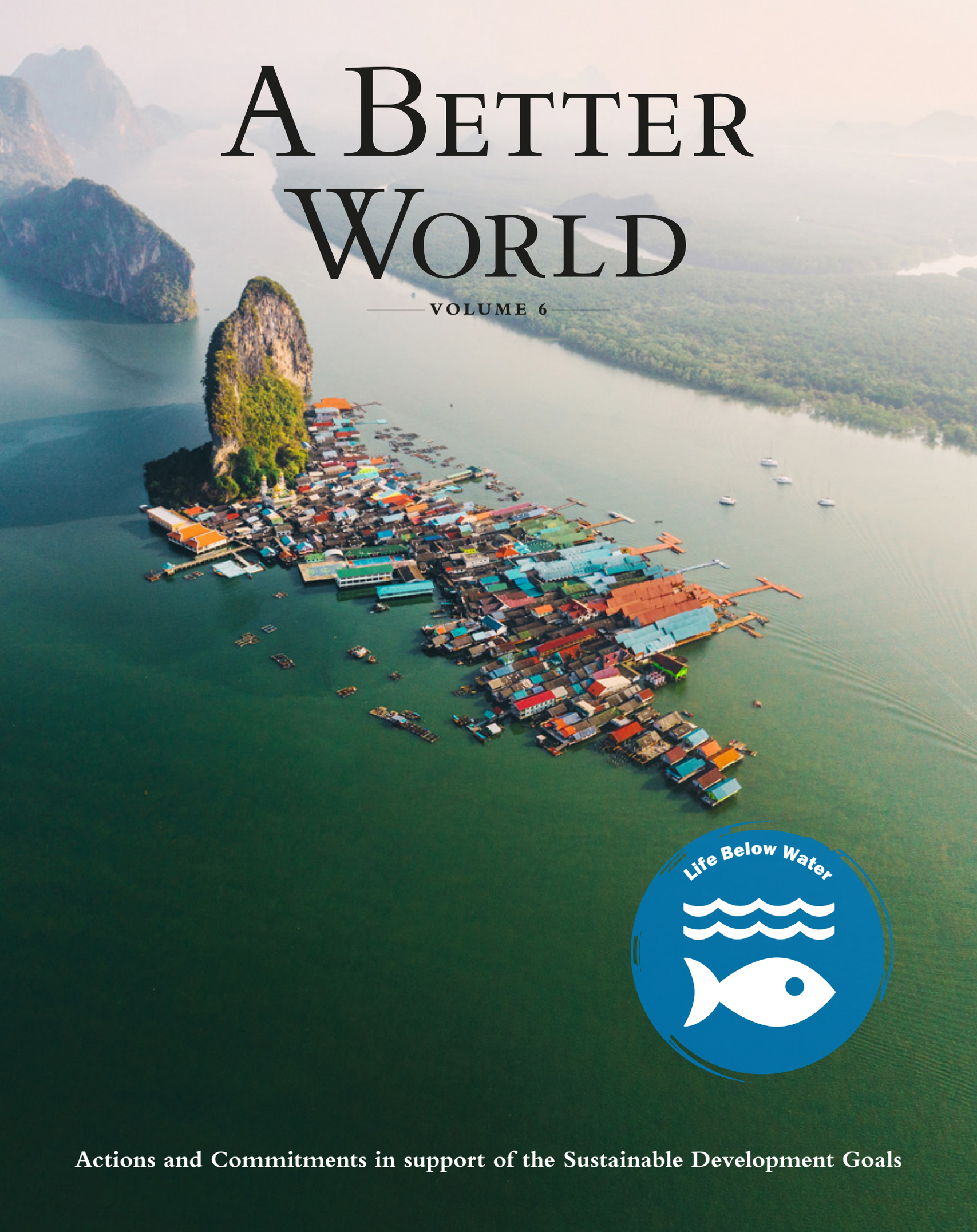
A Better World

VOLUME 6



Actions and Commitments in support of the Sustainable Development Goals

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VOLUME 6

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ISBN 978-1-9160325-0-7
Original title: A Better World Volume 6

Published in 2020 by Human Development Forum
www.humandevelopmentforum.org

Human Development Forum

Acknowledgements

Compiled by Sean Nicklin and Ben Cornwell
Edited and designed by Leigh Trowbridge

Printed in the UK by Gomer Press Ltd.

Cover photo: aerial view of the fishing village Ko Panyi, Phang Nga, Thailand
Photo taken by Oleh Slobodeniuk

With thanks to all of the authors listed throughout the book for their support in compiling *A Better World, Volume 6*, and for their continued efforts in working towards the achievement of SDG 14.

Coral Triangle Initiative — Corals, Fisheries and Food Security (CTI-CFF)

Earth Law Center

Forest Research Institute Malaysia (FRIM)

Indonesian Agency for Metorology, Climatology and Geophysics (BMKG)

Institut National des Sciences et Technologies de la Mer (INSTM), Tunisia

Institute of Marine and Antarctic Studies (IMAS), University of Tasmania

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Japan International Cooperation Agency (JICA)

Maritime Institute of Malaysia (MIMA)

Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC), Malaysia

Ministry of Environment and Climate Affairs, Sultanate of Oman

Mura Technology Ltd.

National Institute of Oceanography and Fisheries, Egypt

National Institute of Water and Atmospheric Research Ltd (NIWA), New Zealand

Natural History Museum, UK

Ocean Policy Research Institute of the Sasakawa Peace Foundation

Pacific Ocean Program, Association of Pacific Rim Universities (APRU)

Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA)

Secretariat of the Pacific Regional Environment Programme (SPREP)

South Pacific Regional Fisheries Management Organisation (SPRFMO)

The Pacific Community (SPC)

UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC)

WorldFish

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Foreword

SEAN NICKLIN, GENERAL COORDINATOR, THE HUMAN DEVELOPMENT FORUM

With the establishment of the United Nations Sustainable Development Goals (SDGs) in 2015, the Human Development Forum launched a series of publications entitled *A Better World*, each volume dedicated to one of the 17 SDGs. This volume, published in June 2020, covers Goal 14 — Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

It is our belief that enhancing the contribution of marine biodiversity is hugely beneficial to the world in general, and to the future of small island developing states and least developed countries in particular. With the health of the oceans in jeopardy, and the ramifications understood in relation to sustainable human activity in general, it is crucial that the objectives of Goal 14 are swiftly realized. The Goal's targets include the significant reduction of marine pollution, sustainable management of marine and coastal ecosystems, minimizing the impacts of ocean acidification, and regulating overfishing. It the aim of this publication to celebrate the increase in scientific knowledge, research capacity and marine technology that are contributing to the global efforts to meet those targets.

By focusing on the experiences and livelihoods of people, especially those in vulnerable human habitats, the book shows the benefits of best policy and practices, and how these may develop further as we come to terms with a changing and more turbulent world. This innovative endeavour is a striking example of sharing respective resources to engage the many official governmental, international organizations, institutions and professional interests in displaying the extent and variety of their efforts to make the world a better place.

Since 1999 Tudor Rose has published over 30 books in partnership with the United Nations and its agencies, covering a diverse range of subjects from disaster reduction, water management and climate science to intercultural dialogue and humanitarian assistance. They are read extensively by the human development sector and especially by community leaders in vulnerable regions around the globe. The books are close collaborations between individual United Nations agencies, United Nations Member States and civil sector organizations, committed to a better future for the world. They have widened the knowledge of people in vulnerable communities and given them inspiration and knowledge to better their lives in a sustainable way.

Sean Nicklin
Human Development Forum
March 2020

SDG 14
Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Oceans provide key natural resources including food, medicines, biofuels and other products. They help with the breakdown and removal of waste and pollution, and their coastal ecosystems act as buffers to reduce damage from storms. Maintaining healthy oceans supports climate change mitigation and adaptation efforts. The seaside is also a great place for tourism and recreation.

Even more, Marine Protected Areas contribute to poverty reduction by increasing fish catches and income, and improving health. They also help improve gender equality, as women are the owners of many small-scale fisheries.

The marine environment is also home to a stunning variety of beautiful creatures, ranging from single-celled organisms to the biggest animal ever to have lived on the Earth–the blue whale. It also hosts coral reefs, which are among the most diverse ecosystems on the planet.

Outlining the challenges

Increasing levels of debris in the world's oceans are having a major environmental and economic impact. Marine debris impacts biodiversity through entanglement or ingestion of debris items by organisms, which can kill them or make it impossible for them to reproduce.

As far as the world's coral reefs are concerned, about 20 per cent of them have been effectively destroyed and show no prospects for recovery. About 24 per cent of the remaining reefs are under imminent risk of collapse through human pressures, and a further 26 per cent are under longer term threat of collapse.

Furthermore, improper marine management results in overfishing. The lost economic benefits from the fisheries sector are estimated to be around US$ 50 billion annually. The United Nations Environment Programme estimates the cumulative economic impact of poor ocean management practices is at least US$ 200 billion per year. In the absence of mitigation measures, climate change will increase the cost of damage to the ocean by an additional US$ 322 billion per year by 2050.

The costs of taking action largely are offset by the long-term gains. In economic terms, the Convention on Biological Diversity suggests that scaled-up actions to sustain the global ocean require a US$ 32 billion one-time public cost and US$ 21 billion dollars a year for recurring costs.

What can be done internationally?

For open ocean and deep sea areas, sustainability can be achieved only through increased international cooperation to protect vulnerable habitats. The establishment of comprehensive, effective and equitably managed systems of government-protected areas should be pursued to conserve biodiversity and ensure a sustainable future for the fishing industry.

What can be done locally?

On a local level, ocean-friendly choices can be made when buying products or eating food derived from oceans. It is important to select certified products and to consume only what is needed. Making small changes in daily routines such as using public transport and unplugging electronics saves energy. These actions reduce carbon footprint, a factor that contributes to rising sea levels.

Plastic usage should be eliminated as much as possible. Beach clean-ups should be regularly organized.

Most importantly, the message can be spread about how important marine life is and why we need to protect it.

Goal 14 and the United Nations

UN-Oceans is an inter-agency mechanism that seeks to enhance the coordination, coherence and effectiveness of competent organizations of the United Nations system and the International Seabed Authority, in conformity with the United Nations Convention on the Law of the Sea, the respective competences of each of its participating organizations and the mandates and priorities approved by their respective governing bodies. UN-OCEANS was established to:

- Strengthen and promote coordination and coherence of United Nations system activities related to ocean and coastal areas
- Regularly share ongoing and planned activities of participating organizations within the framework of relevant United Nations and other mandates with a view to identifying possible areas for collaboration and synergy
- Facilitate, as appropriate, inputs by its participating organizations to the annual reports of the Secretary General on oceans and the law of the sea and on sustainable fisheries to be submitted to the Secretariat
- Facilitate inter-agency information exchange, including sharing of experiences, best practices, tools and methodologies and lessons learned in ocean-related matters.

Key subjects in this book reflecting SDG 14 and its targets

CORAL REEFS

Coral reefs are one of the most diverse ecosystems on earth.

IMPLEMENTATION OF INTERNATIONAL LAW

Support should be provided for Member States in implementing their voluntary commitments related to implementation of international law as reflected in UNCLOS.

MANGROVES

Mangroves are highly productive ecosystems providing numerous goods and services that include support of fisheries, maintenance and improvement of water quality.

MARINE AND COASTAL ECOSYSTEMS MANAGEMENT

Diverse area-based measures and management tools can be used to sustainably manage, protect, conserve and restore marine ecosystems.

MARINE POLLUTION

Marine pollution from human activities can be found at all points across the ocean's vast expanse, whether in the deep, at the surface, or in the organisms that live in it.

OCEAN ACIDIFICATION

Ocean acidity has increased by roughly 26 per cent since pre-industrial times because of increased releases of CO_2 due to the burning of fossil fuels and other human activities.

SCIENTIFIC KNOWLEDGE

Sustainable management and conservation of the ocean requires a solid and trusted knowledge base upon which decisions are based.

SUSTAINABLE BLUE ECONOMY

The oceans are central to sustainable development globally, and particularly for Small Island Developing States and coastal least developed countries.

SUSTAINABLE FISHERIES

Marine fisheries are a key source of economic and food security, providing livelihoods for the 300 million people involved in the sector.

Image: Milos Prelevic on Unsplash

Healthy coral, Ko Lipe, Thailand. The danger is that changes in conditions such as temperature, available light or nutrients causes the corals to expel the symbiotic algae living in their tissues, causing them to turn completely white. If such stresses are prolongued, the corals die, precipitating loss of habitat for many species

Image: Tarzan9280

Fishing on the beach at Cox's Bazar, Bangladesh. It is the objective of SDG 14 to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

Image: Dustan Woodhouse on Unsplash

Marine pollution from human activities is most obvious on the shore line, as evidenced at Punta Cana, Dominican Republic

Participation in UN-Oceans is open to United Nations system organizations with competence in activities related to ocean and coastal areas and the International Seabed Authority.

UN-Oceans must regularly prepare a work programme allowing it to effectively coordinate the response of its participating organizations to the mandates approved by their governing bodies. UN-Oceans prepares a biennial work programme allowing it to effectively coordinate the response of its participating organizations to the mandates approved by their governing bodies. The work programme is presented by the UN-Oceans Focal Point to the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea.

