanism (CDM), the first methodologies took years to be approved. The initial methodologies are expected to come from the CDM, which does not include any blue carbon methodologies.

When it comes to nature, a lot of what is at stake is being discussed in the Article 6.4 Supervisory Body throughout 2025. The Supervisory Body is tasked with refining technical rules, including those related to post-crediting monitoring and downward adjustments of baselines. These decisions are directly shaping the potential for nature-based methodologies to play a significant role in Article 6.4.

The biggest concern for the role of blue carbon has been the Supervisory Body's decisions regarding non-permanence and the risk of reversals. Requirements in the initial draft would have effectively banned nature-based credits. After a record-breaking number of public comments and other avenues of feedback, the final non-permanence text addressed many of these concerns by moving specific requirements from the standard to the methodologies applied for approval under Article 6.4. This approach allows different methodologies to reflect varying sectoral needs (such as nature-based credits), for example, by specifying how to account for reversals that occur after a project has ended, and represents a significant improvement over the draft text. Nonetheless, additional work will be needed to ensure the acceptance of high-quality nature-based methodologies under Article 6.4.

5. ADAPTATION

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Adaptation refers to adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects and is a critical component of the long-term global response to climate change to protect people, livelihoods and ecosystems.[355] The cumulative impacts of climate change on coastal and ocean environments are now being felt so quickly that short-term adaptations are becoming ineffective in response to the threats and challenges affecting ocean-reliant communities.

The original ROCA initiative (2016-2021) incorporated an approach for assessing progress in adaptation measures based upon the implementation of EbA strategies through Integrated Coastal and Ocean Management (ICOM) institutions at national, regional, and local levels to reduce vulnerability of coastal/ocean ecosystems and human settlements, and to build the management capacity, preparedness, resilience, and adaptive capacities of coastal and island communities. In this chapter, our focus remains the same, although today the term NbS is often used as a broader umbrella term. NbS includes EbA measures, but more widely refers to solutions to societal challenges that involve working with nature.[356] In this case, we are focusing on ocean-based NbS for climate change.

5.1 Actions within and outside of UNFCCC

The parties to the UNFCCC and the Paris Agreement recognize that adaptation is a global challenge faced by all with local, subnational, national, regional and international dimensions. It is a key component of the long-term global response to climate change to protect people, livelihoods, and ecosystems. Parties acknowledge that adaptation action should follow a country-driven, gender-responsive, participatory and fully transparent approach, considering vulnerable groups, communities and ecosystems, and should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socio-economic and environmental policies and actions.

The IPCC Working Group II Report entitled "Impacts, Adaptation and Vulnerability" published in February 2022[357] found that:

- Climate, ecosystems and biodiversity, and human societies are interdependent, and the report endeavors to integrate knowledge across natural, ecological, social and economic sciences;
- Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related loss and damage to nature and people, pushing natural and human systems beyond their ability to adapt;
- Approximately 3.3 to 3.6 billion people live in areas that are highly vulnerable to climate change with vulnerability differing among and within regions;
- The magnitude and rate of climate change and associated risks depend strongly on near-term mitigation and adaptation actions, and projected adverse im- pacts and related losses and damages escalate with every increment of global warming;
- Financial, governance, institutional, and policy constraints serve as the primary roadblocks for human adaptation to climate change;
- Climate resilient development is facilitated by international cooperation and by governments at all levels working with communities, civil society, educational bodies, scientific and other institutions, media, investors and businesses; and by developing partnerships with traditionally marginalized groups, including women, youth, Indigenous Peoples, local communities and ethnic minorities; and
- Climate resilient development prospects are increasingly limited if current GHG emissions do not rapidly decline, especially if 1.5°C global warming is exceeded in the near-term.

As stated by the UNFCCC, the world is already experiencing changes in average temperature, shifts in the seasons, an increasing frequency of extreme weather events, and slow onset events.[358] The faster the climate changes and the

longer adaptation efforts are put off, the more difficult and expensive responding to climate change will be. The adaptation cycle under the UN climate change regime includes four general components:

1. Assess impacts, vulnerability, and risks;
2. Plan for adaptation;
3. Implement adaptation measures; and
4. Monitor and evaluate adaptation (Figure 17).

Within the UN climate change regime, adaptation-related activities are carried out in a number of workstreams, through work programs, and in specialized groups and committees, including National Adaptation Programmes of Action (NAPAs), NAPs, the LDC Expert Group, and the Adaptation Committee. Within the Paris Agreement, the GGA sets out to enhance adaptive capacity and strengthen resilience, with a view to reducing vulnerability and contributing to sustainable development. It requires all parties to engage in and communicate their efforts to plan and implement adaptation.

Since the adoption of the Glasgow Climate Pact at COP26,[359] there have been increasing efforts within the UNFCCC to advance the importance of adaptation as climate change impacts become more damaging and the risks to communities and socio-economic activities increase.

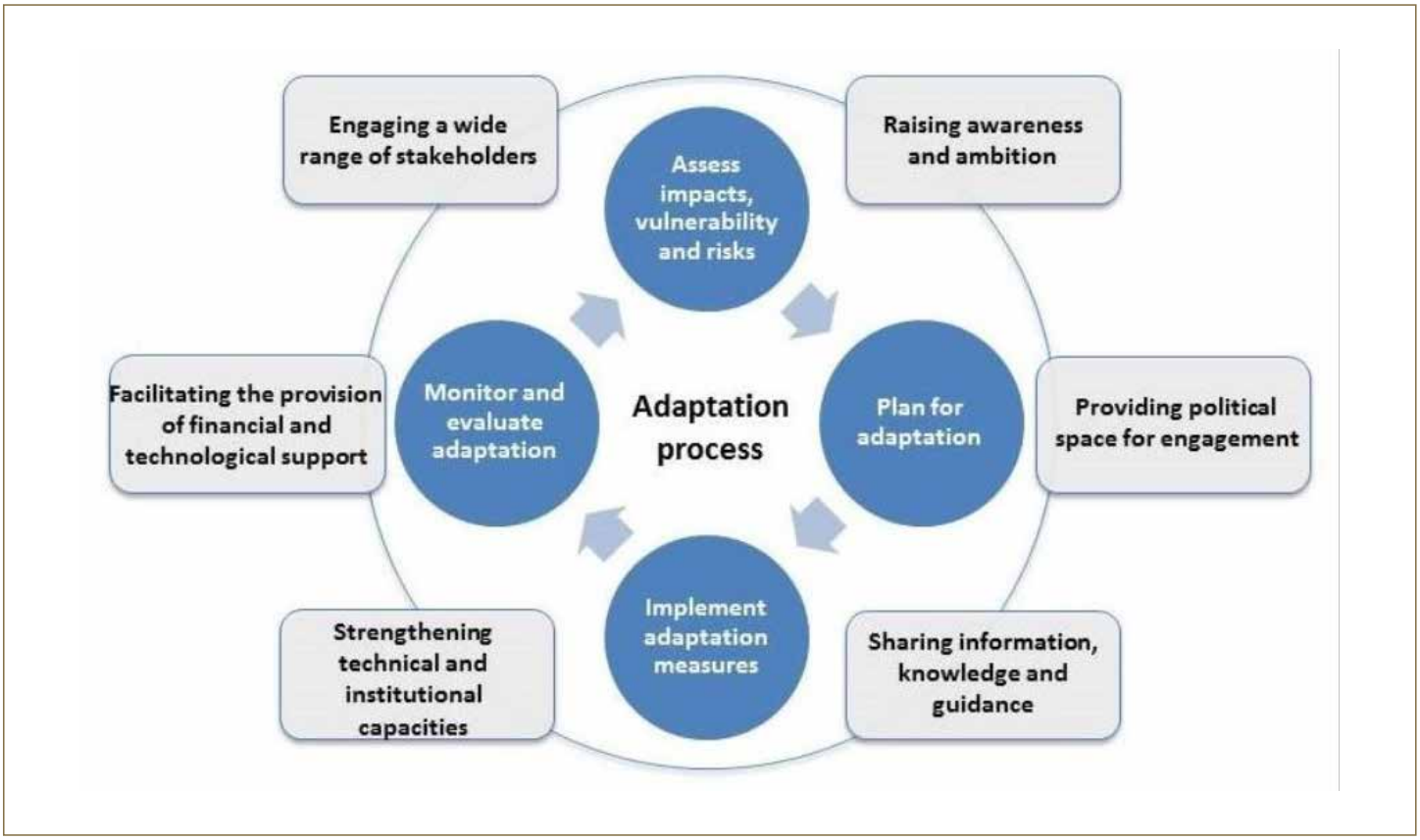

Figure 17. Adaptation Cycle under the UN Climate Change Regime[360]

Sharm Adaptation Agenda

Within the UNFCCC process, the Sharm Adaptation Agenda produced its final report in 2024.[361] Under Coastal and Ocean Systems,[362] the Report highlighted a number of key ocean developments, including:

- The Ocean Breakthroughs, launched in 2023, for setting targets to ensure a healthy, productive ocean by 2050, and the launch of the Coastal Tourism Breakthrough at COP29 in 2024;
- The UN Global Compact for developing an OIP, aimed at channeling coastal and ocean investments, unveiled at the UNOC3 in 2025;
- The launch of the ORCA at COP28 in 2023 to secure US$300 million in funding for ocean climate solutions;

- Ocean Breakthrough partners such as Blue Justice for developing an Ocean Equity Index to integrate equity considerations; and
- The ORRAA introduced an Early Adopter Kit for the High-Quality Blue Carbon Principles and Guidance launched at COP27.

The Report also highlighted three prioritized outcomes, which are summarized below.

- *Mangroves Outcome:* Secure the future of US$15 million hectares of mangroves globally by mobilizing US$4 billion to halt mangrove loss, restore half of recent losses, double protection and ensure sustainable financed for mangroves globally to support the resilience of 15 million people and over US$65 billion worth of property annually.
    - *Status:* Despite a lack of comprehensive global data on the status of mangroves, efforts are developing on multiple fronts to tackle mangrove conservation and unlock finance under the Mangrove Breakthrough.
- *Coral Reefs Outcome:* Secure the future, halt loss, protect and restore 125,000 sqm of shallow-water tropical coral reefs with investments of US$12 billion to support the resilience of more than half a billion people globally.
    - *Status:* Coral reefs remain at risk, demonstrated by a global coral bleaching event this year; efforts to tackle coral conservation and unlock finance are unfolding on multiple fronts.
- *Coastal City Protection Outcome:* Coastal cities are protected from ocean-based hazards by green, grey and hybrid solutions, increasing the resilience of at least 900 million people worldwide.
    - *Status:* Despite a lack of global data on coastal city protection, initiatives are in place to support cities and finance coastal and ocean NbS (*e.g.,* Coastal 500, Sea'ties initiative, ORRAA).

United Arab Emirates (UAE) Framework for Global Climate Resilience

The UAE Framework for Global Climate Resilience[363] was adopted at COP28 in Dubai in 2023. The purpose of the Framework is to guide the achievement of the GGA and the review of overall progress in achieving it with a view to reducing the increasing adverse impacts, risks and vulnerabilities associated with climate change, as well as to enhance adaptation action and support. It was also decided that the Framework should guide and strengthen efforts, including long-term transformational and incremental adaptation, towards reducing vulnerability and enhancing adaptive capacity and resilience, as well as the collective well-being of all people, the protection of livelihoods and economies, and the preservation and regeneration of nature, for current and future generations, in the context of the temperature goal referred to in Article 2 of the Paris Agreement. The Framework is designed to be inclusive in terms of adaptation approaches, taking into account the best available science and the worldviews and values of Indigenous Peoples, to support the achievement of the GGA.

According to the United Nations Foundation, "The Framework is the culmination of two years of workshops and consultations with hundreds of government officials, scientists, and advocates. It expands on the GGA, which was established in the Paris Agreement in 2015. The UAE Framework will improve our ability to measure progress on the GGA and maintain accountability. More broadly, the framework's adoption signals the need for accelerating global action on, and support for, adaptation, which, until now, has not received the same level of funding or attention as other aspects of the Paris Agreement." [364] The key aspects, sectors, and targets of the Framework are depicted in Figure 18 (see next page).

Baku Adaptation Roadmap and Global Goal on Adaptation

The Baku Adaptation Roadmap (BAR) adopted at COP29 aims to provide a strategic path forward for achieving the Global Goal on Adaptation (GGA) beyond COP30.[365] This initiative replaces the Sharm Adaptation Agenda which was originally adopted at COP28. The goals of the BAR are to coordinate adaptation efforts, avoid duplication of work with existing UNFCCC processes, facilitate knowledge exchange, and support international cooperation. The roadmap also established the Baku high-level dialogue on adaptation, to be convened by the Presidency of the CMA and the incoming Presidency of the CMA on the margins of each session of the CMA with the aim of identifying ways of enhancing the implementation of the UAE Framework for Global Climate Resilience. The BAR's conclusion is planned for COP35 in 2030 following a review of its progress.

Linked to the BAR, the "Baku to Belém Roadmap" focuses on scaling up climate finance for developing nations, with the goal of mobilizing at least US$1.3 trillion per year by 2035 from public and private sources. After years of negotiation, this was a major breakthrough at COP29 aimed at providing the necessary funds to protect populations and economies from climate disasters and facilitate the clean energy transition.

OCCDs 2024 and 2025

The 2024 OCCD was held in Bonn from 11 to 12 June 2024 at the 60th session of the SBSTA under the direction of the co-facilitators Julio Cordano (Chile) and Niall O'Dea (Canada). Adaptation was addressed under the two topics of "marine biodiversity conservation and coastal resilience" and "technology needs for ocean-climate action," but was not a prime focus of the Dialogue. However, one of the key recommendations was to encourage Parties to enhance their ocean-based mitigation and adaptation efforts in the next round of NDCs in February 2025. Adaptation was, however, a primary focus of the Dialogue in 2025.[366]

Held in Bonn on June 17-18, 2025, one of the three topics of the 2025 OCCD was "The Ocean under the GGA." The additional topics included "Ocean-based measures in the NDCs" and "Ocean-climate-biodiversity synergies," both of which are critically important for ocean and coastal adaptations. These topics were determined by the two new co-facilitators, Ambassador Carlos Márcio Bicalho Cozendey (Brazil) and Ulrik Lenaerts (Belgium), after a broad consultative meeting held on 3 April 2025.

Two questions were discussed:

1. How can the ocean dimension best be integrated in the indicators as presently considered under the UAE–Belém work programme, particularly to accelerate EbA and advance NbS for coastal resilience?
2. What scope do you see for better alignment between NBSAPs and NAPs, including for monitoring progress?

Regarding the NDCs topic, there was strong support for considering the integration of ocean-based mitigation and adaptation measures into NDCs, recognizing the ocean as a vital climate solution while underlining the need to raise climate mitigation ambition to preserve the ocean's natural capacity as climate regulator. Proposals for specific adaptation included: ocean-based science measures, MSP, NbS, sustainable ocean planning, and MPAs. The interventions at the Dialogue emphasized the importance of sharing good practices, tools, and

Figure 18. Understanding the UAE Framework for Global Climate Resilience[367]

guidance related to NDCs development, including financial instruments and enabling policy frameworks, as well as the systematic integration of NDC-related ocean actions within the United Nations Sustainable Development Cooperation Frameworks, was proposed.

It was agreed that the dialogue will serve as a platform to encourage Parties to scale up ambition through the inclusion of robust ocean-based measures in their new NDCs. The dialogue will also identify the obstacles in implementing ocean targets, policies and measures in Parties' NDCs. It was noted that there has been an encouraging trend in the recently submitted NDCs. Of the 23 new NDCs analyzed between 1 October 2024 and 5 May 2025, 74% included ocean-based mitigation and adaptation measures, targets, and policies. Ocean-based adaptation measures were featured in the recent NDCs of 88% of the Parties. These measures primarily focus on restoring coastal and marine ecosystems (such as mangroves, coral reefs, and seagrass beds), building coastal protection infrastructure, implementing MSP, and advancing sustainable fisheries management. NbS, EbA approaches, and investments in shoreline resilience are also common.

For the GGA topic, the focus was on the inclusion of the ocean dimension in the implementation and the operationalization of the targets within the UAE Framework for Global Climate Resilience, including implementing and assessing the target on EbA and NbS. Among the 11 targets under the framework, the target on ecosystems and biodiversity but also the targets on food and infrastructure are particularly relevant for ocean-based adaptation. It emphasizes reducing climate impacts on ecosystems and biodiversity and accelerating the use of EbAs and NbS, including through their management, enhancement, restoration and conservation and the protection of terrestrial, inland water, mountain, marine and coastal ecosystems. Other thematic targets, such as water and livelihoods, also have strong interlinkages with ocean systems, and the dialogue should consider their ocean dimension.

After reviewing indicator submissions from Parties and observers under the UAE–Belém Work Programme, experts compiled 490 indicators across all 11 targets. The indicators for the national adaptation efforts are shown in Table 6.

The interventions under the GGA topic underscored the importance of the Dialogue to contribute to the development of ocean-related indicators under the UAE–Belém work programme, and that the recommendations emerging from the Dialogue inform the work of the ecosystems, food and agriculture indicators expert group.

Under these topics, the interventions suggested a focus on adaptation for coastal and vulnerable communities, including IPLC; the development, deployment and transfer of marine technology; and the scaling up of ecosystem-based approaches such as mangroves, salt marshes, and seagrasses. It was recommended that the Dialogue share best practices on early warning systems and coastal resilience, with suggestions to include relevant sectoral targets from the ocean breakthroughs. Moreover, exploring linkages between GGA indicators and other international frameworks was suggested. However, there is concern this list of indicators may still require further refinement to provide strong momentum to support adaptation especially for ocean ecosystems, as species and habitats move in response to changing ocean conditions, affecting wild species populations, global biodiversity patterns, and interacting with human activities in the ocean. For instance, the ecosystem resilience indicator chosen derives from terrestrial applications, and development is needed to ensure both the correct ecosystem conditions and species datasets

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Table 6. Indicators for National Adaptation Efforts under the UAE–Belém Work Programme[368]

Target Language	Parent Indicator	Sub-indicator
By 2030, all Parties have designed, established and operationalized a system for monitoring, evaluation and learning for their national adaptation efforts	Number of Parties that have designed a system for monitoring, evaluation and learning for their national adaptation efforts	A clear mandate or legislative requirement for MEL of the national adaptation efforts exists
		Non-state actors and vulnerable groups have been adequately engaged in the design (and operation) of the MEL system
	Number of Parties that have established a system for monitoring, evaluation and learning for their national adaptation efforts	Adequate institutional arrangements for the national adaptation MEL system have been established
		The MEL system covers adaptation of at-risk sectors as identified in the assessments described under para 10a
		Number of Parties with MEL systems that are gender-responsive
		Actions addressing transboundary climate risks are adequately monitored
		Integration of adaptation data and indicators into the national statistical system where relevant
	Adaptation has been integrated into M&E systems of relevant development or sectoral plans	None
	Number of Parties that have operationalized a system for monitoring, evaluation and learning for their national adaptation efforts	NAP implementation is monitored regarding achievements of the defined NAP goals or targets
		Number of countries that publish an adequately detailed report about the implementation progress of their national adaptation efforts
		Number of countries where MEL findings have informed policy revision or adaptation planning
		Adequate resources and budgetary allocation to operate and sustain the MEL system
		Methodologies, tools and sources of verification used in the operation of the MEL system are progress publicly accessible
By 2030, all Parties have built the required institutional capacity to fully implement the system	Number of Parties that have built the required institutional capacity to fully implement the national adaptation MEL system	Systems and processes for building and maintaining capacity for national adaptation MEL system are in place
		Institutional capacity to operate and sustain the MEL system has been built and funding to sustain the MEL system is available
		Inclusion of vulnerable and Indigenous and Local People in capacity building for the MEL system of national adaptation efforts

considered for it to become a useful tool in the development of solutions for ocean wildlife adaptation. These changes are needed to ensure both ocean biodiversity and associated human activities have a sustainable future, and a consultation is underway in October 2025.

The OCCD 2025 Information Note contains a useful update of contributions from numerous UN and other bodies.[369] As part of its mandate to promote the implementation of enhanced action on adaptation, the Adaptation Committee continues to strengthen the integration of ocean-based adaptation in climate resilience frameworks. This includes ongoing work under the UAE Framework for Global Climate Resilience (decision 2/CMA.5, paras. 44–45), particularly through the development of technical guidance and training materials and by leading the work of the NAP Taskforce. The Adaptation Committee is supporting countries incorporating marine and coastal ecosystems into national adaptation planning, in recognition of their role in reducing climate risks and enhancing resilience.

The 2024 Report of the Adaptation Committee[370] continues the committee's work on supporting the Parties to enhance adaptation action and support. The report includes Committee's progress in implementing its flexible workplan for 2022-2024 and in developing its flexible workplan for 2025-2027, with a detailed worksheet showing plans for supporting adaptation out to 2027 under four workstreams:

1. Providing technical support and guidance to the Parties on adaptation, including on means of implementation;
2. Considering information provided by Parties on adaptation action and support to enhance overall adaptation progress;

3. Communication, collaboration and coherence; and
4. Process-related work.

Convention on Biological Diversity

The OCCD 2025 Information Note also outlines key processes and initiatives under the CBD that are particularly relevant to strengthening synergies across the ocean-biodiversity-climate nexus.[371] The goals and targets of the GBF adopted in decision 15/4 are highly relevant to ocean and climate change issues, particularly Target 8 on climate change and ocean acidification and Target 11 on nature's contributions to people. Other relevant targets include Target 1 on spatial planning, Target 2 on restoration, Target 3 on area-based conservation, Target 10 on sustainable production, and Target 16 on sustainable consumption.

Accordingly, CBD Parties are working on their NBSAPs and national reports, including developing national targets aligned with the Framework. At its seventeenth and nineteenth meetings, the COP will conduct global reviews of collective progress in implementing the Framework, primarily based on national reports and two global reports on the collective progress (16/32).

During its sixteenth meeting in 2024, the CBD COP adopted several decisions directly relevant to the ocean-biodiversity-climate nexus, including decision 16/22 on biodiversity and climate change, which emphasized the interlinkages between the two crises and the need for solutions to address both. With respect to achieving Targets 8 and 11, it urges Parties to, *inter alia:*

- Identify and maximize potential synergies between biodiversity and climate actions, including by prioritizing the protection, restoration and management of ecosystems and species important for the full carbon cycle and contributing to climate change adaptation;
- Promote the positive and avoid or minimize the negative impacts of climate actions on biodiversity, ecosystem integrity, functions and services, including for vulnerable species, and ecosystems important for the full carbon cycle or to which damage is irreversible; in particular for IPLC, and relevant stakeholders that directly depend on biodiversity. Consider integrating into their revised NBSAPs and relevant national targets, as appropriate, and promoting, as appropriate, NbS and/or ecosystem-based approaches to climate change adaptation and mitigation and DRR;
- Consider integrating into their revised NBSAPs and relevant national targets, as appropriate, and promoting, as appropriate, NbS and/or ecosystem-based approaches to climate change adaptation and mitigation and DRR; and
- Promote synergies with other national planning processes established under the UNFCCC and the Paris Agreement.

Other issues pertaining to adaptation included the following*:*

- Improving understanding of the impacts of geoengineering on marine and coastal biodiversity in line with the precautionary approach;
- Enhancing the use of NbS and/or ecosystem-based approaches in coastal and marine ecosystems;
- Mapping, monitoring, restoring and effectively managing marine and coastal ecosystems that contribute to climate mitigation and adaptation (such as mangroves and seagrass);
- Promoting ecological restoration in island ecosystems, particularly for ecosystems contributing to DRR and resilience; and
- Improving understanding of ocean acidification and warming impacts, in particular in combination with other stressors, on island ecosystems (such as coral reefs, seagrass, mangroves and rhodolith beds) and enhancing their resilience.

Food and Agriculture Organization of the United Nations (FAO)

The Food and Agriculture Organization (FAO)'s Blue Transformation roadmap aims to build resilient aquatic food systems through sustainable growth of aquaculture as an essential mechanism to adapt to climate change, effective management of 100% of fisheries, and upgrading of aquatic food value chains benefiting from circular economy

principles.[372] Furthermore, in support of the GGA, FAO offers a range of adaptation policy frameworks and tools, including the Adaptation Toolbox for fisheries and aquaculture,[373] early adaptation frameworks and adaptation policy cycles,[374] as well as guidance on good practices to climate proof the fisheries management cycle.[375]

Building on these, FAO is implementing a portfolio of fisheries and aquaculture adaptation field projects across over 20 countries in Africa, Asia Pacific, the Caribbean, and Latin America. Additionally, special attention needs to be given to the adaptation of small-scale fisheries and aquaculture communities, who are crucial stewards of natural resources, including biodiversity, but among the most vulnerable to the impacts of climate change. The FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) provide a policy framework that is ready to be leveraged to improve these communities' engagement in climate policymaking at national, regional, and global levels.[376]

United Nations Environment Programme (UNEP)

UNEP provides technical support and helps governments access finance to strengthen climate resilience. The organization promotes Nature based Solutions, NAPs, early warning and climate services, and climate-resilient livelihoods—delivering US$40 million in grants through several climate funds (LDCs Fund, Special Climate Change Fund (SCCF) and the Green Climate Fund (GCF)). Projects are underway in Africa, the Caribbean, and Asia-Pacific, including in many SIDS, enabling adaptation in water, land, infrastructure, and planning. UNEP enhances coastal and island resilience (*e.g.* Comoros and Tuvalu) by restoring mangroves, coral reefs, and coastal forests, to provide buffers against sea-level rise and storms. UNEP also supports climate-resilient coastal livelihoods (GGA6) and risk-informed planning such as ICZM and EbA (GGA 9 & 10) all of which showcase UNEP's holistic approach to adaptation, linking ecosystem restoration, social resilience, and institutional capacity.

United Nations Environment Programme (UNEP) 2024 Adaptation Gap Report

The most recent UNEP Adaptation Gap Report[377] comes at a time when the impacts of climate change are having increasingly intense and, in some cases, devastating effects on the ocean and ocean-reliant communities, especially the poorest. Hence its sub-title, "Come hell and high water." As global average temperature rise approaches 1.5°C above pre-industrial levels, the latest predictions from the Emissions Gap Report 2024[378] put the world on course for a catastrophic rise of 2.6-3.1°C this century unless there are immediate and major cuts to GHG emissions. There is therefore an urgent need to significantly scale-up adaptation this decade to address rising impacts. But this is being hampered by the huge gap that exists between adaptation finance needs and current international public adaptation finance flows.

Despite the fact that international public adaptation finance flows to developing countries increased from US$22 billion in 2021 to US$28 billion in 2022 (the largest absolute and relative year-on-year increase since the Paris Agreement), the report finds that progress in adaptation financing is not fast enough to close the enormous gap between needs and flows. This gap contributes to a continued lag in adaptation planning and implementation efforts. The increase in finance does reflect some progress towards the Glasgow Climate Pact, which urged developed nations to at least double adaptation finance to developing countries from US$19 billion (2019 levels) by 2025. However, the report notes that even achieving the Glasgow Climate Pact goal would only reduce the adaptation finance gap, which is estimated at US$187-359 billion per year, by about 5%. The report called for nations to step up adaptation by adopting an ambitious NCQG for climate finance at COP29 in Baku, Azerbaijan, and by including stronger adaptation components in their next round of climate pledges, or NDCs, due early next year ahead of COP30 in Belém, Brazil.

In addition to finance, there is a need to strengthen capacity-building and knowledge and technology transfer to improve the effectiveness of adaptation actions. Developing countries are already struggling with increasing debt burdens as they experience increasing loss and damage from climate change impacts. Effective and adequate adaptation, incorporating fairness and equity, is thus more urgent than ever. The report calls for nations to step up by adopting a strong NCQG for climate finance and including stronger adaptation components in their next round of climate pledges, or NDCs, due in early 2025.

Overall, the report notes that increased efforts will be needed to meet the GGA through the eleven targets of the UAE Framework for Global Climate Resilience that was adopted at COP28.[379] The eleven targets include four dimensional targets to address elements of an iterative adaptation policy cycle (namely impact; vulnerability and risk assessment; planning; implementation; and monitoring, evaluation, and learning (MEL) processes) with a 2030 time-horizon; and seven thematic areas including water, food and agriculture, health, ecosystems and biodiversity, infrastructure, poverty and livelihoods, and cultural heritage. The report analyzed the degree to which NAPs were aligning with the eleven targets (Figure 19).

The report states that there is clear evidence of the benefits of adaptation compared to inaction, such as the findings that every US$1 billion invested in adaptation against coastal flooding leads to a US$14 billion reduction in economic damages. Interestingly, the ocean is not mentioned in the report, but coastal examples of adaptation mentioned include coastal hazards (flooding, erosion, and responses to tropical cyclones), coastal management, and storm surge barriers for coastal protection.

