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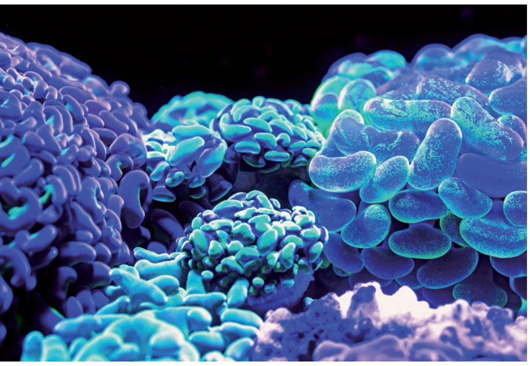
# HIGH-LEVEL SCIENTIFIC CONFERENCE FROM COP21 TOWARDS THE UNITED NATIONS DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT (2021-2030)

## CONFERENCE REPORT



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# HIGH-LEVEL SCIENTIFIC CONFERENCE
# FROM COP21 TOWARDS THE UNITED NATIONS DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT (2021-2030)

# CONFERENCE REPORT

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The present Report was prepared by the Ocean and Climate Platform in its own capacity, in order to provide helpful information on the subjects discussed during the Conference. The opinions and views exposed in the Report are the Ocean and Climate Platform's own and do not engage any of the co-organizer of the Conference, partners nor its speakers.

## ACRONYMS

**ABNJ.** Area Beyond National Jurisdiction
**AR.** Assessment Report
**BBNJ.** Biodiversity Beyond National Jurisdiction
**CBD.** Convention on Biological Diversity
**CI.** Conservation International
**COP.** Conference Of Parties
**EEZ.** Exclusive Economic Zone
**FAO.** UN Food and Agriculture Organization
**GDP.** Global Domestic Product
**GHG.** Greenhouse Gases
**GMP.** Gross Marine Product
**IMO.** International Maritime Organization
**INDCs.** Intended Nationally Determined Contributions
**IOC-UNESCO.** Intergovernmental Oceanographic Commission of UNESCO
**IPBES.** Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
**IPCC.** Intergovernmental Panel on Climate Change
**ISA.** International Seabed Authority
**IUCN.** International Union for Conservation of Nature
**LMMA.** Locally Managed Marine Area
**LSMPA.** Large Scale Marine Protected Area
**MEA.** Millennium Ecosystem Assessment
**MEI.** Management Effectiveness Initiative
**MGRs.** Marine Genetic Resources
**MPA.** Marine Protected Area
**MSP.** Marine Spatial Planning
**NDCs.** Nationally Determined Contributions
**NGOs.** Non-Governmental Organizations
**OCIA.** Ocean and Climate Initiatives Alliance
**OECD.** Organisation for Economic Co-operation and Development
**OHC.** Ocean Heat Content
**OMZ.** Oxygen Minimum Zone
**RCP.** Representative Concentration Pathway
**REDD.** Reducing Emissions from Deforestation and Forest Degradation
**SDG.** Sustainable Development Goal
**SIDS.** Small Island Developing States
**SLR.** Sea Level Rise
**SR.** Special Report
**UN.** United Nations
**UNCLOS.** United Nations Convention on the Law of the Sea
**UNEP.** United Nations Environment Programme
**UNFCCC.** United Nations Framework Convention on Climate Change
**WCPA.** IUCN-World Commission on Protected Areas
**WMO.** World Meteorological Organization
**WWF.** World Wildlife Fund

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# FOREWORD

In December 2015, the Ocean came into the international climate negotiations by taking its place in the preamble of the Paris Agreement. Two years later, the United Nations General Assembly proclaimed the UN Decade of Ocean Science for Sustainable Development (2021-2030).

We are now halfway through this ambitious pathway, which invites us all to move from word to action, from commitments to solutions, by calling upon scientific forces worldwide to gather together to achieve the goals of COP21 and to create the sustainable ocean our planet needs. "The Ocean will rule the Earth's fate" said Marie-Joseph Chénier. Today, the prophecy of this poet is becoming scientific truth. In fact, the health of the entire Earth system depends on the ocean's integrity.

Because it is the Ocean that makes the planet habitable. It is its lungs, thanks to phytoplankton, which provides more oxygen than the world's forests and absorbs the $CO_2$ present in the atmosphere. It is its thermal regulator: it prevents terrestrial temperature to vary up to 250 degrees from day to night as it happens on the Moon. It is its storage, rich in so many resources: living species on which humans feed and of which they exploit properties; minerals; oil; without mentioning waves, wind and ocean currents energy. Not only it provides commodities to people, it also allows their movement from one continent to the other, thanks to the commercial routes that cross it.

But the Ocean is a colossus with feet of clay: it is opulent, powerful, it generates those extreme events of which our coasts are the first witnesses, but it is at the same time very vulnerable. From pollution to overexploitation of resources, including the urbanization of coasts, it gathers the scarring effects of human activities, despite being considered an eternal virgin, wild and rebel territory. Eventually, humanity, even though could never tame it, succeeded in invading it by creating an seventh continent made up of plastic in the Pacific – sad proof of the Ocean's inability to wash away the world' stain. In addition to this, it is through climate change that the Ocean suffers from the effects of human activities: its water rises, becomes more acidic and warmer, and sometimes it even changes colour, as it happened last summer in Brittany due to the proliferation of phytoplankton Noctiluca scintillans.

The Ocean is at the crossroads of all big challenges that humanity faces – climate change, biodiversity loss, a new energy model, food security, health. In other words, the Ocean is one of the keys to the sustainable future we must build.

Yet, the reality is that 90% of the deep ocean is still unexplored and that 1 to 50 million marine species are still to be discovered. What an amazing research field for science!

Here is the greatest challenge for science, which justifies an international scientific cooperation: the dimension of its object of research. First, in a physical sense: how to observe, monitor, map and catalogue such a vast and deep space? The close and continuous monitoring of temperature, salinity and currents is essential to understanding ocean variability and assessing climate change, to cite but one example.

If the Ocean is difficult to understand in its wholeness, it is also due to its underlaying multiple meanings. In other words, the Ocean is a multidimensional object that breaks the walls between scientific disciplines. Oceanography already integrates several approaches, from physics to biology and chemistry, from mathematics to Earth science, but today the Ocean goes beyond this scope. In order to be able to cope with its object, oceanography must join forces with other disciplines, such as sociology, anthropology, law, ethical and political science. From now on, oceanography must develop into ocean science, on the model of climate science.

Especially since ocean science includes now a new, essential dimension: society expectations. There is a need for a marine citizenship at the individual level, and for a blue growth at a wider scale. Ocean science can contribute to both, by fostering public debate and informing policies.
How to create a sustainable future, if not by building on what lasts, resists trends, opinions and beliefs, in other words, on science, or rather on the science effort?

It is for this effort, for this global mobilization of ocean science that we need the United Nations.

**Frédérique Vidal**, Minister of Higher Education, Research and Innovation of France

# ABOUT THE CONFERENCE

## I. FROM COP21 TOWARDS THE UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT (2021-2030)

In the last decade, scientific advances have enhanced our knowledge and understanding of coastal and marine ecosystems and how these interact with the climate system. These confirmed that climate change significantly alters the ocean, its ecosystems and its capacity to act as climate regulator. Since COP21 and the adoption of the Paris Agreement, the ocean has become a key element of climate negotiations, and it is widely recognised that a healthy ocean can provide solutions to future challenges.

In light of the current context and challenges ahead, the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), the Ocean and Climate Platform (OCP) and the Ocean and Climate Initiatives Alliance (OCIA) are organizing a High-Level Scientific Conference on 10 and 11 September 2018, at UNESCO Headquarters in Paris. The conference aims at synthesizing recent scientific progress on ocean and climate interplays; evaluating the latest ocean, climate and biodiversity trends within the context of increased concerted ocean actions; and reflecting on ways to move "from science to action".

In view of the recent proclamation of the UN Decade of Ocean Science for Sustainable Development (2021-2030), a particular focus will examine how the ocean, climate and biodiversity nexus can be enhanced by fostering synergies amongst key ocean-related initiatives, including the UNFCCC, the Sustainable Development Goals (especially SDG 14 - Conserve and sustainably use the oceans, seas and marine resources for sustainable development), the Ocean Pathway Partnership and the Biodiversity Beyond National Jurisdiction process (BBNJ).

Organized around four core sessions and three special sessions, the event will bring together the scientific community, policymakers, civil society representatives and UN organizations to discuss the interlinkages between ocean, climate and biodiversity. Building on scientific evidence, the conference will provide the opportunity for in-depth discussions on the interface between science and policy from COP21 towards the UN Decade of Ocean Science for Sustainable Development, including milestones such as the IPCC special report on the Ocean and Cryosphere in a Changing Climate to be released in 2019.

### THE UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT (2021-2030)

On 5 December 2017, the UN General Assembly designated the years 2021 to 2030 as "UN Decade of Ocean Science for Sustainable Development" to support efforts to reverse the cycle of decline in ocean health and create improved conditions for sustainable development of the ocean, seas and coasts. Under the coordination of IOC-UNESCO for its planning phase, the Decade will gather ocean stakeholders worldwide, including the scientific community, policy makers, businesses and civil society organizations. Two overarching goals were identified for the Decade:

- To generate the scientific knowledge and underpinning infrastructure and partnerships needed for the sustainable development of the ocean.
- To provide ocean science, data and information to inform policies for a well-functioning ocean in support of the 2030 Agenda and the Sustainable Development Goals.

For more information please visit: en.unesco.org/ocean-decade.

# II. PROGRAM

## OPENING CEREMONY

| MASTER OF CEREMONY | |
|---|---|
| **George PAPAGIANNIS,** Chief Media Services, UNESCO | |
| **WELCOME ADDRESS** | |
| **Vladimir RYABININ,** Executive Secretary, IOC-UNESCO | |
| **SPEAKERS** | |
| **Byong-hyun LEE,** Chair of the Executive Board, UNESCO<br>**Ana Paula VITORINO,** Minister of the Sea of Portugal | **Frédérique VIDAL,** Minister of Higher Education, Research and Innovation of France<br>**Romain TROUBLÉ,** President, Ocean and Climate Platform |

## SESSION 1

WHAT DOES SCIENCE TELL US TODAY ABOUT THE OCEAN?

| MODERATORS | |
|---|---|
| **Anny CAZENAVE,** Member of the French National Academy of Sciences | **Françoise GAILL,** Emeritus Research Director, CNRS |
| **SPEAKERS** | |
| **William CHEUNG,** Associate Professor, University of British Columbia / NF-UBC Nereus Program<br>**Patricia MILOSLAVICH,** Project Officer, GOOS Biology and Ecosystem Panel<br>**Martin VISBECK,** Head of the Research Unit Physical Oceanography, GEOMAR | **Sheila JJ HEYMANS,** Executive Director, European Marine Board<br>**Lauren MULLINEAUX,** Senior Scientist and Biology Department Chair, Woods Hole Oceanographic Institution |

## SESSION 2

AN INTERGOVERNMENTAL PERSPECTIVE ON OCEAN, CLIMATE AND BIODIVERSITY KNOWLEDGE

| MODERATORS | |
|---|---|
| **Joachim CLAUDET,** Researcher, CNRS-CRIOBE | **Laura HAMPTON,** Journalist |
| **SPEAKERS** | |
| **Elva ESCOBAR-BRIONES,** Institute of Marine Sciences and Limnology, Universidad Nacional Autónoma de México<br>**Valérie MASSON-DELMOTTE,** Co-chair, IPCC<br>**Sir Robert Tony WATSON,** CMG, FRS, President, IPBES | **Nathalie HILMI,** Environmental Economist, Scientific Center of Monaco<br>**Hans-Otto PÖRTNER,** Co-chair, IPCC |

## SESSION 3

FROM SCIENCE TO ACTION: HOW CAN THE UN DECADEOF OCEAN SCIENCE MAKE A DIFFERENCE?

| MODERATORS | |
|---|---|
| **Julian BARBIÈRE,** Head of the IOC Marine Policy and Regional Coordination Section, IOC-UNESCO | **Patricia RICARD,** President, Paul Ricard Oceanographic Institute |
| **SPEAKERS** | |
| **Peter HAUGAN,** Chair, IOC-UNESCO<br>**Jacqueline UKU,** President, WIOMSA | **Torsten THIELE,** Economist, Global Ocean Trust<br>**Anna ZIVIAN,** Co-chair, Future Earth Ocean Knowledge-Action Network Development Team and Senior Research Fellow, Ocean Conservancy |

## SESSION 4

FROM SCIENCE TO ACTION: WHICH POLICIES?

| MODERATORS | |
|---|---|
| **Rémi PARMENTIER,** Director, The Varda Group | **Salvatore ARICÒ,** Head of the Ocean Science Section, IOC-UNESCO |
| **SPEAKERS** | |
| **Serge SÉGURA,** French Ambassador for Ocean Affairs | **Ricardo SERRÃO SANTOS,** Member of the European Parliament |

## CLOSING CEREMONY

| WRAP-UP | |
|---|---|
| **Peter HAUGAN,** Chair, IOC-UNESCO | **Lisa Emelia SVENSSON,** Director of the Marine and Coastal Ecosystems Branch, United Nations Environment Programme |
| **CLOSING REMARKS** | |
| **Vladimir RYABININ,** Executive Secretary, IOC-UNESCO | **Serge SÉGURA,** French Ambassador for Ocean Affairs |

## SPECIAL SESSION

### SCIENCES COOPERATION, POLICIES INTERFACES AND SDGS IN SOUTH ATLANTIC OCEAN

*Organized by the French National Research Institute for Sustainable Development (IRD) and the University of Western Brittany (UBO)*

| WELCOME ADDRESS | KEYNOTE SPEECH |
|---|---|
| **Frédéric MÉNARD,** Head of the OCEANS Scientific Department, IRD | **Amadou GAYE,** Director General of Research, Senegal |
| **SPEAKERS** | |
| **Bamol SOW,** Head of Physics Department, Assane Seck Ziguinchor University, Senegal<br>**Isabelle ANSORGE,** Department of Oceanography, University of Cape Town, South Africa<br>**Silva OSVALDINA,** President of the National Institute for Fisheries Research and Development, Cape Verde | **Moacyr ARAUJO,** Department of Oceanography, Federal University of Pernambuco, Brazil<br>**Alexander TURRA,** Oceanographic Institute, University of São Paulo, Brazil<br>**Patricia Norma MUÑOZ SEVILLA,** Director of the Center for Research and Advanced Studies, National Polytechnic Institute and President of the Climate Change Council, Mexico |