United Nations Secretary-General António Guterres appointed Peter Thomson of Fiji as his Special Envoy for the Ocean in 2017, and he has galvanized concerted efforts in support of the 2030 Agenda for Sustainable Development, maintaining the momentum for action to conserve and sustainably use the oceans, seas and marine resources for sustainable development. He has led United Nation's advocacy and public outreach efforts inside and outside of the UN system, ensuring that the many positive outcomes of The Ocean Conference, including the close to 1,400 voluntary commitments, are fully analysed and implemented. This includes his tireless work with civil society, the scientific community, the private sector and other relevant stakeholders, to coalesce and encourage their activities in support of the implementation of Sustainable Development Goal 14.

Mr. Thomson brings a distinguished track record in diplomatic services, including as Permanent Representative of Fiji to the UN and President of the 71st session of the UN General Assembly during which he provided visionary leadership in guiding the preparation of The Ocean Conference.

Image: Creative Commons

HE Peter Thomson, President of the United Nations General Assembly, and Ambassador of the Republic of Fiji to the United Nations, speaking at World Water Week 2017

14 LIFE BELOW WATER

CONSERVE AND SUSTAINABLY USE THE OCEANS, SEA AND MARINE RESOURCES FOR SUSTAINABLE DEVELOPMENT

OCEAN ACIDITY HAS INCREASED BY

26% SINCE PRE-INDUSTRIAL TIMES

IT IS EXPECTED TO RAPIDLY INCREASE BY 100–150% BY 2100

THE INCREASE IN OCEAN ACIDITY IS A NEGATIVE PHENOMENON. IT IMPACTS THE ABILITY OF THE OCEAN TO ABSORB CO_2 AND ENDANGERS MARINE LIFE.

THE PROPORTION OF FISH STOCKS WITHIN BIOLOGICALLY SUSTAINABLE LEVELS DECLINED FROM

90% (1974)

TO

67% (2015)

87 COUNTRIES

SIGNED THE AGREEMENT ON PORT STATE MEASURES, THE **FIRST BINDING** INTERNATIONAL AGREEMENT ON ILLEGAL, UNREPORTED AND UNREGULATED FISHING

104 OUT OF 220

COASTAL REGIONS IMPROVED THEIR **COASTAL WATER QUALITY** (2012–2018)

17% OF WATERS UNDER NATIONAL JURISDICTION ARE COVERED BY PROTECTED AREAS

MORE THAN DOUBLE

THE 2010 COVERAGE LEVEL

Source: United Nations: https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/E_Infographic_14.pdf

One ocean for one planet — a Pacific Community perspective on fulfilling SDG 14

Cameron Diver, Deputy Director-General, the Pacific Community (SPC)

Despite the many sustainable development challenges faced globally, 2020 is being hailed as a 'super year' for ocean, biodiversity and nature-based solutions. The United Nations Ocean Conference will identify strategies and solutions "to conserve and sustainably use the oceans, seas and marine resources for sustainable development" — the heart of SDG 14.

In August 2020, the small island/large ocean State of Palau will host the "Our Ocean" conference focusing on six areas of action to identify solutions to manage marine resources, increase the ocean's resilience to climate change and safeguard its health for generations to come. 2020 is also the final year of preparation before the launch of the United Nations Decade of Ocean Science for Sustainable Development 2021–2030. The increased recognition of the nexus and multiple synergies between ocean and climate, ocean and biodiversity, ocean and development (to name but a few), means that the ocean, ocean science and ocean-based solutions will have a critical role to play, not only in 2020 but up to the end of the 2030 Agenda period and beyond, in contributing to a new, more sustainable global development paradigm.

It is, however, abundantly clear that expressed ambition and strategy needs to transform into tangible action at global, regional, national and local scale in order to advance the objectives of SDG 14 and reduce marine pollution, protect marine and coastal ecosystems, minimise acidification, end illegal and over-fishing, increase investment in scientific knowledge and marine technology, and ensure widespread respect of international law as a primary universal mechanism for the safe and sustainable use of the ocean and its resources. The Pacific Community (SPC)[1], the Pacific region's oldest and largest intergovernmental organization, was established to do just that: to translate agreed strategies for development into action that makes a positive difference to the lives of populations in Pacific Community Member Countries (MCs) and contributes concretely to national, regional and global challenges. The Pacific Community is privileged to be able to serve many MCs and peoples for whom the ocean is a fundamental aspect of their individual and collective identity, together with their lives and livelihoods. But the new reality is that, under the effects of ocean/climate change, the islands and peoples of the Blue Pacific continent are both sustained and threatened by the ocean.

Image: Cameron Diver

The waters around New Caledonia's Ile des Pins: a pristine yet fragile habitat

It is not only for the MCs that these issues are critical. They are just as vital for Small Island Developing States around the globe and, whether or not they realize it, for countries and peoples around the globe, from the coastline to the highest mountains, from the world's megacities to the farthest reaches of the planet's great continental landmasses. Last year's IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) highlighted that "It is virtually certain that the global ocean has warmed unabated since 1970 and has taken up more than 90 per cent of the excess heat in the climate system" with observed negative impacts on ecosystems, people and ecosystem services. The SROCC underscored the risks that this creates for, among others, biodiversity, water use and access, vulnerability to extreme weather events, changes in the distribution of natural resources and "intrinsic values important for human identity".

In this context, where rapid ocean change is driven by the twin threats of climate change and unsustainable human activity and where each, in turn, compounds the negative impact of the other, then the science and the crosscutting benefits of integrated action cannot, and should not, be ignored. As such, the Pacific Community has placed ocean management and governance, together with climate change, among the key priorities for action.

Through these priority areas and an approach where greater multisectoral collaboration enhances the scientific and technical expertise within the communities of practice, SPC will continue to bring its capacity and partnerships to

Image: Jurgen Freund

Traditional coastal fisheries in action: a subsistence fisherman at work near a coral reef in Papua New Guinea

bear to take action on SDG 14 and drive co-benefits across the 2030 Agenda.

The Pacific Community is home to many of the region's most robust ocean science and technical teams supporting the MCs. Within SPC's multi-year work programme, the teams have implemented, and are implementing, significant initiatives focused on SDG 14, driven by greater integration to harness the synergies between sectors and enhance ultimate development outcomes. As a limited illustration, the Pacific Community is a lead agency in the Pacific-European Union Marine Partnership, which has a large component dedicated to scientific and management advice for oceanic fisheries and sustainable use of coastal and marine biodiversity through improved marine spatial planning, increased resilience to climate change, enhanced conservation, mitigation and rehabilitation measures. In addition, SPC has led and published research on the vulnerability of tropical Pacific fisheries and aquaculture to climate change and, with partners, developed and refined projections for the future geographic distribution of tuna stocks in the Western and Central Pacific (representing over 34 per cent of the global annual tuna catch, worth over US$ 2.3 billion) under the effects of a warming ocean.

SPC also has a longstanding programme of legal, technical and capacity building assistance to support Pacific Island nations in establishing their maritime boundaries and extended continental shelf claims. SPC's work has contributed to the successful conclusion of treaties to settle 35 of the region's 48 shared boundaries with ongoing negotiations on the 13 remaining treaty lines. Three of the MCs, the Federated States of Micronesia, Papua New Guinea and the Solomon Islands, were also supported in their successful joint submission to the United Nations Commission on the Limits of the Continental Shelf (CLCS), claiming sovereign rights over 600,000 km^2 of additional seabed known as the Ontong Java Plateau under the provisions of UNCLOS.

SPC is also undertaking groundbreaking work on the legal and social implications of the impact of climate change and sea-level rise on maritime boundaries, with the objective of fixing baselines and maritime boundaries to ensure that the impact of climate change and sea-level rise does not result in reduced jurisdiction of Pacific Island Countries and Territories. At the request of MCs, SPC teams also carried out scientific and technical analysis on how to facilitate development of deep-sea mineral resources as a potential source of economic development, without compromising environmental sustainability and the best interests of the countries and peoples of the Pacific region. Further, a draft Regional Agreement for cooperation among Pacific Island Countries and Territories has been developed to support responsible deep sea mineral management, as a means of providing a legally binding international framework of minimum standards for deep-sea mining in parties' areas of national jurisdiction, including the Exclusive Economic Zone (EEZ) and continental shelf.

All of this work is of critical importance, as the MCs are the stewards of 20 per cent of the planet's EEZs representing more than 28 million km^2 of oceanscape. In the transport sector, through programmes like the Green Pacific Port initiative,

SPC is helping MCs increase port energy efficiency, reduce their carbon footprint, and enhance environmental management including marine pollution and waste management. Through the Pacific Community Centre for Ocean Science (PCCOS), SPC is also seeking to integrate its internal ocean science expertise, foster world-class scientific partnerships and knowledge exchange and focus that capacity on action to strengthen the collaborative contribution ocean science can bring to SDG 14 and the global goals more broadly, particularly in the context of the upcoming United Nations Decade of Ocean Science for Sustainable Development.

In addition, SPC's efforts include working with MCs to enhance resilience and ecosystem sustainability through integrated coastal zone management and strengthened ocean and coastal monitoring and prediction services; assisting countries and local communities with mangrove restoration, ecological restoration and erosion control of coastal areas; setting up and managing marine and land protected areas; building the capacity of Pacific Island National Meteorological Services and other relevant agencies to understand and apply climate, ocean and sea level information; providing world class scientific analysis of the health of Pacific fish stocks to inform sustainable fisheries management decisions; working with small-scale and subsistence communities to enhance access to marine resources and markets; supporting economic development through improved safety and energy efficiency of maritime shipping; and ensuring best practice and lessons from the field are documented, published and shared with MCs and partners.

Image: Cameron Diver

View from Micronesia: the beauty and vulnerability of Majuro, Marshall Islands

In the partnerships space, as a supporter of the Because the Ocean Initiative and the Ocean Pathway Partnership, SPC supported the third regional workshop on the integration of the ocean into nationally determined contributions under the Paris Agreement and a special ocean-climate negotiators symposium in May 2019. In close cooperation with the Intergovernmental Oceanographic Commission (IOC) of UNESCO, SPC hosted and organized the first regional consultation to prepare the United Nations Decade of Ocean Science.

Image: Nicolas Petit

Another fragile but vital ecosystem: mangrove swamps are a natural barrier to environmental degradation and a source of food and livelihoods for coastal communities

Image: Arthur Webb

A community at work: the importance of intertidal flats for local livelihoods, Kai Bun, Tarawa, Kiribati

In this context, experts were brought together from around the Pacific to facilitate sectoral and interdisciplinary discussions to ensure regional input and participation in the next phases of activity, and identify how Pacific solutions, including traditional knowledge, can contribute regionally and globally to the six main expected societal outcomes of the Decade: a clean ocean, a healthy and resilient ocean, a predicted ocean, a safe ocean, a sustainably harvested and productive ocean, and a transparent and accessible ocean. The Pacific Community also actively contributed to the "Friends of Ocean and Climate" group at UNFCCC COP 25 that successfully negotiated a final COP decision recognizing the importance of the ocean and requesting that the Chair of the Subsidiary Body for Scientific and Technological Advice (SBSTA) convene a dialogue on the ocean and climate change in June 2020.[2]

Through all of this work, SPC is also seeking to improve regional and global ocean literacy. This ranges from fostering an appreciation of the ocean among school students to enabling rigorous academic study, brokering knowledge to actors in rural and urban communities and enhancing awareness of key ocean issues for decisionmakers at the highest levels of government. SPC's work in this field recognizes and values traditional ocean knowledge and management practices and ensures that these are taken into account and built into sustainable management plans.

However, while progress is being made, significant challenges remain. Beyond the need for significant multiyear funding to match the level of ambition, the ongoing negative effects of climate change, inadequate agricultural, industrial and household waste management, plastic and chemical pollution, corruption and lack of robust governance mechanisms, the alarming rate of biodiversity loss in global ecosystems and the sometimes wilful ignorance of scientific evidence and advice, to name but a few, all threaten and undermine our capacity to fully implement SDG 14.

At the Pacific Community, it is time for action as the effects of ocean change and the climate crisis become ever more present. Vulnerable populations, whether from Small Island States, the rural heartland or the world's megacities, are becoming ever more vulnerable, and the well-being of people and planet continues to face its most existential threat. The celebrated Pacific author Epeli Hau'ofa wrote: "The sea is our pathway to each other and to everyone else, the sea is our endless saga, the sea is our most powerful metaphor, the ocean is in us". That statement eloquently captures the idea that fundamental ocean identity comes from the heart of Oceania, from the strength of the cultures and traditions of the Blue Pacific continent. As we advance through the 2020 Super Year and into the final decade of the 2030 Agenda, imagine how powerful it would be if we collectively harnessed "the ocean in us" as a driving force to increase ocean ambition and enhance ocean action; as a catalyst to reverse the declining health of the global ocean as our planet's "Blue Lung"[1], embed the nexus between the ocean and sustainable human, social, economic and environmental development, and fulfil the promise of SDG 14: a healthy, sustainably managed ocean for a healthy, sustainably managed planet. The opportunity is there. All we have to do is seize it.