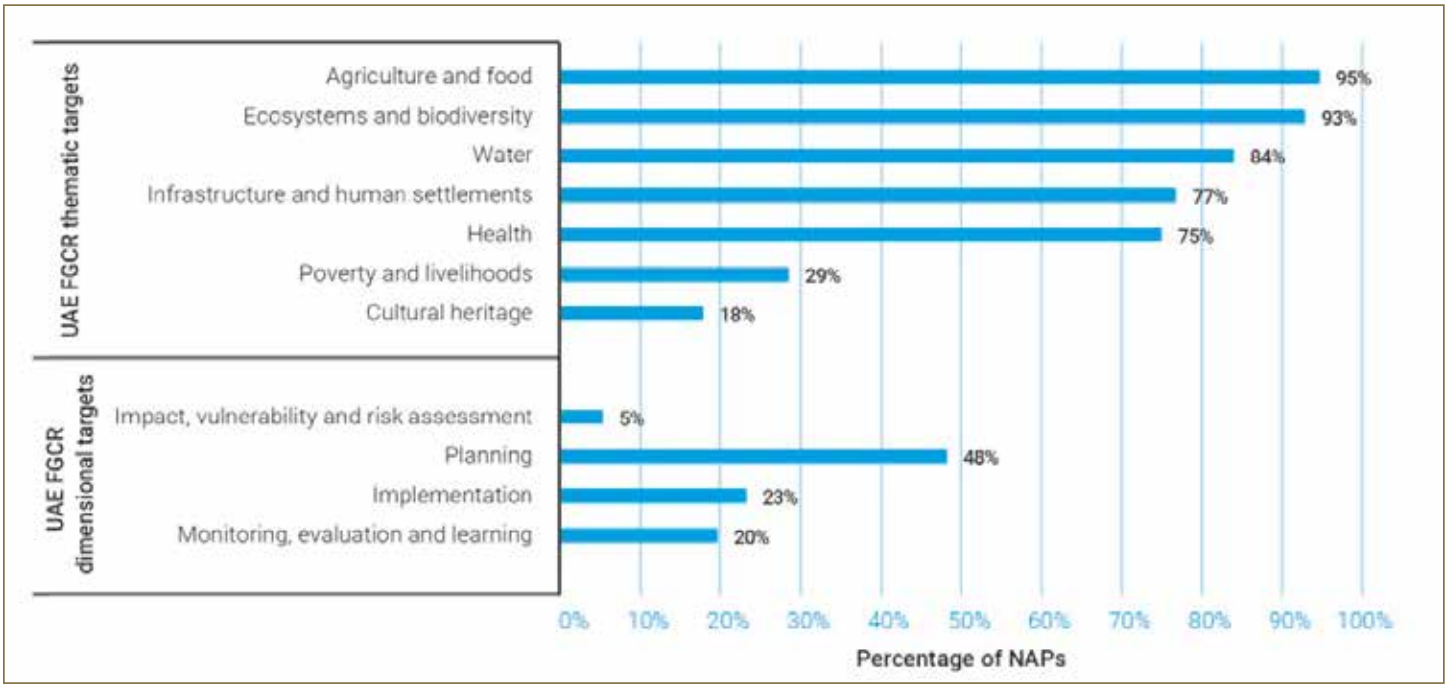


Figure 19. Percentage of NAPs with adaptation priorities addressing the thematic and dimensional targets of the UAE Framework for Global Climate Resilience[380]

The report also evaluated a total of 168 funded adaptation projects (of which 10% were classified as "coastal management") that were deemed to be completed, rating their success and sustainability. The overall results are shown in Figures 20 and 21.

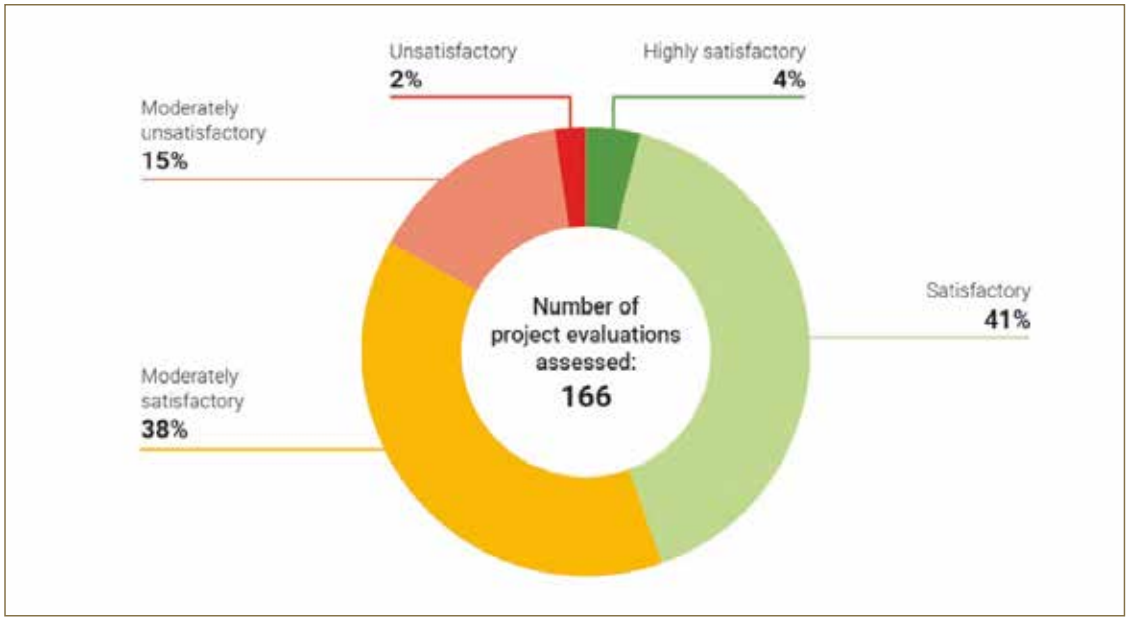


Figure 20. Completed Adaptation Project Outcome Ratings[381]

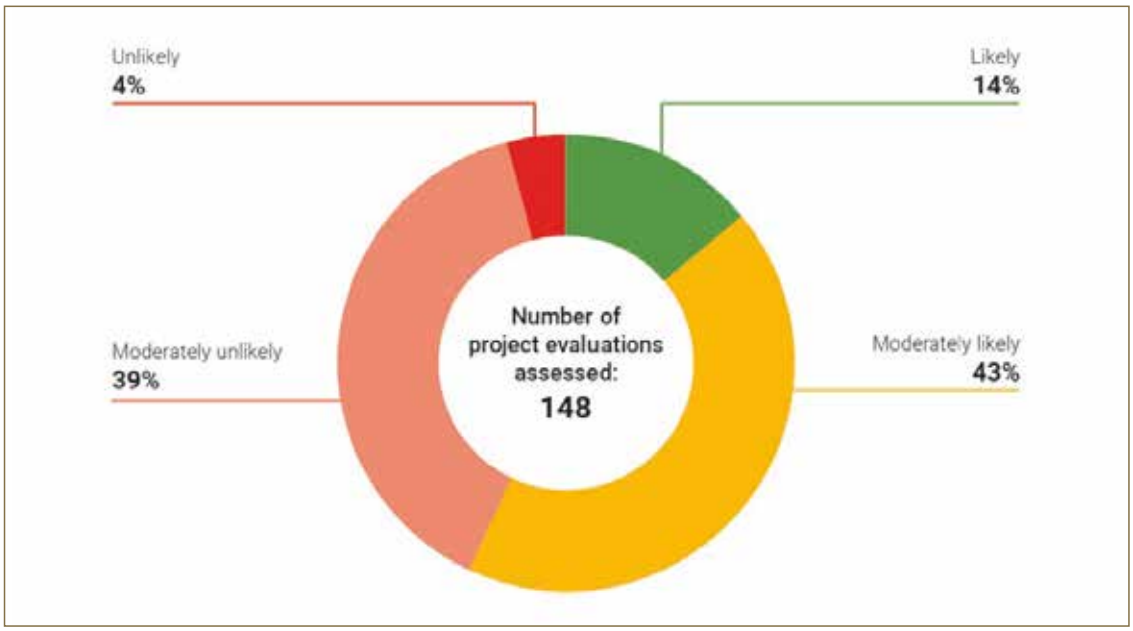


Figure 21. Completed Adaptation Project Sustainability Ratings

A large majority of projects were assessed to be moderately to highly satisfactory, and while a majority were assessed as being likely or moderately likely to be sustainable, it is disconcerting to see that 43% of projects were seen as moderately unlikely or unlikely to be sustainable.

The Report also reviews 3,501 adaptation actions that were self-reported by 536 cities in 2023, including NbS and coastal hazards in the assessment. The summaries of the types of nations, hazards, and co-benefits of the actions are shown in Figure 22 broken down by five world regions. In total, 20.4% of all actions were identified as nature-based and 4.4% as coastal hazards. Coastal hazards include coastal flooding (including sea-level rise), oceanic events, hurricanes, cyclones and/or typhoons, and extreme windstorms.

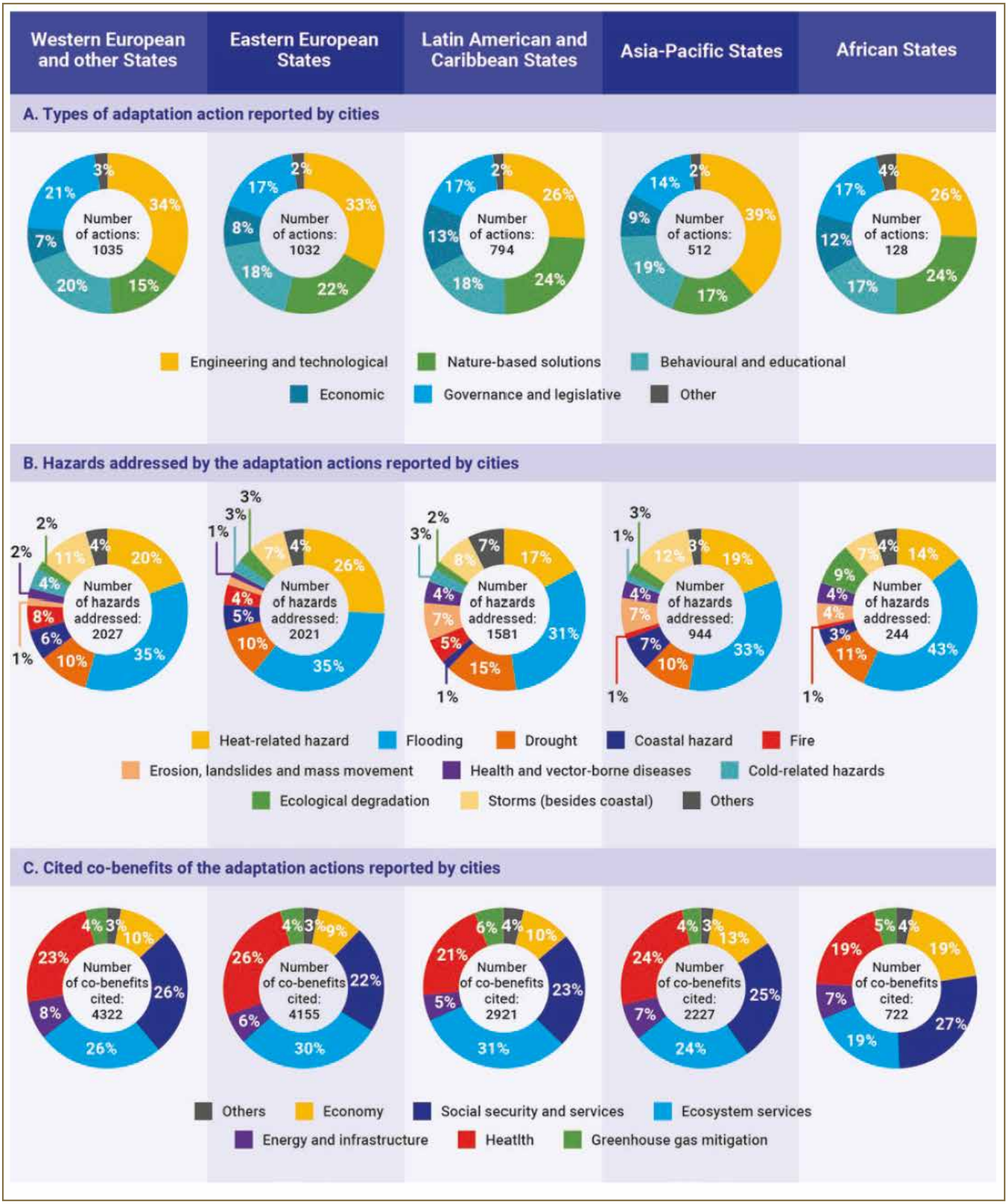


Figure 22. Frequency of Self-reported Adaptations Actions Reported by Cities[382]

Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations

Once it enters into force, the Agreement under the UNCLOS on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement) will provide a framework for action to address the impacts of climate change on marine biological diversity in the vast marine areas beyond national jurisdiction (ABNJ). The Agreement acknowledges the need to address, in a coherent and cooperative manner, biological diversity loss and degradation of ecosystems of the ocean due to climate change impacts on marine ecosystems (preamble). Its Parties are to be guided by an approach that builds ecosystem resilience, including resilience to adverse effects of climate change and ocean acidification, and maintains and restores ecosystem integrity, including carbon cycling services that underpin the role of the ocean in climate (article 7(h)). Among the objectives of ABMTs, including MPAs under the Agreement, is the strengthening of resilience to stressors, including those related to climate change, ocean acidification, and marine pollution (article 17(c)). Also, its arrangements for environmental impact assessment are highly relevant for safeguarding the adaptive capacities of the ocean. Moreover, the provisions on fair and equitable benefit sharing, capacity building and the transfer of technology, as well as the financial mechanism will be crucial tools to enable Parties to implement the Agreement´s objectives, with positive impacts on climate action.

United Nations Office for Project Services (UNOPS)

On the GGA, the United Nations Office for Project Services (UNOPS) considers an exchange of views for recommendations towards the scaling up of action-based solutions, such as mangroves, seagrasses, and salt marshes projects, through the expansion of capacity of UN agencies to support countries' implementation of solutions, useful. UNOPS has worked with partners to enable stronger commitments to decarbonization, NbS, and blue carbon ecosystems, and has provided climate resilient solutions to accelerate EbAs and NbS, including the management, restoration, and conservation of terrestrial, inland water, mountain, marine, and coastal ecosystems. UNOPS has provided effective technical assistance to countries and communities at risk of climate-induced disaster impacts through the Santiago network.

UN Trade and Development (UNCTAD)

In a 2024 report, United Nations Trade and Development (UNCTAD) identifies 606 ocean-related measures in NDCs of SIDS, with 54% on sustainable ocean economies and 46% on ecosystem conservation. [383] Adaptation measures dominate (77%), reflecting the harsh reality that SIDS face. An overwhelming 77% of the ocean measures aim to strengthen ecosystems, develop infrastructure, and enable economic resilience against climate impacts, while mitigation measures (23%) focus on renewable energy, shipping, and ports (aligning with SIDS' minimal contribution to global CO_2 emissions).

In the GGA, ports are critical for global trade and development, access to the ocean economy, and DRR, but at considerable risk of climate impacts, with implications for supply chains and the sustainable development prospects of SIDS and other vulnerable nations. In light of infrastructure lifespans, growing hazards, and the significant cost of inaction, climate-adaptation of ports is a matter of strategic economic importance and increasing urgency. Multifaceted approaches are needed, including supportive policy and legal frameworks, capacity building, and major scaling up of affordable climate finance for developing countries.

Since its establishment in 2019, the OCCD has become a key platform to accelerate ocean-based climate action and strengthen the ocean's role across UNFCCC processes. As COP30 approaches, the Dialogue plays a key role in shaping ambition and building momentum. As stated by the Nature Conservancy (TNC), the Co-Facilitators need to ensure the Dialogue's outcomes are translated into clear, actionable messages for COP30 and connected to relevant UNFCCC processes. Continued engagement with both Party and non-Party stakeholders will be essential to advancing progress throughout the year. This Dialogue comes at a time when ocean action is more urgent—and more aligned with global climate, biodiversity, and development goals—than ever before.[384]

Looking ahead to 2025, it is expected nations will be completing their next round of climate action plans under the Paris Agreement (NDCs) this year, with the expectation that ambition will go beyond actions outlined in the first UNFCCC's 2023 GST at COP28 (which is expected to take place every 5 years). By then, it was recognized that considerable efforts had been made by nations in climate change adaptation planning and implementation, with 51 parties having submitted NAPs. Key trends included the recognition of sea-level rise as an important hazard, a focus

on support for low-lying and coastal zones as priority areas for interventions. However, it was noted that NAPs were still fragmented, sector-specific, not sufficiently ambitious, and that lack of clarity was still frequent on issues such as financing and monitoring and evaluation of the effectiveness of measures proposed.

The GST further called for urgent, incremental, transformational, and country-driven adaptation actions focused on national contexts; greater linkage and synergy between nations and global goals on adaptation; and integrated and multisectoral solutions for adaptation, such as nature based-solutions and ecosystem-based approaches. The call for ecosystem-based and NbS for adaptation echoes the 2020 call of the High-Level Panel for a Sustainable Blue Economy for SOPs and reflects both national and international policy ambition that have, over the last decade, focused on the development of CSMSP. Both approaches (CSMSP and SOP) focus on ecosystem-based management solutions for challenges such as climate change and the inclusion of NbS. They both present an opportunity to accelerate ocean-climate action, though it has been noted that whilst climate change mitigation now frequently features as part of MSP policies around the world (*e.g.* through a push for the growth of renewable energy and the conservation of blue carbon habitats), fewer countries are yet implementing climate-adaptive MSP that focuses on supporting communities and ecosystem adaptation, with greater ambition, finance, and capacity development needed for MSP, and SOPs still beginning to emerge.

The UN Decade of Ocean Science for Sustainable Development

Launched in January 2021, the United Nations Decade of Ocean Science for Sustainable Development (2021-2030, the "UN Ocean Decade"), provides a convening framework for a wide range of global ocean stakeholders to engage and collaborate outside their traditional communities to generate the data, information and knowledge needed for more robust evidence-based marine policies and stronger science-policy interfaces at global, regional, national and even local levels. By collectively aligning research, investments and initiatives around ten Challenges, the Ocean Decade community aims to contribute to a well-functioning, productive, resilient, sustainable and inspiring ocean.

Climate change adaptation features prominently across several of the Ocean Decade Challenges,[385] considering both wild species and ecosystems (Challenge 2), food security (Challenge 3), the resilience of the blue economy (Challenge 4), ocean-based solutions (Challenge 5), and coastal resilience to climate hazards (Challenge 6), with scientific data, knowledge and technology co-creation and sharing seen as key facilitators. The 10 challenges are underpinned by a series of White Papers publicly available since the Ocean Decade Conference in Barcelona (April 2024), which outline strategic ambitions, milestones and deliverables championed under each Challenge.

Regarding natural ecosystems, the White Paper for Challenge 2 highlights the importance of traditional ecological knowledge (that held by Indigenous Peoples and Local Communities) as key to the development of adaptation pathways for nature. The Challenge 3 White Paper, in turn, highlights how climate change impacts aquatic food webs in complex ways (through range shifts and community complexity), which in turn creates the need for complexity in adaptation pathways to promote ocean-based food security governance, which is seen to be typically overlooked, leading to mal-adaptation in governance and poor outcomes for nature and people. The paper highlights the need for improved monitoring of climate-driven effects on ocean-based food resources. The White Paper for Challenge 4 recommends the comprehensive policies and governance frameworks such as SOPs are implemented, promoting sustainable management of ocean resources, and ensuring equitable access and benefits distribution among all stakeholders, towards a more resilient ocean economy, underpinned by strategic, multi-actor partnerships and targeted resource mobilization. The Challenge 5 White Paper outlines the need for improved predictive capability of ocean, climate, and weather models to enable sustainable planning, and particularly CSMSP, and help build resilience for coastal communities, 40% of the global population which resides within 100 kilometers off the coast. The White Paper for Challenge 6 highlights the need to devise adaptation strategies that specifically target risks associated with the ocean, including those linked to climate change, with a focus on early-warning systems.

In addition to the challenges, Ocean Decade Actions (programs, projects, contributions and activities) are the concrete initiatives carried out across the Ocean Decade ecosystem to deliver its vision of 'the science we need for the ocean we want.' Ocean Actions tackle the ten Ocean Decade Challenges by generating and applying knowledge to support the development of ocean solutions. Endorsement of Decade Programmes and Projects is granted through biannual Calls for Decade Actions, whilst Contributions and Activities can be submitted for endorsement on a rolling basis. As of September 2025, there are over 800 Ocean Decade Actions (live and complete), 46 of which list

climate change adaptation as a key objective.[386] Actions cut across global, regional, and national scale initiatives, with a strong emphasis on capacity building. Key initiatives promoting capacity building and coordination in climate change adaptation are the UNESCO-IOC led Sustainable Ocean Planning program (launched June 2025 at the time of the UNOC3 (Nice, 2025), United Nations Decade Programme for Sustainable Ocean Planning, IOC,[387] and the UN Ocean Decade Collaborative Centre for Coastal Resilience (launched in 2024 and tightly linked to Challenge 6, Decade Collaborative Centre for Coastal Resilience).[388]

Other initiatives

Finance to deliver outcomes in ocean climate change adaptation is important. Funding to help bridge the financial burden of climate change adaptation at the national level has emerged via debt for nature (also known as debt for climate) swaps, which have the ambition to create new financial flows that support governments in reaching climate and nature targets. Locally, these can lead to credit enhancement and commercial capital, hopefully leading to a reduction in debt outstanding, lower interest rates, and/or longer repayment periods, and savings for governments which can then be applied to the development of improved governance and nature management. First proposed by WWF in 1987, this approach has received increased attention since 2023, for ocean areas and, particularly, in Small Island, Large Ocean States. Participation in debt-for-nature swaps has been restricted primarily to countries where the risk of default on debt payments is high, whereby the funder can purchase the debt at well below its face value. While negative criticism of this financial mechanism exists, it is also seen as a key route to deliver funds to develop capacity in ocean management and climate change resilience development. At COP28, a "Task Force on Sustainability-Linked Sovereign Financing for Nature and Climate" was created, bringing together multilateral development banks, environmental institutions and others, to help alleviate international debt, biodiversity loss and climate change, including, through reforming debt-for-nature swaps.[389] Supported by large NGOs, these mechanisms are advancing CSMSP and climate change adaptation in nations such as the Seychelles and Barbados, through debt-for-nature swaps and blue bond-financed debt conversions.[390] [391] Similar initiatives are seen as necessary to scale-up support for adaptation in coastal areas, beyond Loss and Damage, in nations particularly limited by financial debt.

5.2 Adaptation responses in management of marine ecosystems, fisheries and aquaculture

Adaptation for fisheries and aquaculture

Adaptation policy frameworks for resilient fisheries and aquaculture exist,[392] including the FAO Adaptation Toolbox for fisheries and aquaculture,[393] the Guidelines for Sustainable Aquaculture (GSA),[394] as well as guidance on good practice criteria and a compilation of good practices to climate proof the fisheries management cycle.[395] However, examples of successful implementation are limited,[396] due to several factors including financial constraints and the lack of accessible, high-resolution climate data.

An effective management system is often the best adaptation and the first foundation of climate-resilient fisheries and aquaculture.[397] FAO has been actively promoting the adoption of participatory, adaptive, and precautionary fisheries and aquaculture management systems across the world through dedicated capacity development programs.[398] Despite the progress made in some jurisdictions, many areas of the world still face problems caused by ineffective management systems, including the overfishing of stocks and illegal fishing, as well as undesirable social and environmental impacts associated with unsustainable aquaculture development.[399]

Achieving climate resilient aquatic food systems requires the reciprocal mainstreaming between climate change adaptation and fisheries and aquaculture management. One critical aspect is the integration of climate change adaptation into national and local fisheries and aquaculture management and the use of climate data and information, including results from climate risk assessments and monitoring,[400] in decision-making. Another crucial aspect is the integration of fisheries and aquaculture into local and national climate change adaptation planning and implementation, which can be accomplished through mechanisms such as the NDCs and NAPs. Overall, 60% of the second round NDCs with adaptation components submitted by countries as part of their commitment to the Paris Agreement, referred to adaptation in fisheries and aquaculture, including ocean and coastal zone management.[401] Moreover, countries such as Chile,[402] Saint Lucia,[403] and Senegal[404] have developed fish-related NAPs, demonstrating

the importance of addressing climate change impacts in the fisheries and aquaculture sector within national planning frameworks.

FAO has analyzed the adaptation finance gap in the aquatic food sector.[405] By 2030, developing countries are expected to face adaptation costs of around US$4.8 billion annually. Yet, between 2017 and 2021, the sector received only about US$220 million per year in public international adaptation finance, revealing a considerable shortfall. To address this gap, FAO is supporting efforts to mobilize resources, expand climate solutions for aquatic food systems, and strengthen countries' capacity to access climate finance.[406]

ATSEA tool to develop Climate Change Adaptation plan

In the ATS region, climate change is expected to intensify existing pressures, significantly affecting the status and distribution of coastal and marine habitats, the species they support, and, in turn, the communities and industries that rely on them for food and livelihoods. The Guide for Facilitators and Decision-Makers[407] was developed as part of the ATSEA-2 Project implementation. It complements the regional Climate Change Vulnerability Assessment, which details the vulnerability of marine and coastal habitats, species of conservation interest, and key marine species important to regional fisheries. The Guide bridges the gap between large-scale climate change vulnerability assessments and the local-level actions needed to build resilience. While regional assessments provide valuable insights into vulnerable species, habitats, and fisheries, their broad scale and long-term projections often make them difficult to apply directly at the community level. The Guide addresses this by outlining a step-by-step process for linking regional results with local threats, helping users identify adaptation actions that address key drivers of vulnerability and supporting the development of a Community Action Plan. This tool helps managers and communities understand climate vulnerability at the local level, to prepare for climate-related impacts and identify effective, targeted adaptation measures.

6. LOW CARBON BLUE ECONOMY

Co-authors: Nigel Bradly and Ayla Lunn, EnviroStrat; Indumathie Hewawasam, Global Ocean Forum

The concept of a low-carbon blue economy has gained significant international traction, evolving from a niche topic to a central pillar of global climate and development agendas since COP28/29. This evolution is driven by growing evidence that the health of the ocean is inextricably linked to climate resilience, biodiversity, and human well-being. This chapter provides an update on key international developments, including new reports, funding mechanisms, and major programs. Concrete examples of sustainable blue economy initiatives exist worldwide, demonstrating practical pathways to scale.

6.1 International developments to advance blue economy practices

Changes in status/science

The scientific community has continued to strengthen the case for a blue economy that is economically viable and both environmentally and socially sustainable. New reports and analyses have highlighted the economic potential of marine sectors, while also underscoring the severe risks posed by climate change, pollution, and overfishing. For example, a 2025 report by UN Trade and Development[408] shows the ocean economy has grown 2.5 times since 1995 but warns of significant threats. It also provides a critical analysis of emissions from key sectors, noting that the ocean economy accounts for at least 11% of global CO_2 emissions.[409] This new data strengthens the argument for integrating decarbonization into blue economy strategies.

The Ocean Panel's 2024 Progress Report also emphasizes the critical role of sustainable ocean management and the development of SOPs by its member countries, showcasing a shift towards more concrete, national-level implementation.[410]

Separately, global ocean governance advanced in 2025: the High Seas Treaty (BBNJ) reached its 60th ratification in September 2025, triggering entry into force on 17 January 2026. This milestone paves the way for new MPAs in ABNJ and supports delivery of the global 30×30 biodiversity target.[411] [412] [413]

Developing sustainable blue economies continues to be one of the main ways in which countries implement SDG 14 on the ocean and coasts. This is evident from the UN Ocean Conference registry of Voluntary Commitments,[414] where 882 of the 2658 current commitments are seen to contribute to the Community on Ocean Action on Sustainable Blue Economies. Communities of Ocean Action are made up of entities registering voluntary commitments who wish to work together to exchange knowledge and further implementation of specific topics.

Financial considerations

Since COP28 and COP29, there has been a notable (albeit still insufficient) increase in financial commitments and innovative financing mechanisms for the blue economy from countries, multi-lateral banks, non-profits and private investors.

Key Frameworks

- The growth of blue bonds and sustainable ocean-linked finance has accelerated. Sovereign issuances in Latin America and Southeast Asia demonstrate investor appetite, while blended finance facilities (*e.g.*, World Bank PROBLUE Trust Fund, Asian Development Bank blue finance pilots) are scaling. However, integrity concerns remain, underscoring the importance of aligning with ICMA's Blue Bond Guidance and the International Capital Market Association's sustainability frameworks.
- The World Bank's PROBLUE Trust Fund continues to be a central financial vehicle. The PROBLUE 2024 annual report reveals an expanded portfolio of technical assistance activities, amounting to over US$182 million in more than 100 economies. The Trust Fund's extension to 2030, with additional donor support, underscores the sustained international commitment to financing sustainable ocean development.415 PROBLUE focuses on areas like sustainable fisheries, marine pollution, marine spatial planning and blue carbon, and its publications, such as the Unlocking Blue Carbon Development: Investment Readiness Framework for Governments, provide crucial guidance for countries to access this new finance.

- The EU and European Investment Bank (EIB) have been active in promoting blue finance. The EU Blue Economy Report 2025 confirms that the European blue economy has fully recovered from the COVID-19 pandemic, with sectors like marine renewable energy leading the charge by creating new business opportunities and economic growth.[416] The report notes that public research and development investment in ocean energy (wave and tidal; excluding offshore wind) reached €48 million in 2022, around 53% of global public research and development in this niche. The EIB continues to finance projects that support the development of "blue digital technologies," clean energy from the ocean, and circular economy projects to reduce plastic waste.[417]
- Integrity frameworks are maturing. The ICVCM Core Carbon Principles now cover the vast majority of the voluntary carbon market programs, while the Science Based Targets Network (SBTN) launched the first ocean science-based targets (seafood value chain) in March 2025, together raising the bar for high integrity ocean finance and corporate action.
- Country market signals are growing. Indonesia released a national blue-carbon standard and methodology for mangroves in 2025. Brazil enacted legislation for a regulated national carbon market in December 2024, and Fiji has advanced a national carbon market strategy roadmap with explicit blue-carbon pathways.
- Private-sector engagement is increasing. There is a rapid uptake of regenerative ocean business models across fisheries, aquaculture, and coastal tourism. Large seafood companies are trialing seaweed–shellfish polyculture, while offshore renewable energy developers are exploring co-location models (e.g., offshore wind + aquaculture). These developments point towards mainstreaming the blue economy within corporate sustainability and ESG (environmental, social, and governance) strategies.
- Regional initiatives continue to expand, including the Sustainable Blue Economy Partnership (SBEP) under Horizon Europe, which launched its third transnational call in September 2025 to align national R&I investments across key themes such as digital twins, low-impact fisheries, and resilient communities.