## SPECIAL SESSION

### MAKING WAVES: WOMEN IN OCEAN SCIENCE

*Organized by Fisheries and Oceans Canada (DFO) and the Permanent Delegation of Canada to UNESCO*

| MODERATOR | |
|---|---|
| **Elaine AYOTTE,** Canada's Ambassador to UNESCO | |
| **SPEAKERS** | |
| **Wendy WATSON-WRIGHT,** Chief Executive Officer of the Ocean Frontier Institute, Canada<br>**Angela HUTTON,** Director of Science and Technology, National Oceanography Centre, UK | **Jacqueline UKU,** Senior Research Officer and Research Coordinator, Kenya Marine and Fisheries Research Institute and President of the Western Indian Ocean Marine Science Association, Kenya<br>**Gretta PECL,** Director, Centre for Marine Socioecology and IMAS ARC Future Fellow, University of Tasmania, Australia |

## SPECIAL SESSION

### ACADEMIC RESEARCH: WHICH CONTRIBUTIONS TO THE UN DECADE OF OCEAN SCIENCE?

*Organized by the French National Center for Scientific Research (CNRS) and the French National Research Alliance for the Environment (AllEnvi)*

| MODERATORS | |
|---|---|
| **Marie-Alexandrine SICRE,** Research Director, CNRS-SCOR | **Agathe EUZEN,** Scientific Deputy Director, Institute of Ecology and Environment (INEE-CNRS) |
| **SPEAKERS** | |
| **Nele MATZ-LÜCK,** Professor of Law, University of Kiel<br>**William CHEUNG,** Associate Professor, University of British Columbia / NF-UBC Nereus Program | **Laurent BOPP,** Research Director, CNRS<br>**Rodolphe DEVILLERS,** Professor, Department of Geography, Memorial University of Newfoundland |

# III. ABOUT THE ORGANIZERS

## IOC-UNESCO

The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO) is the only UN body entirely dedicated to ocean science. It promotes international cooperation and coordinates programmes in marine research, services, observation systems, hazard mitigation, and capacity development in order to understand and effectively manage the resources of the ocean and coastal areas. By applying this knowledge, the Commission aims to improve the governance, management, institutional capacity and decision-making processes of its Member States with respect to marine resources and climate variability and to foster the sustainable development of the marine environment, in particular in developing countries. IOC's work in ocean observation and science significantly contributes to building the knowledge base of the science of climate change. It is within this context that IOC has been mandated by the UN General Assembly to coordinate the preparatory process of the UN Decade of Ocean Science for Sustainable Development (2021-2030) to support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for the sustainable development of the Ocean.

United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission · 2021 2030 United Nations Decade of Ocean Science for Sustainable Development

## OCEAN AND CLIMATE PLATFORM

The Ocean and Climate Platform (OCP) was established in 2014 during the World Oceans Day with the purpose of highlighting scientific expertise and supporting ocean and climate issues advocacy before policy makers and the general public. During COP21, the Ocean and Climate Platform emphasized the importance of "a healthy ocean, a protected climate". It is important to show how the ocean is affected by climate change, and more importantly to show that "the ocean is part of the solution" against climate change. OCP gathers over 70 organizations, including members of the civil society, scientific institutions, the private sector, international organisations and public institutions, all acting to bring the ocean to the forefront in climate discussions. In February 2017, the Platform launched the Ocean and Climate Initiatives Alliance (OCIA) to federate ocean-based solutions for climate mitigation and adaptation. OCIA brings together 20 multi-stakeholder initiatives around the globe, which are committed to preserving the ocean in the face of climate change. OCIA's aim is to consolidate and coordinate the concrete actions initiated in this area by individual partnerships to address the interlinkages between climate change and ocean protection, in order to push forward the objectives of the Paris Agreement and the 2030 Agenda for Sustainable Development.

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## IV. POSTER EXHIBITION

Partner organizations and participating institutions have displayed their activities in posters, which provided an overview of current research and on-the-ground initiatives in ocean science worldwide.

A SAFE AND PREDICTED OCEAN – IFREMER
BUREAU DES LONGITUDES
COASTAL BLUE CARBON – The Blue Carbon Initiative
DEEP OCEAN OBSERVING STRATEGY – DOOS
ECOLOGICAL RESTORATION – Paul Ricard Oceanographic Institute
ICEMASA – French National Research Institute for Sustainable Development - IRD
INTEGRATED CLIMATE AND OCEAN STUDIES AROUND WEST AFRICA AND IMPACTS OF CLIMATE CHANGE IN SENEGAL – French National Research Institute for Sustainable Development - IRD
INTEGRATED MULTI-TROPHIC AQUACULTURE – Paul Ricard Oceanographic Institute
JEAI GABES MARINE BIODIVERSITY AND ANTHROPISATIONS – GAMBAS French National Research Institute for Sustainable Development – IRD
MPA-ADAPT – Spanish National Research Council – CSIC
OCEAN AND CLIMATE INITIATIVES ALLIANCE – Ocean and Climate Platform
OCEAN PLANKTON, CLIMATE AND DEVELOPMENT – Tara Expeditions Foundation
OCEAN UNIVERSITY INITIATIVE – University of Western Brittany – UBO
OCEANOLAB – Oceanopolis
PADDLE – French National Research Institute for Sustainable Development – IRD
PREDICTION AND RESEARCH MOORED ARRAY IN THE TROPICAL ATLANTIC – PIRATA French National Research Institute for Sustainable Development – IRD
TAPIOCA: TOWARDS A MULTIDISCIPLINARY STUDY OF THE TROPICAL ATLANTIC – French National Research Institute for Sustainable Development - IRD
OCEAN FOR FUTURE – Take OFF Paul Ricard Oceanographic Institute
TAKING ACTION TO PROTECT COASTAL COMMUNITIES AND LIVELIHOODS FROM A CHANGING CLIMATE INTERNATIONAL ALLIANCE TO COMBAT OCEAN ACIDIFICATION – OA Alliance
T-MEDNET – Institut de Ciències del Mar
WHAT ARE COS FOR? – YO!

## V. EVENT FACTS AND FIGURES

- 4 PLENARY SESSIONS
- 3 SPECIAL SESSIONS
- 53 SPEAKERS
- FROM 17 DIFFERENT COUNTRIES
- MORE THAN 700 USES OF #OCEANDECADE
- MORE THAN 1400 INTERACTIONS
- MORE THAN 100,000 REACHES

## SUMMARY FOR POLICY-MAKERS

Since COP21 and the adoption of the Paris Agreement, the Ocean has gained increased interest in the climate negotiations, and it is widely recognised that a healthy ocean is part of the solution to tackle global challenges. Despite considerable progress, many knowledge gaps still remain. Strengthening ocean science is key to better understanding ocean mechanisms and advancing solutions to ocean-, climate- and biodiversity-embedded issues. Science is urgently needed to inform policy-makers and international frameworks, such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD), the 2030 Agenda for Sustainable Development, and the Biodiversity Beyond National Jurisdiction (BBNJ) negotiations.
The High-Level Scientific Conference gathered fifty-three high-level panelists to share their expertise on the ocean, climate and biodiversity nexus; and to discuss how to improve the science-policy interface to move "from science to action". The current Report aims at synthesizing the key messages from the Conference, by identifying the cross-cutting themes that arose and putting them in perspective with the latest available scientific research.
This effort strives to convey a clear message on the importance and interconnectedness of ocean, climate and biodiversity. In that context, the UN Decade of Ocean Science shall be a critical juncture for policy and action.

## I. FOSTERING/STRENGTHENING AN INTEGRATIVE OCEAN SCIENCE

Over the last decades, scientific research has considerably improved our understanding of the ocean system. However, many gaps remain, particularly when it comes to the effects of climate change on marine and coastal ecosystems. Deoxygenation, acidification, sea-level rise and the responses of specific ecosystems, including the deep ocean, still require greater attention and mobilisation of resources. According to the Conference outcomes, the latter should build on the following principles:

- Adopting a multidisciplinary approach to ocean science, by integrating social sciences into oceanography.
- Improving ocean modeling through multi-scale observation and prediction systems.
- Monitoring the impact of sea level rise on coastal populations through a global systematic space-based system.
- Fostering research on deep sea ecosystems under existing mechanisms such as the Deep Ocean Observing Strategy.
- Strengthening the understanding of the ocean, climate and biodiversity nexus, with a focus on ocean-based solutions to climate change adaptation and mitigation.
- Strengthening the interface between ocean science and policy, at the international, national and local scales.

## II. INTEGRATING THE ENVIRONMENTAL AND SOCIO-ECONOMIC DIMENSIONS

Ocean-based economic activities and coastal populations are threatened by declining ocean health and rising climate concerns. Marine Protected Areas (MPAs) can be used as a tool for climate mitigation and adaptation. They can be designed with the goal to conserve and sustainably use marine biodiversity. However, as their effectiveness is debatable, complementary tools are required in order to boost MPAs conservation capacity and to strengthen the adaptation capacity of coastal communities. For a better understanding of marine ecosystems, participants to the High-Level Scientific Conference made the following recommendations:

- Promoting and integrating ocean-based solutions to climate change mitigation and adaptation into the climate agenda, such as Marine Protected Areas and blue economy.
- Encouraging cooperation and knowledge-sharing at the international, regional and local level on ocean-related topics such as finance, technology-sharing and harmonized warning systems.
- Promoting multidisciplinarity for a better understanding of the ocean and climate interplays, as well as their interactions with the socio-economic dimension.
- Taking into account indigenous knowledge, empowering women and involving youth into the research and decision-making processes.

## III. GOVERNING OUR BLUE PLANET

Ocean governance is currently fragmented due to a significant lack of coordination. The United Nations Convention on the Law of the Sea of 10 December 1982 (UNCLOS) has put in place a "three pillars" system along with sectoral agreements and regional conventions. These three components often overlap therefore contributing to the fragmentation of ocean governance. Within climate negotiations, the ocean has made its first appearance only in 2015 in the Paris Agreement. The integration of the ocean into the UNFCCC process is still at an early stage, and more efforts are needed to both increase the scientific evidence - namely through the work of the Intergovernmental Panel on Climate Change on its special reports on Global Warming of 1.5°C and on the Ocean and Cryosphere in a Changing Climate – and to foster the integration of the Ocean into Nationally Determined Contributions (NDCs). It is also crucial to fill the legal vacuum regarding marine biodiversity of areas beyond the limits of national jurisdiction (BBNJ), and to revise biodiversity targets for the post-2020 period. The United Nations Decade of Ocean Science for Sustainable Development will provide a unique opportunity to strengthen ocean governance. Recommendations on how to move forward include:

- Promoting multi-stakeholder governance and multi-sectoral policies through international and regional cooperation.
- Fostering synergies between key intergovernmental processes such as the IPCC and the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services (IPBES).
- Integrating the Ocean into countries' NDCs to achieve the objectives of the Paris Agreement.
- Providing scientific evidence to the negotiations on the conservation and sustainable use of marine Biodiversity of areas Beyond the limits of National Jurisdiction (BBNJ).
- Promoting innovative finance through public-private partnerships and trust fund mechanism.

# INTRODUCTION

The ocean and the climate are intrinsically linked. As a heat reservoir, the ocean has absorbed over 90% of the heat emitted since the Industrial Revolution. As a carbon sink, it captures 30% of the carbon dioxide ($CO_2$) released into the atmosphere through two mechanisms: the main part of atmospheric $CO_2$ (about 90%) is transferred to the ocean by its simple dissolution into surface seawater; in addition, phytoplankton floating in the sunlit ocean surface layer contributes to absorbing $CO_2$ by performing photosynthesis. The ocean therefore plays a key role in regulating the Earth's climate by limiting the greenhouse effect, and thus global warming.

Marine ecosystems, supporting biodiversity in coastal and ocean habitats, are also essential to human societies: about 30% of the world's population lives less than 100 km away from coasts; nearly 3 billion people depend on marine resources for their daily protein intake and many economic activities such as freight transport and tourism are linked to the sea.

However, the ocean is strongly affected by anthropogenic activities, therefore threatening its ability to act as a climate regulator and limit the effects of climate change. These pressures – including $CO_2$ emissions, overexploitation of natural resources, destruction of habitats and pollution – affect ocean ecosystems and increase their vulnerability.

With the adoption of the Paris Agreement in 2015, the ocean gained recognition both as a solution to future challenges and as an intrinsic component of climate regulation. Nevertheless, knowledge gaps regarding ocean and climate interactions still remain. Strengthening ocean science is crucial not only to better understand this large ecosystem covering 71% of our Planet which remains largely unknown; but to identify concrete solutions to tackle ocean, climate and biodiversity issues. Sound scientific expertise is urgently needed to inform policy-makers in order to achieve the objectives set by global processes such as the Conferences of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), the Biodiversity Beyond National Jurisdiction (BBNJ) negotiations and the 2030 Agenda for Sustainable Development.

The United Nations (UN) has proclaimed a Decade of Ocean Science for Sustainable Development (2021-2030) to address these needs and support efforts to reverse the cycle of decline in ocean health. As part of its preparatory phase, the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), the Ocean and Climate Platform and the Ocean and Climate Initiatives Alliance (OCIA) organized a High-Level Scientific Conference on 10-11 September 2018 at UNESCO headquarters in Paris. There, over fifty internationally renowned experts have shared their knowledge of ocean, climate and biodiversity interactions, and debated how to improve the science-policy interface to move "from science to action". More than four hundred international participants, representatives of the scientific community, civil society, UN organizations and national governments, took part in these discussions.

The present Report aims at synthesizing the key messages which emerged from the Conference, by identifying cross-cutting themes addressed by the panelists and putting these into perspective with the latest available scientific research. This effort strives to convey a clear message on the importance of the ocean, climate and biodiversity nexus, while setting a milestone in the preparation of the UN Decade of Ocean Science. Chapter 1 will provide an overview of existing scientific knowledge in ocean science and remaining research gaps. Chapter 2 will examine the services provided by the ocean to human societies and the tools to be implemented for protecting coastal and marine ecosystems. Lastly, chapter 3 will address how to build upon ocean science to achieve global ocean governance, with a focus on the need for a coherent and coordinated approach to fully address the ocean-climate-biodiversity nexus.