Towards strengthening management of high seas biological diversity

Iwao Fujii, Research Fellow; Dr. Miko Maekawa, Senior Research Fellow,
The Ocean Policy Research Institute of the Sasakawa Peace Foundation

The appropriate management of biological diversity in high seas is key to achieving SDG 14. A new treaty is currently being discussed at the United Nations in order to agree on "an international legally binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ)". Once the agreement is developed it is expected to function as a catalyst to achieve SDG 14 as stated in its objective.

According to the draft text of an agreement published on 17 May 2019, the objective of the agreement is "to ensure the long-term conservation and sustainable use of BBNJ through effective implementation of the relevant provisions of the Convention and further international cooperation and coordination." This new agreement is to be the third under UNCLOS, which was adopted in 1982 and came into effect in 1994, and named the Constitution for the Oceans for its comprehensive and universal nature. The new agreement to be negotiated is directly linked to one of the ten Goal 14 targets, namely SDG 14.C: "Enhance the conservation and sustainable use of oceans and their resources by implementing international law."

Image: Dr. Takashi Nakamura

There are already many existing efforts at local, national, regional, and international level that can potentially contribute to conservation and sustainable use of BBNJ. One of the initiatives undertaken to highlight the sustainable management of oceans is the Palau Coral Reef Island Ecosystem Project (P-CoRIE), conducted with an objective of strengthening Palau's capacity in scientific research and conservation of coral reefs

The new Agreement on BBNJ is a good example of how international law is supposed to be implemented to ensure the appropriate management of oceans and their resources through the conservation and sustainable use of marine biological diversity in high seas. The following summary focuses specifically on the new BBNJ Agreement under the theme "implementation of international law in relation to UNCLOS."

The new agreement negotiation process

In September 2018, the first intergovernmental conference concerning biological diversity in areas beyond national jurisdiction took place at the United Nations headquarters. This was the first substantive negotiation among governments to establish a new treaty on conservation and sustainable use of BBNJ. Covering more than 60 per cent of the entire ocean, areas beyond national jurisdiction, or high seas, are important sources of food. These areas also accommodate the passage of much of the world's shipping as well as infrastructure such as marine cables. However, there has been no international framework that comprehensively manages the high seas, especially biological diversity in these areas. Due to a growing awareness of the importance of the high seas, discussion on BBNJ began in 2004 in the form of an ad hoc open-ended informal working group. After a series of group meetings and preparatory committees convened between 2004 and 2017, the first negotiation finally began in 2018, with an intergovernmental conference scheduled to occur four times between 2018 and 2020. In these sessions, four elements of the new treaty are discussed:

- Marine genetic resources, including questions on the sharing of benefits
- Area-based management tools, including marine protected areas
- Environmental impact assessment
- Capacity building and the transfer of marine technology.

The governments of the United Nations Member States discussed all of the potential options of the treaty text during the first two sessions. A draft of an agreement was made based on the discussions in these two sessions, and the first text-based negotiation was held in the third intergovernmental conference. The last session is scheduled to take place in 2020. However, there are still several divergent views among

The first session of the intergovernmental conference on the new BBNJ Agreement

the participating States. One significant dichotomy is which principle — that of the common heritage of mankind or that of the freedom of the high seas — is applied to the marine genetic resources (MGRs) discovered in the little known areas around the sea bed. Most developing countries support the former to ensure that MGRs are co-managed and that benefits from such resources are shared evenly. Some of those states also argue that the sharing of benefits must be fair and equitable in order to align with the Convention on Biological Diversity Nagoya Protocol. Because these divergent views have persisted through the discussions, negotiations are slated to be prolonged beyond 2020.

Capacity building

Convergent opinions are more likely to occur in discussions on capacity building and the transfer of marine technology. To ensure the effective management of BBNJ, capacity building is considered an enabler of the other three elements of the treaty. During the conferences, most Member States expressed their views that capacity building is an essential aspect of the negotiations to fulfil the rights and obligations of the states, particularly developing countries. Some of them have also argued that the criteria and guidelines on transfer of marine technology of UNESCO's Intergovernmental Oceanographic Commission can provide a template for operationalizing capacity building for the BBNJ Agreement.

There is also a broad consensus among the Member States that capacity building should be provided based on needs assessment, and that the new agreement would include an indicative, non-exhaustive list, which could be developed at a later stage. The list would include scientific and technical assistance, for example through joint research cooperation programmes; education and training of human resources including through workshops; and data and knowledge sharing. Institutional capacity building is also included to help countries in need implement BBNJ policies.

Despite consent to the importance of capacity building among states, there are still conflicts such as whether capacity building and the transfer of marine technology are provided on mandatory or voluntary basis. Many of the developing countries affirm mandatory capacity building, stressing that it is an important driver for them in order to pursue goals of the new agreement. Conversely, the developed countries have negative views on mandatory capacity building, claiming that it should be provided only on a voluntary basis. Another conflict arises due to the status of funding. Many of the developing countries support a hybrid mechanism of voluntary and mandatory funding. Some developed countries also support their view, but add that mandatory funding should be limited to institutional and clearing-house mechanism costs. In contrast, many other developed countries have expressed a preference for voluntary funding.

Such conflicts clearly pose difficulties in reaching a consensus. One possible reason for the conflicts is a shortage of information on both capacity building and the transfer of marine technology. Although the participating delegates have long been discussing it, little is known about what capacity building efforts exist and what efforts are needed. A recent assessment of capacity needs conducted by the Global Ocean Forum revealed that science and law are the areas of greatest need for developing countries to cover their shortages in BBNJ management. However, further details on existing efforts (supply) and needs (demand) are not available. As a result, a stalemate has arisen around discussions on what types of capacity building activities should be addressed and what methods of procedure should be adopted in the new agreement. So far, little effort has been invested in assessing the gap between demand and supply of capacity building.

Potential contributions to capacity building for BBNJ

Capacity building for the ocean is not starting from a zero basis. There are already many existing efforts at local, national, regional and international level that can potentially contribute to conservation and sustainable use of BBNJ. In addition, a wide range of sectors, including governments, international organizations, the private sector and civil societies, provide capacity building. One notable example is the Science and Technology Research Partnership for Sustainable Development (SATREPS)[1], a Japanese government programme that promotes international joint research targeting global issues. Although this initiative does not specifically address BBNJ, there have been several efforts made by the programme that highlight the sustainable management of oceans. Among those is the Palau Coral Reef Island Ecosystem Project (P-CoRIE), conducted with an objective of strengthening Palau's capacity in scientific research and conservation of coral reefs. P-CoRIE consists of three main elements provided as a package:

- Improvement in the capacity of local researchers in coral reef monitoring through collaborative research
- Transfer of analytical skills using new research devices
- Acceptance of local scientists to a master's programme at the University of Ryukyu, Japan.

What makes this project unique among several efforts is the training not only for local scientists but also for future leaders through providing a master's degree. More notably, its capacity building concluded with the submission of policy recommendations on coral reef management based on scientific evidence, given that the use of best available science is often stressed in BBNJ negotiations. Such a long-term vision can form part of a modality for capacity building not only for coastal areas, but also for the high seas.

The private sector and civil societies also play a significant role in capacity building. The cumulative number of participants from such sectors, categorized under NGOs in the BBNJ conferences, have been increasing since the first preparatory BBNJ committee in 2016. At the time of the third session held in August 2019, over 70 NGOs have participated in BBNJ-related meetings at least once, indicating a notable presence of non-governmental parties. Most of those NGOs also provide a wide variety of capacity building opportunities ranging from workshops to financial assistance. Among those is the Nippon Foundation (NF), which conducts several ocean-related capacity building initiatives. A unique example is the General Bathymetric Chart of the Oceans (NF-GEBCO) training project — a one-year course leading to a postgraduate certificate in Ocean Bathymetry (PCOB), held at the University of New Hampshire, US. Many of its trainees are from developing countries and take a leading role in the area of bathymetry in their home countries after training. A notable advantage of this project is the network

Image: Dr. Takashi Nakamura

Scientists at the Palau International Coral Reef Center, each of whom has received a master's degree at the University of Ryukyu, Japan

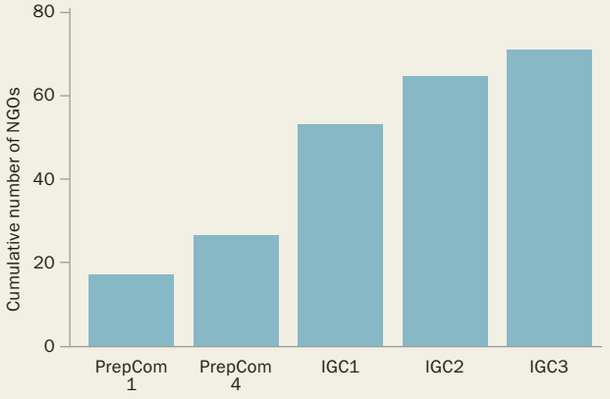
Image: Dr. Takashi Nakamura

Community meeting held on behalf of the Palau Coral Reef Island Ecosystem Project (P-CoRIE)

Negotiation path of the new BBNJ Agreement

2004–2015: Ad hoc working group
June 2015: 69th United Nations General Assembly resolution
2016–2017: Preparatory Committee
December 2017: 72nd United Nations General Assembly resolution
2018–2020: Formal negotiations

The cumulative number of NGOs that have participated in BBNJ-related meetings



Information on PrepCom 2 and 3 is not publicly available

Image: the NF-GEBCO alumni team

The alumni team of the General Bathymetric Chart of the Oceans (NF-GEBCO) training project, celebrating their win at the award ceremony of the Shell Ocean Discovery XPRISE, a global competition that challenged teams to advance deep sea technologies for autonomous, fast, high-resolution ocean exploration

of graduates that expands across the world. The NF created a team comprising 13 graduates of the project to compete in the Shell Ocean Discovery XPRISE, a global competition that challenged teams to advance deep sea technologies for autonomous, fast, high-resolution ocean exploration. The team was able to win the first prize of US$ 4 million through leveraging the wide range of knowledge and expertise that has emerged as a result of the members' diverse backgrounds. Such a network of trainees can be one of the keys to long-term capacity building effectiveness in managing biodiversity in the high seas.

Ensuring capacity building efforts for the effective implementation of the new agreement

Although there is a significant number of existing capacity building efforts, most of them are part of broader training initiatives in ocean policies, governance and science, while activities directly related to BBNJ capacity building remain limited. In addition, most efforts focus on training at an individual level such as through workshops, most of which take place on an ad hoc basis. However, training at the institutional level is also required to effectively implement BBNJ-relevant policies.

Image: the Nippon Foundation

Members of the NF-GEBCO alumni team reporting the winning performance of XPRIZE to the Japanese Prime Minster, Shinzo Abe

Furthermore, attention needs to be drawn to societal level capacity building by raising awareness to citizens such that the sustainable management of BBNJ can be achieved through both top-down and bottom-up approaches. It is also important to note that there is currently no evidence of coordination among existing efforts. In order to consolidate the appropriate management of BBNJ, it is necessary to assess the lessons learned and discuss possible modalities of capacity building through scaling up and coordinating existing efforts towards ensuring biodiversity in the high seas.

SDG 14 — a holistic approach to global sustainable development

Paola Reale, Research Programme Manager;
Dr. Michael Phillips, Director of Aquaculture and Fisheries Science, WorldFish

The world's water bodies are essential resources for food production, biodiversity, carbon sequestration and human well-being. However, the current trends in environmental deterioration, fisheries management, water pollution and climate change are affecting the oceans and aquatic ecosystems in ways that will be detrimental for the well-being of future generations.

The United Nations Sustainable Development Goals (SDGs) provide multiple targets for a sustainable future, many related directly and indirectly to the oceans, including SDG 2 (Zero hunger), SDG 1 (No poverty), and SDG 14 (Life below water). An integrated and holistic food systems approach to delivering wide access to healthy food diets from aquatic systems could create decent livelihoods and employment for many, while creating solutions to the climate and environmental crises and their impacts on human welfare.

Aquatic foods, farmed and caught from the world's waters, are a key solution to the goal of transitioning the world's food systems towards nutritious, healthy, sustainable and inclusive pathways. Aquatic foods have unique qualities for nutrition and human well-being, with low carbon footprints among animal source foods, and with high potential for future growth, without increasing environmental impacts. In addition, both capture fisheries and aquaculture can provide important social inclusion and employment opportunities for many people across the developing world. These many opportunities for aquatic foods, and their enhanced role within food systems to contribute to human well-being, remain to be fully realized.

Image: Heba Al Begawi/WorldFish, 2014

Women selling fish from a newly constructed marketplace, Fayoum, Egypt. The fisheries and aquaculture sectors provide social inclusion and employment for many people across the developing world

In developing countries alone, oceans support 47 million women and men engaged in small-scale fishing and fish trading.[1] The total global value of caught wild fish and aquaculture was estimated at US$ 362 billion in 2016, with fish accounting for 17 per cent of global animal protein consumption in 2015. In the Lower Mekong river basin alone, fisheries are estimated to be worth around US$ 17 billion a year, supporting many millions of people living throughout the region.