Collectively, these developments signal a shift from conceptualizing the blue economy towards operationalizing it, particularly through finance and investment mechanisms that connect global policy goals with local action.

6.2 Examples of work on a sustainable blue economy

Implementation at National and Regional Levels

A key trend observed following the 2022-2023 ROCA Report is a shift from high-level policy to on-the-ground investment and implementation. Building on the examples of government-led initiatives, private sector action is also playing a crucial role. The 1000 Ocean Startups (1000OS) initiative, a global coalition of entrepreneur-supporting organizations, exemplifies this shift by directly accelerating the growth of regenerative blue businesses. Examples of implementation at national and regional levels involving private sector engagement are highlighted below:

- *Innovative Finance for MPAs - The Galapagos Case Study:* A plan for a huge Galapagos MPA provides a compelling example of a localized, yet globally significant, approach to financing conservation through innovative financial mechanisms. In a landmark 2023 transaction, Ecuador completed a debt-for-nature swap that is expected to generate over US$450 million in total conservation resources over 20 years. By converting a portion of its national debt into a lower-interest loan (a blue bond), the country freed significant funds for marine protection. The resulting Galapagos Life Fund is tasked with managing these funds to strengthen management, monitoring, and enforcement of the marine protected area, including patrols and technology-enabled surveillance.[418] This example demonstrates a powerful pathway for bridging the blue finance gap at a national level through blended finance.
- *Comprehensive Approach to Marine Restoration:* The Japan Blue Economy (JBE) Model: Japan's approach to financing marine restoration highlights a multi-stakeholder model that integrates public, private, and academic efforts. The JBE Association serves as a platform for researchers, engineers, and practitioners to collaboratively develop and fund technologies for coastal restoration and conservation. This model is underpinned by government financial measures to support organizations and projects focused on marine debris, coastal ecosystems, and resource management.[419] This cooperative framework, which also includes the promotion of environmental education and

public awareness, shows how financing for marine restoration can be embedded within a broader national strategy that fosters long-term, multi-sector collaboration rather than relying on a single financial transaction.

- *National Strategies:* The Galapagos Islands provide a compelling example of a localized, yet globally significant, approach to the blue economy. Funded by the World Bank's PROBLUE initiative, the Strategic Plan to Foster the Blue Economy in Galápagos 2025-2040 is a multi-stakeholder effort that balances economic development—particularly in tourism and small-scale fisheries—with environmental conservation.[420] This plan is a practical example of a country acting on its commitment to sustainably manage its ocean area under national jurisdiction, a core goal of the Ocean Panel.
- *Supporting Local and Regional Innovation:* 1000OS is a network that connects incubators, accelerators, and venture capitalists dedicated to ocean health. This model fosters implementation by empowering local and regional ecosystems to create, fund, and scale solutions that are tailored to specific geographical challenges. For example, the coalition has supported the launch of the Asia Ocean Fund, a fund specifically designed to accelerate blue economy startups in the Asia-Pacific region, thereby addressing a critical funding gap in that area.[421] The ventures supported by 1000OS go beyond simply reducing harm; they are developing tangible, regenerative blue businesses that actively restore and protect marine ecosystems while also creating economic value. By backing at least 1,000 such ventures by 2030, the global coalition is a powerful, non-state mechanism for turning global policy goals into practical, on-the-ground action.[422]

Addressing Lingering Impacts of COVID-19

While many sectors of the blue economy, particularly in the EU, have shown a strong recovery from the COVID-19 pandemic, some continue to face challenges. The EU Blue Economy Report 2025 noted a full recovery for many sectors, but the report also highlights the need for continued investment to build resilience against future shocks.[423] For many developing nations, particularly those reliant on coastal tourism and artisanal fisheries, the pandemic's disruptions to supply chains and tourism flows have had a more lasting impact on livelihoods and economic development. The ongoing work of organizations like the World Bank and the FAO seeks to address these vulnerabilities by supporting diversification and strengthening value chains in a post-pandemic world.

6.2.1 Organization for Economic Cooperation and Development: Blue Economy in Cities and Regions

In recognition that cities and regions are at the forefront of marine economic activity, including ports, fisheries, tourism, and marine industries, the Organization for Economic Cooperation and Development (OECD) launched an initiative: "Blue Economy in Cities and Regions" to address governance fragmentation and unlock integrated planning opportunities. The program emphasizes that local governments play a critical role in shaping blue economy outcomes, yet often lack the tools, coordination mechanisms, and policy coherence needed to do so effectively. It is an effort by the OECD to harness the potential of the blue economy while ensuring ecological sustainability.

Drawing on a global survey of over 80 cities, regions, and coastal basins, the OECD identified key challenges and opportunities in subnational blue economy governance. These include: 1) lack of coordination across sectors (*e.g.,* fisheries, tourism, transport, environment); 2) limited stakeholder engagement, especially with marginalized coastal communities; 3) gaps in data availability and monitoring systems; and 4) missed opportunities for linking blue economy planning with climate adaptation and urban resilience

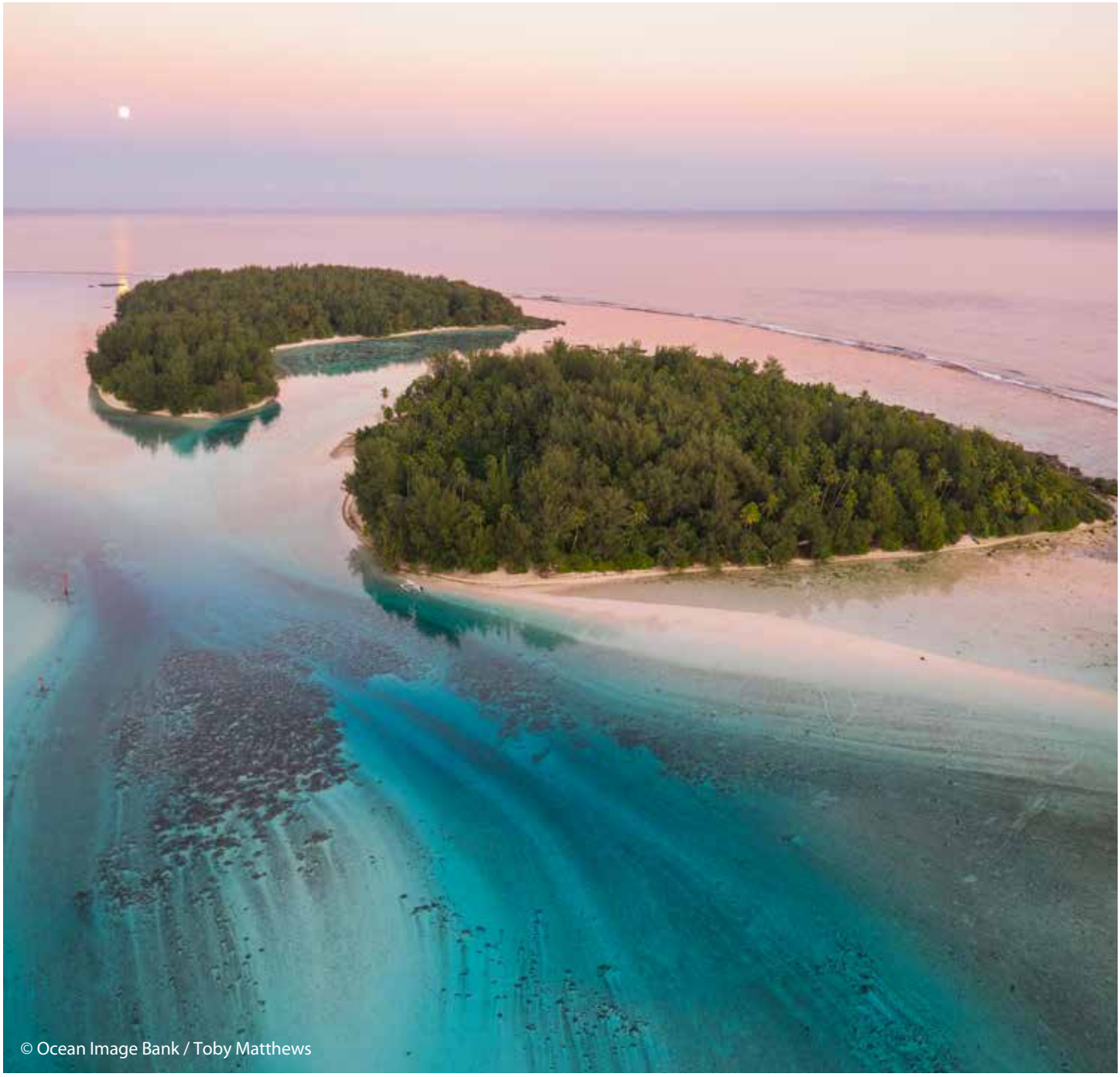
To address these challenges, the OECD developed the RISC-proof model, a diagnostic and planning tool that helps subnational entities evaluate and improve their blue economy strategies. The framework encourages cities and regions to endeavor to become resilient, inclusive, sustainable, and circular, as defined below:

- *Resilient:* Able to withstand climate and economic shocks;
- *Inclusive:* Ensuring benefits reach marginalized and vulnerable groups;
- *Sustainable:* Protecting marine ecosystems and biodiversity; and
- *Circular:* Minimizing waste and maximizing resource efficiency. The RISC tool enables local governments to self-assess their readiness and identify priority areas for reform and investment.

The initiative promotes the following:

- *Multi-level governance:* Fostering coordination between national, regional, and local authorities;
- *Policy coherence:* Aligning blue economy strategies with broader development, climate, and biodiversity goals; and
- *Stakeholder engagement:* Ensuring participatory planning with coastal communities, indigenous groups, and private sector actors.

This initiative encourages cities and regions to incorporate blue economy planning within broader frameworks, including climate adaptation and DRR, urban resilience and infrastructure development, and water security and pollution control.



7. POPULATION DISPLACEMENT

Co-authors: Christopher Richter and Pablo Escribano, International Organization for Migration

The migration, displacement, and planned relocation of populations in coastal areas is one of the major social dynamics that results from the impacts of climate change. Scientific literature has increasingly shed light on the very diverse manifestation of these movements, which includes displacement due to sudden onset hazards, planned relocation away from exposed areas, and migration in contexts of dwindling resources and livelihoods. At the same time, migration and displacement to exposed areas may increase vulnerabilities, and affected populations may not have the means, opportunities or willingness to move when disasters strike.[424] [425] [426] This chapter identifies the most recent evidence and information surrounding human mobility processes tied to the impacts of climate change in coastal areas, while discussing policy progress and opportunities moving forward in this area.

7.1 Status, current work, and future projections

In such a complex environment, where population movements are multifaceted and dynamic, responses led by communities and local and national authorities are being deployed to mitigate risks associated with displacement and offer dignified solutions for people on the move. Both at the global level – where migration, displacement and planned relocation have been included in the scope of the Fund for Responding to Loss and Damage and the Santiago Network – and at the national level, where human mobility derived from the impacts of climate change is gathering increased attention, notably in coastal areas where the resettlement of exposed populations appears as a growing priority.

The challenge: Exposure and vulnerability of coastal areas to climate mobility

Climate mobility patterns and processes in coastal areas are closely intertwined with the exposure and vulnerability conditions of affected populations. Recent analysis shows that "current human population growth along Earth's coasts is on a collision path with anticipated consequences of increasing natural and anthropogenic induced coastal hazards."[427] As the IPCC has pointed out, the worsening impacts of climate change increasingly shape human mobility patterns, directly and indirectly affecting population movement.[428] This was verified for example thorough a cross-sectional survey in coastal areas of Pakistan, which found "a strong positive relationship between climate change variables (SLR, temperature increases, and flooding) and migration patterns."[429]

However, other case studies have also identified that variables including household income, power dynamics, place attachment, and rootedness play a key role in shaping mobility decisions, sometimes resulting in a reluctance to move and immobility situations, as it was described in Bangladesh, Vanuatu, and the Philippines.[430] In Southwest India, recent research has shown that the implementation of coastal protection measures significantly impacts the decision of coastal populations to stay, along with social and household factors, while post-disaster rehabilitation assistance influence decisions to migrate.[431]

The number of new displacements due to disasters worldwide has generally increased over the last years, attaining 45.8 million in 2024.[432] While aggregated data is available on the type of hazard, the location of these movements, and whether they happened in coastal areas, is not available at the global scale. In the Americas, large scale new disaster displacement figures are often associated with active hurricane seasons affecting coastal communities, including in 2017 (Irma and Maria) and 2020 (Eta and Iota). Temporary displacement associated with hazards in coastal areas of Bangladesh has been associated with long term negative consequences from income, food insecurity and poverty markers.[433] Research has evidenced the gendered dimensions of disaster displacement and the mental and psychosocial dimensions of loss and damage.[434]

Available projections tend to identify the concrete exposure of current and future population to hazards, with an increase from 1.6 billion to 1.9 billion of people likely exposed to a 1% (100-year) flood hazard between 2020 and 2100, due to climate change (21.1%), population change (76.8%), and both climate and population change (2.1%).[435] Progress has been achieved in the quantification of compound risks under climate change scenarios for coastal areas, in a context where human settlements are confronted with the impact of multiple flood drivers.[436]

Human mobility itself may increase exposure to climate hazards, as populations settle in unsafe and high-risk areas

thus thwarting DRR and land planning efforts. For instance, an assessment in coastal and inland flood exposed North Carolina found that for every property removed through buyouts between 1996 and 2017, more than 10 new residences were constructed in floodplains.[437] In the Brazilian state of Sao Paulo, coastal urbanization has been assessed to have ecological impacts which greatly increase environmental risk.[438]

Studies and analyses have focused on estimating "populations affected as a consequence of projected sea-level rise"[439] and other associated hazards. While evidence has noted that "coastal hazards, including flooding, erosion, and salinization, might influence internal migration pressures through impacts on infrastructure, property, agricultural production, income, and health," the overall impact on changes in migration trends is more difficult to ascertain.[440] Migration associated with SLR and associated flood risks is likely to be highly context specific, and studies that have compared situations across countries expose how multiple factors (response efficacy, self-efficacy, place attachment, and age, as well as more context specific factors such as perceptions of climate change, costs, networks and income) shape climate related mobility trends.[441]

Future SLR scenarios have been assessed for different socio-economic pathways, to project potential land loss and associated migration. Twenty-first century movements derived from these variables could result in the coastal migration of 17 to 72 million people, with large countries of South and South-East Asia accounting for the largest absolute numbers and small island countries being most affected relatively.[442] Research modelling has also shown that storm surge increases have historically reduced the number exposed populations in coastal areas through their relocation, with notable differences across regions.[443]

Planned relocation movements have the potential to reduce exposure to SLR, coastal flooding and other associated hazards but may also entail maladaptive consequences.[444] Planned relocations may become increasingly required under climate change scenarios, as increased attention is being given to pre-emptive resettlement and the potential pathways and necessary governance, finance, and institutional arrangements to support this strategy.[445] Overall, case evidence shows that planned relocation processes tend to achieve a smaller exposure to flooding risk,[446] but also in some cases, such as the Volta Region of Ghana, entail negative impacts on wellbeing and psychosocial health for affected populations.[447]

The approach: Improved governance and pilot initiatives

Policy development on climate mobility has continued to advance in several processes at the global, regional, and national levels. In the context of the annual COP of the UNFCCC for example, climate mobility was included in key negotiated decisions—most notably the GGA[448] and the NCQG on Climate Finance.[449] It was also prominently featured in signature initiatives such as the Baku Call for Climate Action for Peace, Relief, and Recovery[450] and the Baku Guiding Principles on Human Development for Climate Resilience.[451]

Its inclusion in eight negotiation tracks, and in several high-level segments of the COP, marked a significant increase in interest and relevance compared to previous iterations. Critically, climate mobility has been an important dimension in discussions related to the new Fund for responding to loss and damage, where migration, displacement and planned relocation now feature as elements in the scope of the Fund, as outlined in its Governing Instrument. This is also particularly relevant in the context of ocean and climate action, given the linkages with sea-level rise, which is also a dimension to be addressed by the Fund.

This progress is also underpinned by recent attention provided to the human rights implications of climate mobility, solidified in the Advisory Opinion of the ICJ on the Obligations of States in Respect to Climate Change[452] and the Advisory Opinion of the Interamerican Court on Human Rights on the Climate Emergency and Human Rights. Both documents reflect on the rights obligations that are relevant to climate mobility scenarios, including the non-refoulement implications in cases where "there is a real risk of irreparable harm to the right to life in breach of Article 6 of the International Covenant on Civil and Political Rights if individuals are returned to their country of origin."[453] The Interamerican Court on Human Rights provides more specific answers to the question on climate mobility asked by Chile and Colombia in the request for an advisory opinion and defines a set of rights and obligations that notably derive from the rights to residence and free movement in the context of climate change.[454]

Regionally, several initiatives have also been advanced to address climate mobility. In the Pacific, for example, governments of the Pacific Islands Forum (PIF) endorsed a Regional Framework on Climate Mobility at the PIF

Leaders Meeting in 2023. This Framework is framed as a contribution to the 2050 Strategy for the Blue Pacific Continent and recognizes the importance of Pacific peoples' cultural connections to both land and ocean, as well as the value of traditional knowledge systems in ensuring the protection of all Pacific peoples, including with respect to the ocean and natural resources. The Framework also commits governments to preserve their formal ties to home and, recalling the Declaration on Preserving Maritime Zones in the Face of Climate Change-Related Sea-Level Rise, to continue to exercise sovereignty and sovereign rights over maritime zones and resources, even in the context of possible inundation. As of August 2025, a Pacific Regional Framework on Climate Mobility Implementation Plan was in the process of being developed ahead of its consideration at the 2025 PIF Leaders Meeting.

Modelled on the pioneer Kampala Ministerial Declaration, countries of the Organization of Eastern Caribbean States signed in 2023 an Eastern Caribbean Ministerial Declaration on Migration, Environment and Climate Change,[455] which highlights the region's commitment to addressing the impacts of climate change on human mobility. In an area severely affected by climate hazards that include hurricanes and tropical storms and SLR, the Ministerial Declaration charts a collaborative way to ensure protection for people on the move in a changing climate.

There are also several instances of countries addressing climate change, the ocean, and climate mobility as cross-cutting and inter-related issues in various climate-related policies and frameworks at the national level. The NAP of the Republic of the Marshall Islands, for example, addresses adverse climatic impacts on the ocean in a cross-cutting way. It refers to several challenges, such as ocean warming and acidification, impacts on fish and other marine organism distribution (and subsequent impacts on food supply and income generation), impacts on coastal water salinity and nutrient levels, and sea-level rise, as critical challenges affecting this 'large ocean' nation. The NAP outlines a pathway of responses to address these challenges, which include 'putting in place nature-based adaptation, consolidating services on atolls that can be protected as sea levels rise, investments in "hard" and "soft" protective infrastructure, the creation of raised and protected land into new centers, and ultimately, planned relocation to protected areas,' thereby recognizing human mobility as part of the continuum of responses.[456]

Larger countries are also identifying hazards and responses linked to climatic impacts on the ocean. In its NAP, for example, Bangladesh has also highlighted sea-level rise and associated challenges, including increased storm surges and salinity, as a key focus. Much like the Marshall Islands, Bangladesh is concerned about the impacts to availability of cultivable lands, the potential for lower crop yields, impacts on fisheries and hampered food security, amongst other issues. Human mobility, including migration, displacement, and planned relocation, also features throughout the NAP document.

However, planned relocation receives more attention in the context of the ocean-related issues identified in the NAP, being listed amongst several potential interventions, including raising the polder (*i.e.* tracts of reclaimed land, supported by dikes), sea-wall construction, and water pumping. The document also draws attention to solutions such as establishing oyster reefs for coastal shoreline or embankment erosion protection, an initiative already implemented on Kutubdia Island in the Cox's Bazar district.

The Falepili Union Treaty signed between Australia and Tuvalu in November 2023 has also gathered international attention as a first of its kind approach to enabling international mobility options for Tuvaluan nationals as a response to climate hazards. Research has shown the importance of grounding these processes in localized understandings of climate justice,[457] while upholding national sovereignty and strengthening collaboration.[458]

Despite the clear examples of progress in tackling interrelated climate change, ocean, and climate mobility issues, more is needed to properly integrate these policy concerns on the political agenda and, importantly, to drive tangible action on the ground. The advances that have been made at the global level, in particular in the context of the UNFCCC, are welcome. However, efforts to promote a more comprehensive and holistic approach that addresses climate mobility across different workstreams is needed, while continuing to expand upon the achievements made to date.

For example, while climate mobility has been well integrated in the loss and damage track under the UNFCCC, more could be done to ensure it is well reflected in the adaptation track as well, for example in the indicators to support the GGA. At the same time, further effort is needed to shore up references to mobility in loss and damage, especially in the context of the new Fund for responding to loss and damage, to ensure that adequate resources begin to flow

towards initiatives that address mobility issues. The recent increased attention to human rights implications of climate mobility offers an important path to be explored in the near future.

At the regional and national levels too, there are opportunities to expand cross-regional learning to promote more comprehensive approaches. This includes better integrating climate mobility in relevant policies and frameworks, including NAPs and NDCs, as well as developing stand-alone policies as needed. Efforts to advance common regional approaches, similar to the Pacific Regional Framework on Climate Mobility and other examples such as the Kampala Ministerial Declaration on Migration, Environment and Climate Change (KD-MECC), and the Eastern Caribbean Ministerial Declaration would also be important, especially in regions where progress has not advanced as well.

8. FINANCING OCEAN AND CLIMATE ACTION

Co-authors: Indumathie Hewawasam, Global Ocean Forum; Torsten Thiele, Global Ocean Trust; Stefanie Simpson and Christine McClung, The Nature Conservancy

Past ROCA recommendations highlighted the need to support adaptation and mitigation efforts in particular in SIDS and ocean-reliant communities by securing sufficient funding for ocean and climate action. Suggested strategies included directing a significant portion of current climate funds to SIDS and ocean-reliant communities as well as developing supplementary financing to support adaptation and mitigation methods through innovative approaches and partnerships. This chapter summarizes current levels and trends of financing for the ocean and climate, examining both public and private financing efforts. It then examines progress with innovative sources of ocean financing and potential challenges.

8.1 Financing ocean and climate action

Finance for climate action includes the provision and mobilization of public financial resources for developing countries through a variety of channels in accordance with Articles 4 and 11 of the UNFCCC, and Article 9 of the Paris Agreement, as well as finance through market-based approaches in accordance with Article 6; and other finance mobilized by the private sector for climate action. The NCQG on Climate Finance will be one of several critical pathways to scaling climate finance for ocean solutions.[459] At UNFCCC COP29 in Baku, there was some progress made. The COP29 Declaration on Water for Climate Action[460] highlighted the critical role that the water-energy-food-ecosystems nexus plays for both climate mitigation and adaptation. The COP29 Baku Ocean Declaration affirmed that effective, transparent, and equitable climate finance mechanisms at scale and new and cooperative approaches to climate mitigation and adaptation are central to a blue economy that ensures healthy marine ecosystems, sustainable use of marine resources, and a prosperous future for all.[461]

A priority of the UNOC3 in Nice in June 2025 was "Mobilizing sources of finance to conserve and sustainably use the ocean, seas, and marine resources for sustainable development (SDG 14) and support the development of a sustainable blue economy." In preparation, a number of organizations provided updated information on the state of ocean finance. The High-Level Panel for a Sustainable Ocean Economy Working Paper on "Ocean Finance for a Sustainable Ocean Economy"[462] notes that current investments fall significantly short of the estimated US$550 billion annually required to secure long-term ocean health and a sustainable ocean economy. Less than 1% of official development assistance (ODA) and philanthropic funding are directed toward ocean sustainability. Fragmented financial structures across sectors and agendas, such as biodiversity and climate, further undermine impact and coherence. Redirecting financial flows toward sustainable activities supported by robust governance, fiscal reform, and integrated planning, such as Sustainable Ocean Plans, can drive resilience and shared prosperity.[463] The paper underscores the need to build ocean finance literacy and prioritize equity.

"The Ocean Economy to 2050"[464] by the OECD provides key data on blue economy pathways going forward. UNCTAD highlights the relevance of trade and refers back its 2023 call for a Blue Deal approach to coherently bring together the interlinked issues of ocean finance, investment, trade, technology, and innovation and align them with sustainable ocean economies, particularly in developing countries.[465] There also remains a need to improve the use of ODA in terms of targeting, predictability, and volume, as well as the importance of leveraging ODA strategically to unlock other sources of capital, both public and private.[466]

Development finance institutions continue to play a critical role in supporting blended finance approaches and infrastructure project finance. The World Bank focuses on Accelerating Blue Finance[467] and recently joined the Finance in Common Ocean Coalition, an initiative already endorsed by 20 Public Development Banks, to transform ocean finance.[468]

The Blue Economy Finance Forum (BEFF) [469] at the margins of UNOC3 provided significant momentum. A total of €8.7 billion was committed to be deployed over the next five years by philanthropists, private investors and public banks, into a regenerative and sustainable blue economy, of which €1 billion has already been deployed or is investment-ready in 2025. In addition, 80 organizations from 25 countries, representing a combined turnover of US$600 billion, endorsed the 'Business in Ocean' call to action, and the #BackBlue Ocean Finance Commitment was cited as a formal outcome of the BEFF.[470]

Investment needs to reach key blue economy targets by 2030 are as high as US$2.5 trillion (See Figure 23 from the Standard Chartered Blue Economy Report).[471] A thriving Sustainable Ocean Economy depends on bold partnerships to unlock investment and de-risk opportunities. The OIP offers a blueprint for this transformation.[472]

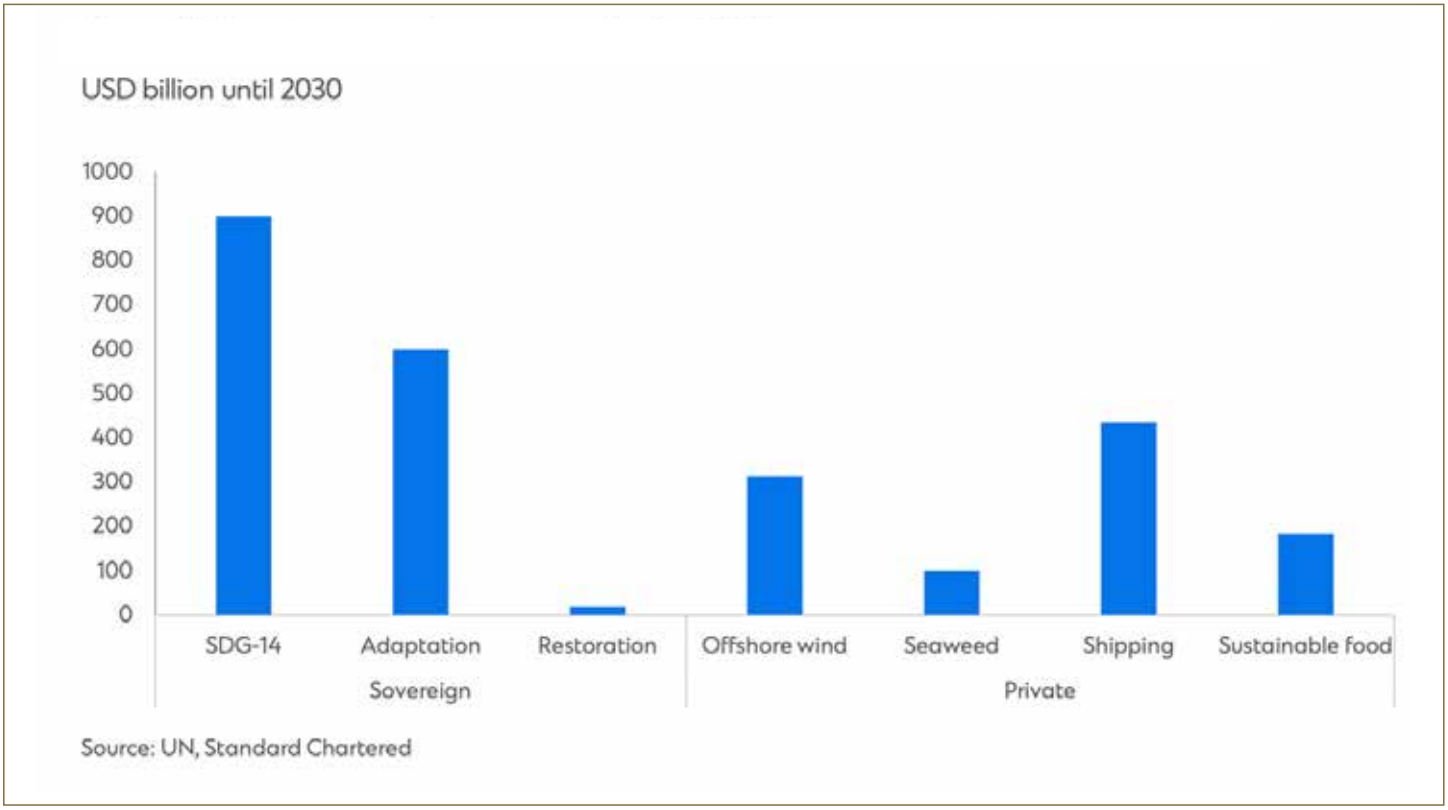


Figure 23. Investment Needs for Key Blue-economy-related Markets 2030 are as High as US$2.5 Trillion

Current levels and directions of financing

The WBG provided US$42.6 billion in climate finance in fiscal year 2024,[473] with a growing share directed toward ocean-related adaptation, resilience, and sustainable blue economy initiatives.[474] The Multi-Donor Trust Fund PROBLUE managed by the WBG in fiscal year 2024, disbursed US$37.8 million across 64 approved proposals. The World Bank and 12 donor partners have extended PROBLUE through 2030, reinforcing its commitment to ocean health and sustainable development.