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# CHAPTER 1 – OCEAN SCIENTIFIC KNOWLEDGE IN A CHANGING CLIMATE

AUTHORS: FRANÇOISE GAILL, VICTOR BRUN AND THÉOPHILE BONGARTS LEBBE

The ocean – the largest ecosystem on Earth – covers three quarters of the surface of the globe. However, its importance for the planet goes beyond its spatial extent. The ocean regulates our planet's climate by exchanging energy and water with the atmosphere. Oceanic circulation enables heat to be distributed from tropics to poles, which therefore determines rainfall patterns and atmospheric temperatures influencing regional climates. Understanding the climate system and anticipating future changes requires considering the ocean as both a physical and biogeochemical system.

Acting as a biological carbon pump, the ocean limits the global impacts of climate change. Nevertheless, higher water temperature caused by the increase of greenhouse gases (GHG) has consequences on ocean properties and functioning. Ongoing changes in the physical and chemical composition of the ocean lead up to world spread phenomena: alterations in oceanic circulation and stratification evolution, sea ice and glaciers melting, sea level rise, oxygen loss, and water acidification.

## I. PREDICTING THE FUTURE OCEAN IN THE FACE OF CLIMATE CHANGE

### A. ANTHROPOGENIC IMPACTS ON OCEAN PROPERTIES

Over the last decades, our understanding of the ocean system has considerably improved thanks to advances in ocean science. Because all organisms

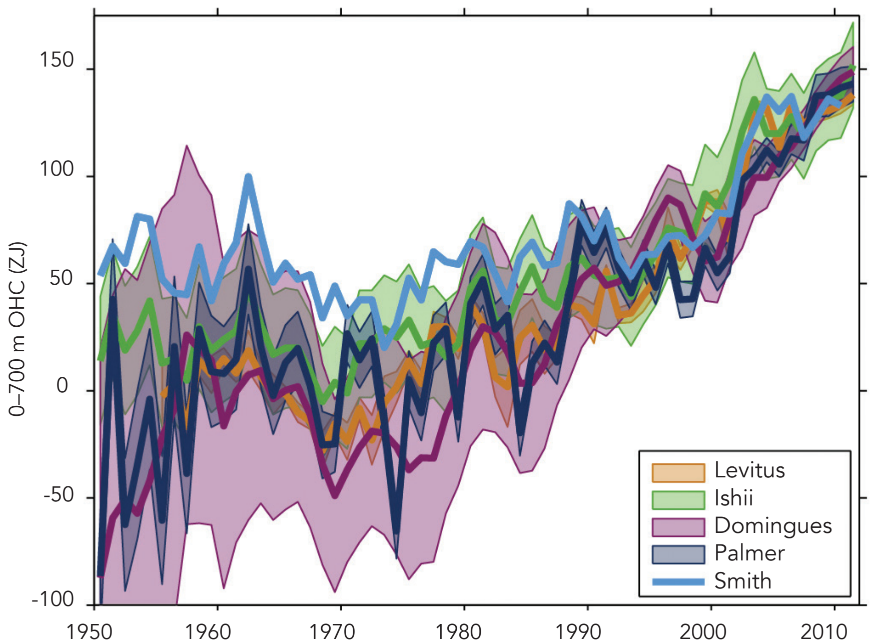


**Figure 1.** The annual global average ocean heat content (OHC) above 700 meters deep, over the 1950-2012 time frame. Other academics (*i.e.* Levitus, Ishii, Domingues, Palmer and Smith) have produced models and all of them show an increase in OHC.
*Source: IPCC (2013) Observations: Ocean. Chapter 3, figure 2.3, p.262. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F. et al.]. Cambridge University Press, United Kingdom and New York, NY, USA.*

in the ocean respond to changing environmental conditions, data collection has allowed scientists to observe modifications of ocean properties. Below are detailed some of these changes – already observed and measured – directly linked to human activities.

## OCEAN HEAT

Human activities have induced the accumulation of $CO_2$ and other heat-trapping gases in the atmosphere, impacting its radiative properties and therefore modifying the Earth's heat balance. Direct observations have shown a general warming of all ocean basins, especially in the ocean's upper layer, warming up at a higher rate than anticipated. From 1971 to 2010, the first 75 meters below the surface have warmed by 0.11°C per decade[1]. Depending on the IPCC's different scenarios, in 2100, the ocean will have absorbed between 5 and 7 times the amount of heat it has absorbed since 1970[2].

## SEA LEVEL RISE

Among all the impacts climate change has on the ocean, sea level rise (SLR) is a serious threat to coastal populations, particularly to the Small Island Developing States (SIDS). This vulnerability has received worldwide attention and is therefore increasingly integrated into climate negotiations. On average, since 1993, sea level rose by 3.2 mm per year. Around 75% of this observed SLR is due to continental ice melt, mostly from the Greenland and Antarctica ice sheets, or to thermal expansion,[3] (*i.e.* when warmed up, water molecules take up more room, therefore causing oceanic expansion).

## OCEANIC CIRCULATION

Global warming also affects the oceanic thermohaline stream function – an ocean circulation driven by differences in water density – which, in turn, impacts the climate system. Oceanic currents therefore disrupt heat transfers from hot waters of equatorial areas to cold waters of polar regions. Two stressors modify this thermohaline circulation: the ocean's upper waters temperature rise, and the melting of Arctic, Greenland, Antarctica and glaciers ices producing an influx of freshwater.[4,5] In polar regions, this results in a decrease in salinity and warmer waters, thus modifying waters' capacity to mix together, impacting ocean stratification and disturbing oceanic circulation.

## DEOXYGENATION

The stratification of oceanic waters with different masses results in another impact of climate change on the ocean:

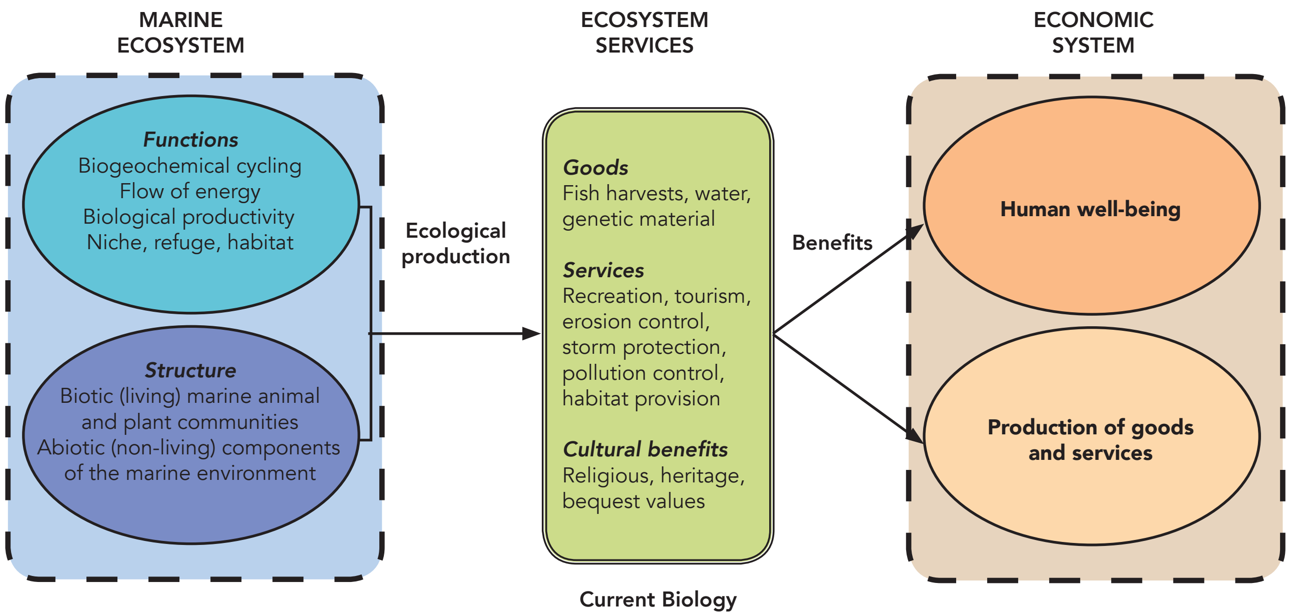


**Figure 2.** How marine ecosystems generate economic benefits. The structure and functioning of marine ecosystems lead to the ecological production of ecosystem services. Some of these goods, services and cultural benefits directly impact human well-being, whereas others indirectly impact the welfare of humans through supporting or protecting valuable economic assets and production activities.
*Source: Adaptated from Barbier, E.B. (2017) Marine Ecosystem Services. Current Biology, 27(11), pp.507-510.*

deoxygenation. Global water warming reduces the solubility of the $O_2$, and accelerates organisms' demand for metabolic $O_2$. Recent research has shown that the ocean already lost from 0.5 to 3.3% of its oxygen, and this value should reach 4% in the near future. The enrichment of the ocean with minerals and nutrients due to land-based pollution, called eutrophication, can act as an additional stressor and expand coastal areas depleted of oxygen (*i.e.* Oxygen Minimum Zones (OMZs)). Although scientists knew little of the impacts of deoxygenation on the ocean for a great time, they have now found out that the global biomass could decrease by up to 15% by 2100 under RCP8.5 (*i.e.* IPCC's worst scenario of GHG concentration).[6] Further research yet needs to be conducted.

## RESEARCH GAPS

Although science has made great progress in understanding the ocean and climate dynamics, knowledge gaps remain and must be filled.

The deep sea – at depths below 200 meters and plunged in darkness – is the largest biome on Earth, making up about 90% of the ocean's volume. Similarly, to other marine ecosystems, climate change impacts the deep sea by modifying its capacity to sequester and store both heat and $CO_2$[7]. More than 95% of the deep sea is still unexplored – because of technological and time constraints – and research gaps in this area are twofold. On the one hand, the heterogeneity of the deep ocean makes understanding the functioning of its ecosystems even more difficult as it comprises different habitats (*e.g.* canyons, seamounts, abyssal plains). On the other hand, deep sea biodiversity is poorly known because of its inaccessibility. Therefore, evaluating it and determining the costs of losing it is urgent as the deep sea is becoming more and more coveted in terms of rare minerals.

Comprehending the threats faced by the ocean requires scientists to gain a global interconnected understanding of all ocean components. Models are essential tools as they help build future scenarios by including biophysical and socio-economic variables. Model projections should achieve displaying the multi-stratified deep ocean – a three-dimensional reality – in a two-dimensional representation. To this end, a global ocean observation system is needed to provide the science of numerical modeling with data. Lastly, developing models is key in understanding the physical behaviour of the continental ice melt in Greenland and Antarctica, and should be developed to predict and assess future sea level changes.

### B. DATA MODELING: FROM GLOBAL TO LOCAL

The development of models in the last decades has bridged important knowledge gaps. For instance, in the first IPCC report published in 1990, scientists did not know how much $CO_2$ was absorbed by the ocean. In 2018, they were able to state with high confidence that 30% of the anthropogenic $CO_2$ is absorbed by the ocean.[8] This progress is the result of an increased observing network and of the contributions of a new generation of scientists that helped understand the new processes at play. In addition to depicting global phenomena, models also represent key tools to identify risks and vulnerability. For example, they have recently been used to show that areas with important decreases in fisheries stocks match the locations in which populations' survival is most dependent on fish resources.

Up until now, the comprehension of the Earth-climate system's functioning has relied on data relevant at the global level, but the scale of the observation should be questioned. Large-scale observations integrate the internal variability of local situations, but soften and/or average out the data. The weak level of details available at the local scale and the accuracy of long-term global projections is paradoxical. Local spatial and temporal variabilities make it difficult for an accurate representation of small-scale phenomena. Admittedly, man-made impacts on climate change are strongly established on the global scale, but a thinner comprehension is needed at the local scale.[9] Consequently, the lack of regional or local data analysis could prevent the proper design of local-scale adaptation measures. Scientific knowledge should adapt to the specifics of the studied area in order to provide a portfolio of locally- and regionally-sourced solutions.

When applied to the ocean-climate system, local-scale observations have proven useful for understanding its dynamics and suggesting adaptation measures. Recent technological progress, such as increased precision in satellite imagery, have transformed observation and monitoring of SLR, a hard-to-predict phenomenon due to the dynamic nature of the ocean and the challenge of understanding the behavior of continental sea ice. Satellite imagery enables a quasi-global coverage and real-time monitoring of SLR. Monitoring sea level change provides a valuable indicator to obtain realistic predictions of the effects of climate change and anticipate extreme coastal events. Considering the significant impacts SLR has on low-lying coastal regions, this knowledge contributes to the implementation of a global systematic space-based monitoring of coastal sea level. Similarly, SIDS should benefit from improved warning systems and technical trainings thanks to satellite imagery. In light of this observation, harmonizing existing warning systems and strengthening international cooperation for technology-sharing must be a priority.

## II. OCEAN SCIENCE FOR AND BY SOCIETIES

In addition to regulating the climate, the ocean provides multiple direct and indirect services to individuals and societies. Throughout the world, the ocean shapes local economies and livelihoods, ensures food security for three billion people, and creates employment opportunities such as tourism and aquaculture. The ocean also provides cultural resources by shaping coastal communities' social organizations. Lastly, marine ecosystems such as coral reefs or mangroves protect coastal settlements from SLR and extreme weather events.

Understanding and measuring individuals' dependence on marine ecosystems and the impacts of climate change on the services they provide is urgent, especially in light of the global threat faced by marine ecosystems. However, assessing the global human dependency on marine life is just as difficult as measuring the evolution of ocean properties, mainly because individuals use and value ecosystems differently depending on time and locations. As such, researching the intrinsic link between the ocean and societies will involve a broad range of academic disciplines, from economics to anthropology, including ecology and other natural sciences.

### A. MEASURING ECOSYSTEM BENEFITS TO SOCIETIES

The concept of ecosystem services was designed as a framework to measure the value of these ecosystems' resources and their benefits to societies. In 2005, the Millennium Ecosystem Assessment (MEA),[10] produced a global evaluation of ecosystem services' values by dividing them into three categories: provisioning (*e.g.* food and materials), regulation (*e.g.* climate regulation and water purification), and cultural services (*e.g.* spiritual and inspirational values, touristic and leisure values).