This critical source of income and nutrition is under threat. With rapid and sometimes destructive development, over-fishing, and extreme climatic events, the once thriving breeding grounds are rapidly degrading. As a result, it is anticipated that, in many places, fish catches and vital protein and nutrient sources for local populations will likely fall in the coming years.

Livelihoods within the aquatic food systems need to become increasingly sustainable and resilient, with adequate incomes, secure access to food, markets and nutrition, and the capacity to manage natural resources in equitable, sustainable and innovative ways.

Inclusion, nutrition and food security

The populations of developing countries that earn their living by fishing, or that consume fish, need not only a higher income, but also better nutrition and food security. Small-scale fishers are experiencing a reduction in food availability due to competition with large-scale fisheries in some countries, the effects of climate change, and unequal access to primary production, with dramatic consequences for those communities who traditionally rely only on a daily catch for feeding their families and ensuring a healthy life. Around the developing world, commercial fishing fleets from across the globe, racing against a global squeeze on fish stocks, have moved into the near and offshore waters where they catch millions of tons of fish for trade each year. Valuable fish are sold to other developed countries.

As the burgeoning fish industry became a national priority for emerging island and coastal nations, flows of low- and high-value fish to local, coastal populations have changed. Pacific Islanders are missing out on the food that has served

Image: WorldFish

Community members in Timor-Leste work together to deploy a nearshore fish aggregating device (FAD). For Small Islands Developing States and many emerging economies elsewhere, the multibillion-dollar global fish trade is an increasingly important income source, supplying jobs in catching, processing and trading

as a bedrock to their cultural traditions, incomes and health. As a result, governments are facing a mounting public health crisis — even as their fish industries soar. Local communities are now so reliant on cheap, energy-rich but micronutrient-poor processed foods instead of healthy fish, that they have experienced a surge in obesity and associated diseases. At the same time, many more islanders, including pregnant women and young children, suffer from micronutrient deficiencies.

For Small Islands Developing States and emerging economies elsewhere, the multibillion-dollar global fish trade is an increasingly important income source, supplying jobs for millions of people in catching, processing and trading, but also generating a trade-off between lucrative fish exports and public health. People in emerging economies need fish, not just as an income source but also as a source of essential micronutrients.

Micronutrient deficiencies account for an estimated one million premature deaths annually, and for some nations can reduce gross domestic product by up to 11 per cent, highlighting the need for food policies that focus on improving nutrition rather than simply increasing the volume of food produced.[2] People gain nutrients from a varied diet, although fish — which are a rich source of bioavailable micronutrients that are essential to human health — are often overlooked.

A lack of understanding of the nutrient composition of most fish and how nutrient yields vary among fisheries has hindered the policy shifts that are needed to effectively harness the potential of fisheries for food and nutrition security.[3] One recent study looked at how to harness global fisheries to tackle micronutrient deficiencies, and estimated how environmental and ecological traits predict the nutrient content of marine finfish species using the concentration of 7 nutrients in more than 350 species of marine fish. This predictive model was used to quantify the global spatial patterns of the concentrations of nutrients in marine fisheries and compare nutrient yields to the prevalence of micronutrient deficiencies in coastal human populations. Species from tropical thermal regimes were found to contain higher concentrations of calcium, iron and zinc; smaller species contained higher concentrations of calcium, iron and omega-3 fatty acids; and species from cold thermal regimes or those with a pelagic feeding pathway contained higher concentrations of omega-3 fatty acids. There was no relationship between nutrient concentrations and total fishery yield, highlighting that the nutrient quality of a fishery is determined by the species composition.

For a number of countries in which nutrient intakes are inadequate, nutrients available in marine finfish catches nevertheless exceed the dietary requirements of populations that live within 100 km of the coast. Also, a fraction of current landings could be particularly impactful for the benefit of children under five years of age.

Food strategies based on fish and other aquatic foods have the potential to contribute substantially to global food and nutrition security. The critical factor of this nutrition solution is that it does not require more fish, but calls mostly

for its redistribution, as diverting just a fraction of the catch away from export to coastal communities could end the problem of malnutrition. Policies and practices that reduce waste and loss in fish value chains can also help considerably in recovering nutrients.

Moreover, studies have shown that the consumption of fish rich in zinc, iron, vitamins A and B12, healthy fats and lean protein, addresses the triple burden of overnutrition, undernutrition and micronutrient deficiency. Importantly, it ensures that pregnant and breastfeeding mothers fortify their babies' bodies and brains and is associated with low stunting in children. Fish also enhances the absorption of iron and zinc in the foods eaten alongside it.

Governments interested in boosting both health and economic growth, and doing so sustainably, should find ways to redesign supply chains to deliver fish to poor, malnourished people, whether or not they live close to the sea. With the right policies in place, ensuring that local populations have better access to more fish could cut public health costs and help meet climate goals. A balance between lucrative fish export operations and domestic fish consumption promises to fortify economies.

The blue economy and sustainable management trade-offs in developing nations

The world's coasts and oceans offer vast opportunities to support economic development and are increasingly prominent in the discourse on global environmental futures.[4] A critical challenge for adapting ocean governance for the 21st century is to balance competing interests, and to realize economic potential while avoiding irreversible environmental change. Simultaneously, ocean governance transformations must ensure that the human rights of those who depend on the sea for their livelihoods are respected, that benefits of growth are equitably distributed and that human well-being of coastal and marine resource-dependent people is maintained or enhanced.[5] This is the "safe and just space" that defines the scope for sustainable development more broadly.[6] Small-scale fisheries (SSF) provide a powerful example of the way in which contemporary changes to ocean governance are balancing, reconciling and trading off multiple interests and objectives.

The economic promise of oceans has captured the attention of conservationists, business leaders, funders, governments, and multilateral organizations including the United Nations and the World Bank. This is illustrated by an uptick in global ocean-focused conferences that have previously framed conservation as the leading agenda, which now emphasize a focus on the "blue economy".[7]

The blue economy aims to tap into the estimated US$ 24 trillion in potential goods and services derived from the world's oceans, such as energy generation, mining, tourism, maritime transport, aquaculture and capture fisheries, and to balance the industrialization of oceans with environmental protection.[8] Initiatives framed around the blue economy, or blue growth, purport that economies, societies and marine environments will all benefit; however, the logic for reaching these win-win-win outcomes through the strategies described has been contested.[9] It has been argued that these same strategies have not led to environmentally sustainable and equitable outcomes on land[10], and therefore there is little reason to expect them to perform better at sea.

Image: Neil Palmer, WorldFish

Participatory mapping of rice-fish landscapes near Siem Reap, Cambodia. Funded by the European Union and IFAD, the project aims to improve the nutrition and livelihoods of poor, rural households in selected provinces of Cambodia by increasing production and consumption of micronutrient-rich small fish and vegetables in rice-field landscapes under threats of climate change

Image: Felix Clay/Duckrabbit, 2012

Multi-purpose canal in Situlu Village, Mongu, Western Zambia. The canal has multiple uses in the landscape, for fishing, transportation and irrigation, and is an important refuge for fish during the dry season and droughts

Oceans provide broad-based public goods, although the governance strategies and management practices proposed in blue economy initiatives may lead to, or accentuate, inequitable capture of these goods to generate private wealth for a relative few.[11] There are concerns expressed by small-scale fisher groups that the blue economy agenda undervalues social objectives, and in doing so threatens the basic imperative of providing both livelihoods and affordable, nutrient-dense food for those who need it most.[12]

To date, considerations of food security and human rights have not been front and centre in high-level dialogue around the blue economy. Small-scale fishers have been notably underrepresented, for instance at the World Ocean Summit in 2017, and the Our Oceans Conference in 2018, considering that SSF employ more women and men than all of the other ocean economic sectors combined.[13] This imbalance has raised considerable concern from small-scale fisher associations, other civil society groups, social scientists and development practitioners.[14] These actors have spearheaded strong resistance to ocean initiatives that were viewed as driving economic reforms[15] and, more recently, those specifically aligned to the blue economy agenda.[16]

The blue economy and other initiatives frame transformation as necessary in order to "fix" an ocean that is in an environmentally degraded and economically underperforming state. There are three additional considerations for the blue economy, and other initiatives grounded in 'environmental crisis' and 'untapped economic frontier' narratives[17]:

- Market-based trajectories of change put forward as part of the blue economy pose risks to the benefits that SSF provide to society
- SSF are uniquely placed to produce and distribute food and income to those whose nutritional and financial needs are greatest
- There is the need for more meaningful uptake of well developed inclusive governance principles by engaging emergent governance platforms to ensure that the course navigated is one toward sustainable, equitable and just ocean futures.

A multi-regional and sectoral perspective for delivering development outcomes

To overcome climate change, bearing in mind the human dynamics that affect the world, and in particular poor communities living near water, it is important to structure and understand the intricate interconnections between SDG 14 (Life below water) and other SDGs. Almost all of the SDGs and many associated targets — more than 34 — are relevant to the world's aquatic food systems and provide diverse benefits and opportunities to aquatic ecosystems and their people.

Research by Worldfish and CGIAR contributes knowledge to many SDGs through the focus on aquatic food systems, and delivers direct benefit to the most vulnerable people by harnessing the potential of fisheries and aquaculture to reduce hunger (SDG 2) and poverty (SDG 1). This research strives to make fish available and affordable to the poor in

Image: Kate Longley, 2013

Irrigated rice fields in Sefula, Zambia. By encouraging fisheries to flourish within irrigation systems, incomes within and beyond the system can be raised, water supply for multiple users can be ensured, biodiversity can be maintained, and food and nutritional security improved

order to help combat malnutrition and alleviate nutritional deficiencies that often occur in developing countries (SDG 3 — Good health and well-being). WorldFish research seeks to highlight and support the major role played by women in fisheries and aquaculture by closing the gender gap and helping to improve productivity and increase incomes and food security (SDG 5 — Gender equality).

WorldFish research shows that adopting new technologies alone is not sufficient for improving productivity, profitability and sustainability. Using natural resources efficiently, pursuing innovation, and access to credit for investment in business activities, especially for the poor, are vital considerations. Particular attention must be given to strengthening the relations between research and the private sector to enable innovation at scale, and with government to ensure informed policy decisions in support of sustainable growth in supply of fish and aquatic foods from wild and farmed sources. WorldFish works with an extensive network of partners to create change for the millions who depend on fish in the developing world. Partnerships are essential to bring technologies and innovations to scale and achieve development impact.

A food system approach is increasingly being used to maximize sustainability and impacts of aquatic foods on nutrition and health. The approach connects food production through to consumers. Sustainable aquatic food supply can be achieved in various ways, but integrated approaches have shown very good results in maximizing production while addressing environmental and social concerns. For instance, the presence of fish within irrigation systems has gained in importance and, thus, an ancient polycultural practice has proven to be a solution to ensure a more sustainable future for communities most in need. In Asia and Africa, irrigation is important for producing food in the face of climate change, as rainfall becomes more difficult to predict. Today, irrigated agriculture represents over 20 per cent of cultivated agricultural land and contributes to approximately 40 per cent of global crop production.

Ironically, irrigation infrastructure can adversely affect aquatic biodiversity and fish populations — by impeding the flow of rivers and obstructing breeding opportunities, or by creating oxygen-poor reservoirs where aquatic life cannot thrive. Many schemes suffer from poor maintenance, need constant rehabilitation and rarely operate at the levels originally anticipated. Enhancing infrastructure solely to more effectively deliver water for increased crop production is no longer sufficient if the irrigation sector is to help achieve multiple sustainable development objectives. Those modernizing irrigation schemes must now consider the sustainability and food security needs of a growing global population, and work on maximizing the benefits of irrigation for multiple users, all within the ecological limits of the ecosystems in which they are located.

Fish farming in irrigation systems is not a new practice, with recorded cases dating back two millennia. A new paper argues that explicitly integrating fisheries into irrigation systems as a part of irrigation modernization could be the key to achieving both the contemporary demands on irrigation and enhanced global food security. The combined socioeconomic and environmental benefits that could be

derived are just the kind of win-win scenario required if the SDGs are to be achieved.

This new paper, which was prepared by researchers at the CGIAR Research Programme on Fish Agri-Food Systems (FISH); WorldFish; the CGIAR Research Programme on Water, Land and Ecosystems (WLE); and the International Water Management Institute, proposes a framework for how fisheries can be better integrated into water policies and investments at a variety of scales, from local communities to watershed to national and regional levels.

Recognizing the many demands placed on the irrigation sector, the study suggests various ways to integrate fishery management and aquatic food production into irrigation schemes, taking care to consider the local context, national food production and water usage goals.

For instance, in some areas, enhancing capture fisheries can be achieved by incorporating fish passes into scheme design, or changing gate design and operation to avoid injuring or killing fish that swim through them. In addition to the infrastructure change, these solutions require improved governance systems to ensure that the increased catch goes to the intended beneficiaries. Viewing governance as integral to the upgrade ensures both a more holistic process of modernization, and greater overall benefits for local water users and fishers.