The GEF provides grants, blended finance, and technical assistance for climate and ocean-related projects, with over US$23 billion in grants and US$129 billion in co-financing mobilized since its inception. It supports countries through dedicated funds like the LDC Fund and the SCCF. LDC Fund[475] focuses on climate adaptation in vulnerable countries while the SCCF[476] supports adaptation and technology transfer across all developing countries. US$5.33 billion is pledged by donor countries for the GEF-8 replenishment (2022–2026).

The GCF is the world's largest dedicated climate finance mechanism, established under the UNFCCC to help developing countries pursue low-emission, climate-resilient development. It launched its second replenishment cycle (GCF-2) for 2024–2027 with US$12.8 billion pledged by 31 contributors. Over the next five years, the GCF aims to accelerate funding for transformative climate action, including coastal resilience, sustainable fisheries, and ocean-based adaptation, with a strong focus on vulnerable communities and NbS.[477]

A key outcome from COP29 (Baku, Azerbaijan),[478] is the agreement of countries to a NCQG on climate finance, committing to mobilize at least $300 billion annually by 2035 for developing nations—tripling the previous US$100 billion target. They also set a broader ambition to scale up total climate finance to US$1.3 trillion per year from public and private sources.[479] NCQG aims to provide predictable, scaled-up funding for developing countries to mitigate emissions, adapt to climate impacts, and address loss and damage. COP30 will need to address gaps in the agreement including the lack of binding commitments and lack of clarity on how the NCQG targets will be met.

8.2 Innovative sources of ocean financing

Blue carbon offsets

Climate finance continues to present a growing opportunity for coastal wetlands, particularly for mangroves, seagrass meadows, and tidal marshes. These ecosystems are increasingly eligible for carbon market finance through voluntary and emerging jurisdictional carbon markets, as more standards adopt methodologies and high-integrity principles tailored to blue carbon. However, the supply of blue carbon offsets remains limited due to the complexity of project development. Persistent barriers include high start-up costs, unclear land tenure, and growing uncertainty around government ownership and project authority, especially as countries develop frameworks from Article 6 of the Paris Agreement that will shape which project types and partners can participate. Despite these challenges, demand for blue carbon offsets is expected to grow, driven by corporate climate commitments and interest in NbS.[480]

Non-carbon co-benefits

A promising frontier in climate finance is the recognition and monetization of non-carbon co-benefits provided by blue carbon ecosystems. Verra's Sustainable Development Verified Impact Standard (SD VISta) now includes a Nature Framework protocol for biodiversity credits, and is developing a protocol to recognize coastal resilience benefits. While these instruments are still nascent, they offer potential for stacking or bundling ecosystem services with carbon offsets or for creating standalone non-carbon credits, depending on how market demand evolves. Additions of non-carbon benefits have the potential to justify premium prices and attract new funders to invest in high impact projects.

Nature-based insurance

Another innovative mechanism gaining attention is nature-based insurance. TNC has piloted reef insurance schemes in Mexico and Hawai'i,[481] which trigger payouts following storm events. These funds mobilize rapid response teams to assess and repair habitat damage, enhance ecosystem resilience, and sustain flood protection services. With increasing examples of nature integrated into insurance schemes, such as the wildfire resilience insurance coverage in California,[482] ocean and coastal system benefits are also being covered, as the work on weather-based parametric insurance by ORRAA and others shows.[483] The Mesoamerican Reef Fund uses parametric insurance to protect coral reefs from storm damage. It enables rapid recovery and resilience-building after climate shocks.[484]

Blue Carbon Plus

Continuing to look beyond carbon, Blue Carbon Plus (BC+)[485] combines high-level market analysis with on-the-ground environmental knowledge to identify blue carbon positive businesses around the world with the greatest potential for economic and conservation success. Launched by Conservation International (CI) and TNC in 2024, BC+ helps emerging businesses grow their operations and positive environmental impact. Businesses selected by BC+ learn how to access new markets and navigate regulatory obstacles. They receive the scientific insights needed to capitalize on blue carbon opportunities while ensuring local communities and natural systems continue to benefit as their market reach expands. BC+ also connects emerging businesses to potential investors, markets and partners.

BC+ takes an entrepreneurial approach toward blue carbon conservation, helping launch scalable business models that integrally link the production of goods and services with the preservation of healthy coastal systems. Collaborating with governments, financial institutions, emerging entrepreneurs, the private sector, and others around the world, BC+ is driving sector-wide transformation by working with partners to unlock systemic challenges, shaping enabling environments, influencing policy, and strengthening the infrastructure required to scale and sustain impact. While it supports innovative business models, the focus is not on the success of individual ventures, but on creating the conditions for a thriving blue carbon economy that delivers lasting, collective outcomes.

By 2050, BC+ aims to:

- Conserve and restore up to 16.9 million hectares of mangrove, tidal marsh, and seagrass;
- Remove and store up to 2.2 billion tons CO_2e from the atmosphere;
- Support increased incomes for more than 100 million people;

- Disburse US$50 million or more to the blue economy; and
- Help 20 or more businesses receive at least US$50 million in early-stage venture capital

Blue bonds

Blue Bonds are **s**overeign, corporate or financial institutions bonds earmarked for ocean-friendly projects.[486] Following Seychelles first sovereign blue bond in 2018 to fund sustainable fisheries and MPAs.[487] the cumulative issuance by Q3, 2025 has exceeded US$16 billion, with clear IFC/ICMA guidelines[488] and the Blue Bond Accelerator launching as global not-for-profit initiative to drive investment into sustainable and regenerative blue economies.

Debt-for-Nature swaps

In July 2024, the United States and Indonesia finalized a US$35 million debt-for-nature swap to protect coral reef ecosystems. The funds were channeled into a conservation trust to support local NGOs and community-led projects. Key partners included CI, TNC, and local NGOs.

Impact funds & blended finance platforms

The One Ocean Finance initiative supported by 8 UN organizations as well as IUCN and WRI aims to unlock billions for ocean-solutions by engaging with ocean-dependent industries like shipping and tourism. The initiative aligns commercial incentives with conservation and regenerative blue economy goals.[489]

PPPs are essential for mobilizing private capital where public funds fall short; scaling innovation in ocean-based climate solutions; and ensuring accountability and efficiency in project delivery**.** Examples include:

- *Indonesia – Blue Halo S Initiative:* Partnerships among the Government of Indonesia, TNC, and private investors focus on promoting and developing marine management strategies. This blended finance instrument combines public grants, philanthropic capital, and private investment focused on sustainable fisheries, MPAs, and community-based conservation.[490]
- *Kenya – Mangrove Restoration PPP:* Partnerships among the Kenya Forest Service, local NGOs, and carbon offset companies focus on mangrove reforestation for blue carbon credits. The government facilitates generating carbon finance through voluntary markets to enhance coastal resilience and generate income for local communities.[491]
- Fiji – Blue Bond Program: Partnerships among the Government of Fiji, World Bank, and private investors support marine resource conservation, climate adaptation and sustainable tourism. This is one of the first national-level blue bonds, setting a precedent for ocean-climate finance.[492]
- Partnerships among the Chilean Ministry of Environment, Rockefeller Foundation, and insurance firms develop risk sharing mechanisms through insurance. This protects vulnerable coastal zones while reducing disaster recovery costs.[493]

The combination of public funds with private capital to reduce risk and attract investment, involvement of communities to ensure sustainability and equity, the inclusion of measurable climate and biodiversity outcomes, the integration of blue finance into national development plans and budgets, and robust monitoring and verification to ensure transparency and impact are key factors enabling the success of these PPPs.[494]

Challenges in accessing ocean-climate finance

Access to ocean-climate finance is not always readily available. Challenges in accessing ocean-climate finance include:[495]

- Limited technical capacity to design and manage complex instruments like blue bonds or parametric insurance;
- High transaction costs for debt-for-nature swaps or blended finance deals;
- Uncertainty related to risk and returns, which may affect investor perception;
- Lack of short-term revenue streams despite long-term ecological benefits;
- Overlapping mandates, which may delay project approval and implementation; and
- Complex application processes, including co-financing requirements such as for GEF.

Scaling blue finance requires aligning policy, data, governance, and capital flows. Instruments like blue bonds, debt-for-nature swaps, and parametric insurance must be embedded in national systems and supported by development partners to deliver resilient, inclusive, and climate-smart ocean economies.

Innovative sources of ocean financing will need to take a multifaceted approach.[496] As blue carbon finance continues to evolve, its future lies in embracing a more holistic and inclusive approach, one that goes beyond carbon to recognize the full suite of ecosystem services provided by coastal wetlands. From biodiversity and resilience credits to nature-based insurance and entrepreneurial models like BC+, the sector is expanding its toolkit to unlock new sources of capital and drive systemic change. As blue bonds are established and implemented, more funding is anticipated to flow toward these ecosystems, further catalyzing investment in high-impact coastal projects. By integrating science, policy, and market innovation, these mechanisms are laying the groundwork for sustaining blue carbon systems in a way that not only delivers measurable climate benefits, but also supports livelihoods, safeguards biodiversity, and strengthens coastal resilience for generations to come.

9. CAPACITY DEVELOPMENT

Co-authors: Catie Mitchell, Global Ocean Forum; Marjo Vierros, Ocean Voices and University of Helsinki; Aditi Yadav, Guillaume Lheureux, Iwona Gin, and Lolita Couchene, Nausicaá Centre National De La Mer and World Ocean Network; Karina Higa, Empathea Blue Ltda; Aygün Karlı, Atılım University; Natalie Hart, Communications INC; Diz Glithero and Jen McRuer, Canadian Ocean Literacy Coalition; Bernadette Snow, Scottish Association of Marine Science

Amidst increasing and complex threats to marine ecosystems, capacity development will be critical to ensure ocean and climate practitioners have the necessary skills and resources to develop and implement effective ocean governance strategies. This chapter will explore capacity development efforts within and outside of UNFCCC processes efforts. Sections will also address capacity needs and gaps in consideration of enhanced engagement with ocean and climate issues from civil society and the youth, the impact of strategic communication in ocean and climate related outreach, and the role of gender in ocean decision-making, noting the current status of gender balance in ocean governance.

9.1 Building capacity for the ocean in a changing climate: Update 2024-2025

Capacity building as well as the transfer of marine technology (CBTMT) are fundamental for effective ocean-climate action. This is evident from the text of the BBNJ Agreement, where capacity building and technology transfer are seen as a central enabler for effective implementation of the Agreement and a key component of ocean equity.[497] Under the BBNJ Agreement, Parties are required, within their capabilities, to provide resources to support capacity-building for developing State Parties. The Agreement also sets out funding mechanisms to ensure financial support for such activities. With the entry into force of the Agreement set to take place on 17 January 2026, countries will be undertaking Needs Assessments to determine their capacity and technology needs, as well as priorities. The COP will also be expected to operationalize supporting mechanisms, such as financing for CBTMT, and the CBTMT Committee. In undertaking these tasks, the Agreement stipulates that CBTMT should be a country-driven, transparent, effective and iterative process that is participatory, cross-cutting and gender responsive.

The 2024 ITLOS Advisory Opinion on Climate Change also highlights the importance of capacity building in the context of ocean conservation. The Advisory Opinion states that under UNCLOS, State Parties must take "all necessary measures to prevent, reduce and control marine pollution from anthropogenic GHG emissions" and that State Parties have a "specific obligation" to protect and preserve the marine environment from climate change impacts and ocean acidification. In addition, States Parties to UNCLOS have an obligation to "assist developing States, in particular vulnerable developing States, in their efforts to address marine pollution from anthropogenic GHG emissions" and to provide appropriate assistance, in terms of capacity-building, either directly or through competent international organizations.[498]

The Political Declaration of the 2025 at UNOC3 recognized "the importance of increasing scientific knowledge and development of research capacity of developing countries, in particular SIDs and LDCs, including through technology transfer on mutually agreed terms and capacity-building, to allow them to invest in conservation and restoration efforts and to sustainably use our ocean, seas and marine resources for sustainable development."[499] In addition, one of the official Ocean Action Panels (Panel 7) addressed the topic of "Leveraging ocean, climate and biodiversity interlinkages," highlighting the important connections between ocean, biodiversity and climate action. The voluntary commitments and initiatives announced at the conference also contained ocean-climate actions that are relevant to CBTMT, and some of these are highlighted below.

- *The Ocean Rise & Coastal Resilience Coalition:* The Coalition promotes adaptation to SLR and ocean change by supporting cooperation among all stakeholders committed to the transformation of coastal cities and regions. In addition, the Coalition facilitates capacity building as well as access to strategic partnerships to empower local players in driving community-led adaptation efforts.[500]
- *The IOC Regional Training and Research Center on Ocean Dynamics and Climate (IOC ODC Center:* Hosted at the First Institute of Oceanography, State Oceanic Administration of China in Qingdao, China, the Center aims to promote international cooperation and enhance research capacity in the WESTPAC region on ocean

dynamics, air-sea interactions, climate change and numerical modelling.[501]

- *Reef Check Malaysia:* This program builds capacity of IPLC to co-manage marine ecosystems, with the aim to ensure long-term social, economic and climate resilience. Their experience demonstrates that communities can make a significant contribution to marine conservation, and that funding for capacity building helps community-based organizations to grow to make an even greater contribution.[502]
- *The Government of Madagascar:* The government registered a voluntary commitment to strengthen fishing community resilience to climate change through the development of a sustainable artisanal fishery and the implementation of effective ecosystem management measures.[503]
- *The Government of Singapore:* The government offers training courses in climate action.[504] They also offer an online training courses on international law, climate change and sea-level rise under the Singapore-Pacific Resilience and Knowledge Sharing (SPARKS) package.[505]
- *The FAO:* The UN Organization supports the application of the Ecosystem Approach to Fisheries (EAF) management, considering climate and pollution impacts.[506]
- *The EU:* The EU and its member countries support several climate initiatives, including capacity development and the provision of data. For example, the European Commission has announced €45 million for adaptation projects for cities, regions and islands as part of its Horizons Europe. The European Space Agency has announced the launch of a call for projects for local authorities of €50,000 to €3 million for the analysis of the risk for coastal communities based on spatial data.[507]

The UN Decade on Ocean Science for Sustainable Development (the Ocean Decade) continues to contribute to scientific knowledge and research capacity development relating to the ocean and climate. Relatively recent initiatives under the Ocean Decade building capacity on ocean and climate issues include the following:

- *UN Ocean Decade Collaborative Centre on Ocean-Climate Nexus and Coordination Amongst Decade Implementing Partners in P.R. China:* The Centre is committed to enhancing the understanding of the ocean-climate nexus and generating knowledge and solutions to help mitigate, adapt to, and build resilience against climate change across all geographies and at various scales.[508]
- *International Ocean Institute (IOI) Ocean Academy:* The Academy offers courses that range from ocean literacy to ocean governance in mitigating climate change.
- *Ghana Ocean-Climate Innovations Hub (GOCIB):* The Hub aims *to form a dedicated task force for implementing nature- and ocean-based solutions for climate remediation in Ghana and across West Africa*.
- *The International Blue Carbon Institute:* Led by Conservation International, the Institute forms partnerships towards effective policy, finance and implementation strategies for blue carbon ecosystems. The Institute also serves as a hub for exchanging knowledge and learning in blue carbon research and implementation.

In addition, long-standing ocean-climate initiatives continue to innovate and include both capacity building, and in some cases technology transfer, into their work. Two initiatives are highlighted below:

- *The GOA-ON:* This collaborative international network is designed to address three goals: 1) improve our understanding of global OA conditions; 2) improve our understanding of ecosystem response to OA; and 3) acquire and exchange data and knowledge necessary to optimize modelling for OA and its impacts. The Network provides capacity development for its members. This includes training, mentorship, support for early career professionals, as well as low-cost technologies for monitoring OA. In addition, the Network's Data Portal provides open access and visualization of ocean acidification data and data synthesis products.[509]
- *The World Bank's ProBlue Program:* The Program has funded a training course in ocean governance that aims to build capacity in protecting and preserving the marine environment and in conserving and sustainably using marine resources. The Online programme is free and is delivered in partnership with the University of Melbourne Law School, DOALOS, the ISA, the FAO of the United Nations, and the Center for Maritime and Oceanic Law at the University of Nantes.[510]

On a more general level, the discourse related to capacity development in the ocean space is increasingly being reframed as "capacity sharing." Capacity sharing indicates a partnership approach, which is based on knowledge sharing, rather than a provider-recipient approach. The premise of this approach is that all partners bring to the

table important knowledge, and that mutual learning and respect is key to success. Diverse skills, backgrounds and knowledge systems are required to develop ocean solutions that are fit for purpose both locally and globally.[511] Capacity sharing is crucial to enable collaboration by multiple nationalities, particularly in the global commons.[512]

As terminology is being reframed, it is also important to reframe how success is measured through long-term outcomes rather than short-term outputs. Metrics of success should measure the meaningful participation of all qualified individuals, as well as the degree of knowledge co-production that takes place in the design and implementation of the initiative. This ensures that diverse voices contribute to identifying a greater set of potential solutions and provides new ways of understanding and interpreting information. An important component of success is also diversifying leadership positions of capacity sharing initiatives to scientists and policymakers from the global South. Capacity sharing initiatives are successful when they meet national and local needs and aspirations, when they are sustainable in the long term through stable finance, and when they contribute to the personal development and career goals of individuals. While metrics to measure such outcomes will still need to be worked out, it is important that measurement of success not only consider short-term outputs, but also, and more importantly, longer term outcomes.[513]

9.2 Empowering civil society and the youth

Empowering youth and civil society in ocean and climate governance is both an environmental and democratic imperative, and central to advancing intergenerational justice. Strengthening youth capacity is essential to overcome systemic barriers, ensure inclusive and sustained engagement, and tailor ocean-based climate solutions to local contexts. This requires equipping communities and younger generations with the knowledge, skills, and mechanisms needed to meaningfully participate in decision-making and drive innovative, context-sensitive strategies.

Education and Community Empowerment

Education plays a pivotal role in shaping long-term citizen engagement. Highlighted initiatives and strategies to promote citizen engagement are included below:

- *Blue Schools – The EU Blue Schools Network:* Schools that join this network commit to introducing ocean and climate education, translating awareness into tangible actions such as waste reduction, electricity saving, and sustainable mobility campaigns. These initiatives actively engage students, teachers, and communities in behavioral change. [514]
- *Capacity Building for Teachers:* Training educators in the ocean-climate literacy, democratic practices, digital skills, and communication equips them to empower students and communities alike. [515]
- *Educator Training in Emotionally Positive Communication:* Political decisions and civic mobilization are often shaped as much by emotion as by evidence (POLEMIC Project).[516] Educators and youth leaders need training in emotionally intelligent communication[517] that inspires constructive action.
- *Positive Emotional Framing:* Communicating climate and ocean issues in ways that emphasize hope, resilience, and agency, rather than fear or despair.
- *Emotional Story Crafting:* Linking personal stories, community values, and aspirations to political choices makes policy issues more relatable and mobilizing.
- *Educator as Facilitator:* Empowering teachers and youth mentors to guide emotionally positive conversations can ensure that debates about climate and ocean challenges remain inclusive, respectful, and solution-oriented
- *Youth Engagement Techniques:* Developing practical exercises for youth to practice persuasive and empathetic communication can improve interactions with peers, policymakers, or the public.

The blue justice concept aims to identify the consequences of unregulated blue degrowth – who benefits, who bears burdens, and who decides in ocean governance. Recent syntheses identify ten risks through which blue growth can create injustices, dispossession, livelihood loss, gendered inequities, and more, while outlining solutions that place rights, participation, and equity at the center of ocean policy.[518]

Conceptual work further stresses procedural and epistemic justice for small-scale fisheries (SSF), calling for co-produced hermeneutical resources that enable communities-especially youth- to name and contest harm.[519] The recommended capacity-building priorities identified include the following initiatives:

- Youth Blue Justice Labs: A short, practice-oriented training on rights-based fisheries, the labs offer MSP engagement, and climate finance safeguards, building on sustainable small-scale fisheries rights instruments and existing justice platforms (*e.g.,* TBTI's Blue Justice program and global scan e-book).
- *Youth SSF Data Corps:* Community monitoring is conducted using open templates to document access, displacement and pollution to feed into national dialogues.
- *Blue Degrowth Policy Dialogues:* This youth-led fora with planners aims to pilot sufficiency-oriented indicators in MSP, NDCs, and coastal adaptation. These leverage ongoing initiatives without duplicating them and strengthen youth agency in evidence, agenda-setting, and accountability.

Empowering Youth Advocacy skills

Opportunities for young people to actively take part in discussions on ocean protection remain limited. It is therefore crucial to maximize the impact of each opportunity, a challenge made even greater by the fact that many young people may lack prior experience.

The Youth Ocean Leadership and Advocacy project[520] brings together experts and young representatives from around the world to co-develop a youth ocean advocacy training programme. In March 2025, a first cohort of 53 participants followed the first training and more than 16 of the trained youth took an active part in the UNOC3, coordinating a manifesto endorsed by more than 35 organizations representing more 1.7 million youth around the world. Following an initial pilot phase, the project aims to launch a freely accessible online course designed to equip and empower young people to strengthen their advocacy for the Ocean.

At the UNOC3 in June 2025, the Coalition of Emerging Ocean Leaders was officially launched. This is the largest youth coalition bringing together more than 27 youth and early career networks committed to protecting the ocean. The coalition has set several key objectives: advocating for the formal recognition of young people as official stakeholders in international negotiations on the future of the ocean (as it is already the case in the CBD COP), act as a facilitator for governments and international organizations wishing to work with young people, foster synergies among the initiatives of its member networks, promote secured public funding to ensure the participation of Youth in international conferences, and strengthening the capacities of network facilitators.

Democratic mechanisms for citizen engagement

Citizen engagement is a cornerstone for implementing local ocean–climate solutions. Trust and genuine inclusion require platforms where citizens' voices are heard and considered. Mechanisms include:

- *UN-Habitat Guidance:* The UN-Habitat emphasizes inclusive, participatory, and transparent processes for sustainable urban governance frameworks.[521]
- *C40 Pilot Initiatives:* The C40 Cities network[522] offers examples of urban hubs where citizen-led action is integrated into climate planning, providing replicable models for coastal adaptation.
- *Local Assemblies and Youth Councils:* Examples across Europe show how citizen assemblies contribute to climate strategies (European Citizens' Assemblies),[523] while youth councils create direct channels for young people to influence policies. Globally, several C40 Cities Youth Climate Councils guidance[524] demonstrate meaningful youth participation, as highlighted below, underscore the need for advocacy tools such as the Youth Climate Council Toolkit to guide youth-driven civic structures:
    - In Auckland, youth recommendations helped shape the city's 10-year climate budget.
    - In Los Angeles, young people are connected with city resources and NGOs to achieve their climate goals.
    - In Quezon City, climate and environment topics were integrated into school curricula, making climate education more accessible.
    - In Seattle, youth influenced transport policy, leading to a 2022 law providing free public transport for under-18s.
- *Participatory Budgeting:* Cities such as Paris (France), Lisbon (Portugal) or Chorzow (Poland) allocate portions of municipal budgets for citizens to decide on, enabling communities to prioritize green and climate-related projects.[525]

Scenario building and storytelling for future literacy

Preparing communities for future ocean–climate challenges requires creative, participatory approaches that empower people to imagine, test, and co-design solutions. Suggested strategies and resources are highlighted below:

- *Scenario Building Workshops:* Communities collaboratively envision possible future challenges applicable to sea-level rise, displacement, or climate-driven migration and test adaptation pathways. [526]
- *Citizen Storytelling and Future Thinking Toolkit:* A toolkit designed to foster intergenerational conversations, where youth, elders, and diverse stakeholders share stories, experiences, and hopes for the future. Storytelling creates emotional connection and social cohesion, while future thinking exercises enable communities to identify solutions that balance long-term sustainability with immediate needs. [527] [528]
- *Intergenerational Dialogues:* By combining youth perspectives with the wisdom of older generations, these sessions create shared visions of resilience. They also highlight local knowledge and cultural practices that can enrich science-driven policy. [529]

Building trust through communication

Effective engagement depends on trust, which can be strengthened through capacity building in communication and dialogue. Suggested strategies to promote effective communication and dialogue are highlighted below:

- *Nonviolent Communication (NVC):* Introducing NVC in youth councils, hackathons, and community assemblies helps young people articulate needs without confrontation, while also understanding policymakers' constraints. A study by Kansky and Maassarani (2022)[530] applied NVC training in community dialogues in Namibia and found a significant increase in empathic concern, both between people and towards wildlife, demonstrated through 36 examples of attitudinal change and 71 examples of behavioral change.[531] These findings demonstrated how empathetic communication tools foster collaboration, trust, and sustainability, principles readily transferable to ocean-climate contexts.
- *Narrative-Driven Engagement:* The POLEMIC Project[532] highlights positive storytelling's ability to reduce climate anxiety and galvanize civic participation. Likewise, the EU ARENAS initiative[533] advances citizen engagement through narrative forums, enabling emotionally authentic and inclusive public debate.

With the rapid advancement of AI and digital technologies, youth require a diverse set of skills that combine ethical awareness, creativity, inclusivity, and systemic thinking. Suggested strategies to achieve these skillsets are highlighted below:

- *Creative Problem-Solving:* Leveraging digital tools such as *Minecraft for Citizen Participation*[534] for participatory city planning, helping communities envision climate adaptation strategies for coastal cities.
- *Systems Thinking and Critical Analysis:* Breaking away from siloed perspectives to understand global climate–ocean governance and adapt solutions effectively at the local level.

The convergence of climate urgency, technological innovation, and generational mobilization provides historic opportunities for reshaping civil society and youths as vulnerable groups affected by environmental degradation into empowered agents of systemic change, subject to capacity building programs that bridge structural divides and tap the tried and tested potential of these stakeholders to offer innovative solutions, effective advocacy, and sustainable community-based conservation initiatives.

9.3 Public engagement and outreach: The role of communications in ocean and climate action

Mainstreaming and reaching broader audiences

Building a society that better understands, values, and cares for the ocean is increasingly being recognized as fundamental to efforts to integrate the ocean into national and global policies and action. In 2025, for example, the UNOC adopted a political declaration that specifically referenced public outreach for the first time, calling on states to 'promote awareness and education campaigns at the local, national, regional and international levels.' Strengthening the ocean-society connection facilitates and supports all other workstreams identified in the ROCA

report. It helps to raise the prominence of the ocean in climate discussions, to support and implement policy decisions, and to de-risk investment in ocean action.

As recognition of the value of a strengthened ocean-society connection grows, so do collaborative, coordinated efforts to build the knowledge, skills, decision-making capacity, and opportunity for all levels of society to take more ocean positive action. Foundational to increased recognition of the importance of ocean-society connection has been the Ocean Decade Vision 2030 Challenge 10 White Paper: Restoring Society's Relationship with the Ocean.[535] The paper sets out a clear strategic ambition to ensure that: 1) the multiple values and services of the ocean for human wellbeing, culture, and sustainable development are widely understood; 2) society-ocean connections are strengthened; and 3) that there is increased motivation, capability, and opportunity for people across all sectors of society, to make decisions and behave in ways that ensure a healthy ocean.

The White Paper identifies four key drivers to influence society's connection to the ocean (knowledge systems, communications, education, and cultural connections) and identifies key milestones to operationalize this strengthened ocean-society connection, all grounded in current work. Although written specifically for the UN Decade of Ocean Science, the report is an invaluable roadmap against which all ocean practitioners focused on public outreach and engagement can situate their activities.

Responding to the driver of 'communications' specifically, the Advancing Strategic Ocean Communication project was launched in 2024 to advance the practice of strategic communications in the ocean space; make evidence and tools more accessible to all; and galvanize greater investment in ocean communications. The project is led by Communications INC in partnership with the Calouste Gulbenkian Foundation and the David and Lucile Packard Foundation.

Since its inception, the project has run a two-day communication symposium as an official satellite event at the UN Ocean Decade Conference in Barcelona; launched a series of capacity-sharing resources including 'Better Practice Principles' in ocean communication, co-created by a global group of experts; and delivered a series of webinars and how-to guides available to all practitioners in the ocean-climate space. The project has grown to an extended community of practice with more than 725 practitioners from over 50 countries, demonstrating the collective desire for knowledge exchange and aligned approaches in this field.

A key theme emerging from the Advancing Strategic Ocean Communication project was 'the science of communication' in ocean outreach efforts, as opposed to simply the communication of science. This underscores the need for more data to better understand what audiences value, what motivates them, and how to most effectively reach them with ocean-related content and initiatives. A separate global initiative, the Ocean and Society Survey (the OSS), coordinated by the Canadian Ocean Literacy Coalition, is making considerable progress in generating exactly the kind of data that can help to support the design and delivery of public engagement projects, strategies, and campaigns aimed at strengthening the connection between ocean and society.

The OSS[536] is a collaborative research tool designed to answer two key questions: 1) How do people around the world connect with and value the ocean? And 2) What influences peoples' interests and concerns about the ocean, and their willingness and capacity to take action for the ocean? The Survey is the culmination of 18 months of collaboration by an international and multisectoral team of researchers and partners from the Global North and South. To date, the survey has been administered to nationally representative population samples in twelve countries (Canada, USA, Brazil, UK, Spain, Sweden, Norway, Bulgaria, Ireland, Finland, Cyprus, France).

The goal is to administer the survey in as many countries as possible by 2030, generating baseline, country-level data to track changes in how people understand, value, and/or care for the ocean over time. Individual countries can fund or administer the Survey for their own purposes. The Survey is designed to support the interests of a wide range of users – ocean researchers, communicators, educators, business and industry professionals, and/or policymakers. This growing source of open access data offers diverse users the opportunity to better understand and monitor how people think, feel, and act with regard to the ocean over time. Such evidence-based insights help to facilitate the design and delivery of more targeted interventions to catalyze action.

By mainstreaming ocean engagement and building evidence-based understanding of society's connection to the ocean, these initiatives create the foundation for more coordinated, effective, and inclusive action at all levels. As

knowledge, tools, and data continue to expand, practitioners and policymakers are increasingly equipped to foster an informed and motivated global society that values the ocean and acts to ensure its health and resilience.