A large amount of work has been produced to measure marine ecosystem services as well as to provide estimates of individuals' dependences on ecosystems at different scales.[11] In 2015, the Reviving the Oceans Economy: The Case for Action report from the World Wildlife Fund (WWF) estimated the global "gross marine product" (GMP) produced by the ocean and related activities to be of at least US$2.5 trillion.[12] Furthermore, a 2018 regional study co-led by UN Environment established that corals reefs contribute US$13.9 billion per year to the economy of the Coral Triangle,[13] located in the western Pacific Ocean. Putting a price on ecosystem services has proven useful in certain decision-making contexts. However, critics argue against the commodification of nature that struggles to capture how individuals truly value ecosystems.

Although carefully designed for decision-making and widely used, the ecosystem services framework faces criticism as it fails to capture critical elements of the human-nature relationship. Among other things, critics,[14] argue that certain core cultural values cannot be integrated into this framework as they are not based on existing ecological structures. Enjoying looking at the ocean for instance or considering the ocean as an integral part of ones' identity, are difficult parameters to account for when assessing ecosystem services. Therefore, the measurement of these should integrate social sciences and humanities,[15] and indigenous knowledge in particular should be accounted for in the decision-making process since they can be instrumental in solving local challenges.

## B. JOINING SCIENTIFIC EFFORTS IN DATA COLLECTION

The amount of physical and biological data collected in the ocean is significantly uneven. On the one hand, physical parameters (*e.g.* sea surface temperature, salinity, wave heights, winds and currents) can be either measured from space – with the global network of satellites – or using *in situ* data. The latter requires very little workforce once the data collection devices are up and running. The Argo Network, for instance, has over 3.800 floats drifting along the currents all over the global ocean. These floats measure temperatures and salinities of the first 2.000 meters of the ocean, allowing for a continuous monitoring of the ocean's upper-layer. Collected data is then transmitted to a satellite and made available within hours of its collection on an open online platform.

On the other hand, biological data (*e.g.* coral, mangrove or algal cover in different areas; fish distribution; phytoplankton and microbial diversity and activity) is much more difficult and time-consuming to collect. Carrying out these observations – absolutely necessary to predict future ocean changes – would require an army in order to achieve the same level of data collection that the physical and biogeochemical fields have gathered.[16] A solution to increased biological data collection is through the help of citizen science. The great public participation has been increasingly growing, especially with the development of new means of transmitting information to scientists. The voluntary monitoring of coastlines has allowed for more data to be acquired on sea level evolution, marine litter, whale tracking, water quality and much more. With the development of more affordable equipments, citizen science should be encouraged, both for the educational opportunity it provides as well as for data collection to be used in modeling.

Moreover, for the purpose of building transdisciplinary models, a close collaboration between physicists and biologists is needed, therefore enabling them to synchronize their data collection efforts. A broad training of graduate students would facilitate this collaboration by allowing young researchers to navigate in both fields.

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# CHAPTER 2 – PROTECTING MARINE AND COASTAL ECOSYSTEMS

**AUTHORS: ELÉONORE BACQUET, ELISABETTA BONOTTO, VICTOR BRUN, MOUNA CHAMBON, LUNA MERINO, LORELEY PICOURT**

Preserving the integrity of marine and coastal ecosystems is an integral part of maintaining human well-being and a sustainable economy. In many cultures, the ocean plays a central role in shaping cultural beliefs and identities. In Polynesia, for instance, societies consider the ocean as the extension of the dry land upon which human societies depend. This singular relationship is a crucial reminder that a healthy and productive ocean is central to the resilience of societies.

In the face of climate change, the ocean further holds great potential by providing adaptation and mitigation solutions. Adequately balancing the conservation of the ocean and its sustainable use by societies will depend on our ability to better understand these possible trade-offs. In that regard, the upcoming UN Decade of Ocean Science will strive to "create a better understanding of the interactions and interdependencies of the environmental conditions and processes, the use of resources and the economy" (§ 36).[17]

Adapting to climate change requires an adjustment to actual or expected climate change and its effects, in order to moderate harm and/or benefit from

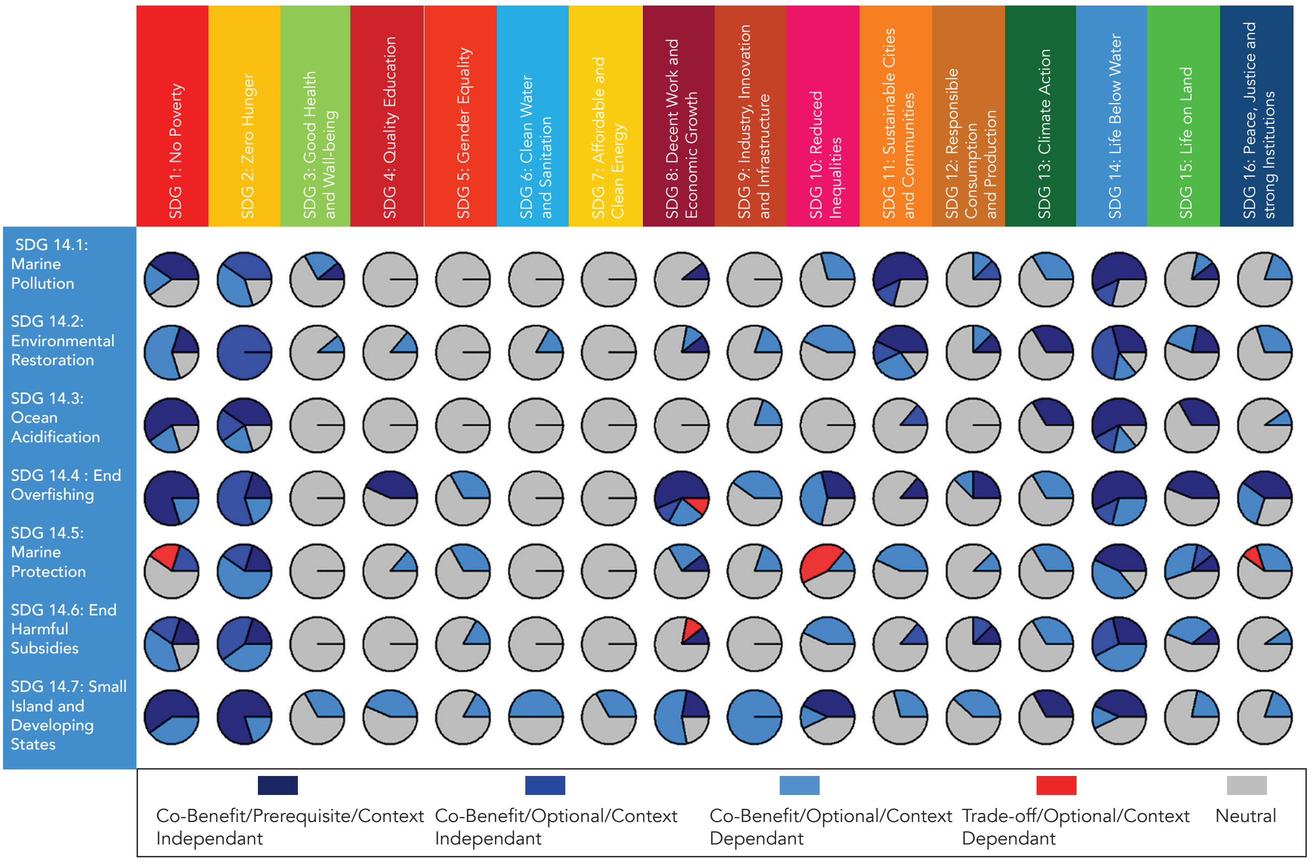


**Figure 3.** SDG 14 and other SDGs - Characterized relationships between Oceans targets and other SDGs. Pie charts represent the proportion of targets within SDGs to which a given Oceans target contributes, according to the framework presented in this paper. The pie charts do not indicate how much achieving Oceans targets contributes to other SDGs. *Source: Adaptated from Singh, G., Cisneros-Montemayor. A., Swartz, W., et al. (2018) A rapid assessment of co-benefits and trade-offs among Sustainable Development Goals, Marine Policy (93), pp. 223-231.*

potential opportunities. In other words, populations are in dire need to develop solutions which, in turn, will be decisive for their ability to "anticipate, absorb, accommodate or recover" from the adverse effects of climate change. Nonetheless, we must bear in mind that adaptation is not only the product of human societies but can be provided by ecosystems themselves. Based around three pillars – societies, economics and the environment – the 2030 Agenda for Sustainable Development,[18] provides a unique framework to achieve a sustainable future. This roadmap to success defines 17 interconnected Sustainable Development Goals (SDGs) on issues such as people, planet, prosperity and partnerships.

The 2030 Agenda further highlights that water, biodiversity, ocean and climate are intrinsically linked. At the heart of this "life-supporting" package, SDG 14 focuses on the conservation and sustainable use of the ocean, seas and marine resources. Declined around 10 targets, SDG14 sets out a global plan to restore respect and balance to humanity's relationship with the ocean (Figure 3). It is this balance between protection and production that we must nurture as a global community.[19] This understanding of the singular role of the ocean and the need to preserve it is thus reflected in various UN actions pointed out by the forthcoming UN Decade of Ocean Science for Sustainable Development (2021-2030).

# I. THE INTRINSIC LINK BETWEEN THE OCEAN AND SOCIETIES

## A. THE OCEAN'S CULTURAL SIGNIFICANCE

Interconnectivity between the Earth system and human societies is reflected in the concept of ecosystem services, which refers to the contributions provided by marine and terrestrial ecosystems to human well-being. Indeed, coastal and marine ecosystems offer various services: fresh air (*i.e.* oxygen supply), fish stocks, water security and medicines, among others. The ocean also contributes to human well-being through cultural, aesthetic or recreational features (*e.g.* beauty of coral reefs).[20] The cultural dimension is to be addressed as a priority as it encompasses an array of values, meanings, knowledges and practices linked to the ocean.[21] Coastal and marine ecosystems are key elements of coastal communities' culture and identity.[22,23] For instance, the Ocean Declaration of Maupiti – endorsed by fifteen Pacific nations in 2009 – highlights that "for many Pacific communities, there are sacred and intrinsic links with land, sky and ocean. This constitutes for many a fundamental and spiritual basis of existence (...)".[24]

However, the cultural significance of the ocean is not reflected in SDG 14 and has only been formally recognized in the aftermath of the 2017 UN Ocean Conference. One of the main reasons for this is that the qualitative dimension of cultural services is difficult to measure and comprehend, especially since a wide range of social sciences lacked interest for the subject,[25] (*e.g.* anthropology). In the last decades, the notion of ecosystem services has shifted towards the term nature's contributions to people (see box 1) to emphasize this cultural dimension and embrace a more integrated approach. Research in this field should be encouraged, strengthened and deepened in order to integrate the interactions between ocean and culture into decision-making processes.

## B. ENHANCING ACCESS TO OCEAN KNOWLEDGE

"*Education is extremely important. We need to give people the sense of what the connection is between them and the ocean*" – Patricia Miloslavish.

As mentioned above, the ocean is essential to individuals and societies. In this regard, priority must be given to (1) creating a global knowledge system on ocean-climate interactions and (2) improving ocean literacy worldwide to safeguard the ocean's ability to provide solutions for mitigation of and adaptation to climate change.

There is a great disparity of inputs to the body of knowledge on ocean-climate interactions, with a large amount of contributions coming from scientific communities based in developed countries. Additional efforts are needed in developing countries – especially on the African continent – where gaps on ocean science remain and prevent the

**Box 1. From "ecosystem services" to "nature's contributions to people"**

In 1997, the term ecosystem services was coined in a scientific paper,[26] disclosing the total value of services provided by the world's ecosystems. The concept was then popularized in 2006 with the Millenium Ecosystem Assessment (2005),[27] which classifies ecosystem services into four categories:

- **Supporting services:** maintain the ecosystem itself (*e.g.* nutrient cycles).
- **Provisioning services:** produce food, water, wood, fibers or pharmaceutical raw materials.
- **Regulating services:** ensure regulating functions (*e.g.* carbon sequestration).
- **Cultural services:** provide recreational, aesthetic, cultural or spiritual fulfillment.

However, assessing these services is highly debated and has been addressed by competing conceptual frameworks.[28] In 2018, the IPBES defined nature's contributions to people as "all the positive contributions, or benefits, and occasionally negative contributions, losses or detriments, that people obtain from nature".[29] Going beyond the notion of ecosystem services, this definition emphasizes the pluralistic and inclusive worldviews on values associated to nature and knowledge systems.[30]

Yet, IPBES' definition faces several criticisms.[31] First, it is discredited for its unidirectional dimension (*i.e.* from nature to people), whereas ecosystem services recognize the reciprocal dimension of human-nature interactions. Secondly, the use of the word "nature" could overshadow certain types of ecosystems such as urban- and agro-ecosystems that concentrate most of the world's population. Lastly, a change in terminology can confuse the general public and hinder ocean awareness.

Overall, Peterson & al (2018),[32] call for the "recognition of pluralism" in the perspectives on human-nature relationships. While each of them presents limitations and advantages, the goal is to encourage dialogue between the different approaches and integrate them in a unique framework.

implementation of local mitigation and adaptation measures. As such, the focus should be on improving networks and partnerships for data sharing,[33] so that solutions designed at the global level can be locally implemented while accounting for the specificities of regional challenges.

Likewise, efforts must be strengthened to better promote gender equality and inclusion into the various scientific fields. To this day, women only account for 30% of the world's researchers,[34] and opportunities to be part of research teams are lacking. Empowering women and girls from an early age is crucial to equip them with the necessary confidence to challenge this gender imbalance in sectors and professions historically dominated by men. Promoting strong female role models, investing in mentorships for young female scientists, creating networks of collaborations, targeting and listening to female beneficiaries in indigenous communities… are some of the many ways women representativity in ocean science, and beyond, can be improved.

Ensuring diversity in ocean science and strengthening efforts to produce sound knowledge on ocean-climate interactions are at one end of the spectrum. On the other end, we find the great public who is increasingly demanding for accessible information to better understand our global environment. In an effort to respond to this growing challenge, the concept of ocean literacy has emerged. Defined by IOC-UNESCO as "understanding the ocean's influence on you and your influence on the ocean", ocean literacy is the result of a close collaboration between scientists and communication specialists, for the purpose of producing easily understandable ocean science for the great public. These resources – most often available online – strive to guide citizens on day-to-day choices and actions that can have cumulative benefits on the ocean and its ecosystems' health.