In addition, aquaculture has great potential within irrigation schemes in its provision of water storage infrastructure that is constructed as part of a scheme, or ponds built specifically on farm plots. A second option is the combining of aquaculture with irrigated rice farming, such as co-producing rice and aquatic foods in the same farm or landscape, or as a replacement for rice if the profit margin for fish is higher. However, the sustainability of aquaculture is dependent on a number of factors, including good management, improved farmer capacity, and access to stable markets. All of these need to be assessed before investing in aquaculture within irrigation schemes.

Beyond the system level, to be truly sustainable, the kind of changes proposed need to take place within an enabling environment that takes into account catchment and national development and water strategies, as well as water and food needs. Instead of merely improving the efficiency of irrigation systems, adding fisheries can improve the value of water in that it can be re-used — once as a habitat for fish, and again as irrigation for crops, thereby increasing the overall water productivity, and nutrition and economic values of water.

By encouraging fisheries to flourish within irrigation systems, incomes within and beyond the system can be raised, water supply for multiple users can be ensured, biodiversity can be maintained, and food and nutritional security improved. By creating a more diverse set of benefits from irrigation systems, integrating fisheries into those systems also has the potential to empower women or youth who might have more control over fish-based nutrition or income within their families. It can also lead to a reduced need for chemical fertilizers and pesticides, with fish and aquatic life taking the place of pest control while nutrient-rich waste is added to the water to improve fertility, thereby reducing the environmental impact of agricultural systems.

To conclude, the unique nutritional quality of fish and other aquatic foods is able to fuel minds, bodies and economies. At the top of the global agenda for the future should be: integrated approaches to the blue economy, polyculture systems, fisheries management, and ensuring access to a nutritious and balanced aquatic-food-based diet for all.

Image: Noor Alam

The thriving fish market of Gollamari at Khulna, Bangladesh, illustrating a diversity of fish and aquatic foods within a rural market

A partnership for the Pacific — sustainable ocean development 2030

Lead researchers from the Association of Pacific Rim Universities (APRU) Pacific Ocean Program: Gerald Singh, Assistant Professor, Memorial University of Newfoundland and Nippon Foundation Nereus Program; Yoshitaka Ota, Assistant Research Professor, University of Washington and Nippon Foundation Nereus Program

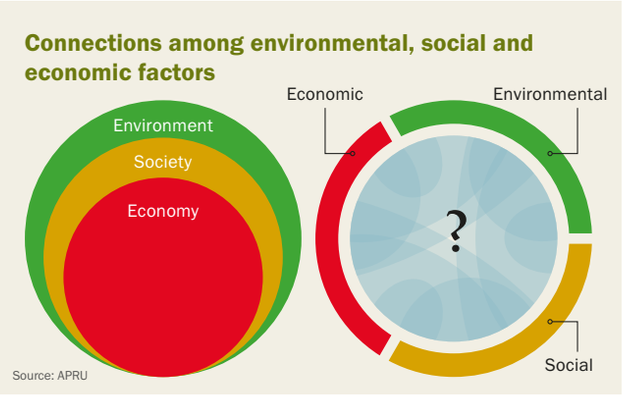
The adoption of the Sustainable Development Goals (SDGs) in 2015 marked an unprecedented diplomatic governance achievement in which the United Nations, for the first time, formally recognized global oceans as an important part of achieving sustainable development. The SDGs also acknowledge the goals as being interdependent — the success of each goal is predicated on the achievement of others. The connected structure of the goals resonates with the fundamental philosophy of "leave no one behind" pledged by UN Member States, as the world's most vulnerable and marginalized people face incremental factors that negatively affect their well-being.

The Association of Pacific Rim Universities (APRU) believes that universities have a critical role to play in contributing to the achievement of SDGs from driving education and learning experiences to raising awareness, educating the public and students, funding researchers, building research infrastructure, and facilitating cooperation between ocean sciences, social sciences, and the international policy community. In 2017, APRU joined over 1,500 NGOs, governments, intergovernmental organizations, academic institutions and philanthropic organizations, and registered its voluntary commitment to addressing SDG 14 (Life Below Water): to conserve and sustainably use the oceans, seas and marine resources.

Founded in 1997 by the presidents of UC Berkeley, Caltech, UCLA, and the University of Southern California, APRU is a network of 51 leading research universities located around the Pacific — The Americas, Asia, and Oceania. It serves as an advisory body to governments, business and international organizations on the many ways in which education and research can advance solutions. The network has played an influential role with many pressing issues facing the region, from disaster management and recovery, population aging and global health, to sustainable cities, labour mobility and the impact of AI on society.

One pledge in the commitment to SDG 14 was the establishment of the Pacific Ocean cluster research project, identifying socioecological relationships to support the SDGs. Led by Gerald Singh (Memorial University of Newfoundland), Yoshitaka Ota (University of Washington) and William Cheung (University of British Columbia), the project evaluates the economic, social, governance and environmental conditions that promote sustainable oceans throughout the Pacific Rim. The cluster project is being built on the work of the Nippon Foundation Nereus Program, which currently brings together 17 institutions globally, including APRU members, outlining the institutional cooperation needed to enact appropriate policy and evaluating the effectiveness and feasibility of specific options to reduce the risks associated with climate change impacts.

Meeting the ambitious targets for sustainable oceans also provides co-benefits that contribute to all other SDGs. Previous research from the Nippon Foundation Nereus Program has found that achieving the goals of sustainable oceans is a requirement in meeting the targets of many other goals, including eliminating poverty and hunger, providing quality education, ensuring the availability of meaningful work and economic opportunities for all, promoting sustainable cities and communities, and contributing to peaceful and strong institutions. While these findings are celebrated and promoted within academic circles, they would be more meaningful if they could successfully aid the implementation of sustainable development policy. However, the feedback received from governments, intergovernmental organizations, nongovernmental organizations and civil society organizations is that this research does little to advance policy planning besides highlighting the importance of the oceans.



APRU'S research moves beyond the framework that assumes that sustainable development ultimately rests on environmental health, and acknowledges that there are deep connections among environmental, social and economic factors that we are often uncertain about

Image: Marlena Skrobe

Pursuing development for small island developing states may have trade-offs for reducing marine pollution and restoring marine habitats

Filling the policy research gap

While highlighting the importance of the oceans can be useful in some contexts, other research similarly highlights the importance of other SDG concerns, including reforming production and consumption systems, and achieving public health commitments and gender equality, among others. Moreover, highlighting the particular significance of any individual SDG is a redundant exercise, as each SDG was chosen precisely for its importance. More useful for policymaking would be to analyze the contribution that each individual SDG makes to others in a systematic way, as this could help prioritize SDG achievement. Perhaps even more useful would be to invert the nature of this research and, instead of assessing how any particular goal provides co-benefits or trade-offs with other goals, explore the ways that all SDGs provide co-benefits or trade-offs toward SDG 14. This kind of research can help policymakers align policy programmes to achieve their sustainable development priorities while minimizing the chances of unrealistic expectations and avoidable side-effects.

In spite of the recent attention to the connections between sustainable oceans and societal benefit, including food security and climate change mitigation, there is considerable uncertainty as to how to achieve sustainable oceans in the first place — that is, which SDGs need to be advanced in order to achieve sustainable oceans. While a current popular framework holds that environmental health underpins all aspects of sustainable development, this framework underestimates the social and economic dimensions necessary to achieve environmental sustainability.

This question is being investigated throughout Pacific Rim nations specifically, because the Pacific is the world's largest ocean and has the largest number of small island nations. It is a perfect focus for understanding the strategies to address ocean sustainability in pursuit of larger sustainable development.

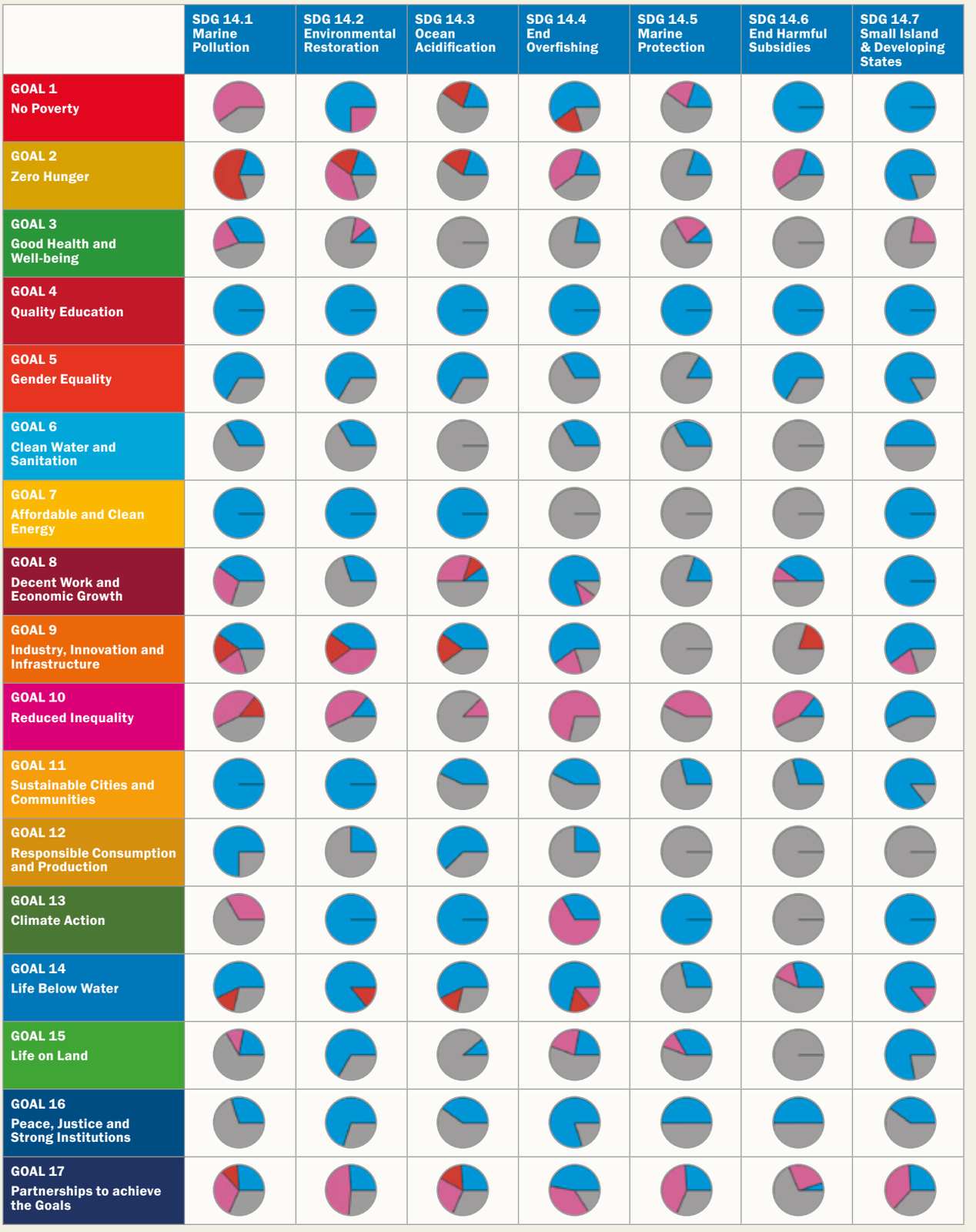
Partnership for the Pacific

While the Nereus Program has the capacity to conduct complex research, it is not a policymaking agency. APRU, by contrast, is tightly connected to policymakers and is explicitly focused on fostering collaboration among universities and connecting academic research to policy concerns. The collaboration between these two organizations allowed for development as well as ongoing policy-relevant and innovative research, but it needed to overcome significant obstacles in order to succeed.

As the Nereus Program is a networked research institution, the coordination of work both within and outside of itself is a challenge. While coordinating activities across institutions can be difficult even when the missions of each institution align perfectly, this hurdle is especially prominent in cases where collaborating networks have different core objectives and work plans, such as research through peer-reviewed publications (Nereus) and addressing policy needs through leveraging collective academic capacity (APRU). Even though theoretically these institutions should complement each other, in practice the slightly differing responsibilities and organizational cultures makes alignment more complex.

For instance, efforts to achieve sustainable development for the oceans include not only a lack of certainty in the

Co-benefits and trade-offs in addressing a given SDG area to promote specific targets for a sustainable ocean throughout the Pacific



Pie charts indicate the proportion of targets within each SDG that promote co-benefits and trade-offs, either, or neither, towards the given target

kinds of policies and programmes that would promote sustainable oceans (an area more commonly addressed by academic research), but also a lack of certainty regarding how to engage the necessary actors (an area more commonly associated with coordinating organizations). Additionally, issues of sustainable development, where the topics of investigation are commonly addressed by people outside of academia, stretch the classical academic notion of an expert. Any meaningful investigation of sustainable development must therefore cross academic and policy boundaries.