Evolution of communications in Ocean and Climate Action Post-COP28–29

Since COP28 and COP29, the role of communications in the ocean–climate nexus has evolved from showing the ocean solely as a victim of climate change to recognizing it as a critical part of the solution. Where earlier efforts emphasized raising awareness of ocean risks such as sea-level rise, acidification and biodiversity loss, communications now play an important role in mobilizing solutions, finance, and societal engagement.

The First GST, finalized during COP28, marked a turning point by recognizing the ocean's role in mitigation and adaptation and elevating it to an important element of climate action narratives.[537] Communication efforts have since shifted toward showcasing the ocean as a solution provider, emphasizing practical pathways such as blue carbon, sustainable aquaculture, offshore renewables and coastal resilience. Following the COP29's focus on climate finance, narratives have been increasingly framing these ocean solutions as investment opportunities, positioning communication as a bridge between science, policy, and finance.

Moreover, ocean–climate communications have started to reach broader global audiences through education, youth movements, virtual/hybrid engagement and media coverage, moving beyond scientific communities and policy circles. Ocean literacy initiatives by the IOC-UNESCO and European Commission[538] calling for embedding ocean literacy in national curricula, underscore this mainstreaming trend.

Furthermore, storytelling has become central: personal testimonies from coastal communities, indigenous peoples, and youth have been increasingly used to humanize the science, highlighting equity and justice dimensions of climate action. In addition, public engagement started to link ocean issues to everyday impacts (fisheries, food prices, coastal safety).

Social media, immersive visualizations (*e.g.* Ocean Digital Twin), and youth-led campaigns became dominant since COP28 accelerating outreach, while AI-driven tools have altered communication strategies (for both outreach and risk of misinformation).

A critical challenge lies in the rise of misinformation and disinformation,[539] which undermine public confidence in science and weakens collective capacity to act. The spread of mis and disinformation has been reshaping communication priorities. Building trust in science, transparency and critical thinking have now become as important as amplifying scientific findings. Consequently, communication and outreach on ocean and climate issues will increasingly depend on the ability to ensure credibility, trust and inclusivity. Strengthening ocean literacy will therefore require not only expanding outreach but also equipping citizens with the tools to identify reliable sources, critically assess information, and navigate a rapidly evolving media landscape.

Emerging technologies such as AI will play a growing role in shaping these dynamics. On the one hand, AI offers opportunities to enhance outreach through new forms of interaction, personalization and accessibility. On the other hand, it also carries significant risks,[540] including the large-scale spread of misleading or fabricated content,[541] environmental costs of digital infrastructures, and concerns related to intellectual property. If not carefully managed, these risks could deepen public mistrust and amplify existing information divides.

COP29's finance focus pushed communicators to connect ocean science with climate finance and policymaking and promote investment in blue solutions. Therefore, messaging has been increasingly emphasizing resilience, risk reduction, and opportunity, aligning with the financing frameworks discussed

Before COP28, communications on the ocean–climate nexus focused mainly on raising awareness of ocean risks. Since COP28/29, the focus has shifted toward mobilizing society and finance by showing the ocean as a solution provider, an equity issue, and an investment opportunity, while countering misinformation and reaching wider audiences. Today, effective communication demands scientific credibility, compelling storytelling, digital innovation, and trust-building.

Informal education spaces such as aquariums are playing an increasingly prominent role in fostering ocean literacy and mobilizing citizens around ocean and climate issues. Once primarily conceived as places for exhibition and conservation[542] awareness, aquariums have increasingly evolved over the past decades[543] into multi-purpose

institutions that combine public awareness, education, scientific research and civic engagement.[544]

Education spaces

Traditionally, aquarium exhibitions focused primarily on ocean threats, highlighting issues such as coral bleaching, acidification, overfishing, and pollution. Since COP28 and COP29, however, many aquariums have transitioned to solution-oriented storytelling, emphasizing actionable climate solutions and human agency. For instance, Nausicaá Centre National de la Mer in France unveiled the exhibition *In the Eye of the Climate*, which explores the role of the ocean in climate regulation and showcases NbS and blue carbon ecosystems. In Asia, S.E.A. Aquarium in Singapore collaborated with researchers to study climate change impacts on marine life, integrating scientific research into their exhibits. These exhibitions reflect a broader trend in ocean communication, moving from highlighting environmental risks to promoting positive, solution-focused narratives that engage and empower audiences.

Moreover, aquariums are increasingly extending their role from educating on-site visitors to engaging with broader society through global campaigns, youth initiatives, and policy-linked programs. By engaging in initiatives such as the EU4Ocean Coalition and its #MakeEUBlue campaign, they can enhance ocean literacy, foster sustainability practices, and encourage community action across Europe.

With broad and diverse audiences, they serve as platforms to connect people with ocean knowledge, encourage behavioral change and engage actors beyond the traditional environmental community.

Several initiatives have demonstrated how aquariums can act as intermediaries between scientific knowledge and public action, engaging not only visitors but also entire value chains in promoting sustainable practices. For example, the *Mr.Goodfish* programme,[545] developed under the aegis of the World Ocean Network by Acquario di Genova (Italy), the Aquarium Finisterrae (Spain) and Nausicaá (France), promotes responsible seafood consumption by involving both consumers and fisheries actors. Its latest development, *Mr.GoodFish 3.0,* seeks to scale this approach across Europe by leveraging digital tools, mobilizing science centers and cross-border collaboration to strengthen citizen engagement.

Collaborating with local actors, aquariums are also expanding their contribution to participatory science and innovation through the concept of "living labs,"[546] which foster open and collaborative innovation by bringing together researchers, businesses, civil society and policymakers to co-design and test solutions in real-life contexts. Applied to the ocean-climate issues, living labs serve as experimental spaces where scientific knowledge, technological development and social engagement intersect to address sustainability challenges. In this context, aquariums are well placed to act as living lab hosts, amplifying their role as mediators between science and society. For example, the TREASURE[547] project's Living Labs across the North Sea region—including the Dutch Delta, Nieuwpoort Yser Estuary, Frisian Peninsula, French ports from Dunkirk to Brest and West Coast watersheds—combine citizen science, policy development, and technological testing to tackle plastic pollution while actively engaging local communities. By hosting such living labs, aquariums and educational centers move beyond their traditional role as transmitters of scientific knowledge to become facilitators of dialogue, experimentation and co-creation at the science–society interface, exemplifying the evolution of ocean communication and outreach toward solution-oriented, participatory approaches.

Future needs

Despite progress to date, much work remains to ensure that strengthening society's relationship with the ocean is fully recognized and implemented as an integral part of ocean-climate efforts, supporting action at all levels. This is a vital area of focus for future activities. A society that values and cares for the ocean includes not only individuals, but also decision-makers, the media, industries, and investors. The goal is to develop a society that fully appreciates the extent to which a healthy, functioning ocean underpins climate regulation, livelihoods, food security, economic stability, human health, and community wellbeing. Strengthening the ocean-society connection creates an enabling environment for all other areas of action highlighted in this report. It helps to raise the prominence of the ocean in climate discussions, to support and implement policy decisions, and to de-risk investment in ocean action.

To date, the potential acceleration that a strengthened ocean-society connection could bring to the implementation of meaningful ocean action has yet to be fully recognized or leveraged. As a result, funding and resources for public

outreach and engagement tend to remain limited, except when tied to specific lobbying or advocacy efforts, or when focused on formal education (although even in these cases, resourcing is often low). A clear sign of growing recognition of the ocean-society connection will be the provision of stronger and sustained funding for social science and public opinion research and the integration of public engagement budgets within broader programs of work.

The creation of a strong base of data and evidence is also necessary to ensure that public engagement efforts are targeted, effective, and have high impact. Just as data informs sound policy, it also provides the foundation for effective public engagement. Greater emphasis and resources should be directed to the science of ocean communication, not only the communication of ocean science. Data can elevate communicator impact by: 1) establishing baseline metrics to track and measure changes over time; 2) generating audience specific insights to inform campaign and activity design; and 3) supporting message development and creating advocacy hooks (*e.g.* by showcasing public levels of care/concern). Drawing on data in these ways can in turn elevate the return on investment for policymakers and investors, as more effective campaigns result in greater public buy-in, stronger long-term behavioral shifts, enhanced trust between institutions and communities, and a more resilient foundation for collective action on ocean challenges.

The growing dominance of misinformation and declining public trust in science, amplified by social media and AI, presents a serious challenge for ocean and climate communications. To maintain effective engagement, it is critical to implement trust-building strategies that leverage credible spokespersons, participatory campaigns, and co-created content. Integrating critical thinking and media literacy (*e.g.* source evaluation and fact-checking skills) into ocean education, proactive use of pre-bunking and fact-checking tools can help counter false narratives surrounding climate change, ocean health, and emerging technological solutions. In addition, engaging community leaders, educators, and youth as trusted messengers will strengthen the reach and credibility of accurate information, fostering a more informed and active public.

Ocean governance, climate finance, and the sustainable management of marine resources are increasingly shaped by regional tensions and global power dynamics. Effective communication in this context requires adapting messages to diverse geopolitical and cultural settings and ensuring sensitivity to local values and political realities. Promoting inclusive, multilateral narratives can encourage collaboration on shared ocean challenges, while emphasizing climate justice and equity highlights the disproportionate impacts on vulnerable communities. By integrating these considerations, communicators can support more cohesive and credible messaging, enabling broader societal engagement and cooperative action across borders.

As recognition of the importance of the ocean-society connection and supporting research grows, these efforts must be pursued in a just, equitable, diverse, and inclusive way. The OSS illustrates the challenge: 11 of the 12 countries with nationally representative data are in the Global North, despite efforts to secure funding for work in the Global South. Within public outreach and engagement, including strategic communication and ocean literacy, Brazil has been a leading force. It would be both a loss and an injustice if this Global South leadership were undermined as initiatives scale up and funding continues to concentrate in the Global North.

Moving forward, ensuring that the ocean-society connection is recognized, resourced, and guided by robust data will be critical to unlocking the full potential of ocean action worldwide. Equitable, inclusive, and evidence-based engagement across both the Global North and South will be essential to building a society that values the ocean and drives meaningful, lasting change.

9.4 Mainstreaming gender in ocean and climate action

Decision -/CP.29 on gender and climate acknowledges the continuing need for gender mainstreaming, the important role of the enhanced Lima work programme on gender and its gender action plan, and the role of women and girls in the UNFCCC process.[548] The Lima work has been extended for a further 10-year period, and despite the acknowledgement and encouragement, gender intersectionality is still neglected in ocean science data.[549] [550] Intersectionality goes beyond gendering of the ocean and considers the impact of gender, race, and economic status on equitable access to the ocean, resources and employment.[551]

Climate impacts are experienced differently across genders. It is projected that approximately 158 million women and girls (more than men and boys) will be poor because of climate change.[552] Women still face many barriers, and while numerically there is an increase of women representation, there are still fewer women in top positions.

Tokenistic involvement serves to achieve gender balance on paper, and inclusion is not equitable due to barriers that are both cultural and structural.[553] [554]

Climate impacts are not the same across geographies, with emerging economic countries and large ocean developing states significantly impacted, however, gender-related data is often biased, and there is a gap in ocean data.[555] [556] Climate impacts on women's health have also been researched, which not only impact newborns and babies, but also unborn children[557] and women's reproductive health in general.[558] There is a need for climate policies addressing the intersectionality between health, socioeconomic and environmental impacts on gender dimensions.[559] Impacts reported include increased impacts on mental health, including eco-grief and anxiety, delaying or reconsidering having children,[560] delayed recovery from increased severity and occurrence of natural disasters *e.g.* flooding and fire, exposure to high temperature impacts and increased vulnerability while pregnant and intersectionality with ethnicity, migration and child labor.[561] Heat stress increases the risk for child-bearing women and drought reduces food supply and nutritional quality, in addition climate change causses increased incidences of existing social inequalities.[562] There is a call to climate justice, inclusive of sexual, reproductive health rights, and justice.[563]

Men and women use the ocean differently, and management decisions impact women disproportionately. Gender disaggregated data is needed. More research on women's connection to the ocean is needed and there is still a long road ahead to better recognize women's contributions, values and voices. [564] Women possess invaluable knowledge and perspectives that can drive transformative environmental initiatives to address global issues such as climate change.[565]

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10. CLIMATE CHANGE AND ABNJ

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Climate change and ABNJ are interconnected. Nearly two-thirds of the ocean are considered ABNJ, and these vast areas are home to unique species and ecosystems that are key to marine biodiversity.[566] Human activities in ABNJ are predicted to increase, and the resulting cumulative impacts are difficult to measure and manage.[567] The degradation of biodiversity in ABNJ in the face of mounting pressure from pollution, overfishing, and seabed disturbance will affect the ocean's resilience to climate change and its capacity to provide resources necessary for human survival. Conservation and sustainable use of biodiversity in ABNJ are the focus of the new international BBNJ Agreement, which aims to address the growing biodiversity crisis for ocean life in ABNJ.[568] This chapter will provide an overview of the interplay between climate change and ABNJ with a focus on the potential of the BBNJ Agreement to address much-needed gaps in sustainable ocean governance.

The potential development of deep-sea mining activities, an emerging issue for climate change and ABNJ, is not included in this chapter. A co-author was not secured to provide a recent update on deep-sea mining before this report's publication. Future editions of the ROCA Report will cover this important topic.

10.1 Climate Change and the BBNJ Agreement

Many believe that the new Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction, also known as the BBNJ Agreement, the first comprehensive, cross-sectoral ocean treaty in decades, can help with the gap in climate governance. It was adopted on 19 June 2023, following nearly twenty years of negotiations. Its adoption marked a historic achievement in efforts to ensure the health and resilience of ocean ecosystems, and to level the playing field in the capacity to participate in and benefit from activities in ABNJ. The Agreement was open for signature for two years, from 20 September 2023 until 20 September 2025. After the period for signature has closed, a State or regional economic integration organization may become party to the Agreement through accession in accordance with its internal procedures. The Agreement will enter into force on 17 January 2026, 120 days after the 60th instrument of ratification, acceptance, approval or accession was deposited on 19 September 2025, with Morocco and Sierra Leone as the final Parties pushing the agreement over its ratification threshold. As of 27 October 2025, there are 145 signatories and 75 parties to the Agreement.[569]

On 24 April 2024, the General Assembly adopted resolution 78/272, in which it decided to establish a Preparatory Commission[570] to prepare for the entry into force of the BBNJ Agreement, and to prepare for the convening of the first meeting of the COP to the Agreement.

Following the organizational meeting of the Commission, the General Assembly, in its decision 78/560 of 13 August 2024, requested the Secretary-General to convene the first and second sessions of the Commission from 14 to 25 April and from 18 to 29 August 2025, respectively, and to convene at least one session of 10 working days in 2026, which will be from 23 March to 2 April, 2026.[571]

The Agreement addresses a package of issues[572] under the general objective of conserving and sustainably using marine biological diversity of ABNJ. In this context, the Agreement addresses the impacts of climate change on marine biological diversity of ABNJ. For instance, its Preamble recognizes the need to address, in a coherent and cooperative manner, biological diversity loss and degradation of ecosystems of the ocean, due, in particular, to climate change impacts such as warming, ocean deoxygenation, as well as ocean acidification. To achieve its objectives, the Agreement emphasizes that its Parties shall be guided by an approach that builds ecosystem resilience, including to adverse effects of climate change and ocean acidification, and also maintains and restores ecosystem integrity, including carbon cycling services that underpin the role of the ocean in climate. Furthermore, strengthening resilience to stressors related to climate change and ocean acidification is an objective of part III of the Agreement on ABMTs, including MPAs. Among the types of capacity building and transfer of marine technology included in annex II to the Agreement, is that related to Stressors on the ocean that affect marine biological diversity of areas beyond national jurisdiction, including the adverse effects of climate change, such as warming and ocean deoxygenation, as well as ocean acidification.

The BBNJ Agreement is acknowledged to be the first global instrument to address climate change impacts on marine biodiversity of ABNJ, that can support Parties to adapt to the accelerating impacts of climate change.[573] [574] [575] The BBNJ Agreement's inclusion of strategic environmental assessments (SEAs), and new institutional arrangements, are seen as important vehicles to address climate change mitigation.[576] The Agreement's incorporation of climate change reflects the strong and unified influence of the G-77+China in championing the rights of the developing world, which is most vulnerable to climate change. During the final negotiations, the G-77 (with support of the Deep Ocean Stewardship Initiative) successfully advocated for an important modification to the climate language, emphasizing the critical carbon cycling services provided by the ocean in ABNJ (Art. 7h). This BBNJ text was noted by the International Tribunal for the Law of the Sea in its advisory opinion on climate change and international law, suggesting that BBNJ Agreement can provide a strong basis for States and non-State actors to conserve nature-based carbon services in ABNJ.[577] Beyond the literal interpretations of the existing text, the BBNJ Agreement offers many untapped opportunities to align UNFCCC climate and BBNJ biodiversity policy, including through incorporation of carbon conservation in MPA criteria, UNFCCC-BBNJ technical body collaborations, a shared OCCD, joint funding of climate- and biodiversity-positive actions, and more.[578]

The OCCDs held in Bonn, Germany during UNFCCC SB 61 in 2024 and SB62 in 2025 both addressed ABNJ and the BBNJ Agreement. A key message of the 2024 Ocean Dialogue emphasized the importance of MPAs and other ABMTs in supporting livelihoods, safeguarding marine biodiversity, and increasing resilience to climate change. The Dialogue recognized the BBNJ Agreement's specific procedures for the establishment of ABMTs in ABNJ, including MPAs, and their importance for achieving the CBD/GBF's 30 by 30 goal. The Agreement's emphasis on strengthening cooperation among relevant legal instruments and frameworks and relevant global, regional, sub-regional, and sectoral bodies is especially relevant to addressing climate change. Data accessibility through the clearinghouse mechanism to be established under the BBNJ Agreement were identified as important to effective climate resilience. Participants in breakout groups highlighted the importance of harmonizing efforts across conventions like UNCLOS, BBNJ, and CBD to support marine conservation and biodiversity.

The high profile of the BBNJ Agreement and other international agreements in the 2024 Ocean Dialogue led the 2025 Dialogue convenors to select 'ocean-climate-biodiversity synergies across global processes and frameworks' as one of the three discussion themes. Presentations called out that the designation of area-based management by the BBNJ Agreement should be informed by climate change considerations and supported through capacity building and technology transfer. One of the 2025 breakout questions was: *How can the dialogue support Parties in the early ratification and implementation of the BBNJ Agreement in its different sections including the establishment of ABMTs, and MPAs*? One proposal suggested dedicating the 2026 OCCD to sharing experiences from early implementers of the BBNJ Agreement – particularly on ABMTs that support mitigation and adaptation from conservation.

The BBNJ Agreement progress was highlighted in the high-level opening of the UNOC3 held in Nice, France in June 2025. The conference generated significant momentum towards BBNJ Agreement ratification, with 19 new ratifications and 20 new signatures during the UNOC week. Financially the week saw renewal of the High Ambition Coalition for BBNJ, with €10 million (via the EU's €40 million Global Ocean Programme) dedicated to provide technical assistance to developing countries for both BBNJ ratification and implementation. For high seas protection, private philanthropy (Mindaroo Foundation) pledged US$6.5 million, and funding was secured for a secretariat for the First Movers initiative, which will help advance early proposals for High Seas MPAs.

On 19 September 2025, the BBNJ Agreement reached the 60-ratification threshold required to trigger its entry into force 120 days later, on 17 January 2026. The Agreement closed for signature one day later on 20 September 2025, although a State may still become Party to the Agreement through accession in accordance with its internal procedures.[579] Negotiations are underway to prepare for the Agreement's entry into force and the convening of the first meeting of the COP to the Agreement with the first session of the Preparatory Commission (PrepCom) convened in April 2025 and the second session convened in August 2025.[580] PrepCom I focused on the "nuts and bolts" that will guide the Agreement's orderly implementation in alignment with three clusters of work to be addressed by the PrepCom: 1) Governance; 2) Clearing-House Mechanism; and 3) Financial rules, resources and mechanism.[581][582] PrepCom II continued with discussions organized around the three clusters and deliberated on matters to be addressed by the COP at its first meeting.[583] The session set a clear path for the intersessional period toward PrepCom III, which will be held in March 2026, with sights towards the first COP anticipated at the end of 2026.[584]

Moving forward, the success of the BBNJ Agreement and its eventual impact on the ocean governance landscape will be dependent on its implementation. Both the financing of the Agreement and its interactions with relevant legal instruments and frameworks as well as relevant global, regional, subregional, and sectoral bodies (IFBs) will be critical in the operationalization of the Agreement.[585] Article 52 of the Agreement establishes a financial mechanism, which includes a voluntary trust fund, a special fund, and the GEF trust fund, although it is clear that the substantial financial resources for key aspects of the Agreement such as implementation of MPAs will require investment beyond current allocations.[586] Similarly, while the text of the Agreement is clear that it should not undermine existing IFBs and should instead promote coherence and coordination (Article 5(2)), the Agreement represents a new, and therefore untested, model for multilateral environmental agreements. While its obligation to involve relevant IFBs in its decision-making processes could constrain its institutional power, it could take precedence in the event of serious or irreversible harm to marine biodiversity.[587] With adequate funding and the establishment of relevant cooperative relationships, the implementation of the Agreement has the potential to address longstanding gaps in the conservation and sustainable use of marine biodiversity in ABNJ.

11. THE WAY FORWARD FOR THE OCEAN-CLIMATE COMMUNITY AT THE UNFCCC AND BEYOND

Co-authors: Peter Ricketts, Acadia University and Global Ocean Forum; Indumathie Hewawasam, Marea Hatziolos, Miriam Balgos, and Catie Mitchell, Global Ocean Forum

The global ocean is at a critical tipping point that demands immediate action. Over nine years, the ROCA Reports have documented rising recognition of the ocean–climate nexus and the ocean's central role in both mitigating and adapting to climate change. Having achieved this objective, the focus since COP25 has shifted to strengthening commitments and driving concrete action to protect, restore, and sustain ocean health and the livelihoods that depend on it.

11.1 Findings from this ROCA Report

The ocean has absorbed about 95% of excess heat from greenhouse gas emissions and roughly one quarter of anthropogenic CO_2, but its capacity to continue buffering heat and carbon is showing clear signs of strain. These limits are manifesting as prolonged, geographically extensive marine heatwaves, record surface and subsurface temperatures, accelerated acidification, deoxygenation, and rapid polar ice loss. The WMO confirmed that 2024 was the first calendar year to exceed 1.5°C above the 1850–1900 average, underscoring how close the system is to critical thresholds.[588]

Figure 24 from the Stockholm Resilience Center shows nine Earth system processes with gradients from green (safe) to red (high risk), indicating which planetary boundaries are within or beyond safe operating space.[589]

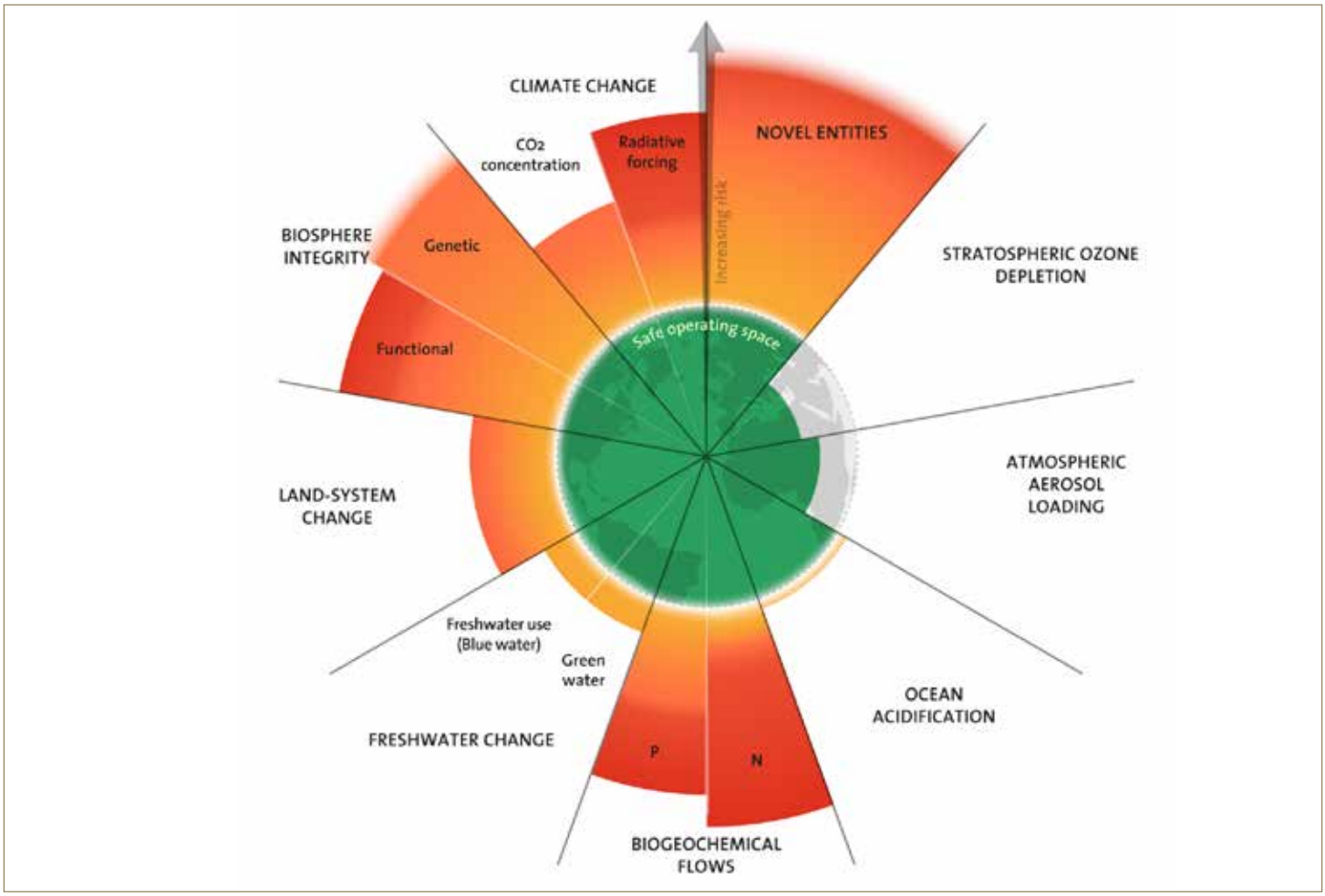

Figure 24. 2025 update to the planetary boundaries

Major systems approaching tipping points

The Global Tipping Points and Planetary Health assessments[590] indicate multiple Earth systems are at or near critical thresholds as warming approaches 1.5°C (Figure 25), with several ocean and coast-related systems becoming especially vulnerable, as highlighted below:

- *Coral Reefs:* Mass bleaching and mortality are already occurring, with projected losses of 80 to 99% in coming decades under continued warming.
- *Greenland Ice Sheet:* Elevation loss accelerates melting and contributes to SLR and ocean circulation changes.
- *West Antarctic Ice:* Ocean-driven melting and ice breakup threaten large-scale SLR.
- *Atlantic Meridional Overturning Circulation (AMOC) and Sub-Polar Gyre (SPG):* Freshening and cooling from Greenland meltwater increases the risk of major slowdown or collapse of one or both of these closely coupled critical ocean circulation systems.
- *Permafrost Thaw and Arctic sea-ice melting:* Amplified coastal erosion from mass wasting and increased exposure to wave action.

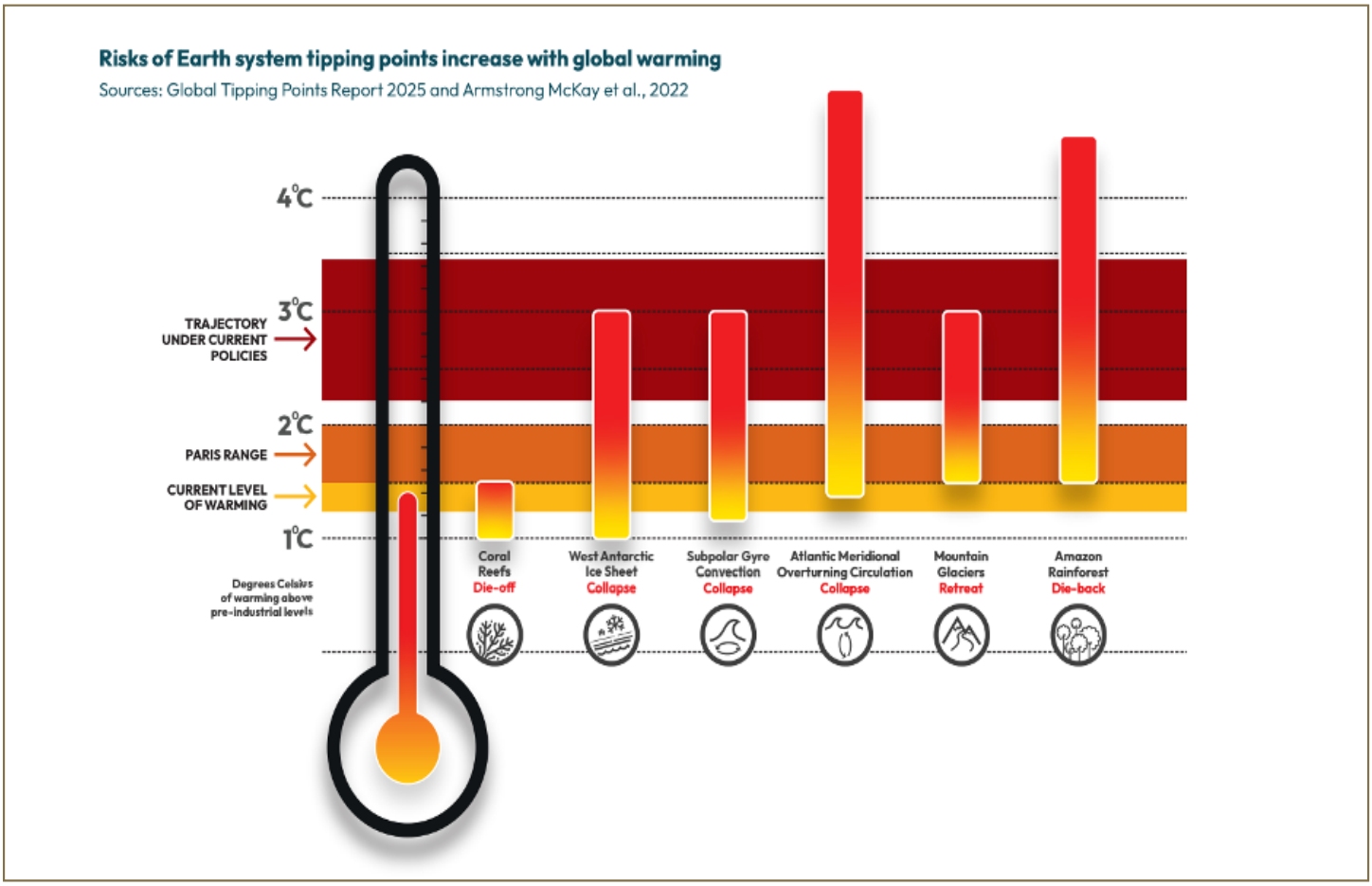

Figure 25. Risks of Earth System Tipping Points

The United States' withdrawal from the Paris Agreement and its backtracking on commitments to transition away from fossil fuels to a green economy powered by renewables risks a slackening of the pace of emission reduction by other countries. Non-cooperation by the US increases the costs of decarbonization to the international community and the risk that some countries will abandon their NDC commitments.[591] China has made great headway in adopting renewables, especially in solar, to run the economy, although new coal-fired power plants are still being built. China's Belt and Road initiative now invests more in renewable energy infrastructure than fossil fuel extraction.