### C. BLUE-ING THE GREEN ECONOMY

Pending on the approval of a consensual definition for the 'blue economy', the World Bank defines it as the "sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health".[35] Arguably, the ocean economy can be divided into two mutually influencing categories: ocean-based industries and ocean ecosystems.[36] While, the latter provides services for industries, the former tends to have an impact on the health of marine ecosystems. In 2010, the OECD estimated the value of ocean economy to US$1.5 trillion and projected it could double by 2030 to reach US$3 trillion.[37] In light of these predictions, existing development models should be challenged to take into account a more environmentally-friendly approach to ensure the ecological transition.

Many countries tend to focus on economic growth and reducing unemployment using development paths inconsistent with the UN SDGs framework. Climate targets to remain below a global warming of 2°C are too often left out from economic policies mainly because (1) climate change impacts are not immediately visible in the short term, and (2) transitioning to a sustainable economy is usually associated with high implementation costs. For instance, in order to ensure that temperatures remain below a 2°C increase, G20 countries would have to invest USD 6.9 trillion per year in new infrastructures over the next fifteen years.[38] Given evident and serious monetary implications, it appears transitioning to a more sustainable economy suffers from a dearth of political will.

Yet, rapidly expanding ocean-based industries are a growing threat to marine and coastal ecosystems, and therefore to the ocean's capacity to sequester $CO_2$. Increasing demand in aquaculture, renewable marine energies, tourism and other sectors entails to boost efforts to conserve and sustainably use ocean resources.[39] Today, thirteen out of the twenty most populated cities are located on the coastline,[40] and according to recent estimates, the population density of coastal cities is set to keep increasing,[41] thus raising serious concerns about the "coastal syndrome",[42] (Box 2).

**Box 2. The coastal syndrome**

While ocean ecosystems are already exposed to climate stress, coastal development amplifies anthropogenic pressures on coastal ecosystems especially because of land-based pollution and overexploitation of resources.[43] This plurality of stressors is responsible for the alarming erosion of marine biodiversity,[44] which reduces the quality of services provided by these ecosystems. As such, a loss in biodiversity will impact the food chain and result in an overall disruption of fisheries' reserves – already plummeting in some areas.

Transitioning to a sustainable blue economy must go hand in hand with the implementation of efficient tools to protect the ocean, while taking into account the development of appropriate green infrastructures. Well-thought spatial planning must take place both on land and at sea.

## II. MARINE PROTECTED AREAS: A TOOL FOR CONSERVATION

Marine ecosystems are subject to increasing pressure resulting directly or indirectly from human activities, such as overexploitation, land-based pollution, habitat destruction and climate change. In its Special Report on the impacts of global warming of 1.5°C, the IPCC stated that a global warming of 1.5°C above pre-industrial levels, although less harmful than an average rise in temperatures of 2°C, will pose great challenges to marine ecosystems.[45] Recent studies have already shown a general increase in cumulative human impacts on the ocean between 2008 and 2013, and that every marine species is affected in one way or another by human activities, with a striking 41% facing multiple factors of stress.[46]

Socially and ecologically relevant conservation measures, such as Marine Protected Areas (MPAs), must be efficiently implemented and would benefit from an improved dialogue among the scientific community, local stakeholders and policy-makers.

## A. DEFINITION AND INTERNATIONAL COMMITMENTS

Although there is no consensus yet regarding a universal definition, the International Union for Conservation of Nature (IUCN) defines an MPA as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem

**Box 3. Locally Managed Marine Areas (LMMAs)**

LMMAs are built on a community-based approach: they integrate indigenous and local populations into the decision-making process, while involving different stakeholders. They can be used to spread knowledge and increase community engagement towards marine protection, as well as to empower local populations by promoting local practices. They are particularly popular in the Pacific region: in Vanuatu, for instance, the Nguna-Pele Marine and Land Protected Area Network covers more than 3,000 hectares of marine and terrestrial area and is managed by 16 different indigenous communities. LMMAs have thus been designed to limit harvesting by raising awareness and engaging fishermen in conservation.

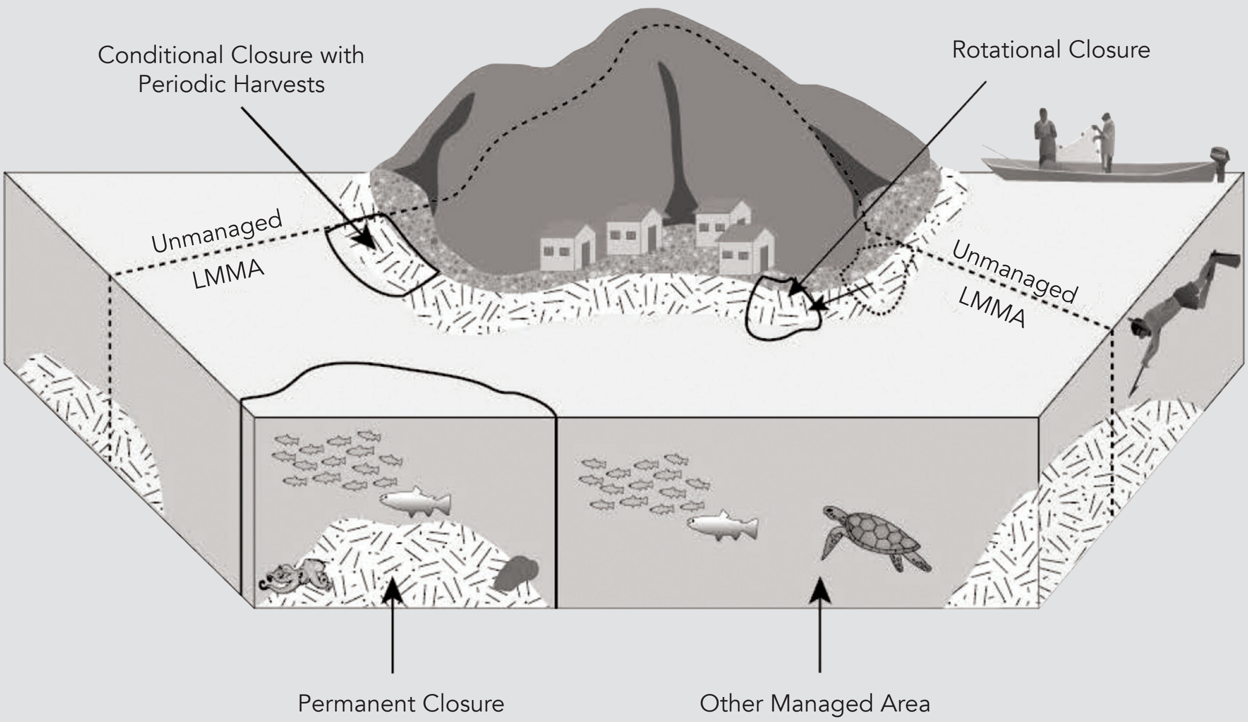


**Figure 4.** An example of management measures implemented within a LMMA on a Pacific Island. The dashed line represents the boundary of the LMMA and adjacent land tenure area.
- Permanent closures prohibit resource extraction for life.
- Conditional closures with periodic harvests are no-take areas, occasionally opened for socio-cultural needs.
- Rotational closures are no-take closures that are lifted and moved after a predefined time.

*Source: Jupiter, S.D. et al. (2014) Locally-managed marine areas: multiple objectives and diverse strategies. Pacific Conservation Biology, 20 (2), pp.165-179.*

services and cultural value".[47] In a nutshell, MPAs aim at regulating extractive and non-extractive activities at sea to ensure the protection and sustainable use of marine ecosystems.

Over the past decade, the international community has made several commitments to achieve global marine conservation. In 2010, the Convention on Biological Diversity updated its 2011-2020 Strategic Plan for Biodiversity and adopted the twenty ambitious Aichi Biodiversity Targets. Although only two targets focus on ocean and marine issues, target 11 particularly identifies the protection of ecosystems, species and genetic diversity in order to improve the status of biodiversity,[48] specifying that "By 2020, at least [...] 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas [...]".[49] In 2015, this quantified ambition was reaffirmed by the United Nations with the adoption of SDG 14.5, calling for a sustainable ocean management, and specifying the urgent need to "conserve at least 10 percent of coastal and marine areas",[50] by 2020. Although Aichi Target 11 provides details on the design, implementation and management of MPAs, both frameworks leave plenty of room for interpretation with regards to concrete protection measures, such as the appropriate level of protection or monitoring and financing mechanisms. The shape and size of each area vary, and they can be located in different maritime zones (*i.e.* Internal Waters, Territorial Sea, Contiguous Zone, Exclusive Economic Zone (EEZ) and the High Seas). MPAs are implemented using different legal frameworks, governance systems and monitoring mechanisms. Based on all these factors, along with their lifespan, MPAs can be more or less efficient.

## B. SOCIO-ECONOMIC AND ENVIRONMENTAL OUTCOMES

MPAs can provide a wide range of long-term socio-economic and environmental benefits. The extent of the latter largely depends on the MPA design, implementation, management,[51] size and age.[52] In principle, MPAs benefit local biodiversity as they help restore ecosystems and resources. A well-protected and well-managed area will result in an increase in both habitat quality and in the size and biomass of mature fishes. The fish population's structure, size and age will be restored, which in turn will increase the activity of egg laying.[53]

The social and cultural benefits of MPAs also depend on their characteristics.[54] If designed in an integrative way – by involving local communities and indigenous knowledge in the planning and management processes (see Box 3), or by establishing Marine Educational Areas (see Box 4) – MPAs have proven effective in improving the interaction of local populations with their environment.

However, potential negative outcomes have been acknowledged, such as local communities suffering from a weakening of local governance rights (*e.g.* limited participation in the management of MPAs, criminalisation of customary practices...) or from cultural impacts (*e.g.* restricted access to cultural or sacred site...).

**Box 4. Marine educational areas**[55]

The concept of "marine educational areas" was born in 2012 in the Marquesas Islands, out of a will to sensitize students to the richness of local biodiversity. Supported by the Motu Haka Federation, the former French MPAs Agency, the Polynesian government, and the Community of the Marquesas Islands, this initiative has been a great success and is unique and innovative in many ways.

School students and teachers manage a small ocean area in a participatory way and according to principles defined by a charter. This scientific and civic initiative promotes – among young people – the protection of the marine environment and knowledge of thet maritime heritage, including jobs in the maritime sector.

MPAs also provide great economic benefits as they offer more abundant biodiversity and resources both within and without their borders due to a spillover effect, *i.e.* a mechanism where an increased competition within the MPA triggers a movement of the biomass towards adjacent areas outside MPAs.56 These benefits can be found in the fisheries and tourism industries, among others, where they generate higher incomes than investment costs.[57]

Lastly, MPAs are extremely valuable for researchers since they provide research stations that gather a broad range of stakeholders and abundant data. They provide a unique opportunity to lead different kinds of research, from studies on the effects of direct, indirect and reduced human pressure on marine ecosystems, to applied research and policy-making.

## C. REMAINING CHALLENGES

Although MPAs can offer a wide range of benefits, some aspects of the design process can be improved to further boost their positive effects.

### IMPROVING MPA PLANNING

Marine habitats are interconnected by the movements of migratory species. The implementation of new well-managed, ecologically coherent MPA networks, and the improvement of existing ones, is essential for enhancing spatial connectivity both within and between MPAs, and therefore boost ecosystem resilience. In this regard, the IUCN World Congress in Hawaii recommended to increase the global coverage of MPA networks to 30% by 2030,[58] establishing a minimum yet crucial standard on which to build future conservation plans. This goal is further supported by a 2015 study of the WWF, [59] which indicates that such expansion could create significant socio-economic benefits. However, in the run up to 2020, it appears that governments might fail to attain the present objective of preserving 10% of the ocean. Moreover, MPAs may be successful in said coverage but provide very limited benefits, *i.e.* paper parks.[60]

### LARGE SCALE MARINE PROTECTED AREAS (LSMPAS)

While size and age do matter,[61] the remote location of an MPA can negatively influence its efficiency. Large scale marine protected areas cover at least 100,000 km² and are mostly located in rather remote areas with fewer socio-economic and environmental value than coastal areas. Also, LSMPAs are often criticized for being allegedly motivated by political opportunism, rather than environmental need. Indeed, creating LSMPAs in remote locations is considered easier than in heavily used areas, especially because there are usually fewer direct stakeholders, thus reducing the possibility of meeting opposition. Bearing in mind that out of

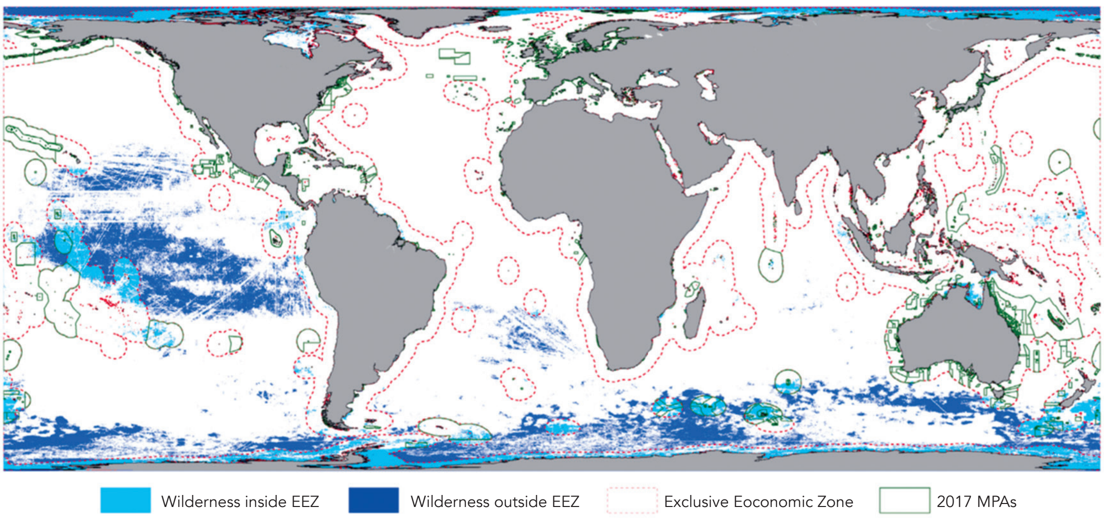


**Figure 5.** Out of the 13.2% of the world's ocean classified as marine wilderness, only 4.9% of it is protected.
Source: *Jones, K. R. et al. (2018) The Location and Protection Status of Earth's Diminishing Marine Wilderness. Current Biology (28), pp.2506-2512.*

13.2% of the world's ocean being classified as marine wilderness, only 4.9% is protected.[62] An improvement in design and management could ensure the role of LSMPAs as valuable tools of ocean conservation through their ability to protect interdependent ecosystems within a unique management area.