Another challenge has been that there is no database, with country-level specificity, of policy priorities to achieve sustainable oceans. Similarly, no single research team exists that can identify country-level policy priorities for ocean sustainability for regions as large as the Pacific Rim. In order to study the policy priorities to achieve sustainable oceans across Pacific Rim economies, the work conducted has thus relied on input from hundreds of experts with specific knowledge from each individual Pacific Rim country. Identifying, contacting and recruiting relevant experts therefore entailed working across academic, non-governmental, and policy institutions throughout Pacific Rim countries and territories.

Despite these challenges, both organizations have realized the potential of leveraging each other's strengths. By working with an organization such as APRU whose boundary-crossing focus connects researchers with policymakers across a distinct geographical region, staff at the Nereus Program were able to conduct all of their research thoroughly. Not only has this collaboration provided a means by which to study and help act upon the modern challenge of sustainable ocean development, but it has also provided a forum of capacity building with which a research institute can engage with a larger inter-university network and policymakers.

Three tiers of governance

The research led by the Nereus program in collaboration with APRU has been designed according to an explicit framework that seeks to align the governance tiers of policy strategy, institutional structure, management plan and project execution. Research into effective policy indicates that the alignment of governance tiers is necessary for achieving broad goals, and that any misalignment can lead to counterproductive results and inadequate policy. Similarly, the policy may fail if strategic goals and institutions are in alignment but ineffective programmes are implemented such as those that inadequately limit waste release or fail to clean up polluted areas.

The first stage of the research was to address strategic policy goals. As stated previously, understanding how other SDG areas contribute to (or detract from) sustainable oceans throughout the Pacific can help establish strategic policy areas. APRU, under the direction of Professor Singh, first set up a survey to ask economy-specific experts how individual SDG areas contribute to (or detract from) specific ocean targets. Initial results from this level of analysis was completed and presented to the Asia-Pacific Economic Cooperation (APEC). Representatives from all Pacific Rim economies were also able to view the results and ask follow-up questions.

The results (aggregated at the level of the entire Pacific Rim) indicate that some SDG areas, including the provision of quality education, promoting peace, justice and strong institutions, and promoting gender equality, can generate co-benefits (that is, where progress in some SDG targets translates into progress in other SDG targets) across all ocean targets. There are also SDGs that, if pursued, may create trade-offs with ocean targets in the Pacific — most notably, promoting industry and infrastructure targets, eliminating poverty and hunger and, interestingly, pursuing some ocean targets that hinder others. For this latter finding, pursuing development for small island developing states may have trade-offs for reducing marine pollution, restoring marine habitats, minimizing ocean acidification impacts, and ending overfishing.

There are also SDGs that may either promote co-benefits with ocean targets or trade-offs, reflecting uncertainty in experts and the context-dependence of how policy is pursued. Notably, reducing global inequalities and developing international partnerships may promote either co-benefits or trade-offs across the ocean targets. The uncertainty in the results, as well as the potential for trade-offs between attaining important SDG targets such as eliminating poverty and hunger and achieving ocean sustainability, means that achieving sustainable development in the Pacific Rim must navigate nuanced policy that will try to realize potential co-benefits while avoiding potential trade-offs. Addressing these nuanced polices will need to occur at national scales.

The next research phases

With initial results collected, APRU continues to collaborate with Professors Singh and Ota, who will start conducting research at immediate scale concerning institutions. By first collecting data from the government agencies and institutions that are most important in regulating SDGs within each Pacific Rim economy, it will be possible to associate mandated government agencies with country-specific SDG priorities determined in the initial round of research. With this data collected, hypothetical governance structures for each Pacific Rim economy can be constructed that should help develop strategy for sustainable ocean development and potentially promote regional collaboration among relevant actors.

Considering research at the scale of ocean management plans, the project will also develop an understanding of climate impact on the oceans through plans which can be extremely varied. As the oceans are facing substantial impacts due to climate change, understanding the local and global level solutions to address those impacts will help to inform policy development in the region. Specifically, an expert workshop will be conducted to collect data and expert knowledge in order to assess various proposed programmes based on their efficacy to reduce impacts, as well as the capacity, cost, potential for collateral impacts, and political feasibility required to implement such programmes.

This research agenda, to study ocean sustainability through a policy-explicit framework at country-level resolution, is ambitious, but achievable if the connection is made between an ocean research institution and a university network that exists on the boundary of academia and policy. It is APRU's belief that pursuing research-based sustainable development to meet the SDGs globally will require more collaborations such as these.

Transforming our relationship with the ocean — changing values to ensure conservation

Michelle Bender, Ocean Rights Manager, Earth Law Center, Member IUCN WCEL;
Jacqueline Evans, Founder and Director, Moana Foundation, 2019 Goldman Environmental Prize winner

Despite coordinated effort, as well as domestic and international laws and agreements designed to sustain and protect the ocean, marine biodiversity and health is still in decline. There are many reasons why that is the case, but ultimately humanity's collective relationship with the ocean has not changed.

The traditional western worldview equates the ocean to a resource and property, with its value derived from the benefit and utility to humans. The terms 'anthropocentric' or 'the anthropocene' are apt descriptions of that culture, with its tendency to overexploit by failing to realize that humans are interconnected and dependent upon the larger Earth system of which they are a part.

Movements around the world are working to transform humankind's underlying relationship with nature by promoting a shift to an ecocentric society and law — with other iterations such as Earth Law, Earth Jurisprudence, Wild Law and Rights of Nature. These frameworks share commonality in that they promote a paradigm shift to a worldview that recognizes the collective duty and responsibility to protect and conserve nature; treats man and nature as equals (in many cases by granting rights or legal personhood to nature); and puts aside short-term gain to consider future generations and the Earth's capacity to regenerate and sustain its natural cycles.

In order for law and policy to effectively sustain ocean life, humankind must return to and transform the underlying values that guide governance and management of the ocean, its species and constituting elements. For that reason, Earth Law Center (ELC) and over 20 partners internationally are building support for a new paradigm for ocean governance that focuses on the ocean's own well-being and is guided by principles of sustainability, ecosystem health, precaution and interconnectedness. This commitment was reinforced by the Cook Islands Prime Minister, Henry Puna, who called on the United Nations to "consider the rights of the ocean." The challenge remains in implementing such calls to action.

Environmental law is well known for its inability to keep pace with scientific developments;[1] significant lag time exists between the identification of threats and the enactment and implementation of law to address them. Ocean law and policy is no different. Management structures put in place 20 years ago simply cannot keep pace with the growing threats faced by the ocean. New models emerge only when man is able to recognize that something has gone wrong, and shifting societal values are known to occur discontinuously rather than gradually. Therefore, to change the existing paradigm of the ocean as property and resource, efforts need to be devoted to revealing the flaws of the current system and simultaneously and persistently promoting an ecocentric paradigm for ocean conservation. Campaigns calling for 'Ocean Rights' or 'Rights of the Ocean' are already emerging from the local and international levels.

One example of successful, local implementation of ecocentric law has come from Santa Monica, California, a densely-populated city of almost 100,000 residents. In 2013, with ELC guidance, the city passed the Sustainability Rights Ordinance, which recognizes that "natural communities and ecosystems possess fundamental and inalienable rights to exist and flourish in the City Of Santa Monica." The ordinance gives residents the authority to protect the rights of groundwater aquifers, atmospheric systems, marine waters and native species within the city boundaries. Coastal communities can implement this approach to specifically reduce marine pollution from land, as called for in SDG 14.1.

Santa Monica has taken several measures to reduce its contribution to marine plastic pollution. The city banned polystyrene containers and plastic bags in 2007, and the use of utensils, cups, lids, lid plugs, stirring sticks, bowls, and other non-marine degradable disposable food service containers in 2018. Additionally, Santa Monica implemented storm water cleaning devices to prevent plastic from entering the ocean through city drains. This demonstrates that public education and ecocentric law can produce the larger cultural shift needed to reduce global plastic pollution.

ELC is also working with organizations and individuals to advance an ecocentric approach to ocean governance in the Pacific region, specifically working towards a convention that would recognize the Pacific Ocean as a legal entity with rights.[2] Partners are advancing this work in the Cook Islands, Australia, New Caledonia, New Zealand and elsewhere. In the Pacific region, it is largely recognized that "the Ocean is us and we are the ocean; our source of life." Projects are progressing around the Pacific to bring awareness to this recognition, such as in New Zealand's Sustainable Seas National Science Challenge, which focuses on honouring the Tiriti o Waitangi/Treaty of Waitangi and the partnership between indigenous Māori and the British Crown. Lara Taylor

Image: Gerson Repreza on Unsplash

The Earth Law Framework suggests many ways to evolve current standards for decision making, including ensuring the priority objective of marine protected areas is conservation and maintaining a healthy ocean, where the definition of healthy is informed by the best available science and defined by the ocean's own well-being and capacity

of LandCare Research, New Zealand says that this entails: "Honouring the relationships and connections to our earth mother and to our ocean and other natural entities. Key to upholding this partnership is work around evolving our legislation and policies to recognize and empower our kinship and whakapapa connections with the ocean — and the obligations to responsibly care for and relate to the ocean, in a way that reciprocates all that nature provides for humankind."

Most efforts to evolve legislation and policies to recognize the interconnection with the ocean involve marine protected areas (MPAs). However, despite the best intentions, many MPAs are created with compromise, allowing degrading or polluting human activity, but on a regulated basis, with regulations lacking implementation and enforcement.

In 2017, ELC created the Earth Law Framework for Marine Protected Areas that serves as a guideline for evolving its current approach to MPA management towards one that is eco- or ocean-centric. This framework can be used broadly in implementing SDG 14, including targets 14.2, 14.4 and 14.5, to sustainably manage marine and coastal ecosystems, reduce overfishing and protect 10 per cent of the ocean in the form of protected areas.[3]

The Earth Law Framework suggests many ways to evolve current standards for decision making, including:

- Ensuring the priority objective of the MPA is conservation and maintaining a healthy ocean, where the definition of healthy is informed by the best available science and defined by the ocean's own well-being and capacity
- Taking the MPA out of the realm of 'property' through the codification of rights or legal personality
- The appointment of guardians to represent the MPA's interests in decisions and disputes. (This approach is being successfully implemented in New Zealand for the Whanganui River and in Colombia for the Atrato River and Amazon Rainforest)
- Ensuring the realization of the precautionary principle and the reversal of the burden of proof
- Requiring decision making to reflect the true cost of the activity (externalities and future generations), and consider that decisions that limit human activity (moratoriums and "no-take zones") are reasonable and viable alternatives
- Ensuring community involvement and indigenous peoples' acceptance, traditional knowledge and management in conservation efforts and regulatory decisions
- Developing alternative livelihoods that allow for both human and ecological interests to thrive.

The Cook Islands offers an example of the intent to evolve the approach to conservation, but also the need to redefine values and the relationship with the ocean in order for conservation efforts to be effective in the long term.

The legislation that established the Cook Islands Marine Park, Marae Moana, demonstrates many key aspects of the Earth Law Framework. The Marae Moana Act 2017 has the principal objective "to protect and conserve the ecological, biodiversity, and heritage values of the Cook Islands' marine

Image: Christina Spicuzza

Ocean view from The Cook Islands. The Marae Moana Act 2017 has the principal objective of protecting and conserving the ecological, biodiversity and heritage values of the Cook Islands' marine environment

environment." Other activities, such as research, recreation, economic activities and education are allowed within the park but must be consistent with the principal objective, placing the burden of proof on users of the ocean to demonstrate that their activity is consistent with protection and conservation.

The initial proposal was to protect the southern half of the Cook Islands Exclusive Economic Zone (EEZ), allowing for fisheries and seabed minerals to be exploited in the north. Following the input of the Prime Minister's Office, the proposal was amended to adopt principles of "protection, conservation, precaution, participation, multiple-use and enjoyment, equitable for present and future generations, and maintenance of values in balanced decision making…" to ensure that "all activities including seabed mining and fisheries will be conducted in a sustainable manner." Communities then asked for the park to be expanded to include the north of the country and for large-scale commercial fishing and seabed mining to be banned around their islands.

Details of the Marae Moana policy and legislation were further developed in consultation with stakeholder groups. The two formal bodies of traditional leaders, the House of Ariki and the Koutu Nui, proposed a ban on all industrial activities extending 100 NM around each of the 15 islands. With pressure from the Ministry of Marine Resources and other government officials concerned with a perceived economic loss resulting from protected areas with "no conservation value," the government reached a compromise by agreeing to 50 NM protection zones, based on seabird foraging distances, nascent studies on large ocean protected areas and public opinion.

The Marae Moana Act was then passed in July 2017, establishing Marae Moana over the entire Cook Islands EEZ, some 2 million km^2 in area, with 15 marine protected areas extending 50 NM around each of the islands where large scale commercial fishing (boats over 10 m) and seabed mineral activities are banned. The Act also provides a framework for marine spatial planning at both the nearshore island scale to 12 NM, and the large EEZ scale. Not only are 50 NM around the Islands protected from perhaps the most destructive activities, but the government has employed the highest form of precaution by creating a baseline of full protection first, with the determination and allowance of human activities after the park's creation (aiming to protect some of all bioregions, habitats and areas of high productivity, diversity, significant ecological processes and uniqueness), through the framework of the National Marae Moana Spatial Plan.