There are, however, scalable actions and policy advances that offer hope:

- 30 by 30 marine and terrestrial commitments to conserve 30% of global lands and waters by 2030;
- Blue-economy frameworks promote sustainable use of ocean resources and equitable benefits for coastal communities;
- Fisheries reforms, including improved management, certification, and supply-chain traceability that reduce overfishing and support livelihoods;
- Inclusive approaches to artisanal and small-scale fisheries management to enhance equity and sustainability;
- Expanded adaptation investments and community-level resilience measures to reduce climate risk for ocean-dependent populations; and
- Strengthened ocean-climate governance through the OCCD and UNOC integration with UNFCCC and SDG processes.

11.2 The GOF Ocean and Climate Strategy

Over two decades, GOF's initiatives in advancing the global ocean agenda through policy analyses, multi-stakeholder dialogues, capacity development, and public outreach have been recognized by numerous governments and civil society stakeholders around the world. There is notable opportunity to refocus the strengths and resources of GOF moving forward in parallel with the major global ocean frameworks, including the Sustainable Development Agenda 2030, the UNFCCC Paris Agreement, the GBF, the BBNJ Agreement, the UN Decade of Ocean Science for Sustainable Development, and the UN Decade on Ecosystem Restoration.

A new strategic plan for 2024-2030 has been developed by the GOF Board with advice from eminent experts and leaders in ocean policy and research around the world. In the context of global megatrends, the GOF has prioritized strategies in the focal areas of ocean and climate, ABNJ, ICOM, and blue economy. Leveraging its past initiatives in these areas, GOF will promote an integrated approach that considers the interaction of the ocean with other global systems, such as climate and biodiversity. This harmonization will facilitate the development and implementation of solutions to megatrends that simultaneously target multiple global goals, including the 1.5ºC and 30 by 30 biodiversity targets.

GOF provides a critical platform for bringing together views and perspectives of different stakeholders and enhancing capacity for effective management and protection of marine ecosystems, with a particular focus on developing countries. Past and ongoing efforts by GOF have facilitated the mobilization of high-level political attention on critical ocean and climate issues in the context of the UN climate negotiations, the BBNJ process, and the UN Ocean Conferences, among other UN and international fora, to highlight the critical roles that the ocean plays in these areas. GOF aims to continue fostering discussion and analysis on emerging policy issues and facilitating the development of mechanisms and capacity for cross-sectoral cooperation and collaboration.

GOF strategies for ocean and climate are shown in Figure 26, which include the current state-of-play, highlight salient issues, identify prospective strategies, and define an intended "Future State 2030" for each issue area, which describe what successful implementation of the strategic plan would look like by 2030.

Engagement with youth has been identified as a priority issue area across all four GOF strategic focal areas, including ocean and climate. UNICEF's first child-focused climate risk index estimates that one billion children are at extremely high risk to the impacts of climate change.[592] Youth are also increasingly aware of these impacts and how it will affect their future, with elevated levels of climate anxiety reported by children and young people globally.[593] Young people have routinely been excluded from decision-making at community, national, and international levels.[594] [595] This precedent must shift to ensure that those who will be most impacted by the far-reaching impacts of climate change have an opportunity to propose, develop, and implement the innovative solutions needed to solve the complex climate crisis. In recognition of this, the GOF has prioritized the consultation of youth voices in its program development and initiatives moving forward.

Ocean and Climate

Current State-of-Play 2024: The scientific evidence about the world's ocean is clear. It is at least 70% of the Earth system, a major climate regulator, and is instrumental to attain the goals of the Paris Agreement and the Global Biodiversity Framework (GBF). The international ocean community, composed of Parties and non-Party stakeholders, has been instrumental in raising the profile of the ocean for inclusion within multilateral negotiations on climate change such as the UNFCCC. The ocean-climate nexus was formally recognized in 2019 at UNFCCC COP 25, held in Madrid. It mandated the "Ocean and Climate Change Dialogue", with subsequent ocean mandates being made at COP26, COP27, and COP28. However, additional financing of at least US$1 trillion is needed between now and 2030 to facilitate a rapid transition to achieve ocean-climate solutions. Further investment into capacity building can ensure that developing countries and SIDS have the resources and know-how to address the growing risks and threats to their survival. The impact of climate change on aquatic ecosystems and the services they provide, as well as the livelihoods that depend on them, is expected to intensify in the future as climate-driven shifts in the geographical distribution and changes in the productivity of fish stocks challenge fisheries worldwide. In 2024, we are at a critical point where good intentions and recommendations must begin to translate into tangible actions that will lead to increased ocean-based mitigation and adaptation.

Issue Area	Strategy	Future State 2030
• Mainstreaming ocean-based actions into national commitments	• Assist Parties and non-Party stakeholders in integrating ocean-based mitigation and adaptation action into national, regional, policies, including NDCs and national adaptation plans through information sharing and capacity building	• Ocean-climate components such as mitigation and adaptation action for marine ecosystems are integrated into an increased percentage of NDCs and NAPs
• Integration across policy landscapes	• Development of a multi-actor coalition across international frameworks and United Nations bodies, Parties and non-Party stakeholders to protect and restore the ocean's contributions to climate regulation, human well-being, and planetary health to promote integrated ways of working across policies and conventions informed by the Global Stocktake	• Cooperation across sectors is strengthened with high-level goals of CBD, UNFCCC, BBNJ, and SDG being synergized throughout policy decisions, high-level dialogues, collaborations and outputs
• Integrating climate finance into investment portfolios	• Develop clear guidance on how countries can access financing for ocean-climate initiatives, clearly outlining expectations and application requirements	• Increased developing country access to climate finance facilitated by widely available guidance and increased understanding of the benefits of integrating adaptation and resilience impacts into investment portfolios and of dovetailing EEZ and ABNJ management by financial institutions
• Women and youth-centered capacity building	• Leverage existing strategic educational initiatives to prepare and empower young people, who are the future leaders of global climate and ocean advocacy efforts, and women, who often face higher risks and greater burdens from the impacts of climate change, with knowledge and skills that they need to cope with the impacts of climate, biodiversity, and ocean change	• Women, youth, and marginalized communities are being empowered with knowledge and skills to cope with climate change impacts and lead and influence global climate and ocean advocacy efforts

Working Group members: Matt Frost (Co-Lead), Cristelle Pratt (Co-Lead), Evelia Rivera Arriaga (Co-Lead), Miko Maekawa, Julian Barbiere, Jacqueline McGlade, Andrei Polejack, and Romain Troublé

Figure 26. GOF Strategies for Ocean and Climate

11.3 Key areas for future action

The science is clear. Alarm bells are signaling the rapidly increasing risk of cascading and potentially irreversible Earth-system and ocean changes. Urgent, coordinated global action is required to accelerate decarbonization, cut methane and other short-lived pollutants, scale carbon removal responsibly, expand protections and sustainable ocean management, and mobilize finance and partnerships to implement adaptation and restoration at scale. Building broad coalitions across levels and sectors is essential to turn commitments into measurable, timely outcomes.

This year the COP30 Virtual Ocean Pavilion[596] organizers, GOF, Plymouth Marine Laboratory and Ocean Generation, together with collaborating partners, with input from the wider ocean community, and in close partnership with Communications INC, have issued a set of key messages for the Pavilion attendees to consider, share, and, where possible, act upon based on relevant priority actions emphasized by the COP30 Presidency, UNOC3 Outcomes, 2025 OCCD, and Marrakech Partnership for Global Climate Action Initiatives. These messages contain global priority actions for the way forward.

1. **Stakeholders should recognize the ocean as the greatest ally in climate change; it is at the frontline of climate crisis and a force for climate solutions.** COP30 is being held in the Amazon, a region that serves as a global carbon sink. But ocean ecosystems – from mangroves to the deep sea – are

equally vital to our climate future and integral to achieving the goals of the Paris Agreement. Protecting, sustainably managing, and financing ocean and coastal ecosystems is essential to limit warming to 1.5°C, safeguard biodiversity, support communities, and build climate resilience.

2. **COP30 should accelerate the ocean implementation era.** COP30 will mark the completion of the first full cycle of the Paris Agreement. Implementation must now be the priority. From Blue NDCs and finance to the Ocean Dialogues and adaptation targets, ocean-climate action must move from talk to implementation, with transparency, accountability, and equity at its core.
3. **Youth voices should be placed at the forefront of ocean, climate, and biodiversity initiatives.** Youth and future generations will bear the most significant impacts of climate change. Inclusive implementation processes must be fostered to encourage intergenerational dialogues. The historic lack of transparency and inclusivity in climate negotiations and decision-making processes must be addressed to resolve persistent equity issues. Traditionally underrepresented communities, including youth, must have a seat at the table. Through targeted engagement and partnerships, the VOP is committed to highlighting youth voices this year.
4. **Ocean finance is climate finance and should be scaled up now.** Ocean-based climate solutions remain drastically underfunded. To meet the US$1.3 trillion annual climate finance target, the ocean must be fully integrated into national climate plans, including the Loss and Damage Fund, Article 6 of the Paris Agreement, and the Standing Committee on Finance. COP30 must mobilize finance for ocean action that is nature-positive, people-centered, and science-backed.
5. **Countries should leverage Blue NDCs to accelerate ocean-climate action.** Although ocean-based climate measures remain underrepresented in national climate strategies, the Blue NDC Challenge launched at UNOC3 shows growing momentum for integrating the ocean into climate action. COP30 must accelerate this by urging all countries to include measurable, science-based ocean targets in their 2025 NDCs, co-designed with non-state actors. These include:
    - Sustainably managing, conserving and restoring coastal and marine ecosystems;
    - Scaling up responsible marine renewable energy;
    - Phasing out offshore oil and gas production;
    - Decarbonizing and adapting maritime industries like shipping, coastal tourism, value and supply chains of aquatic food production, and
    - Fostering sustainable, climate-resilient fisheries and aquaculture.
6. **mCDR should not be a distraction from proven ocean-climate solutions.** Unproven mCDR approaches could pose significant risks to biodiversity, global ocean health, and livelihoods. These technologies currently lack sufficient understanding, governance, oversight, and monitoring, and could do more harm than good. The precautionary principle must apply: mCDR approaches should not be considered viable ocean-based climate solutions until their risks are fully understood, regulated, and managed. COP30 must prioritize investment in nature-based, scientifically proven ocean solutions.
7. **The ocean-climate-biodiversity community should jointly support the Ocean Breakthroughs, which chart a clear course to 2030 for nature, climate and people.** The Ocean Breakthroughs present five science-based, achievable tipping points for 2030 to achieve system transformation in the five sectors of marine conservation, offshore renewable energy, sustainable shipping, aquatic food systems, and coastal tourism. COP30 must leverage existing initiatives, united under the umbrella of the Ocean Breakthroughs, to accelerate ocean-based climate action.
8. **A united ocean-climate-biodiversity agenda is essential – and multilateralism is key.** Ocean action cannot be siloed. The ocean creates a "blue thread" across climate and biodiversity agendas and is critical to both the Paris Agreement and the Global Biodiversity Framework. COP30, as a "Nature COP," must build synergies across the UNFCCC, the CBD, and the BBNJ Agreement to advance ocean-based climate action. Aligning goals and indicators, leveraging integrated solutions, and enhancing institutional coordination across these frameworks will establish policy coherence and maximize impact. Strong multilateralism, including support for developing countries and SIDS, is an opportunity to drive collective progress.

9. **National government agencies, intergovernmental organizations, civil society, and other stakeholders should urgently prepare to implement the BBNJ Agreement, a landmark treaty relevant to global climate and ocean governance**. Covering nearly half the planet and home to vast carbon sinks, the high seas are critical to regulating Earth's climate. The BBNJ Agreement represents a historic opportunity to protect these areas and advance ocean-climate action. Now that the Agreement has reached the required threshold of ratifications and will enter into force on 17 January 2026, States and relevant stakeholders must rapidly begin preparation for implementation to unlock the Agreement's full potential for ocean-climate action.

   The BBNJ Agreement enables the creation of marine protected areas and environmental safeguards in ABNJ. By conserving marine biodiversity and protecting carbon-rich ecosystems, it strengthens the ocean's capacity to absorb carbon and buffer climate impacts. COP30 is an opportunity to accelerate the Agreement's entry into force and implementation as a key pillar of global climate action.

10. **A just transition should put coastal communities first.** A just transition should include the ocean and ocean-dependent people as its central components. This means securing food systems, livelihoods, and cultural heritage across coasts, ocean and islands, especially for SIDS, Indigenous Peoples, and local communities. It is important to acknowledge that Indigenous and traditional knowledge makes an important contribution to ocean and climate solutions along with science, as outlined in the BBNJ Agreement, and as promoted by the UNFCCC Local Communities and Indigenous Peoples Platform. COP30 should amplify the leadership of SIDS, Indigenous Peoples and coastal communities and ensure their access to finance, local knowledge, capacity-sharing, and decision-making.

The ROCA Report has always been global in scope, which is one of its greatest strengths and why it continues to be a very valuable product in supporting the overall goal of fully integrating the ocean into the UNFCCC climate change process. The ROCA approach, developing roadmaps for ocean and climate action at regional and local levels, could add considerable value to the application of the report for ocean and coastal communities going forward.

To use the ROCA approach, a regional or local roadmap needs to be developed by first understanding the interconnectedness of the ocean and climate change, then tailoring action plans to the specific needs and challenges of the area. Key steps involve engaging stakeholders, defining concrete actions across mitigation and adaptation, securing financing, developing capacity, and tracking progress, as outlined by ROCA's six major areas: climate regulation, mitigation, adaptation, displacement, financing, and capacity building.

High-level multistakeholder dialogues facilitate collaborations and outputs at the regional, national and subnational levels, to advance synergies in the integrated ocean climate agenda:

NDCs. The OCCD 2025 underscores the urgency of the inclusion of ocean-based mitigation and adaptation measures in the new NDCs for collectively strengthening ocean-based climate ambition. Key recommendations from the Dialogue include, among others:

- Grounding ocean measures in best available science, with increased investment in research and data collection;
- Encouraging regional cooperation to scale climate action;
- Matching Blue finance with ambition for ocean-based climate action in the NDCs; and
- Setting quantified targets by Parties for their ocean-based measures including ocean-related finance, technologies and capacity-building.

Knowledge sharing across regions. GOF can help reinforce existing regional knowledge management and communications by facilitating the sharing of regional success stories of harmonized laws, joint enforcement, and technical exchanges.

Public outreach and environmental education on ocean issues. Examples of viable measures include:

- Visitor centers, guided tours, interpretive signage, and outreach programs in MPAs;
- Aquariums and marine museums, exhibits, and public lectures that translate research into accessible learning experiences;

- Academic and Research Institutions. Community labs, courses that focus on the ocean-climate nexus, and researcher–community exchanges; [597]
- Citizen science platforms — public data-collection initiatives (*e.g.*, beach monitoring, species sightings, water-quality sampling) that engage volunteers and provide real data for research and policy;
- Digital platforms and apps — interactive websites, mobile apps, online courses, webinars, and social-media campaigns that scale outreach and provide educational resources;
- Documentaries, TV series, and podcasts — narrative storytelling that raises awareness, explains science, and motivates action among broad audiences;
- Create visuals that are easily interpreted by the public showing trends in ocean health indicators;
- Regional networks and multistakeholder dialogues that share best practices, success stories, and coordinated outreach strategies across governments;
- Environmental Journals such as Mongabay, that cover conservation issues including coastal and marine resource management;[598] and
- Online news media such as *Climate News*, and newsletters such as the *Nature Briefing*, to report on status and trends in key indicators of ocean health and of climate impacts around the world.

Strengthening governance. Support countries in reinforcing policy, legal, and institutional frameworks to integrate the ocean-climate nexus into national development and climate strategies: 1) Focus on coastal restoration, maritime decarbonization, and climate-resilient fisheries in NDC targets as detailed above; 2) Prioritize the protection of mangroves, seagrasses, and salt marshes for carbon sequestration and climate buffering; 3) Promote climate-smart practices, inclusive governance, and resilient infrastructure; 4) Align fragmented legal regimes across climate, fisheries, conservation, and human rights; 5) Strengthening institutional capacity-building for regional collaboration, awareness campaigns and inclusive governance for equitable participation; and 6) Strengthen monitoring and accountability by developing disaggregated indicators to track ecosystem integrity and connectivity across climate and biodiversity frameworks.

Scaling up finance and equity. Provide assistance to countries through the following strategies: 1) Mobilize accessible finance for ocean-based solutions—especially in developing countries—through nature-based approaches, regenerative seascapes, and community-led initiatives; 2) Help countries access climate finance by building technical expertise, simplifying procedures, and establishing regional advisory hubs; and 3) Advance partnerships like the Blue NDC Challenge to integrate ocean-based solutions into national climate plans. Early adopters (*e.g.*, Australia, Fiji, Kenya) have committed to coastal restoration, marine renewables, and resilient fisheries—unlocking finance, technology, and collaboration.

Driving transformative change. Youth and women are often on the frontlines of climate impacts but sidelined in decision-making. Initiatives to build capacity in these groups are critical to ensure they are not just participants, but leaders in shaping ocean resilience. Initiatives may include:

- Championing Ocean Breakthroughs by promoting scalable, high-impact solutions that combine conservation with community empowerment;
- Ensuring inclusive participation from youth, women's groups, IPLCs, academia, and research institutions to reflect diverse knowledge systems and values; and
- Encouraging regional collaboration and sharing of best practices.

The ocean is no longer a peripheral concern in climate discourse, and is in fact central to resilience, mitigation, and sustainable development. As the last frontier for climate action, the ocean offers untapped potential to buffer climate impacts, store carbon, and support livelihoods. Realizing this potential requires bold, coordinated action across policy, finance, and governance.

We are fast approaching or have exceeded tipping points of key planetary systems responsible for maintaining the ocean's equilibrium and its ability to stabilize the climate and deliver vital services. The signs of system overload are everywhere--a livable future for our children and generations to come is at stake.

A map produced in 2025 by Global Tipping Points[599] clearly demonstrates the central role played by the ocean in how our planet responds to climate change. All five of the Earth Systems that are identified in this map as closest to their tipping points are either ocean specific or ocean related. If AMOC is added to this list (see the red circle added to the map in Figure 27), because it is closely coupled with the SPG, there are six major ocean systems all approaching critical levels in relation to their potential tipping points.

The way forward demands a paradigm shift, one that places protection of the ocean at the heart of climate action. This means scaling up nature-based solutions, securing sustainable finance, strengthening governance, and empowering communities, especially those on the frontlines of climate impacts. It also requires bold international cooperation, science-based decision-making, and inclusive leadership that reflects the voices of youth, Indigenous peoples, and coastal nations.

This situation compels us to act now. COP30 may be our last real opportunity to set the wheels in motion for collective action, the Global Mutirão, to achieve progress at scale. We can no longer afford the luxury of aspirational outcomes. Our focus must be on immediate and near-term actions that will lead to transformational change, using the levers we have of knowledge (science), finance, good governance and the resilience and productivity of healthy natural systems to accelerate this change. Mobilizing the political will of nations to put these levers in motion and galvanizing civil society to pull in concert will be critical.

By incorporating the ocean as a central pillar of climate ambition, we can unlock a virtuous cycle of regeneration where healthier marine ecosystems drive stronger economies, more resilient communities, and a safer climate future for all. COP30 must launch a new era for climate action. We need to shift from promises to action, and the ocean is at the heart of this shift. We must, in the words of André Aranha Correa do Lago, the COP30 President, "transform the narrative... from fear to hope...and build a future not imposed by catastrophe, but designed through cooperation where all nations and communities act together by choice."

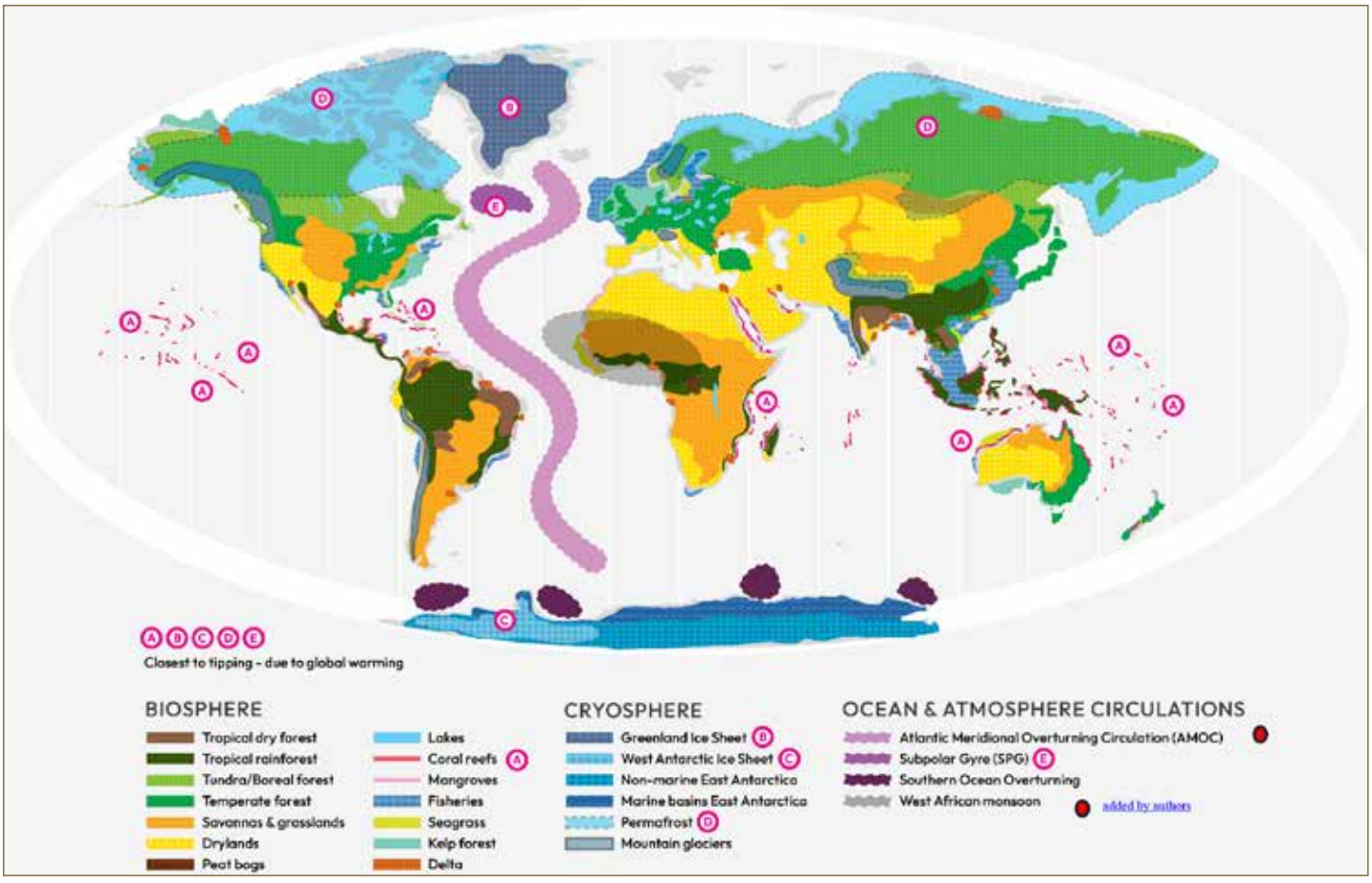

Figure 27. 2025 Global Tipping Points

LIST OF ACRONYMS

ABAS	Antigua and Barbuda Agenda for Small Island Developing States
ABMT	Area-based Management Tool
ABNJ	Areas Beyond National Jurisdiction
AGN	African Group of Negotiators on Climate Change
AHSTAG	Ad Hoc Scientific and Technical Advisory Group
AI	Artificial Intelligence
AMEM	ASEAN Ministers on Energy Meeting
AMOC	Atlantic Meridional Overturning Circulation
AOSIS	Alliance of Small Island States
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
AR	Assessment Reports
ASCC	ASEAN Socio-Cultural Community
ASEAN	Association of South East Asian States
ATS	Arafura and Timor Seas
ATSEF	Arafura and Timor Seas Expert Forum
BAP	Baku Adaptation Plan
BAR	Baku Adaptation Roadmap
BBNJ	Biodiversity Beyond National Jurisdiction
BBNJ Agreement	Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction
BC+	Blue Carbon Plus
BEFF	Blue Economy Finance Forum
CaMPAM	Caribbean Marine Protected Areas Network and Forum
CBD	Convention on Biological Diversity
CBTMT	Capacity Building as well as the Transfer of Marine Technology
CCS	Carbon Capture Sequestration
CDM	Clean Development Mechanism
CEFAS	Centre for Environment, Fisheries, and Aquaculture Science
CH4	Methane
CI	Conservation International
CII	Carbon Intensity Indicator
CITMA	Cuba's Ministry of Science, Technology and Environment
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
COASTAL-NAP	National Adaptation Plan for Coastal Areas
COBSEA	Coordinating Body on the Seas of East Asia
COFI	Committee on Fisheries
CONANP	National Commission for Natural Protected Areas
COP	Conference of the Parties
CO_2	Carbon Dioxide
CSMSP	Climate-smart Marine Spatial Planning
CTCN	Climate Technology Centre and Network
DOALOS	Division for Ocean Affairs and the Law of the Sea
DOCC	Direct Ocean Carbon Capture
DRR	Disaster Risk Reduction
EAF	Ecosystem Approach to Fisheries

EbA	Ecosystem-based Adaptation
EBSAs	Ecologically or Biologically Significant Marine Areas
ECOP	Early Career for Ocean Professionals
EIB	European Investment Bank
EEZ	Exclusive Economic Zone
ENASB-CC	Costa Rica's biodiversity adaptation strategy to climate change
ENSO	El Niño Southern Oscillation
EU	European Union
FAO	Food and Agriculture Organization
FFT	Future Fuels and Technology
FLL	Fuel Lifecycle Label
FOOC	Friends of the Ocean and Climate
GCF	Green Climate Fund
GCRMN	Global Coral Reef Monitoring Network
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFCR	Global Fund for Coral Reefs
GFI	GHG fuel Intensity
GHG	Greenhouse Gases
GGA	Global Goal on Adaptation
GOAP	Global Ocean Accounts Partnership
GOA-ON	Global Ocean Acidification Observing Network
GOCIB	Ghana Ocean-Climate Innovations Hub
GOF	Global Ocean Forum
GoM-LME	Gulf of Mexico Large Marine Ecosystem
GSA	Guidelines for Sustainable Aquaculture
GST	Global Stocktake
IAP	Institute of Atmospheric Physics
ICJ	International Court of Justice
ICOM	Integrated Coastal and Ocean Management
ICP	Informal Consultative Process on Oceans and the Law of the Sea
ICRI	International Coral Reef Initiative
ICSP	Informal Consultations of States Parties
ICZM	Integrated Coastal Zone Management
IFB	Legal instruments and frameworks and global, regional, subregional, and sectoral bodies
IFI	International Financial Institutions
IMO	International Maritime Organization
IMTA	Integrated Multitrophic Aquaculture
IOC	Intergovernmental Oceanographic Commission
IOC ODC Center	The IOC Regional Training and Research Center on Ocean Dynamics
IOI	International Ocean Institute
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPLC	Indigenous Peoples and Local Communities
IRENA	International Renewable Energy Agency
ISA	International Seabed Authority
ITLOS	International Tribunal for the Law of the Sea