## MEASURING THE EFFICIENCY OF MPAS

Assessing MPA efficiency is essential for conducting comparative studies between MPAs to further increase the potential for adaptive management as well as to improve their design and monitoring. Among others, two measurement tools have been developed and are detailed below.

On the one hand, the 'management-based approach' is a methodology designed to assess MPA efficiency depending on the way they are managed. Developed by the *Management Effectiveness Initiative* (MEI),[63] – initiated by IUCN's World Commission on Protected Areas (IUCN-WCPA) and the WWF – this approach assesses a set of biophysical, socio-economic and governance indicators as shown in Figure 6.

On the other hand, the 'regulation-based approach' was developed by Horta e Costa et al.,[64] in response to IUCN's classification system which, they argue, tends to misrepresent the reality of an MPA regulation, and does not consider the potential human impacts on MPAs. The regulation-based classification instead takes into account the different activities taking place in MPAs and their potential impacts on marine ecosystems, as described in Figure 7.

## LAND-BASED POLLUTION

Although MPAs can act as mitigation and adaptation tools, they cannot always tackle land-based pollution such as greenhouse gas emissions, deoxygenation and marine debris, that have a considerable impact on ocean health and on MPAs themselves.[65]

Land-based adaptation and mitigation measures (incl. education and behavioral change) targeting land-based pollution should be tackled at the root-causes,[66] which would be beneficial for marine ecosystems when implemented together with MPAs.

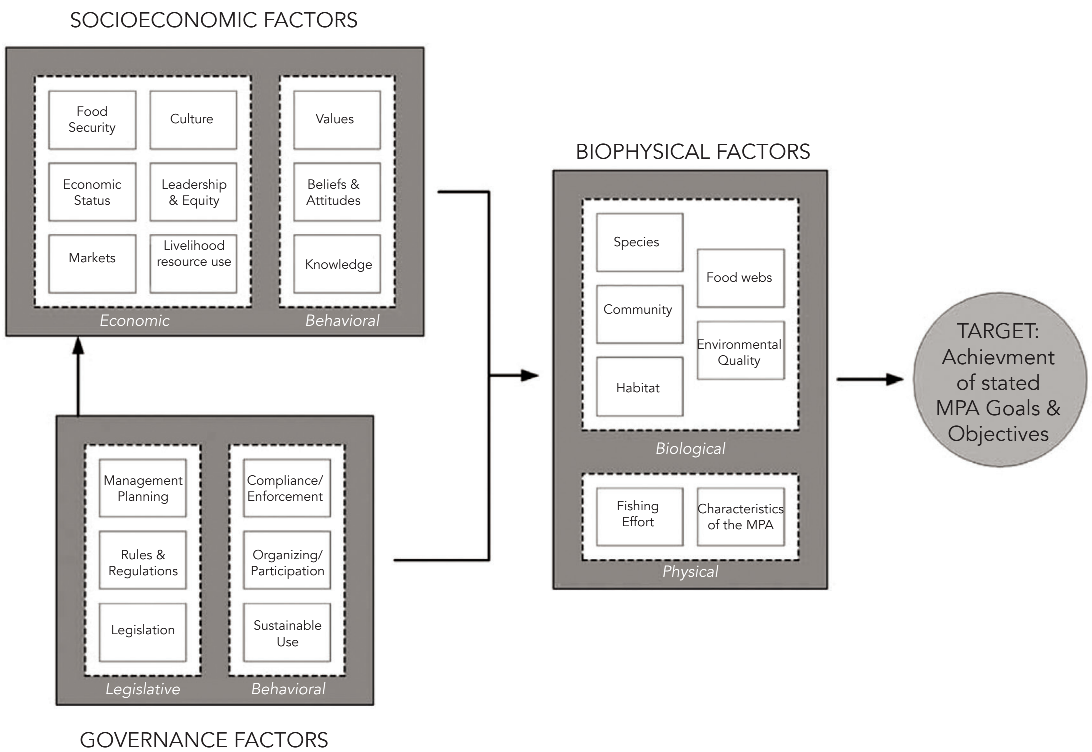


**Figure 6.** Schematic of the operating conditions within and around MPAs.
*Source: Adaptated from Pomeroy, R. S., Watson, L. M., Parks, J. E. & Cid, G. A. (2005) How is your MPA doing? A methodology for evaluating the management effectiveness of marine protected areas. Ocean & Coastal Management 48, pp.485–502.*

MPAs can be key sentinels of climate change, laboratories to monitor the effects of climate change, and areas where to develop new management tools, and showcase concrete examples of adaptation strategies. There is a need to include more actors in MPA planning, including by bringing fisheries into the "knowledge, consultation and collaboration" process to ensure adaptive management.[67] MPAs should be based on an ecosystem approach and boast a new research agenda on the impacts of climate change on ocean ecosystems.[68] Traditional ecological knowledge from fishermen and observations from other sea users must be integrated into the research and monitoring efforts.

Overall, MPAs are valuable tools to ensure the conservation and sustainable use of all marine ecosystems. They benefit both nature and human communities through restoring ecosystems and habitats, and providing social, economical and cultural benefits for the dependent populations. Nonetheless, MPAs' positive aspects can be enhanced if implemented in conjunction with other conservation measures. Far from being a pipe-dream, the efficiency of MPAs still depend on their planning, scale and management. Thus, an efficient conservation policy must take into account the existing diverse conservation tools and develop a further integrated approach.

## III. ENHANCING PROTECTION THROUGH COMPLEMENTARY CONSERVATION TOOLS

The ocean is made of a great diversity of marine and coastal ecosystems with each their own specificities. In order to guarantee their protection, a broad variety of tools have been developed, usually complementary to one another. Among others, promoting marine spatial planning (MSP) and

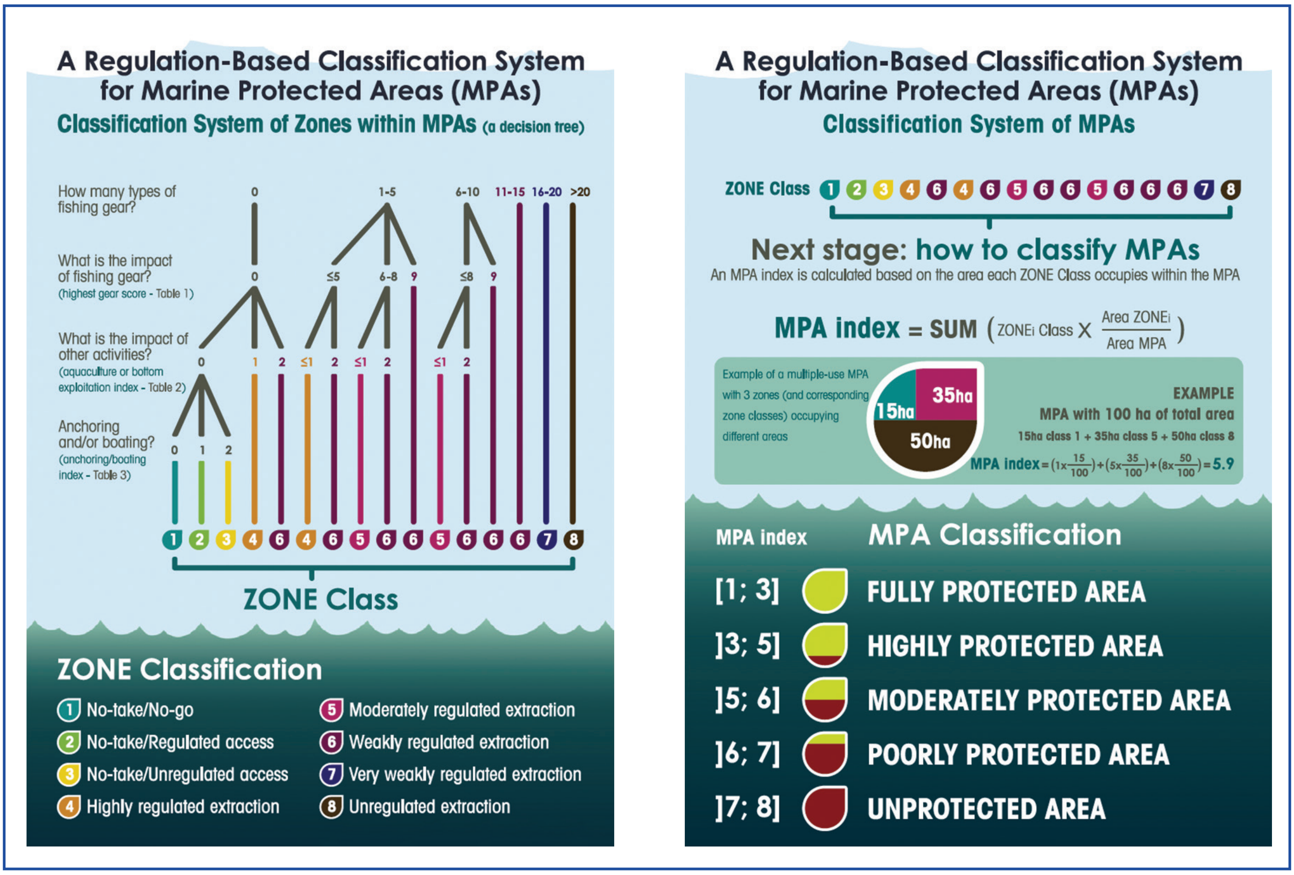


**Figure 7.** Decision tree of the regulation-based classification system. A step by step decision tree for classifying zones within MPAs and MPAs.
*Source:* *Horta e Costa, B. et al. (2016) A regulation-based classification system for Marine Protected Areas. Marine Policy 72, pp.192–198.*

ecosystem-based approaches is determinant for the resilience of these precious ecosystems.

Mangroves, seagrass meadows and salt marshes, among many others, are considerably under threat from human-induced climate change. These ecosystems not only support human activities, such as fishing and tourism, and hold moral, cultural and aesthetic values; they play a critical role in absorbing $CO_2$ and adapting to climate change. They act as buffers against sea-level rise and increased storm intensity.[69] Protecting and restoring these blue carbon ecosystems, along with evaluating their benefits, represent a critical opportunity to combat climate change.

## A. MARINE SPATIAL PLANNING

Along with the creation of MPAs, the UN 2030 Agenda promotes marine spatial planning (MSP) measures in SDG 14.2,[70] which aims to "sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans" by 2020.

According to the IOC-UNESCO, MSP is a public process of both spatial and temporal analysis and allocation of human activities within marine areas in order to attain politically-determined goals (ecological, economic and social). MSP should lead to a more rational use of marine space and help balance economic development and protection of the environment.[71]

In other words, MSP aims to manage and sustainably use marine space outside MPAs, by regulating human activities (*e.g.* fishing and other extractive activities) that directly impact marine ecosystems. Similarly to MPAs, MSP can be an inclusive process, involving local stakeholders in the implementation processes,[72] to plan the sustainable use of marine resources in a concerted manner.

Ongoing debates on the efficiency and means to implement MSP,[73] focus mainly on marine biological diversity of areas beyond national jurisdiction which currently lack from a legal protection framework. Furthermore, MSP is criticised for encouraging the economic use of the ocean at the expense of marine protection.[74] To solve these challenges, we urgently need to implement a global system to identify and measure marine ecosystem services so that policy-makers can define sustainable thresholds for economic uses of the ocean, as recommended by the upcoming UN Decade of Ocean Science.[75]

## B. PROTECTING COASTAL BLUE CARBON

Coastal ecosystems (*e.g.* mangroves, tidal marshes, seagrasses) are key ecosystems to contribute to mitigating climate change.[76] They participate in climate regulation by sequestering and storing atmospheric $CO_2$ in the ocean floor and in woody biomass of marine vegetation.[77] Moreover, blue carbon ecosystems offer a wide range of co-benefits, particularly in the face of sea level rise. Although these coastal habitats cover less than 2% of the total ocean area, scientists estimate that they account for approximately half of the total carbon sequestered in ocean sediments, with a higher sequestration rate of $CO_2$ per unit area than terrestrial vegetation.[78] Therefore, the protection and restoration of blue carbon ecosystems is a significant opportunity for addressing climate change.[79]

However, in spite of the benefits they provide, these ecosystems are greatly threatened by human activities, such as aquaculture, agriculture or the exploitation of mangrove forests. It is estimated that 29% and 35% of the respective global coverage of mangroves and seagrass meadows has already been lost. But when degraded or destroyed, these ecosystems become significant sources of GHG as they release their stored $CO_2$.

To protect these vital ecosystems, NGOs, governments and research institutions have joined the Blue Carbon Initiative,[80] a global program acting on climate change mitigation by preserving and restoring coastal and marine ecosystems. Coordinated by Conservation International (CI), IUCN and IOC-UNESCO, the Initiative promotes financial incentives and policy mechanisms to support blue carbon conservation.

# CHAPTER 3 – GOVERNANCE

AUTHOR: LORELEY PICOURT

For a long time, the Ocean was thought to be the limit of the world, associated with the mysterious horizon line, on which many myths and legends have been built. The XV^th century was punctuated by great European maritime discoveries and the first exploration travels, driven by the discovery of precious resources and exchanges with new trading partners. In the XVII^th century, European powers undertook their first scientific expeditions, guided by the Enlightenment spirit, the desire to expand the knowledge of the research community.

It is only in the first half of the XX^th century that the ocean became a real object of study and observation, leading to thorough analyses of the seabed, water masses, and unknown organisms inhabiting the ocean ecosystem. While scientists previously thought no life existed beyond a certain depth, a world of abundant biodiversity – yet to be explored – had just been discovered.