However, the Marae Moana case also demonstrates that the intent to conserve the ocean may be outweighed by other interests if the conservation value is not perceived. The intended process has been considered too cumbersome and time-consuming for politicians who want to immediately proceed with reserving blocks of ocean space in preparation for the sale of exploration licenses. The multiple-use nature of Marae Moana means that it is considered by some to be a place with exploitation potential while allowing other areas for conservation, whereas it is actually a place for whole-domain conservation while allowing for compatible economic activity.

Unfortunately, there are still some who view the ocean as a source of wealth and are pushing for seabed mining despite broad acceptance that such activities are inconsistent with conservation. Until these values shift, economic pursuit such as that toward seabed mining is threatening to undermine the original intent of Marae Moana.

Therefore, despite the proliferation of environmental regulations, their focus remains flawed as, highly anthropocentric in purpose, they address fragmented environmental problems rather than their underlying cause, and allow pollution and degradation in order to facilitate short-term profit.

Transforming humankind's relationship with the ocean will encourage an assessment of the underlying cause of ocean degradation and therefore of all commitments across SDG 14. This transformation does not entail human activity and usage ceasing altogether and immediately, but managing human activity with more precaution, higher standards and greater foresight. It means protecting 30–50 per cent of the ocean as called for by experts, transitioning to a renewable society to hold off the onslaught of climate change, minimizing human impact by reducing fishing subsidies that lead to overfishing, and considering the ocean as a stakeholder in decisions that affect its health, such as fishing quotas.

The work towards ecocentric law or 'Ocean Rights' has the potential to transform SDG 14 itself. As it is currently interpreted, SDG 14 is to "conserve and sustainably use the oceans, seas and marine resources for sustainable development." Under current assumptions, this means achieving targets for the benefit of humans — "for sustainable development" — but after a transformation in the underlying values behind conservation, communities have already begun to implement SDG 14 for the benefit of the ocean itself, and therefore all life on the planet.

Commitments and challenges to achieving SDG 14 in the Pacific islands region

Stuart Chape, Acting Deputy Director General, Strategic Policy and Technical Programmes, and Director, Island and Ocean Ecosystems Programme, Secretariat of the Pacific Regional Environment Programme

Achieving SDG 14 is fundamental to Pacific island nations, all of which lie within the world's largest oceanic realm. Their combined area, inclusive of land, territorial seas and Exclusive Economic Zones (EEZs), is around 30 million km^2, approximately 18 per cent of the total area of the Pacific Ocean. In this Oceania region only two per cent is land, most of which consists of the large area of Papua New Guinea. The region's coastal and marine ecosystems provide resources for livelihoods, food security and national economic development, including the largest tuna fishery in the world. The ocean and the species within it are also the foundation of Pacific cultural heritage and identity.

Pacific island countries have responded to the vast scale of their combined domains by establishing regional responses and institutional architecture to develop and apply common approaches to development issues and capacity needs over the past 70 years. The first organization to be created was the South Pacific Commission (SPC, now the Pacific Community) in 1947. Thereafter, the University of the South Pacific was established in 1968, followed by the Pacific Islands Forum in 1971 as the region's political and economic policy organization, the Forum Fisheries Agency in 1979, and the Tourism Council of the South Pacific (now the Pacific Tourism Organization) in 1983.

The Pacific Regional Environment Programme (SPREP) was formalized under treaty as an independent intergovernmental organization in 1993, having been originally established in the 1970s as a UNEP Regional Seas Programme within SPC. SPREP membership comprises 21 Pacific Island Countries and Territories as well as Australia, France, New Zealand, UK and US. Collectively the regional organizations form the Council of Regional Organizations in the Pacific (CROP).

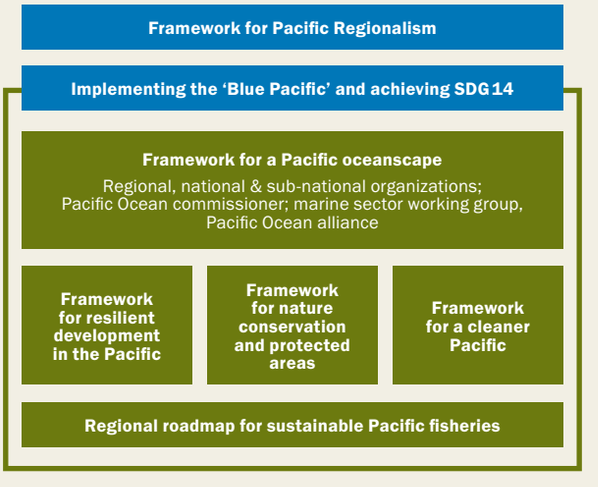
Specific ocean policy commitments for the Pacific islands region commenced in 1999, pre-dating adoption of SDG 14 by 16 years, when the Pacific Island Forum Leaders (PIFL) meeting endorsed the recommendation from an Implementation of the Law of the Sea Convention meeting to create a regional ocean policy. The Pacific Islands Regional Ocean Policy (PIROP) was prepared by the CROP Marine Sector Working Group (MSWG) and subsequently endorsed by the PIFL meeting in 2002 with the vision of "a healthy ocean that sustains the livelihoods and aspirations of Pacific island communities" through application of the following guiding principles:

- Improve understanding of the ocean
- Sustainably develop and manage use of ocean resources
- Maintain ocean health
- Promote peaceful use of the ocean
- Create partnerships and promote partnerships.

The geographic scope of PIROP was defined as: "...that part of the Pacific Ocean in which the island countries and territories (Pacific Communities), that are members of the organizations comprising the Council of Regional Organizations of the Pacific (CROP) are found. As such, the extent of the region includes not only the area within the 200 nautical miles EEZ boundaries circumscribing these island countries, but also the ocean and coastal areas that encompass the extent of the marine ecosystems that support the region."

The increasing urgency and importance of sustaining momentum on ocean action led the Government of Kiribati in 2009 to propose the creation of the Framework for a Pacific Oceanscape (FPO), later endorsed by Leaders at the Pacific Islands Forum in 2010, as a catalyst for action for the PIROP, "to protect, manage, maintain and sustain the cultural and natural integrity of the ocean for our ancestors and future generations and indeed for global well-being." Adopted by

Relationship of regional commitments and SDG 14 in the Pacific islands region



the PIFL in 2010, the overall intent of the FPO is to foster stewardship at scale — local, national, regional and international — to ensure in perpetuity the health and well-being of the ocean. Its objectives are:

- Integrated ocean management
- Adaptation to environmental and climate change
- Liaising, listening, learning and leading.

These objectives are to be achieved through implementation of four strategic priorities:

- Jurisdictional rights and responsibilities
- Good ocean governance
- Sustainable development, management and conservation
- Listening, learning, liaising and leading.

As well as these ocean-specific regional strategic commitments, the Pacific Leaders adopted the overarching Framework for Pacific Regionalism in 2014 to provide the basis for a regional approach to sustainable development, strengthened governance and regional security across a range of sectors including environment. The linkage to ocean matters was enhanced in 2017 when leaders endorsed a "Blue Pacific identity" as the core driver of collective action for advancing their vision under the regionalism framework. Leaders recognized the opportunity of the Blue Pacific identity to reinforce the potential of shared stewardship of the Pacific Ocean and reaffirm the connections of Pacific peoples with their natural resources, environment, culture and livelihoods. In addition, the Pacific region has a number of other regional strategies and polices that seek to address critical issues that, among others, relate to ocean matters, including the Framework for Resilient Development in the Pacific, Regional Framework for Nature Conservation and Protected Areas, Framework for a Cleaner Pacific, and Regional Roadmap for Sustainable Pacific Fisheries. All of these are critical to implementation of the Blue Pacific strategic narrative and achievement of SDG 14.

An important outcome of the FPO has been the establishment of the position of Pacific Ocean Commissioner, a role undertaken by the Secretary General of the Pacific Islands Forum, and the supporting Office of the Pacific Ocean Commissioner (OPOC). An equally important outcome has been the establishment of the multi-agency and multisector Pacific Ocean Alliance (POA) to address the FPO priority to foster partnerships in the development and implementation of ocean-related priorities at national, regional and international levels. Specifically, the POA focuses on providing effective ocean policy coordination and implementation, facilitating regional cooperation for the high seas, as well as supporting national ocean governance and policy processes.

SPREP works closely with its country and territory members, OPOC and other CROP organizations to progress regional and national ocean agendas, including SDG 14, and the ocean is an overarching theme of the SPREP 2017–2026 Strategic Plan. SPREP assists its members to address the multiple pressures on coastal and marine resources that impact on

Image: Stuart Chape

Mangrove islands, Fiji

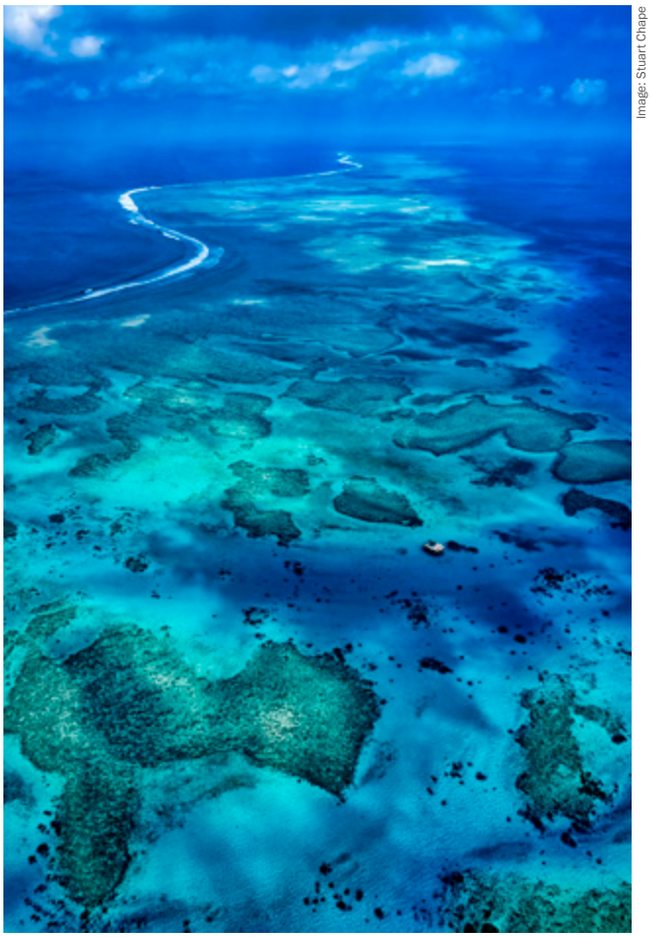


Image: Stuart Chape

Malolo Barrier Reef, Fiji

their sustainable development and biodiversity. These include marine protected areas; protection of threatened and migratory species; marine pollution; marine debris; marine spatial planning; environmental impact assessment; blue carbon ecosystems; protection of biodiversity beyond national jurisdiction (BBNJ); and integrated island and ocean management.

While addressing ocean issues falls within the mandate of all CROP organizations, SPREP has a specific role in relation to adaptation and building resilience to the impacts of climate change and ocean acidification on coastal and pelagic ecosystems, including ecosystem-based adaptation to climate change. It also takes the lead role in a number of ocean-related monitoring and observation mechanisms, and supports Pacific island countries to achieve their commitments on oceans under SDG 14. Specifically, SPREP is assisting its members to address targets by:

- **14.1** *By 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution.*

Working with country members, partners and donors, SPREP has prepared and adopted the Pacific Regional Waste and Pollution Management Strategy 2016–2025 and the Pacific Regional Action Plan for Marine Litter 2018–2025. To date US$ 62 million in donor funding has been secured to help implement the strategy and action plan.

- **14.2** *By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration, to achieve healthy and productive oceans.*

SPREP is working with Pacific island countries, partners and donors to design and implement practical approaches to integrated coastal management, including linking with ecosystem-based adaptation responses to climate change. This includes support for marine spatial planning. Countries such as the Solomon Islands and Vanuatu have developed national ocean policies, and other countries are in the process of preparing national policies and strategies. SPREP is also working on an EU-funded programme to mitigate the impact of fishing by catch on threatened and endangered species, an issue closely linked to Target 14.4.

- **14.3** *Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels.*

SPREP is working with the Government of New Zealand on the issue of ocean acidification and has prepared a Pacific Islands Vulnerability Assessment and a handbook on mainstreaming ocean acidification into national policies.

- **14.5** *By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on best available scientific information.*

The Pacific islands region has made substantial progress in the establishment of marine protected areas (MPAs) and marine managed areas (MMAs). Although some countries must still increase areas under protection, collectively the region has exceeded the 10 per cent target, with a total coverage in 2017 of over 6 million km^2 of MPAs and MMAs or 20 per cent of the total EEZ area. Some of these areas are among the largest in the world, such as the almost 2 million km^2 Marae Moana Marine Park in the Cook Islands and the 408,250 km^2 Phoenix Islands Protected Area in Kiribati. Many countries have also made major commitments to species conservation and declared large scale shark and cetacean sanctuaries.