ITMO	Internationally Transferred Mitigation Outcome
IWECo	Integrating Water, Land, and Ecosystems
JBE	Japan Blue Economy
KD-MECC	Kampala Ministerial Declaration on Migration, Environment and Climate Change
GBF	Kunming-Montreal Global Biodiversity Framework
LBS	Land-Based Sources
LCA Guidelines	Guidelines on Life cycle GHG intensity of marine fuels
LDC	Least Developed Countries
London Protocol	Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
MARPOL	International Convention for the Prevention of Pollution from Ships
MEPC	Marine Environment Protection Committee
mCDR	Marine Carbon Dioxide Removal
MOI	Means of Implementation
MOU	Memorandum of Understanding
MPA	Marine Protected Areas
MRV	Measurement, Reporting and Verification
MSL	Mean Sea Level
MSP	Marine Spatial Planning
MTCO	Million tons of carbon dioxide
MWP	Model Wealth Portfolios
NAP	National Adaptation Plans
NAPCC	National Action Plan on Climate Change
NAFCC	National Adaptation Fund for Climate Change
NbS	Nature-based Solutions
NBSAPs	National Biodiversity Strategies and Action Plans
NCQG	New Collective Quantified Goal on Climate Finance
NDC	Nationally Determined Contributions
NGO	Non-governmental Organization
NORAD	Norwegian Agency for Development Cooperation
NO_2	Nitrous Oxide
NVC	Nonviolent Communication
OA Alliance	Ocean Acidification Alliance
OAD	Official Development Assistance
OARS	Ocean Acidification for Sustainable Research
OCCS	Onboard Carbon Capture and Storage
OECD	Organization for Economic Co-operation and Development
OIP	Ocean Investment Protocol
ORCA	Ocean Resilience and Climate Alliance
ORRAA	Ocean Risk and Resilience Action Alliance
OSS	Ocean and Society Survey
OTP	Ocean Tourism Pact
PB	Planetary Boundaries
PBScience	Planetary Boundaries Science
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PIF	Pacific Islands Forum
PI-TOA	Pacific Islands and Territories OA Hub

PPP	Public-private Partnerships
PrepCom	Preparatory Commission
RFB	Regional Fishery Body
RFMO	Regional Fisheries Management Organizations
ROCA	Roadmap to Ocean and Climate Action
RSO	Regional Seas Organizations
SAA	Sharm el-Sheikh Adaptation Agenda
SBEP	Sustainable Blue Economy Partnership
SBI	Subsidiary Body on Implementation
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice
SBSTA	Subsidiary Body for Scientific and Technological Advice
SBTN	Science Based Targets Networks
SCF	Supply Chain Finance
SCCF	Special Climate Change Fund
SDG	Sustainable Development Goal
SD VISta	Sustainable Development Verified Impact Standard
SEEMP	Ship Energy Efficiency Management Plan
SEMARNAT	Mexico's Environmental Ministry
SFCS	Sustainable Fuel Certification Schemes
SIDS	Small Island Developing States
SLR	Sea Level Rise
SOI	Sustainable Ocean Initiative
SOPs	Sustainable Ocean Plans
SPARKS	Singapore-Pacific Resilience and Knowledge Sharing
SST	Sea Surface Temperatures
SPAW	Specifically Protected Areas and Wildlife
TEC	Technical Executive Committee
TNC	The Nature Conservancy
UNCDF	United Nations Capital Development Fund
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNOC	United Nations Ocean Conference
UK	United Kingdom
UNOPS	United Nations Office for Project Services
WBG	World Bank Group
WMO	World Meteorological Organization
VNR	Voluntary National Reviews
VOP	Virtual Ocean Pavilion
ZJ	Zettajoules
1000OS	1000 Ocean Startups

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ANNEX I

Regional Developments in Latin America

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Introduction

Latin America is home to six of the world's most biodiverse countries, which together harbor 70% of all mammals, birds, reptiles, amphibians, plants, and insect species. The region contains 40% of global biodiversity and over 25% of the world's forests, while the Caribbean alone hosts 50% of plant species found nowhere else on Earth. Coastal and marine ecosystems span approximately 16 million square kilometers and more than 70,000 kilometers of coastline. Despite contributing only 10% of global greenhouse gas emissions, Latin America and the Caribbean already bear some of the worst impacts of global warming. Cyclones, hurricanes, floods, droughts, rising sea levels, and glacier loss are increasingly triggering migration and endangering millions of lives across urban, rural, and coastal areas. Climate change also threatens basic infrastructure, clean water supply, food production, and electricity generation, jeopardizing livelihoods and basic services. Economic loss and damage from these events can exceed 2% of annual GDP. From 1998 to 2020, climate-related disasters claimed over 312,000 lives and affected more than 277 million people in the region.[600] In 2024, the region experienced significant climate impacts and extreme weather events—including droughts, floods, and wildfires—that disrupted lives, livelihoods, and food supply chains. Coastal communities and ecosystems face particular threats from sea level rise, ocean warming, and acidification in both the Pacific and Atlantic Ocean.[601]

Among the 19 continental Latin American countries, seven have access to both the Pacific and Atlantic coasts, four are exclusively Pacific, and eight are solely Atlantic. All Caribbean island nations and territories lie

within Atlantic waters. The size and morphology of each country—especially their longitudinal span—determine their vulnerability to oceanic phenomena and climate variability. The increasing frequency and intensity of tropical, subtropical, and extratropical weather systems have significant consequences for public safety, infrastructure, the economy, and agriculture. From 1991 to 2020, the Atlantic averaged 14 named tropical systems per year, while the Eastern Pacific averaged 15.[602] South American countries are less prone to direct impacts but are not immune, and climate change may shift these patterns. For example, the South Atlantic has seen rare systems such as Catarina (2004), Iba (2019), Raoni (2023), and Akará (2024), which originated as subtropical systems.[603]

The average size of a cyclone—measured as the mean distance from the eye to the outermost closed isobar—is 333 kilometers in the Atlantic and 489 kilometers in the Pacific. "Very large" cyclones can exceed 888 kilometers in radius, with the largest on record being Typhoon Tip (1979), which had a diameter of 2,200 kilometers in the Pacific. Among continental Latin American countries and Cuba, seven (35%) have maximum longitudinal dimensions greater than 1,000 kilometers, while 13 (65%) have extensions of less than 500 kilometers, making them especially vulnerable to cyclonic effects. Caribbean island nations and territories, due to their small size, are even more exposed.

Central America Regional Climate Projections

Mean temperatures are rising across the region, with inland areas experiencing greater warming. Under RCP 8.5, temperatures are projected to increase by 1.5–2°C (low estimate) or 2–3°C (high estimate) by mid-century (2041–2070) under high-end climate change. Coastal regions may see over 100–200 days per year with temperatures exceeding 35°C, with some inland areas approaching 200 such days. Precipitation trends are more complex: the low estimate predicts decreases of 5–25% by mid-century, while the high estimate suggests minor increases of 5–10% in many regions. Some inland areas of Mexico, Guatemala, and Honduras may still see small declines in precipitation under the high estimate. The number of rainy days is projected to decrease across most areas, with little change (fewer than five days) even under the high estimate. Sea levels are rising throughout the region, with increases of 40–45 centimeters expected under high-end scenarios by mid-century. Sea surface temperatures in the Mesoamerican Reef region are projected to rise by 1.5–2°C or more by mid-century, and by over 2–4°C by the end of the century. Ocean acidification is also increasing, with pH declines of 0.14–0.16 by mid-century and 0.25–0.27 by the end of the century. These changes represent a significant increase in acidity, with potential impacts on coral reefs and calcifying organisms.[604]

According to the Global Ocean Accounts Partnership (GOAP),[605] ocean accounts are integrated records of regularly compiled, comparable data describing ocean environmental conditions, economic activities, and social factors. A literature review and interviews with experts highlight progress and future opportunities for ocean accounting in Latin America and the Caribbean. Key findings include that only Guatemala has a SEEA-CF fisheries account; Colombia has a SEEA-EA ocean-related account; and Costa Rica, Belize, Barbados, and Ecuador are planning or developing such accounts. Brazil and Peru are working on ocean economy accounts. Other initiatives are underway in the Caribbean, though not all are publicly accessible. Some regional ocean accounts developed by non-governmental actors are not used by governments due to lack of awareness. Knowledge of environmental economic accounting methodologies varies widely across Latin America (from basic to advanced) and is limited in the Caribbean (from limited to none). At least half of the countries surveyed expressed interest in developing ocean accounts, with some seeking practical guidance. Many have attempted to implement accounts but have faced challenges due to technical expertise gaps. Others are undergoing government transitions or drafting new ocean policies and wish to address data gaps in ocean policy development. Key limitations include data quality and availability, political and policy understanding, technical capacity (especially in Central America and the Caribbean), and the need for data governance frameworks and technical training.[606]

Cavazos *et al.*[607] note that the recent 2019–2023 La Niña events brought extremely wet summer conditions to Central America, as expected. The 2023 El Niño, forecast to produce drier conditions, instead led to atypically wet conditions in some areas due to unusually warm Caribbean and Atlantic Ocean.

South America Region

South America is highly vulnerable to climate change due to its geographic diversity, ecosystems, and concentration of populations in coastal areas. Regional sea levels have risen faster than the global average over the past three decades, especially in the South Atlantic (3.52 ± 0.0 millimeters per year) and subtropical North Atlantic

(3.48 ± 0.1 millimeters per year). This threatens coastal populations through freshwater aquifer contamination and increased storm surge risk. According to the IPCC's AR6, continued SLR will contribute to coastal flooding and shoreline retreat along South America's Atlantic coasts. Highly vulnerable cities include Fortaleza, Rio de Janeiro, São Paulo, and Porto Alegre (Brazil), Buenos Aires (Argentina), Santiago (Chile), and Lima (Peru).[608 609]

Cavazos *et al.*[610] state that current vulnerabilities and climate impact drivers in Latin America and the Caribbean are diverse, complex, and region-specific, with effects expected to worsen due to climate change. However, progress on regional and domestic climate agendas is hindered by scientific gaps, lack of political support, institutional capacity, and financial, technical, human, and economic limitations common in many Latin American and Caribbean countries. Transforming climate data into multidimensional metrics with useful thresholds for different sectors and developing feasible adaptation strategies are delayed by issues, such as lack of inclusive governance, data availability, equity and justice, and transboundary disputes. The three consecutive La Niña events of 2019–2023 have been linked to drought in central South America (Argentina, Brazil, Uruguay, Paraguay, and Bolivia). According to the World Weather Attribution team, the severity of the 2023 droughts in the Amazon basin, affecting several countries, was entirely due to increased global temperatures, not the 2023 El Niño event. The droughts in Argentina and Brazil were the world's third-largest natural disaster in 2023, with US$16.4 billion in economic losses, followed by Hurricane Otis in Mexico in fourth place.

Argentina

A preliminary assessment of Argentina's progress in ocean and climate policies since COP28 in Dubai shows that limited advancements recorded in previous regulations, actions, and participation[611 612] have been significantly hindered by the new national government, which denies climate change and its effects. Among its first actions, the government downgraded the Ministry of Environment and Sustainable Development to a secretariat and dismantled the National Administration of Protected Areas.

In addition, the government has reduced and devalued Argentina's entire scientific system—the main engine of basic and applied research, especially in environmental, oceanic, and climate studies.[613] In 2024, state investment in science and technology was cut by 31.3%, resulting in the suspension of payments for science and technology research projects, which are fundamental to Argentina's scientific development. This led to the loss of entire research lines, representing a severe setback for the country's scientific system.

The government has also shown ambiguity regarding the energy transition. While it promotes renewable energies such as solar, wind, wave, and green hydrogen, it insists that the transition cannot occur without first exploiting hydrocarbon reserves, with significant investments in this sector.[614] In this context, the challenges of generating proactive rather than reactive policies and actions for the ocean and climate are growing, highlighting the need for greater social participation to restore the previously established path to sustainability.[615]

These issues are even more pressing given the increasing complexity of environmental problems worldwide, with consolidated environmental risks and disasters now presenting tangible and undeniable consequences. The interconnectedness of processes, decisions, and social and economic pressures demands globally informed policies based on scientific knowledge.[616 617] In Argentina, coastal areas have experienced significant littoralization due to urbanization, port expansion, and tourism,[618 619 620] often without adequate consideration of climate threats and their potential negative impacts on infrastructure, services, and the economy.

Belize

Mean temperatures are rising across Belize.[621] Under RCP 8.5, areas of interest in Belize are projected to experience increases of approximately 1.5–2.0°C (low estimate) and 2.5–3.0°C (high estimate) by mid-century. The total number of days with temperatures exceeding 35°C in the project area is expected to reach up to 100 per year under the low estimate, with some coastal areas experiencing fewer such days. Under the high estimate, the distribution of extreme heat days remains similar, with the total number ranging from approximately 50 to 150 days per year.

Precipitation is projected to decrease significantly under the low estimate, with the possibility of smaller increases in northern zones under the high estimate. The low estimate indicates precipitation declines of around 10–25% across all zones, while the high estimate suggests possible increases of 5–10% in northern zones and smaller, mixed changes in the southern zone. The number of rainy days is also expected to decline compared to the baseline under high-end climate change scenarios. The low estimate projects a decrease

of 15–30 rainy days per year, whereas the high estimate shows very little change (fewer than five days in either direction) across all zones in Belize.

Sea levels are rising in the Mesoamerican Reef region. In Belize, by the 2050s, SLR is projected to be around 20 centimeters under the low estimate and just over 40 centimeters under the high estimate.[622]

Brazil

Brazil's vast coastline and diverse marine ecosystems are highly vulnerable to the escalating effects of climate change. Recent research and observations highlight several key developments:

1. Rising Temperatures and Ocean Acidification: Sea surface temperatures in Brazil are projected to increase significantly, potentially by 1.5°C by 2050 under a high-carbon scenario.[623] This warming intensifies ocean acidification, reducing oxygen levels and altering the impacts of pollutants.[624] Coral reefs, like those in the Abrolhos Archipelago, are already experiencing bleaching and high mortality due to thermal stress.[625] [626] [627] [628]

2. SLR and Coastal Vulnerability: Sea levels along the Brazilian coast have already risen 9 centimeter in the last 30 years and could increase by up to 80 centimeter by the end of the century.[629] This poses an imminent threat to major coastal cities such as Fortaleza, Salvador, Recife, Rio de Janeiro, São Luís, Santos, and Porto Alegre, which could be partially or completely submerged.[630] Coastal erosion, intensified by SLR and more extreme weather, is causing chaos for Brazil's economy, with potential GDP losses of around 7% by 2100 in a high-emissions pathway.[631] Vulnerability assessments, like those for Niterói (Rio de Janeiro) and Santos (São Paulo), confirm that low-lying coastal areas and urban infrastructure are highly susceptible to SLR and extreme rainfall events.[632] [633] [634]

3. Impacts on Marine Biodiversity and Fisheries: Widespread changes attributed to global warming are observed in virtually the entire EEZ of Brazil.[635] Ocean warming, SLR, and changes in ocean circulation, stratification, and acidity are impacting fisheries and aquaculture. For instance, shrimp and mullet fisheries in Southern Brazil have already experienced significant economic losses.[636] Species distribution is shifting, with some species moving to cooler, deeper waters (*e.g.*, Brazilian sardine) and others migrating to warmer areas (*e.g.*, squid).[637] The decline in populations of key species, such as blue wrasses in Abrolhos, highlights the urgency of conservation efforts.[638]

4. Adaptation and Policy Responses: Brazil is actively working on strengthening its climate change adaptation agenda, with projects like "PROADAPTA" supporting key policy instruments like NDCs and the NAPs.[639] There is a growing focus on urban resilience in smart cities and exploring adaptation and mitigation strategies, though challenges remain in developing nations.[640] Coastal protection measures, such as beach nourishment and the exploration of artificial reefs, are being implemented or studied in areas like Copacabana and Balneário Camboriú.[641] Brazil recognizes the need for a new approach to "climate mobility" due to increasing displacement from extreme weather events, and there are calls for a national strategy and updated adaptation plans.[642] Research on "blue carbon" ecosystems (mangroves, salt marshes, seagrass meadows) highlights their potential for climate change mitigation through carbon sequestration, emphasizing the urgent need for their conservation and restoration in Brazil.[643] Brazil is also participating in regional networks like REMARCO to investigate and diagnose the effects of marine-coastal damage, including microplastic contamination and harmful algal blooms, to inform public policies.[644]

These developments underscore the critical need for continued research, robust adaptation strategies, and effective policy implementation to safeguard Brazil's coastal communities and marine ecosystems from the escalating impacts of climate change.

Chile

Chile, with its extensive coastline, is highly vulnerable to the impacts of climate change on its ocean and coasts. Recent developments highlight a combination of ongoing environmental changes, their consequences, and the country's efforts towards adaptation.[645]

Coastal Erosion and Extreme Events:

- *Intensifying Sea Swells:* A UC Chile study (published April 2025) links excessive urbanization, beach loss, and rising sea swell intensity. Waves reaching up to 11 meters are accelerating coastal erosion, with 86% of beaches between Arica and Puerto Montt shrinking. In extreme cases, erosion exceeds five meters annually in popular tourist destinations like Algarrobo and Santo Domingo. This research was among the first to directly link sea swells and beach erosion in Chile, showing that urban beaches can disappear rapidly.[646]
- *Increased Frequency of Threats:* Coastal areas in Chile now require rebuilding approximately every two years due to recurring threats.[647]

- *Need for Sea Swell Typology:* Researchers are studying sea swell typologies to better predict and prepare for extreme events, categorized similarly to tsunamis.[648]
- *Impact of El Niño:* El Niño events, while natural, are exacerbated by climate change. They contribute to extreme fire weather conditions, prolonged droughts, and changes in rainfall patterns (increased rainfall in central Chile and decreased in other regions). This can impact water availability and biodiversity.[649]

The IPCC's AR6[650] projects continued SLR for Chile, ranging from 0.2 meters to 0.4 meters by the end of the century under a low-emissions scenario and 0.3 meters to 0.6 meters under a high-emissions scenario (compared to 1995-2014 baseline). By 2050, Chile could see a tenfold increase in flooding compared to the past decade. By the end of the century, Chile will likely experience over 100 days of flooding annually across all future scenarios if no additional protections are implemented.[651] [652]

Moreover, a Chilean Environment Ministry study found that 28 out of 35 beaches are already experiencing erosion, and some energy infrastructure (substations, power plants, fossil fuel distribution centers) could be exposed to floods by 2045 due to low elevation and coastal proximity.[653]

The IPCC reports that Chile's coastal areas are experiencing ocean acidification, which threatens the growth and reproduction of aquatic organisms and the abundance and distribution of marine resources. Artisanal fishers and small-scale fish farmers are directly affected by environmental changes impacting species availability and abundance. Studies show that ocean acidification, combined with other factors like "red tide" (harmful algal blooms), negatively impacts commercially important shellfish like mussels, potentially affecting exports and the socio-economic development of southern Chile.[654] Chilean scientists are actively researching and monitoring ocean acidity, noting that during certain periods, chemical conditions decrease calcium carbonate in the water, which bivalve shellfish need for their shells.[655]

Chile is a founding member of the International Alliance to Combat Ocean Acidification, demonstrating commitment to partnerships, sharing best practices, and developing local adaptation actions.[656] Chile has approved its National Climate Change Adaptation Plan, a key roadmap to strengthen the country's resilience and reduce future climate risks. This plan, designed within the framework of the Climate Change Law (effective 2022), aims to integrate adaptation into public policies, build capacity, incorporate adaptation into public projects, reduce vulnerability of communities and ecosystems (including nature-based solutions like wetland restoration), generate knowledge, and establish early warning systems. This law sets a goal of carbon neutrality and climate resilience by 2050, encouraging adaptation measures at municipal levels.[657] [658]

Research highlights the importance of informed decision-making, community cooperation, and ancestral knowledge in promoting adaptive strategies based on community solidarity. Local communities are developing adaptive strategies, such as shifting fishing grounds or target species.[659]

The mining industry, highly sensitive to water scarcity, is increasingly using desalinated water or direct saltwater in its operations. There is a push for diversified energy sources like solar and wind to enhance climate resilience.[660]

In summary, Chile is facing significant challenges from climate change on its ocean and coasts, including accelerating erosion, rising sea levels, and ocean acidification. In response, the country is implementing NAPs, fostering scientific research, and promoting community-level strategies, while also exploring technological solutions to build resilience.

Colombia

Colombia, has a maritime area of 928,660 square kilometers, and 4,171 kilometers of coastline,[661] (2,582 kilometers in the Caribbean, and 1,589 kilometers in the Pacific,)[662] [663] representing 44.86% of its national territory, and has reinforced its commitment to environmental sustainability and climate change mitigation.
The country has achieved significant progress in the conservation of marine, coastal, and oceanic spaces through the implementation of two coastal environmental policies[664] [665] and a Bioceanic CONPES.[666] These efforts are complemented by the expansion of the MPA system, which now covers 37.6% of Colombian marine territory, totaling 34,948,444 hectares, and strengthening of marine governance strategies. This progress has allowed the country to surpass the global conservation target set by the CBD, which aims to protect 30% of marine territory by 2030.

The country has also promoted initiatives for the restoration of strategic ecosystems. Through the "Restoring One Million Corals for Colombia" program, 200 hectares of coral reefs have been restored with an investment of 8,450 million pesos.[667] Mangroves,

covering a total of 280,000 hectares in Colombia, have been the focus of conservation programs as they play a fundamental role in blue carbon capture and protection against coastal erosion. Of this coverage, 71.4% is in the Pacific region and 28.6% is in the Caribbean.

Despite these achievements, challenges remain regarding the implementation of effective management plans in these areas. Insufficient funding, combined with the jurisdictional complexity of some protected areas, has hindered the execution of monitoring and control strategies. In the Colombian Caribbean in particular, tensions arising from the ICJ ruling on the San Andrés and Providencia archipelago have created uncertainty in the administration of certain marine spaces, particularly concerning local communities' fishing rights.

Twenty-nine percent of the country's coral reefs still require intervention for their recovery due to climate change, overfishing, and sedimentation.[668] It is estimated that 30% of fishing in Colombia comes from unregulated practices, negatively impacting the sustainability of commercial fish populations.

Climate change continues to be a significant challenge for the country's marine and coastal areas. Over the past decade, sea level has risen at a rate of 3.5 millimeters per year in the Caribbean region and 5.2 millimeters per year in the Pacific region. These increases have intensified coastal erosion and posed risks to the stability of vulnerable coastal and island communities.

Another key challenge is marine pollution management. It is estimated that 80% of waste reaching the ocean originates from land-based sources, primarily due to inadequate sanitation infrastructure in coastal municipalities. Currently, less than 30% of the coastal population has access to proper wastewater treatment systems, posing a threat to both marine biodiversity and local community health. While regulations have been implemented to reduce single-use plastics and improve urban waste management, further investment in infrastructure and environmental awareness campaigns is necessary to mitigate this issue.

Colombia faces various challenges and opportunities for the sustainable management of its coasts and marine spaces. The nine most critical aspects are:

1. *Coastal Erosion:* Coastal erosion is a significant problem in Colombia, with vulnerable areas identified that require attention to protect coastal infrastructure and ecosystems.
2. *Coastal Infrastructure Projects:* Projects must be developed to improve and protect coastal areas.
3. *Offshore Wind Energy and Blue Economy:* The blue economy has gained importance in recent years, representing approximately 6% of the national GDP. Colombia is exploring the potential of offshore wind energy, particularly in the La Guajira region, with pilot projects in wind and wave energy. Companies such as Bluefloat Energy and Gercol Renovable SAS are developing offshore wind farm projects that could significantly contribute to improving the country's energy matrix and reducing dependence on fossil fuels in coastal activities.
4. *The Need for a Coastal Law:* There is a national debate on the need for specific legislation for Colombian coasts. Some experts suggest that a coastal law could be essential for the sustainable management of the country's marine and coastal resources.
5. *Strengthening Governance*
6. *Improving Financing*
7. *Promoting Sustainable Tourism:* Initiatives aimed at generating income through ecotourism in marine protected areas without compromising biodiversity.
8. *Strengthening Fishing Regulations:* Banning shark fishing in the Caribbean and restricting shark fin trade, as well as improving cooperation agreements with the eight countries with which Colombia shares maritime borders to enhance surveillance and control of illegal fishing in international waters, will strengthen fishing regulations.
9. *Encouraging Community Participation:* The active participation of coastal communities in marine resource management will enable Colombia to continue consolidating a sustainable management model for its seas and coasts, ensuring biodiversity conservation and ecosystem resilience in the face of future environmental challenges as a Bioceanic country.

Costa Rica

Costa Rica is a maritime country, with 92% of its total surface area consisting of sea. Since 2021, it has expanded its MPAs to cover 30% of its maritime territory.[669] The country has developed several key policy instruments, including the National Strategy for the Integrated Management of its Coastal Marine Resources,[670] the National Marine Policy 2012–2027,[671] the National Climate Change Strategy,[672] and the National Strategy for Adaptation of Biodiversity to Climate Change, which is incorporated into the National Policy on Adaptation to Climate Change 2018–2030.[673]

Costa Rica's mitigation strategy focuses on reducing

GHG emissions and increasing carbon sinks to achieve net-zero emissions by 2050. The country implements these measures through its National Decarbonization Plan[674] and its NDC.

Costa Rica's biodiversity adaptation strategy to climate change (ENASB-CC) aims to strengthen the resilience of biodiversity to the adverse effects of climate change. This is achieved through ten strategic guidelines, including the management of protected areas and biological corridors, the integration of biodiversity into territorial planning, and climate change knowledge management. Costa Rica is home to 3.5% of the world's marine biodiversity.[675] Among its efforts, the National Climate Change Adaptation Plan (2022–2026)[676] serves as a key instrument for climate change adaptation, with the ENASB-CC (2015–2025) forming a core part of this plan and contributing to national resilience.

Furthermore, the National Strategy for Blue Carbon[677] is a significant step toward fostering the institutional and stakeholder coordination needed to effectively conserve and restore wetlands. This strategy promotes the conservation and restoration of marine and coastal ecosystems and finances regional projects, such as the Action Plan for Climate Change Adaptation in the Central Region, which includes marine initiatives.

Costa Rica is also developing a roadmap for a National Blue Economy Strategy in collaboration with partners from the private and public sectors, particularly with the British government. Efforts are focused on the sustainable use of marine and coastal resources to drive economic and social development while protecting the environment. This initiative includes the creation of a Blue Fund, which will support productive activities associated with the blue economy on a sustainable basis, ensuring the continued existence of these income sources over time.

Additionally, through Executive Decree No. 44558-MINAE,[678] the country amended the General Forestry Law to introduce payments for environmental services from mangrove forests, including the sustainable use of mollusks and other ecosystem services. This also includes the implementation of an operating manual for a pilot program.

Cuba

The Republic of Cuba has demonstrated a strong commitment to combating climate change and ensuring the sustainability of the ocean, aligning itself with the SDGs and international agreements such as the Paris Agreement. As an island nation, Cuba implemented the State Plan for Addressing Climate Change.[679] It has completed its NDC 3.0,[680] and submitted national reports on climate change, highlighting vulnerabilities and adaptation strategies.[681] [682] [683]

The Ministry of Science, Technology and Environment (CITMA), the governing body for natural resources and the environment, has reported observed changes in climate variation, projecting a hotter, drier, and more extreme climate by the end of the 21st century. Specifically, the Cuban archipelago is expected to experience an increase in annual air temperature of more than 1.0°C by 2030 and 3.5°C by 2070, compared to the reference period 1961–1990. Rainfall during the rainy season is projected to decrease by nearly 10%, and sea level is expected to rise by 29.3 centimeter by 2050 and 95.0 centimeter by 2100.[684]

Since the adoption of the 2019 Constitution, more than 11 pieces of legislation have addressed the regulation of climate change impacts on society. Notable among these are the environmental framework legislation, Law 150/2022 "On the System of Natural Resources and the Environment," Decree 86/2023 "On Addressing Climate Change," Decree-Law 77/2023 "On Coasts," and Decree 97/2023, which regulates Decree-Law 77 "On Coasts."[685] [686] [687] [688] [689] [690]

The integration of scientific research into decision-making to address climate change has been a hallmark of Cuban policy. Among national science, technology, and innovation programs, the Program for Adaptation and Mitigation of Climate Change[691] [692] stands out. This program aligns with the strategic axis of natural resources and the environment in the National Socioeconomic Development Plan 2030[693] and aims to generate new knowledge and solutions to the climate challenges facing the country. Numerous projects have been developed, both nationally and internationally, focusing on climate change adaptation in vulnerable areas, strengthening resilience in coastal communities, promoting renewable energy, and increasing energy efficiency.[694] [695] [696] [697] [698] As part of related public policies, the first stage of the strategy for the transition to a circular economy was completed in 2023.[699]

The Cuban state has also prioritized the promotion and development of scientific training and pre and postgraduate education throughout the country's educational system.[700] [701] These efforts have influenced all public and private organizations and society as a whole, focusing on climate change mitigation and adaptation actions.[702] [703]

Decree-Law 77/2023 legally defines coastal resilience, underpinning all actions aimed at protecting vulnerable coastal areas, restoring mangroves and coral reefs, promoting climate-adapted sustainable agriculture, and reducing emissions in key sectors.[704] Notably, Cuba is working to integrate legal, institutional, and regulatory subsystems, and has defined integrated coastal management as a tool for the conservation and care of coastal marine ecosystems, incorporating new paradigms such as EbA and Community-Based Adaptation. This management approach involves the integration of all levels of government, with special emphasis on municipalities, where key actors in sustainable territorial development collaborate to address the effects of climate change.

For Cuba, overcoming challenges such as securing external financing, fostering technological innovation, strengthening institutions, and ensuring adaptive governance are critical for addressing the challenges posed by climate change as an island nation.

Ecuador

Ecuador's coastal and marine environments are increasingly affected by the impacts of climate change. Recent scientific research and international projects have highlighted the country's vulnerability to SLR, extreme weather events, ocean warming, and ecosystem degradation.