After WWII, scientists and policy-makers set the path to the first legal and policy instruments dedicated to the protection of the ocean and the marine and coastal environment – the UNCLOS, adopted in 1982, becoming the "Ocean Constitution". Yet, a proper ocean governance failed to fully emerge and is currently fragmented due to a significant lack of coordination. If two distinct intergovernmental and multidisciplinary regimes on climate and biodiversity – with the support of the IPCC and IPBES scientific communities – have arisen and are today well-known, the interactions between ocean and climate and its marine biodiversity are still poorly integrated.

While the world is facing up to the challenges of climate change, we must also address the realities of ocean change. Restoring ocean health and safeguarding its ecosystems, requires us all to collaborate and invest our energies, solutions and resources into sustaining the balance and integrity of the ocean. To ensure a stable future for humankind, climate action and ocean action are the two great demands of the XXI^th Century.

Since the 21^st Conference of the Parties of the United Nations Conference on Climate Change, which resulted in the inclusion of the Ocean in the Paris Agreement and the subsequent Global Climate Action Agenda, we have galvanized international attention. These are the years for action and implementation. These are the years of inclusivity, with communities of action partnering up the scientific community, non-governmental organisations, intergovernmental organisations, the private sector and States in a common endeavor to conserve and sustainably manage the resources of the ocean.

This chapter seeks to understand how to build upon ocean science to achieve global ocean governance. Based on the existing legal framework for the High Seas and considering the existing regimes on climate and biodiversity, this chapter intends to focus on the need for a coherent and coordinated approach to fully address the ocean-climate-biodiversity nexus.

## I. A ROBUST TREATY FOR THE HIGH-SEAS

Ocean-related legal and policy instruments have been developed within the UN system since the 1970s with the aim of protecting marine ecosystems. The United Nations Convention on the Law of the Sea (UNCLOS), which entered into force on 16 November 1994, sets forth the rights and obligations of states regarding the use of the ocean, their resources, and the protection of the marine and coastal environment. UNCLOS established that "the Area"— "the seabed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction"—and its resources are the common heritage of mankind. Ocean protection, however, has been challenging given governance difficulties in areas beyond national jurisdictions.

## A. THE HISTORICAL CONTEXT OF OCEAN GOVERNANCE

As early as the XVII[th] century was introduced the principle of freedom of the seas by the Dutch jurist Hugo Grotius. In his renowned book "Mare Liberum" (1609), he defends the vision of an open space where humanity could freely trade and navigate.[81] At the time, the law of the sea was customary.[82] This branch of international law defines both maritime areas and the rights and duties of the states in these areas. Since then, this vision governed the uses of the ocean and its resources. Over the last 60 years, however, there has been an increasing codification of maritime affairs.[83] The development of human activities such as offshore mining and fishing, as well as their associated risks for the environment, led the international community to set up an international framework for the ocean.[84]

From the 1940s, various intergovernmental bodies were established in order to regulate and harmonize the economic uses of the ocean at the global scale. For instance, the International Maritime Organization (IMO) was created in 1948 with a mandate on shipping. With regards to marine resources, since 1945, the UN Food and Agriculture Organization (FAO) has been responsible for the regulation of fisheries. Nevertheless, given the very sectoral mandates of this multitude of actors, the need for a global framework on the ocean was pressing. The first attempt to design such apparatus occurred during the 1958 Geneva Conference,[85] which led to the adoption of four major conventions: the Convention on the Territorial Sea and the Contiguous Zone; the Convention on the Continental Shelf; the Convention on the High Seas ; and the Convention on Fishing and Conservation of the Living Resources of the High Seas. Yet, none of these conventions were ever ratified by states, thus their impact remained very limited.[86] It is only 24 years later that the design of a new framework was initiated.

The UNCLOS is often called the "Constitution for the Ocean".[87] To date, this convention represents the key legal instrument for governing all uses of the ocean and its resources. The convention has notably led to the creation of the International Seabed Authority (ISA), an organisation dedicated to the regulation and control of mineral-related activities in the seabed of the area beyond national jurisdiction (ABNJ).[88] This milestone shows a shift from the regulation of economic activities in the sea to the protection of mineral resources of the international seabed. Today, the ABNJ presents two distinct law regimes. While the international seabed is formally recognised as common heritage of humanity,[89] the water column, or high seas, falls in the principle of "first -come, first-served".[90] In other words, nearly two thirds of the ocean still fall in the principle of freedom.[91] This is all the more pressing issue in the context of climate change and will be at the heart of the United Nations process on biodiversity beyond national jurisdiction (BBNJ), which started in September 2018.

## B. THE STAKES OF GOVERNING BIODIVERSITY BEYOND NATIONAL JURISDICTION

On 24 December 2017, the UN General Assembly adopted a landmark resolution, Resolution 72/249 supported by more than 130 nations, thus initiating global negotiations for an international and legally binding treaty to conserve and sustainably use the high seas by 2020. Resulting from over a decade of scientific and political debates, this two-year negotiation process aims at addressing pressing legal and regulatory gaps to secure the governance of nearly two thirds of our Planet.[92]

The ongoing negotiations on the High Seas are the only legally binding environmental treaty currently being negotiated at the UN level. In particular, this agreement aims to preserve essential ecosystem services – including carbon sequestration and primary production – through strengthened management

**Box 5. The Ocean, Common Good of Humanity**

As the United Nations are currently negotiating the legal regime for the high seas, the question of considering the ocean as a common good is a very timely issue.

Because there is only one global ocean, international cooperation and commitments are needed to ensure its preservation. Ocean health is necessary for the future of humankind as the ocean is instrumental in regulating the climate, providing oxygen and other ecosystem services.[93] However, the acceleration of human activities and their impact on marine and coastal ecosystems is putting the ocean under threat. While UNCLOS represented a significant achievement, this international framework is still incomplete when it comes to 64% of the ocean that lies outside any country's national jurisdiction.[94]

That is why the Appeal for the Ocean, Common Good of Humanity was recently launched.

While the legal regime for the high seas is set to be finalised by 2020, the initiators of the Appeal call for the recognition of the entire ocean as a common: from the coasts to the high seas.

This approach considers the ocean as an inalienable good, a "everyone's thing" that requires shared responsibilities among states. This proposition does not interfere with the principles of liberty and sovereignty. Rather, it brings a new interpretation of the Law of the Sea by "considering that the specific rights which [UNCLOS] gives to a State must be seen first and foremost as a particular delegation of responsibility for the appropriate management of spaces".[95] In this way, regulating the uses of the ocean on a coordinated and sustained manner will ensure the future of the ocean, while respecting sovereign rights.

of marine genetic resources and the development of tools and methods for the protection of marine biodiversity, such as MPAs, environmental impact assessments and ecosystem-based management.

In this context, the UN Decade of Ocean Science could encourage the development of ocean data sharing mechanisms and strengthen ocean observation systems especially in the deep sea.[96] Hence, fostering the Deep Ocean Observation Strategy could contribute to fill the knowledge gaps on deep-sea organisms in the high seas. This is particularly needed in order to demonstrate the vulnerability of these ecosystems and support the design of a strong and binding international framework for the conservation and sustainable use of their resources.

Considering the escalating impacts of human activities on these ecosystems – including overfishing, bioprospecting activities, land-based pollution and climate change,[97] – scientific inputs must complement the diplomatic perspective. Scientific advances highlighted the potential of marine genetic resources (MGRs) for medicine and industrial use. Defining the status of MGRs under this future agreement implies to decide whether their access should be regulated and how the benefits arising from their use should be shared among countries.

At this early stage of the negotiations, the international community is divided into two distinct groups.[98] On the one hand, a group of states, including mostly developing countries and China, is calling for a new conservation-oriented agreement. On the other hand, the US, Canada and Japan are advocating for an improved legal apparatus without creating a new treaty. Meanwhile, the EU is holding an intermediate position by proposing a mechanism on access to genetic resources and the fair and equitable sharing of their benefits.

Despite considerable efforts, the ocean governing landscape remains patchy with the multiplication of international organisations dealing with ocean affairs.[99] Improving current ocean governance requires bridging the gaps between the different bodies responsible for ocean matters at all levels. It is not only crucial to fill the legal vacuum regarding the status of biodiversity beyond national jurisdiction,[100] but we must also identify the synergies between ocean governance and other international regimes.

## II. A SCIENCE-TO-POLICY APPROACH TO DRIVE OCEAN AND CLIMATE ACTION

### A. RAISING OCEAN-CLIMATE AWARENESS IN INTERNATIONAL DISCUSSIONS

The Paris Agreement was a turning point in international climate negotiations. At the center of the agreement, an innovative institutional feature enables governments to make pledges indicating how they are evaluating climate risks and policy opportunities: the Nationally Determined Contributions (NDCs), covered in Article 4,[101] are the core implementing tool of the agreement to help limit global warming to a 2°C-rise.

In the run up to COP21 in Paris, nearly all nations submitted Intended Nationally Determined Contributions (INDCs) to indicate their national strategies for climate action, including both mitigation strategies and adaptation plans.[102] Once countries officially joined the Paris Agreement, INDCs simply became the NDCs. While countries may amend their NDCs at any time, they must revise and update them every 5 years with the aim to increase their ambition with each subsequent NDC. Ahead of COP26, in 2020, all member states shall present their revised NDCs to the UNFCCC Secretariat.

Gallo et al. (2017),[103] empirically assessed whether and how the Parties to the Paris Agreement are focusing on the ocean and marine ecosystems in an effort to understand how marine issues reflect in countries' national interests and capabilities. The study shows that, as of June 2016, a total of 188 countries outlined 161 NDCs,[104] as of which 70% actually refer to the ocean or include marine issues. Most ocean-inclusive NDCs focused on the impacts of climate change and adaptation needs in marine areas, with prevailing concerns regarding coastal impacts, ocean warming impacts, and fisheries impacts. Additionally, countries vulnerable to sea-level rise are no longer alone in advocating for greater consideration of climate change impacts on the ocean. Moving forward, countries should reflect on concrete ways to include ocean-measures into their climate strategies.

In the last three years, the Because the Ocean Initiative has encouraged progress on the incorporation of the ocean in the climate change policy debate. The Because the Ocean Initiative was launched at COP21 by 23 countries, which all signed the first Because the Ocean Declaration calling for the recognition of the importance of the ocean to address climate change.[105] A year later, a second declaration was signed by 33 signatory countries at COP22, encouraging UNFCCC Parties to consider NDCs that "promote, as appropriate, ambitious climate action in order to minimize the adverse effects of climate change in the ocean and to contribute to its protection and conservation".[106] With the growing support of now 39 countries, the Because the Ocean initiative is working towards compiling ocean-related measures for NDCs to be published in September 2019 to coincide with the release of the IPCC report on Ocean and the Cryosphere. A series of workshops has been organised in Latin America (Santiago, Chile), Europe (Madrid, Spain) and the Pacific (Suva, Fiji) to produce recommendations and options for assisting governments in incorporating ocean-related measures into their NDCs. Together with the upcoming IPCC report on the ocean and the cryosphere, this report shall contribute to further raising ocean awareness in the climate regime, which in turn could lead to improved consideration of marine issues in the following NDC review cycle.

While it is encouraging that a significant number of countries are keen to better understand the impacts of climate change on the ocean, there is much left to be done to achieve the objectives set in Paris. At the current rate and even if Nations live up to their commitments, the content of current NDCs imply a 3°C-rise by the end of the century.[107] Keeping global warming well below 2°C requires an imminent and unprecedented shift from all aspects of society.

Scientific evidence is crucial to inform policy-makers, drive action and design solutions. In light of the current context, there is a real potential to increase ambition in the protection of the ocean, particularly addressing issues such as sea-level rise, fisheries adaptation, pollution prevention and abatement, and ocean ecosystem resilience. Strong political engagement will be essential and must be driven by public and scientific support to collectively set a firm foundation for higher ambition for the Paris Agreement.

## B. FOSTERING SYNERGIES BETWEEN IPCC AND IPBES

"*Climate change and biodiversity must be looked at together. They must not be looked at separately, neither in isolation.*" Robert Watson, President of IPBES

Reducing uncertainties in global environmental governance rests on our ability to assess and render knowledge accessible to policy-makers.[108] The growing demand for policy-relevant knowledge and expertise, on ever more complex problems such as global warming and the loss of biodiversity, has led to the multiplication of intergovernmental bodies since the 1980s. These global expert groups, responsible for reviewing and assessing the most recent scientific information produced worldwide, exercise a remarkable amount of epistemic and political authority.[109] By bridging research and policy, they play a significant part of global environmental governance and promote environmental sustainability within and beyond the scientific community.

In this respect, the IPCC pioneered the trend and highlighted the political relevance of climate change – thus pushing the ecological research community to address climate change as an issue of societal concern.[110] Despite successfully establishing a definition of the climate issue, including its consequences and measures for adaptation and mitigation, the IPCC has struggled to enable global policy agreements and stimulate sufficiently rapid and transformative changes in society.[111] For instance, following the publication of the IPCC Special Report on Global Warming of 1.5 °C, Parties to the UNFCCC failed to incorporate the key findings of the Report as the US, Saudi Arabia, Russia and Kuwait objected to "welcoming" the document during the COP24 negotiations in Katowice.

In 2012, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was created to function as an IPPC-like body to implement effective policies for conserving biodiversity.[112] The "Platform's objective is to strengthen the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development".[113] In contrast to the IPCC, it further aims at integrating non-scientific knowledge (including indigenous, traditional or other practical forms of knowledge) on the basis that biodiversity and ecosystem services cannot readily be quantified since they explicitly include values.[114,115] While the IPBES and IPCC differ in their mandate, scope and political contexts, they both have had to face similar challenges to respond to political demands to bridge science and policy, as well as calls for public accountability and participation.[116]

Acknowledging that a one-size-fits-all model does not exist, the role and design of global expert organizations needs rethinking. In that regard, further coordination between IPCC and IPBES could strengthen the way scientific evidence is valued to produce real change in decision-making. Despite our growing understanding of the interplay between land, ocean and the atmosphere – climate change and biodiversity are still addressed as isolated issues. More synergies between IPCC and IPBES would aim at strengthening the science-policy interface around the ocean-climate-biodiversity nexus by ensuring consistency between their respective assessment reports and processes.[117] In mid-2020, the IPCC and IPBES is expected to produce a joint paper on "synergies and trade-offs between the need to protect biodiversity and to mitigate and adapt to climate change", notably through ecosystem-based approaches. This technical report shall discuss, among other things, "the opportunities, challenges and impacts of climate change mitigation and adaptation options" in relation to the strengthening of carbon sinks on land and in the ocean.[118]

Moreover, a harmonized framework could support future holistic approaches in addressing the win-win of biodiversity conservation and climate change. There are remaining challenges to communicate the urgency of ocean conservation to decision-makers in the context of multilateral negotiations. Since the ocean is central to both agendas, ocean governance opens a window of opportunity for a stronger cooperation between the two platforms to adjust how the ocean is being integrated into the reports of the Intergovernmental Bodies and, more broadly, how ocean science is being integrated into UN frameworks.