The observed climate impacts in the country's coastal and marine zones are the following:

- *Temperature and SLR:* Ecuador has experienced an average temperature increase of 1.4°C, with the Galapagos Islands particularly affected (maximum temperatures up by 1.0°C, minimum by 1.1°C). SLR is causing coastal retreat, increased flooding, and salinization of aquifers and river mouths, with projections indicating further intensification of these phenomena.[705]
- *Extreme Events:* The coastal regions are facing more frequent and severe El Niño events, such as the extreme coastal El Niño in early 2023, which led to devastating rainfall, flooding, and public health crises, including record dengue outbreaks. These events are linked to complex ocean-atmosphere interactions, including suppressed upwelling and positive feedback between coastal warming and atmospheric convection.[706]
- *Ocean Acidification and Warming:* Increased ocean temperatures and acidification are threatening marine biodiversity and fisheries, particularly in the Galapagos Marine Reserve, a region highly sensitive to climate variability.[707] [708]

Ecuador's coastal ecosystems responses and adaptation to climate change effects can be summarized as follows:

- *Mangrove Conservation and Restoration:* Mangroves are vital for coastal protection and climate mitigation, however, they are under threat from deforestation, mainly due to shrimp farming. Recent projects, such as the "Mangroves for Climate" initiative, are engaging public, private, and community stakeholders in restoring and sustainably managing mangrove ecosystems. These efforts aim to enhance resilience, improve fisheries, and reduce flood risks through community-based management and results-based payments for sustainable aquaculture practices.[709] [710]
- *Water Governance and Climate Adaptation:* Climate change has affected water resources through glacier melt and irregular rainfall, impacting agriculture, energy, and drinking water supplies. The "Adapting to Climate Change through Effective Water Governance in Ecuador" project focuses on increasing adaptive capacity in water management by integrating climate risk into national and local plans, promoting innovation, and improving access to climate data.[711]
- *Galapagos Islands as a Natural Laboratory:* The Galapagos archipelago, recognized as Ecuador's most vulnerable region, is the focus of international research agendas for climate change adaptation and mitigation. Despite its significance, many ecological processes remain understudied, and there is a pressing need for more science-based adaptation strategies.[712]

The recent scientific and policy advances in Ecuador are:

- *Dynamic Downscaling and Modeling:* Recent research has applied dynamic downscaling to better understand regional precipitation and temperature trends, revealing spatially varied changes along the coast and highlighting the importance of localized adaptation measures.[713]
- *Legal and Institutional Frameworks:* Ecuador is integrating climate adaptation into coastal management, with new policies emphasizing ecosystem-based approaches and community participation.[714]
- *Community Engagement and Resilience:* Projects are increasingly involving local communities

in decision-making, recognizing their role in managing natural resources and implementing adaptation solutions.[715]

Ecuador's coasts and ocean are at the forefront of climate change impacts, facing rising temperatures, sea level, and extreme events. Scientific advances and policy initiatives are increasingly focused on ecosystem restoration (notably mangroves), improved water governance, and community resilience. The Galapagos Islands remain a priority for research and adaptation, given their global ecological importance and vulnerability. Continued integration of science, policy, and local action is essential for building resilience in Ecuador's coastal and marine environments.

Guatemala

The mean temperature is increasing across Guatemala. This increase is projected to be approximately 2°C in many areas under the low estimate (25th percentile), with the central regions of the country expected to warm slightly more. Under the high estimate, most areas are projected to see increases of at least 2.5°C, with many regions reaching up to 3°C of warming. The number of extreme heat days (over 35°C) per year varies across Guatemala, with some central and inland regions experiencing the highest frequency. The total number of days exceeding 35°C in a year ranges from about 50 to over 150 under the low estimate for RCP 8.5 by mid-century. Under the high estimate, many parts of the region could experience more than 150 days, with some northern inland areas seeing up to 200 days or more above 35°C.

Precipitation is projected to decrease significantly under the low estimate across Guatemala, with the possibility of a slight increase in the coastal protected area under the high estimate. The low estimate indicates precipitation declines of around 10–25% across the region, while the high estimate suggests slight increases of less than 10% in coastal Guatemala, and even potential drying in northern inland areas. There is also a projected decline in the number of rainy days compared to the baseline under high-end climate change scenarios. The low estimate projects a decrease of 10–20 rainy days per year in the coastal region, while the high estimate shows very little change, and potentially even a decline of several days per year in the same protected area.

Sea levels are rising in the Mesoamerican Reef region. In Guatemala, sea level rise by the 2050s is projected to be around 20 centimeters under the low estimate and just over 40 centimeters under the high estimate.[716]

Honduras

Mean temperatures are increasing across Honduras. Under RCP 8.5, Honduras is projected to see increases of about 1.5–2.0°C (low estimate) and 2.5–3.0°C (high estimate) by mid-century. The number of extreme heat days (over 35°C) per year varies across the region. The total number of days exceeding 35°C in the project area is projected to reach around 50 per year under the low estimate, with some areas along the northern coastal region experiencing close to 100 days per year. Under the high estimate, the total number of days over 35°C could reach 100–175 days per year in some areas along the northern coast. Most inland areas in Honduras are projected to experience about 10–100 days above 35°C under both the low and high estimates.

Precipitation is projected to decrease significantly under the low estimate across Honduras, with the possibility of slight increases in the coastal protected area under the high estimate. The low estimate shows projected precipitation declines of around 5–20% across the region, while the high estimate suggests slight increases of less than 10% in coastal Honduras, with greater increases on the western side of the protected area. Even under the high estimate, precipitation is projected to decline very slightly across central (inland) Honduras. There is also a projected decline in the number of rainy days compared to the baseline under high-end climate change scenarios. The low estimate projects a decrease of 15–30 rainy days per year in the coastal region, while the high estimate shows very little change and potentially a decline of up to 5 days per year in the same protected area.

Sea levels are rising in the Mesoamerican Reef region. On the Caribbean side of Honduras, sea level rise by the 2050s is projected to be about 20 centimeters under the low estimate and just over 40 centimeters under the high estimate.[717]

Uruguay

Uruguay's extensive coastline along the Atlantic Ocean and the Río de la Plata estuary is highly vulnerable to climate change impacts such as SLR, coastal erosion, flooding, and extreme weather events. These changes threaten critical infrastructure, ecosystems, and the livelihoods of coastal communities, which comprise about 70% of the country's population. Recent scientific research and national adaptation initiatives have focused on understanding these impacts and developing strategies to enhance resilience and sustainable coastal management.

Coastal erosion and flooding are the primary climate change impacts affecting Uruguay's coast. Currently, approximately 42% of the Río de la Plata coast and 32% of the Atlantic coast experience erosion, particularly during extreme storm events driven by wind and wave action. Rising sea levels exacerbate these processes, increasing the frequency and severity of flooding, and the deterioration of beaches and dunes. High tides combined with storm surges cause damage to coastal infrastructure and natural habitats, including wetlands that provide essential ecosystem services such as water filtration and fish spawning grounds.[718] [719] [720]

SLR projections indicate that sea levels along Uruguay's coast will continue to rise throughout the 21st century, driven by ocean warming and melting polar ice. This rise will significantly increase the risk of structural coastal erosion, potentially causing damage comparable to, or exceeding, that caused by extreme events alone by the end of the century. The increasing sea level threatens urban areas, ports, tourism infrastructure, and coastal ecosystems.[721] [722]

Extreme weather and hydrological changes in Uruguay's coastal zone is related to the ENSO phenomenon that strongly influences precipitation and storm patterns in the country, intensifying the risk of flash floods and storm surges. The frequency of extreme storms is expected to increase, further stressing coastal resilience. Changes in rainfall patterns and river discharges also affect sediment transport and coastal morphology.[723] [724]

The National Adaptation Plan for Coastal Areas (COASTAL-NAP) of Uruguay integrates detailed hazard, exposure, sensitivity, and adaptive capacity assessments. This plan guides adaptation at national and sub-national levels, emphasizing evidence-based policy making and stakeholder engagement. The COASTAL-NAP includes pilot projects in vulnerable coastal areas, promoting local working groups and capacity building to implement adaptation measures effectively.[725] [726] [727]

The promotion of ecosystem-based adaptation is central to Uruguay's coastal resilience strategy. Restoration and conservation of wetlands, dunes, and other natural buffers are prioritized to reduce erosion, enhance biodiversity, and protect coastal infrastructure. These efforts are supported by scientific monitoring and community participation, aiming to transform coastal management towards sustainability and equitable access to coastal resources.[728] [729]

Uruguay has strengthened its technical capacity through collaboration with international research institutions and local universities. Training programs for government officials and local decision-makers have improved the understanding of climate risks and adaptation options. This knowledge transfer has facilitated the uptake of climate modeling technologies and the mobilization of funding for adaptation projects.[730] [731]

Adaptation to climate change is being mainstreamed into Uruguay's national sustainable development strategies, with particular attention to vulnerable sectors such as tourism, fisheries, and urban infrastructure. Land use planning in coastal departments like Colonia and Canelones incorporates climate risks to ensure long-term resilience.[732]

The economic cost of coastal erosion and climate impacts is already significant, estimated at approximately US$45.5 million annually. These costs are expected to rise with increasing sea levels and extreme events. Adaptation projects aim to reduce these economic burdens by protecting critical infrastructure and ecosystems, while also addressing social equity by involving women and marginalized groups in decision-making processes.[733] [734]

Uruguay has made significant progress in understanding and addressing the impacts of climate change on its coasts and ocean. Through national adaptation planning, ecosystem-based approaches, capacity building, and policy integration, the country is enhancing the resilience of its coastal systems and communities. Continued investment in scientific research, stakeholder engagement, and sustainable infrastructure will be essential to meet the challenges posed by climate change in the coming decades.

Mexico

Mexico's extensive coastline, spanning over 11,000 kilometers along both the Pacific Ocean and the Gulf of Mexico/Caribbean Sea, is highly vulnerable to climate change impacts. These include SLR, increased frequency and intensity of tropical cyclones, coastal erosion, habitat degradation, and socio-economic pressures from urbanization and tourism. Recent scientific studies and policy initiatives have advanced understanding of these challenges and proposed integrated approaches for sustainable coastal management and adaptation.

Mexico is one of the countries most affected by tropical cyclones, with 386 cyclones recorded from 1863 to 2022, including six category 5 storms mostly on the Atlantic coast. These cyclones generate storm surges, intense waves, and strong winds that reshape coastal geomorphology but also cause significant human and economic losses. Climate change is increasing the

frequency and intensity of these storms, exacerbating risks to coastal populations and infrastructure.[735]

SLR is a critical threat, particularly along the Atlantic coast where vulnerability is highest. Studies show that 30% of tourist destinations on the Atlantic coast are exposed to flooding from sea-level rise, with 66% of hotels located on narrowing beaches. Coastal erosion is widespread, with rates exceeding 25 meters per year on parts of the northern Pacific coast. In Quintana Roo, erosion rates average 1.2 meters per year, with peaks over 4.9 meters, threatening beaches vital to tourism and local economies.[736] [737] [738]

Urban development, coastal armoring, and ecosystem degradation have fragmented habitats such as mangroves, dunes, seagrass beds, and coral reefs. Mangroves, covering nearly 800,000 hectares, remain relatively well preserved, but nearly half of the coastal dunes are degraded. Coastal armoring is prevalent, especially on the Yucatán Peninsula, where 55% of such structures are located. These human pressures, combined with climate impacts, reduce natural coastal protection and increase vulnerability.[739] [740]

Approximately six million people live in Mexico's coastal zones, mostly in the Caribbean region. The combination of population growth, tourism development, and climate-related hazards increases exposure and risk. Economic losses from storms and flooding have reached billions of dollars historically, and projections estimate that without mitigation, climate impacts could reduce Mexico's GDP by nearly 2% by 2050. Adaptation and low-carbon pathways could reduce this economic burden significantly.[741] [742]

There is an urgent need for ICZM legislation in Mexico. Current laws protect ecological equilibrium in certain areas but do not adequately address climate vulnerabilities or provide comprehensive coastal zone protection. Recent projects emphasize collaboration among government, universities, and stakeholders to develop environmental strategic plans and regional coastal programs to support legislation and adaptation.[743]

Initiatives such as Coastal Green Mexico focus on restoring beachfront ecosystems, including mangroves and dunes, to strengthen resilience against climate change. These efforts aim to enhance natural buffers against storm surges and erosion, supporting biodiversity and coastal livelihoods.[744]

The first national-level multidisciplinary study assessed climate change and human pressures on Mexican coasts, identifying key vulnerabilities and research gaps. Recommendations include adapting human settlements to dynamic coastal conditions, implementing coastal protection measures that avoid downdrift erosion, and restoring and preserving coastal ecosystems to reduce risks.[745]

Scientific projections indicate that under high emissions scenarios, heatwaves will last significantly longer, agricultural droughts will intensify, and coastal flooding will expose hundreds of thousands of people by 2050. Economic analyses underscore the importance of adopting low-carbon policies and climate-resilient infrastructure to mitigate these impacts and protect Mexico's coastal economy.[746] [747]

Mexico's coasts and ocean face escalating threats from climate change, including more intense tropical cyclones, SLR, and ecosystem degradation. Recent scientific advances have improved understanding of these impacts and highlighted the need for integrated, ecosystem-based management and robust legal frameworks. Restoration projects and national assessments provide pathways to enhance resilience, but urgent action is required to protect vulnerable communities and sustain coastal ecosystems.

Climate change significantly impacts Mexico's coastal zones, leading to rising sea levels, more intense storms, and alterations in ocean conditions. These changes threaten coastal ecosystems, human settlements, infrastructure and economic productivity, particularly in areas with low-lying ground.

The study on fisheries and climate change made by EDF *et al.*[748] shows that, according to the latest ocean atmosphere models, the main oceanographic changes projected for the country are changes in sea temperature, hurricane intensity, higher sea levels in states with huge lower ground areas, ocean acidification, and lower oxygen concentration. These changes can have significant impacts, particularly on commercial mollusk species. A slight increase in primary productivity was observed in all regions of the Atlantic, while decreasing in Pacific regions (except the Transitional Pacific of Monterrey), which would experience an increase of over 30%; while dissolved oxygen levels would decrease in all sea regions. In the worst-case scenario, all Atlantic regions would experience an 11-15% reduction in primary productivity and a 0.1 to 2.1 mol.m-3 decrease in dissolved oxygen levels, while other regions could experience a slight increase in these variables. For both scenarios, temperature is expected to rise in all regions, particularly high in the Transitional Pacific of Monterrey (1°C to 2.9°C). Only in the worst-case scenario the

region of the Gulf of California in the Pacific, and the Campeche Sound and northern coast of Yucatan in the southern part of the Gulf of Mexico, experience minimal cooling down. In the worst-case scenario temperatures continue rising in all regions, particularly in the Transitional Pacific of Monterrey and the Caribbean Sea. Primary productivity experiences significant reductions (between 50% and 80%) in the Middle American Pacific and the Gulf of California, as well as in the Atlantic regions. Finally, oxygen levels would decrease in both scenarios, particularly in the worst-case scenario, in the Atlantic zone. On the other hand, climate change scenarios towards 2050 indicate that current industrial fishing areas will experience a temperature increase of less than 1°C. Still, primary productivity and dissolved oxygen levels will drop.

Despite Mexico's solid and far-reaching legal framework supporting climate change adaptation policies in the fisheries and aquaculture sector, such policies should incorporate international cooperation, a human rights approach, a gender approach, the participation of young people, and better education and training. These changes will strengthen adaptation capacities in traditional fishing practices.[749]

The Sea of Cortés, known for its biodiversity, is experiencing the effects of climate change, impacting marine life and potentially affecting tourism and fisheries.[750] Meanwhile, the Yucatan Peninsula presents the following projections: Mean temperature is increasing across the entire Yucatan Peninsula with inland areas seeing more warming. Under RCP 8.5, the region will see increases of ~1.00-1.5°C in many areas and reaching ~2°C in more inland areas (low estimate). Under the high estimate, most areas in the peninsula see increases of at least 2°C, with some inland areas exceeding 2.5°C. Many regions are expected to experience a high number of extreme heat days (>35°C) per year by mid-century under high-end climate change with extreme heat days exceeding 100 in many areas. Under the high estimate, large parts of the region exceed 150 days, and some inland areas see ~200 days (or more) of total days over 35°C. Precipitation is projected to decrease significantly with the possibility of a slight increase across parts of the Yucatan peninsula. The low estimate shows projected precipitation declines of around 10-15%, as opposed to possible increases of less than 10% under the high estimate. There is a projected decline in the number of rainy days compared to the baseline under high-end climate change. The low estimate projects a decrease of 5-20 rainy days per year, while the high estimate shows very little change (fewer than 5 days in either direction) in the project region. Sea levels are rising in the Mesoamerican Reef region, with varying rates of increment depending on the location. In the Yucatan peninsula sea level rise in the 2050s ranges from 20-25 centimeters under the low estimate and ~40-45centimeters for the high estimate.[751]

According to Estrada Porrúa *et al.*,[752] the mean sea level varies dramatically through the year and from region to region. The highest SLR along the Mexican Pacific coast occurs mainly in September and October along the Gulf of Mexico coast, and annual cycles have an average amplitude 0.23m and 0.26, respectively. The lowest value on Mexican Pacific coasts occurs in February and April and on the Gulf of Mexico coasts during the months of January, March, May, or June. There are differentiated observed increases in mean sea level in the Gulf of Mexico and the Mexican Pacific since the second half of the 20th Century. The average rate of increase is higher along the Gulf of Mexico (2.4 millimeters per year) than along the Mexican Pacific (1.1 millimeters per year), particularly on the coasts of Oaxaca and Guerrero, experienced decreases in mean sea level at an average rate of 1.5 to 2.8 millimeters per year, respectively. This may be due to vertical movements of the Earth's crust occurring in the vicinity, or to earthquakes, slow earthquakes, and/or subsidence.

In the coastal and marine systems of the Mexican Caribbean, the amount of hard coral has decreased dramatically since the 1970's: from 50% of the reef floor to the current 10%.[753] Coral bleaching events were reported in 2023 due to the El Niño event. In Huatulco, Oaxaca, coral bleaching was sampled from late June to mid–August of 2023 to evaluate the intensity and extent of the changes associated with the warming event. From January of 2023, Huatulco experienced positive sea surface temperature anomalies; however, beginning in June, the high-temperature anomalies became extreme (>31 °C; ~2 °C above historical records). These high temperatures resulted in extensive coral bleaching in mid–late June and mortality from mid–late July (>50–93%). The 2023 event led to widespread coral bleaching and mortality in the southern Mexican Pacific, the Central Mexican Pacific, the Gulf of Mexico, and the Mexican Caribbean.[754] The Mesoamerican Reef has also experienced significant bleaching events, impacting its overall health. The 2023 El Niño event set back the recovery process of corals in this park, which had been partially restored after a government decree stopped uncontrolled tourism.[755] [756]

Finally, oxygen levels would decrease in both scenarios, particularly in the worst-case scenario, in the Atlantic zone. On the other hand, climate change scenarios towards 2050 show that current industrial fishing areas will experience an increase in temperature of less than 1°C, but primary productivity and dissolved oxygen levels will drop.

The port sector is particularly involved in climate change issues in Mexico. The National Port System lists 118 ports and terminals in the country, with two approaches to incorporate impacts from climate change: one from the approach of decarbonization of their GHG emissions and the other, from the impacts on their operations. In the last decade, Mexico's maritime and river transport ranked third in importance after emissions from motor transport and civil aviation with 1.8 to 3.8 million tons of carbon dioxide (MTCO) per year. This places it as the second country in Latin America with the highest MTCO after Brazil,[757] where the ports of Cayo Arcas, Manzanillo, Veracruz, Altamira, Isla Cedros and Salina Cruz stand out. With respect to the effects of climate change on ports, due to their location on the open coast, estuaries and deltas, they are susceptible to impacts, especially those of low altitude. Their effects on navigation due to siltation and scour, and the increasing exposure of their facilities to the force of waves and wind, as well as flooding caused by rising sea levels and storm surges, have led to interruptions in loading and unloading movements, increased maintenance costs and energy consumption in refrigeration areas. Additionally, insurance premiums and payments of unforeseen expenses have negatively impacted the finances of ports such as Manzanillo, which stands out for the movement of containerized cargo of more than 3.4 million Twenty-foot Equivalent Units and occupies 41% of the national port movement.[758]

Another productive sector that shows important concern about climate change impacts is coastal and maritime tourism. According to Jarratt & Davies[759] and the WTTC,[760] the coastal and marine tourism sector has a significant global economic footprint. In 2023, tourists spent approximately $US3 trillion in marine and coastal destinations. This activity, in turn, drives economic growth. The sector is estimated to have directly contributed US$1.5 trillion to the world's GDP in 2023, which represents 1.4% of the global economy. An additional US$1.8 trillion was generated indirectly – in the sector's supply chain – sustaining a total economic footprint worth US$3.3 trillion, or 3.2% of global GDP. Moreover, in 2023, coastal and marine destinations directly employed an estimated 52 million people globally, with an additional 48 million in the sector's supply chain. The 100 million people whose employment was supported by the sector represented around 3% of global employment in 2023. The direct activities of the sector generated an estimated US$820 billion in direct tax revenues, rising to US$1.3 trillion including its supply chain.[761]

However, the environmental footprint of coastal and marine tourism is increasing by the year. The results provided by Appendini *et al*.[762] show a comprehensive assessment of the wave climate in the Gulf of Mexico, suggesting more intense wave conditions in a warmer climate. The quantified effects of global warming on future wave conditions can inform key economic sectors in the region, such as oil and gas production, shipping, tourism, and fisheries. Estrada Porrúa *et al*.[763] and Gerges *et al*.[764] considered that SLR and more frequent and intense extreme hydrometeorological events are currently affecting beaches, fostering the erosion process and therefore, coastal ecosystems, settlements, and infrastructure, resulting in socioeconomic negative effects.

Ruiz-Ramírez *et al*.[765] evaluated the potential economic impacts of increasing SLR along the Mexican Caribbean where there are major gaps in understanding the mechanisms controlling flooding duration and frequency associated with future ecological and economic impacts. These authors determined the negative economic impact of SLR on infrastructure in the largest urban centers (Cancun, Isla Mujeres, Playa del Carmen, Puerto Morelos and Cozumel) in the state of Quintana Roo (Mexico) that are considered the largest tourism "hot spots" in the country. The tourism industry in this coastal area injects more than US$8 billion dollars per year to the Mexican economy. Our conservative economic assessment regarding the impact of SLR, under a 1 meter scenario for all coastal cities is US$330 million Further, projections for worst scenarios (SLR >2 meter) show a non-linear trend where the cost of inaction can reach up to US$1.4 billion (2 meter SLR scenario) and US$2.3billion (3 meter SLR scenario). This potential loss of infrastructure, as construction cost, is staggering and represents a robust baseline to start evaluating with more detail future impacts of climate variability and change on the Mexican Caribbean coastline.

During 2022 there were 34 tropical storms and hurricanes registered in Mexico from May to November, and five of them impacted the coastline or were less than 100 kilometers from the coast. For that year, the resulting damages in the southern Pacific tourism resorts

in Chiapas, Guerrero, Oaxaca, and in the Gulf of Mexico, impacted Tabasco and Veracruz, which added nearly US$257,676,173. During 2023, eight tropical storms and hurricanes hit coastal zones which represents 48% more than the registered average in the past 50 years, resulting in US$ 4,581,970 in damages. And during 2024, there were 30 hydrometeorological systems, 15 tropical storms and 15 hurricanes, that started very late, on July 4. In the Pacific, only the tropical storm Ileana (in Sinaloa), hurricane John (in Guerrero), and tropical depression Once-E (in Oaxaca) impacted Mexico. The Atlantic registered 18 systems, seven tropical storms, six hurricanes' categories 1 and 2, and five categories 3, 4, and 5; leaving damages calculated at US$16 million.[766]

The Mexican Tourism Ministry has developed the AdaptaTur project,[767] financed by international organizations and implemented by the federal Environmental Ministry (SEMARNAT) and the National Commission for Natural Protected Areas (CONANP). This project's aim is to mitigate the negative effects of tourism, while promoting coastal and marine restoration and conservation, especially coral reefs and mangroves. On the other hand, the Mexican government promoted a sustainable policy for tourism through PROSECTUR 2020-2024 that implements the National System for the Democratic Planning for Tourism Sustainable Development.

Conclusions

The scope of public policy on climate change in Latin America and the Caribbean varies depending on the priority assigned by each administration, often slowing progress. However, in a rapidly changing and globalized world, this region faces uncertainty regarding the impacts of climate change, as environmental, cultural, social, and economic damages become increasingly severe and frequent.

Latin America and the Caribbean host key ecosystems for global biodiversity and are also a critical area for climate change. Despite possessing an extraordinary proportion of the planet's biodiversity and forests, the region suffers severe climate impacts, even though its contribution to GHG emissions is relatively low. Therefore, it is still necessary to promote projects that encourage conservation and sustainable resource management, fostering collaboration among society, academia, and governments. Additionally, raising awareness and reevaluating the role of biodiversity and forests in the region is essential.

This part of the world is increasingly vulnerable to extreme weather events such as cyclones, hurricanes, floods, droughts, and wildfires, threatening millions of lives, infrastructure, food security, and livelihoods. The economic losses caused by these events exceed 2% of the annual GDP. While the quality of life of the population has been affected, many individuals lack knowledge or adequate tools to adapt and mitigate the effects of climate change in their local environments, both culturally and economically. Therefore, accessible technologies must be developed to enable the implementation of nature-based actions and solutions.

Geographical and morphological characteristics significantly determine countries' vulnerability to climate hazards. Those with extensive coastlines and large longitudinal enlargements may experience different levels of exposure to oceanic phenomena, while small Caribbean islands are particularly susceptible to cyclonic effects due to their limited territorial area. Thus, countries with insular and/or coastal zones must develop comprehensive marine and coastal management policies, as well as strengthen urban planning based on projections of SLR, coastal erosion, and temperature increases. Additionally, establishing strategies to address the displacement of at-risk populations is crucial, ensuring concrete actions that support adaptation and mitigation in the face of climate challenges.

Changes in tropical cyclone patterns and the emergence of rare meteorological systems highlight modifications in climate dynamics. The presence of subtropical systems in the South Atlantic, along with variations in cyclone size and frequency, underscores the need for continuous monitoring and proactive adaptation. Addressing these challenges requires increased investment in scientific research to develop more efficient, accessible, and rapid meteorological systems, especially in insular and coastal regions. Furthermore, promoting the democratization of scientific knowledge is essential to ensure that all individuals have access to information and tools that allow them to understand and combat climate change effects.

Deficiencies in data collection and uneven coverage hinder effective climate adaptation and mitigation planning. Strengthening international cooperation is crucial to improve climate data gathering, model calibration, and regional information exchange. To this end, fostering the training of young researchers in climate change impacts and creating new academic and governmental positions will help standardize climate data across Latin America and the Caribbean, facilitating evidence-based decision-making and promoting more effective response strategies.

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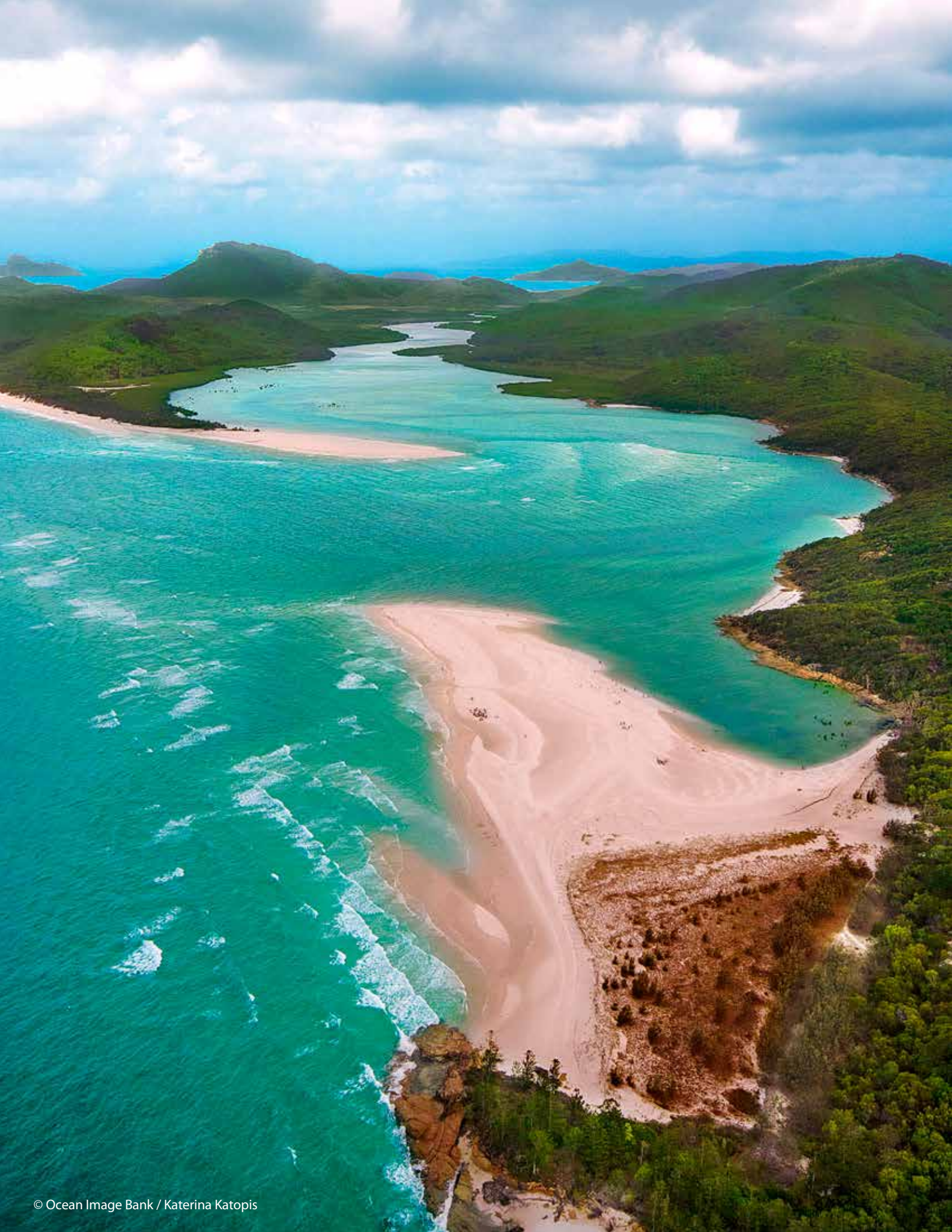

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