## III. GLOBAL COOPERATION TO ACCELERATE EFFORTS

### A. MULTI-STAKEHOLDER GOVERNANCE

The climate crisis and global environmental challenges we face today are tremendous. At the 2017 World Economic Forum meeting in Davos, UN Secretary-General, Antonio Guterres made a strong call for "a new generation of partnerships, partnerships not only with governments, not only with civil society and academia but equally partnerships with the business community in the context of the perspective of implementation of the Sustainable Development Goals and the Paris Agreement on climate change, creating the conditions for an inclusive and sustainable development – the best way to prevent crises and conflicts in today's world."[119]

If we truly mean to achieve the goals set by the 2030 Agenda, then SDG 17 is crucial: strengthening global, effective and inclusive partnerships between governments, the private sector and civil society with a central focus on people and the planet.[120]

Among civil society, NGOs have the ability to shape public opinion and mobilize voters in support or against governments' position. In the context of multilateral negotiations, they can shape international outcomes using a range of resources, including their activities (such as lobbying), access to negotiations and/or NGO resources (such as knowledge and financial assets).[121] The contribution of civil society to ocean governance and conservation is extremely important and wide-ranging.[122] By providing specialized knowledge and federating an array of actors to establish networks, NGOs exert considerable cognitive and social power.[123] For instance, in the run-up to COP21, the Ocean and Climate Platform, in collaboration with other international networks, advocated the crucial role of the ocean in regulating the global climate system and pushed for its recognition in international climate negotiations. This collective effort resulted in the Paris Agreement recognizing in its preamble "the importance of ensuring the integrity of all ecosystems, including oceans".[124]

Breaking down the silos in ocean protection requires bringing together multiple actors from different sectors. Multi-stakeholder governance can help to shape collectively global processes on the ocean,[125] which calls for comprehensive and coherent strategies between states and non-state actors. As mentioned by Peter Haugan, Chair of IOC: "there is a need for enhanced collaboration, through great partnerships and shared-knowledge." A network approach to ocean governance and management is crucial. In that regard, boundary organizations are needed to solve ocean issues. The Ocean Knowledge-Action Network seeks to bridge disciplines to provide timely and useful ocean knowledge by focusing on solutions, engaging with diverse sectors and regions, and drawing on the agendas of the international marine projects and communities in Future Earth and beyond to address global challenges.[126]

The Marrakech Partnership for Global Climate Action, launched at COP22 in 2016, seeks to support voluntary collaboration between Parties and non-Party stakeholders, including civil society, the private sector, financial institutions, cities and other subnational authorities, local communities and indigenous peoples, as well as coalitions and voluntary initiatives. Its mission is to strengthen collaboration between governments and key stakeholders to immediately lower emissions and increase resilience against climate impacts.[127] As part of this framework for accelerated ambition, initiatives and coalitions have bloomed around the globe to spur action in 7 identified priority themes, including the ocean and coastal zones.

## B. INNOVATIVE PARTNERSHIPS

The development of public-private partnerships is particularly important to support ocean protection as well as climate action.[128] The integration of ocean prerogatives in the private sector sphere requires demonstrating the prospective return on the blue natural capital by valuing marine ecosystem services.[129] Such quantifying mechanism can then attract private investments towards the preservation of the marine environment. A recent study focusing on mangrove finance in Asia identified up to 54 funding types.[130] It notably showed that private sources generated significantly more funds in the preservation of blue carbon ecosystems than public ones. Incredible potential lies in partnerships

| | THEMES | | | | | | |
|---|---|---|---|---|---|---|---|
| | NATURAL SYSTEMS | | | SUSTAINABLE INFRASTRUCTURE | | | |
| | Land use | Ocean and coastal zones | Water | Human settlements | Transport | Energy | Industry |
| ACTORS | **Policy makers**<br>*National Governments*<br>*Local and subnational governments*<br>*Regulators* | | | | | | |
| | **Finance and investment**<br>*National and international public finance institutions*<br>*Investors*<br>*Asset owners*<br>*Investment and fund managers*<br>*Financial markets*<br>*Corporation*<br>*International finance organisations and initiatives* | | | | | | |
| | **Technology and innovation and capacity-building**<br>*Technology developers*<br>*National and international organisations*<br>*Technology initiatives and partnerships*<br>*Research institutions* | | | | | | |
| | **Activity implementers**<br>*Public and private project and infrastructure developers*<br>*Business*<br>*Local and municiap service providers*<br>*Farmers and natural resource management associations* | | | | | | |
| | **Civil society**<br>*Communities, citizens and consumers*<br>*Non-governmental organisations*<br>*Trade unions and labour organisations*<br>*Faith based organisations*<br>*Indigenous peoples* | | | | | | |

**Figure 8.** Multi-stakeholder engagement : proposed thematic approach
*Source: Adaptated from United Nations Framework Convention on Climate Change (UNFCCC) (2016) Marrakech Partnership for Global Climate Action*

**Box 6. OCIA and Talanoa Participation**

The *Ocean and Climate Initiatives Alliance* (OCIA) brings together 20 initiatives and intends to drive momentum for concrete ocean-based solutions in the implementation of climate change mitigation and adaptation measures. OCIA is fully integrated in the Global Climate Action Agenda, which aims at supporting engagement of non-party actors and creating the necessary tools to achieve the goals of the Paris Agreement.

In 2018, OCIA took part in the Talanoa Dialogue, an inclusive, participatory and transparent discussion between States and non-governmental stakeholders intended to raise the ambition of the Paris Agreement. As the only ocean-climate NGO attending, OCIA highlighted the need for:

- increased transversal cooperation to encourage a more ambitious climate action;
- a greater inclusion of ocean measures in both Parties' NDCs and the UNFCCC processes (*e.g.* SBSTA, SBI, Global Stocktake);
- more research efforts to better understand future ocean responses to climate change, as well as how the ocean can contribute to climate solutions.

between the public and private sector for channelling additional funds for marine conservation. As stated by Torsten Thiele, Global Ocean Trust: "We are currently moving from traditional public schemes to private and public sector investments.'' While ocean finance can create linkages with climate and conservation finance, developing an ocean finance pathway requires a shift from grants to delivery. Thiele further claimed that "the biological bounty is the ocean richest treasure and the financial world is waking up to what the ocean could provide".

**Box 7. Trust funds for marine conservation**
**The PACIFICO Platform**

Along with private-public partnerships, the authors Thiele and Gerber (2017),[131] highlighted the potential of trust funds as innovative mechanism. As an illustration, the Eastern Tropical Pacific Trust Fund, also known as PACIFICO, acts as an effective platform for funding coastal and marine management. Launched in 2012, this initiative gathers five environmental funds of Latin America.[132] The Eastern Tropical Pacific spans in the national waters of the Pacific coast of Costa Rica, Panama, Colombia and Ecuador. This region is characterized by a high level of endemicity with 30 % of the mangrove species which are found only in this area.[133] In this context, PACIFICO aims to raise financial resources in order to implement actions for conservation and management of marine and coastal ecosystems in the region. PACIFICO illustrates the current trends of creating cross-sectoral networks and alliances throughout the world.

Our capacity to leverage public and private sector relationships is crucial, most importantly to mobilize resources and existing funding. By providing a critical nexus between developing countries and development agencies, cooperative partnerships allow for tailored assistance – mindful of the contexts and priorities of developing countries – while in balance with the development outcomes set by remote partners.[134]

The UN Decade of Ocean Science will provide the adequate time frame for promoting such global cooperation.[135] The development of synergies at all levels encourages to break down the silos and look beyond at inventive partnerships, including with the private sector and civil society. As suggested by Peter Haugan, Chair of IOC, "this decade is an opportunity to bring all actors together, not only UN organisations. We need to include intergovernmental, global and regional bodies but also non-governmental organizations, civil society, philanthropic organisms and industrial actors."

# GLOSSARY

**ACIDIFICATION.** Modification of the natural acid-base state of water by the input of acids, mainly related to the accumulation of CO2 in OMZs (oxygen minimum zones), which are also one of the most important reserves of inorganic carbon near the surface. Planktonic calcifying species are highly sensitive to this change.

**ADAPTATION.** In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

**BLUE CARBON.** In broad terms, the organic carbon that is sequestered in the ocean (for climate-relevant time spans). Further, the concept recognizes "coastal blue carbon" (also known as "coastal wetland blue carbon"; Howard et al. 2017) as the carbon stored in mangroves, tidal salt marshes, seagrass meadows, and other inter-tidal ecosystems within the soil, the living biomass above ground (leaves, branches, stems), the living biomass below ground (roots and rhizomes), and the non-living biomass (litter and dead wood) (Howard et al. 2014). In addition, "ocean blue carbon" includes carbon in ocean sediments, phytoplankton and other forms of stored carbon in the open ocean and deep sea. Some of these stocks and sinks are actionable options through blue carbon mitigation and adaptation options (e.g. conservation, restoration, habitat creation, etc.), and some are not (pending further scientific and technological knowledge, and policy-relevant mechanisms).

**BLUE ECONOMY.** Set of measures for the sustainable exploitation of marine and coastal resources (text adopted by the French parliament in June 2016). Blue economy refers to all the activities connected with the sea. Its regular measurement in terms of gross added value allows us to estimate growth, i.e. doubling by 2030 according to the OECD(2016).

**COMMUNITY-BASED APPROACH.** Where those who are affected by an emergency are included as key partners in developing strategies related to their assistance and protection—is inextricably linked to both the rights-based approach and the survivor-centred approach.

**COST-EFFECTIVENESS.** A measure of the cost at which policy goal or outcome is achieved. The lower the cost, the greater the cost-effectiveness.

**EARLY WARNING SYSTEMS.** The set of technical, financial and institutional capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare to act promptly and appropriately to reduce the possibility of harm or loss. Dependent upon context, EWS may draw upon scientific and/or Indigenous knowledge. EWS are also considered for ecological applications, e.g., conservation, where the organisation itself is not threatened by hazard but the ecosystem under conservation is (an example is coral bleaching alerts), in agriculture (for example, warnings of ground frost, hailstorms) and in fisheries (storm and tsunami warnings). This glossary entry builds from the definitions used in This glossary entry builds from the definitions used in UNISDR (2009) and IPCC (2012a).

**ECOLOGICAL RESTORATION.** Assisting the regeneration of an ecosystem that has been degraded, damaged or destroyed.

**ECOSYSTEM SERVICES.** Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as productivity or biodiversity maintenance, (2) provisioning services such as food or fibre, (3) regulating services such as climate regulation or carbon sequestration and (4) cultural services such as tourism or spiritual and aesthetic appreciation.

**EUTROPHISATION.** Excessive growth of phytoplankton, due to an excess of a nutrient such as nitrogen or phosphorus. It leads to the deoxygenation of the environment.

**INDIGENOUS KNOWLEDGE.** The understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For many Indigenous peoples, Indigenous knowledge informs decision-making about fundamental aspects of life, from day-to-day activities to longer term actions. This knowledge is integral to cultural complexes, which also encompass language, systems of classification, resource use practices, social interactions, values, ritual and spirituality. These distinctive ways of knowing are important facets of the world's cultural diversity. This definition builds on UNESCO (2018).

**IPBES.** Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, open to all members of the United Nations (125 states were members at the end of 2016). Created in April 2012, it aims to improve the connections between knowledge and decision making concerning biodiversity and ecosystem services.

**MITIGATION (OF CLIMATE CHANGE).** A human intervention to reduce emissions or enhance the sinks of greenhouse gases (GHG).

**MITIGATION MEASURES.** In climate policy, mitigation measures are technologies, processes or practices that contribute to mitigation, for example renewable energy technologies, waste minimisation processes, public transport commuting practices. See also Mitigation option.

**MITIGATION OPTION.** A technology or practice that reduces GHG emissions or enhances sinks.

**OCEAN DEOXYGENATION.** The loss of oxygen in the ocean. It results from ocean warming, which reduces oxygen solubility and increases oxygen consumption and stratification, thereby reducing the mixing of oxygen into the ocean interior. Deoxygenation can also be exacerbated by the addition of excess nutrients in the coastal zone.

**PHYTOPLANKTON.** Microscopic algae living suspended in the water and carried along by currents.

**RCP (Representative Concentration Pathway).**
Scenarios relating to the evolution of the greenhouse gas concentration over this century, set up by the Intergovernmental Panel on Climate Change (IPCC).

**RESILIENCE.** The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation. This definition builds from the definition used in Arctic Council (2013).

**RESTORATION.** In environmental context, restoration involves human interventions to assist the recovery of an ecosystem that has been previously degraded, damaged or destroyed.

**SINK.** A reservoir (natural or human, in soil, ocean, and plants) where a greenhouse gas, an aerosol or a precursor of a greenhouse gas is stored. Note that UNFCCC Article 1.8 refers to a sink as any process, activity or mechanism which removes a greenhouse gas, an aerosol or a precursor of a greenhouse gas from the atmosphere.

**SOCIAL-ECOLOGICAL SYSTEMS.** An integrated system that includes human societies and ecosystems, in which humans are part of nature. The functions of such a system arise from the interactions and interdependence of the social and ecological subsystems. The system's structure is characterised by reciprocal feedbacks, emphasising that humans must be seen as a part of, not apart from, nature. This definition builds from Arctic Resilience report (2016) and Berkes and Folke (1998).

**VULNERABILITY.** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

**ZOOPLANKTON.** Marine animals present at the surface and the sub-surface of the ocean.They are most of the time small size organisms and move according to the currents.

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