- **14.7** *By 2030 increase the economic benefits to SIDS and LDCs from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism.*

Through engagement with partners, SPREP seeks to improve the sustainable use of marine and coastal resources, including through valuation of natural capital. For example, SPREP partnered with GIZ and IUCN in the German Government-funded Marine and Coastal Biodiversity Management in Pacific Island Countries (MACBIO) project that had a major focus on marine ecosystem service valuation in five countries. For example, the project identified that marine tourism based on ecosystem services in Fiji was valued at US$ 1.5 billion in 2014.

- **14.c** *Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS.*

SPREP and OPOC are supporting Pacific island country negotiations at the current Intergovernmental Conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the

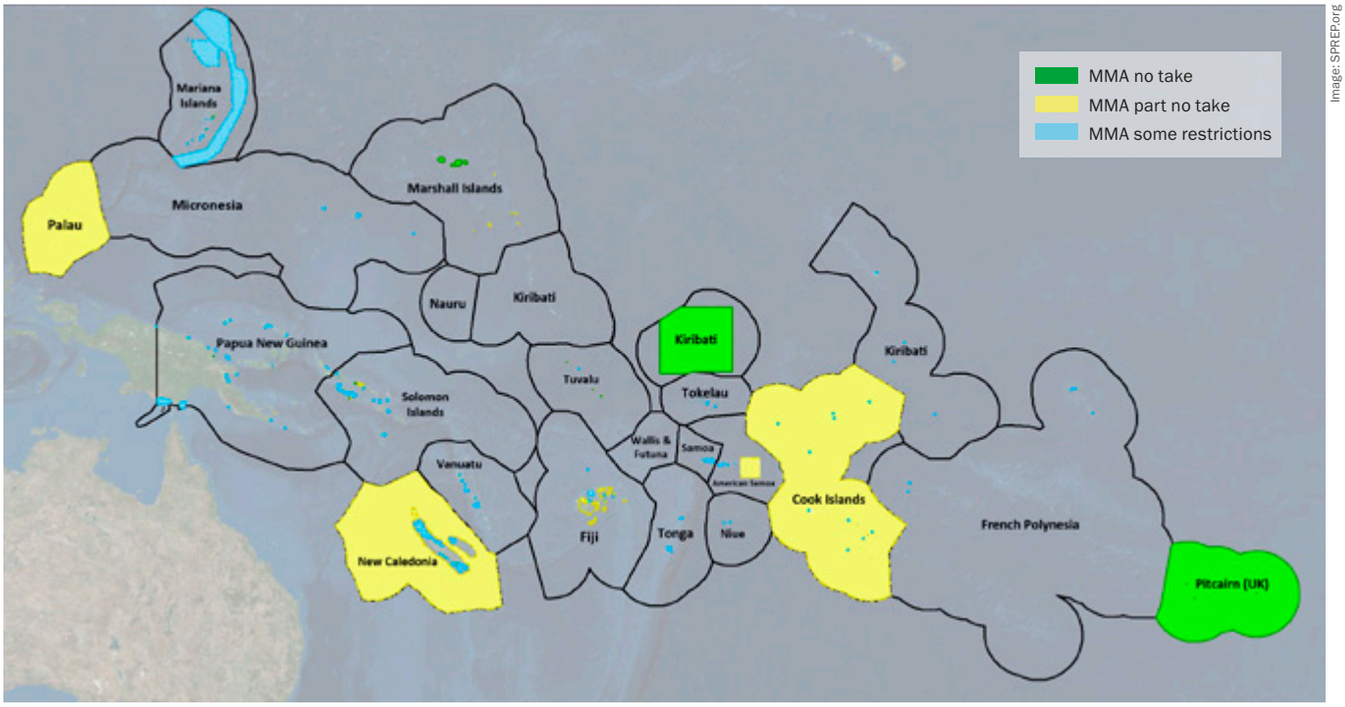


Image: SPREP.org

Marine Managed Areas in the Pacific Islands Region in 2017

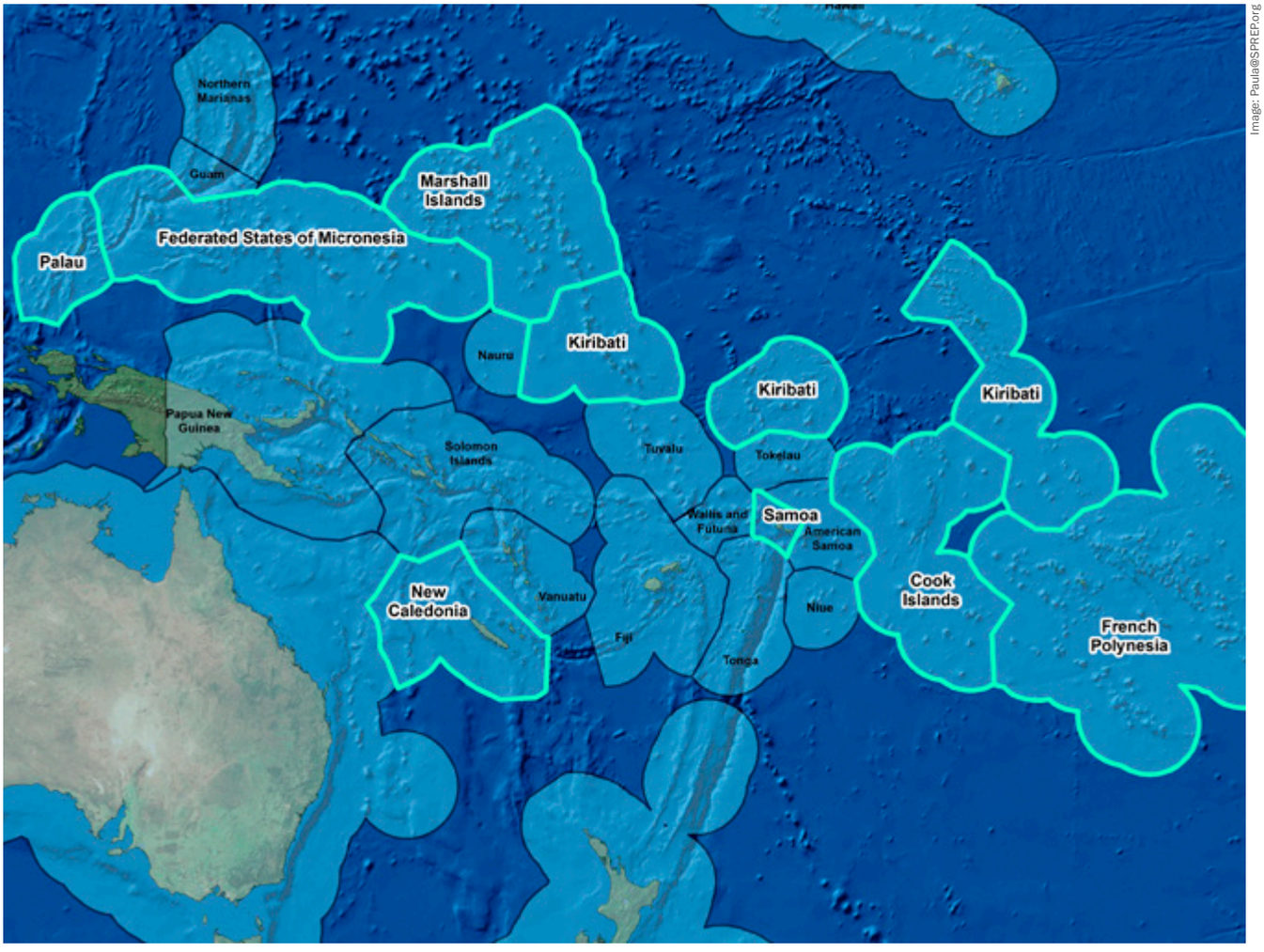
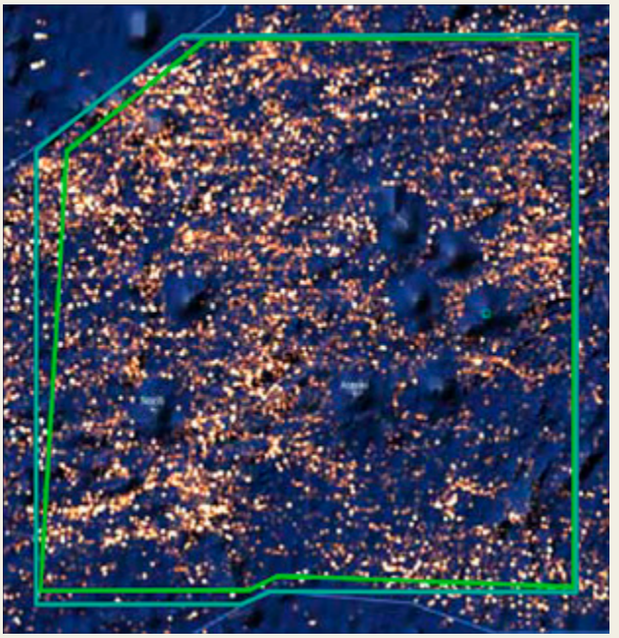


Image: Paula@SPREP.org

Shark sanctuaries in the Pacific islands region

Satellite images before and after declaration of the fishing ban in the Phoenix Islands Protected Area and World Heritage Area

January – October 2014



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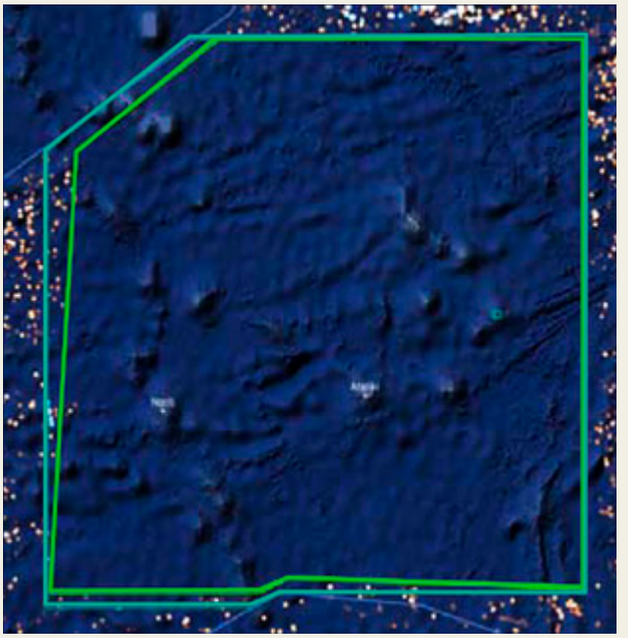

Management Plan boundary Enforcement boundary Fishing effort

Heavy fishing activity was detected by Global Fishing Watch in PIPA from January to October 2014, before the ban was enacted. Fishing activity was nearly non-existent in the first 10 months following the closure of PIPA to commercial fishing. Data was collected until October 2015

Images: adapted from Global Fishing Watch

conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction. The Pacific islands region contains large pockets of ocean beyond national jurisdiction and effective management of these areas is critical to the protection and management of biodiversity and the sustainability of commercial fisheries.

Although Pacific island countries have made important commitments to meeting SDG 14 targets, and progress is being made in many areas, huge challenges remain. Land-based sources of pollution, especially heavy sediment loads generated by erosion and unsustainable logging on high Melanesian islands, threaten the health of coastal lagoons and coral reefs. Overall, coral reefs continue to be lost in the region at a rate of more than two per cent per year, a situation that will worsen with the impacts of climate change through increased sea surface temperature, ocean acidification and sea level rise. In many countries mangrove ecosystems are still being lost at a rate of 1 to 3 per cent per year, mainly as a result of poor development planning and decisions, highlighting the gaps between national policies and international commitments, as well as contradictory development practice.

Management and monitoring of large MPAs is a challenge for small island countries with limited resources and huge ocean areas to manage. This will require support from external actors. For example, organizations such as Global Fish Watch that apply real-time global satellite monitoring can assist countries to manage their protected areas.

Huge amounts of marine litter and pollution enter the Pacific from sources outside or at the edge of the region. 60 per cent of marine litter is sourced from Southeast Asia and a study published in 2017 identified high levels of persistent organic pollutants in the form of polychlorinated byphenols and polybrominated diphenyl ethers in amphipod crustaceans at more than 10 km depth in deep sea trenches in the north and south Pacific Ocean at levels 50 times higher than the most polluted river in China.

The targets for SDG 14 can be met in the Pacific islands region only by strengthening implementation of commitments at national and regional levels to protect and manage the integrity of coastal and marine ecosystems. This will require a rethink of how to approach some national development priorities and issues, including the looming threat of impacts from deep sea mining on marine ecosystems and their services. Compounding all of these issues is the threat of climate change. Failure to take global and national action under the UNFCCC Paris Agreement will make it impossible to achieve many of the SDG 14 targets in the Pacific islands region.

Mangrove resource conservation in Malaysia — a key component of national development

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Malaysia is richly biodiverse, with mangroves forming important ecosystems in the nation's landscape. The mangrove forests have long been managed and sustainably utilized as a source of direct income through the forestry sector, as well as providing valuable ecosystem and ecological services. In line with the United Nations Convention on Biodiversity, Malaysia has taken the approach of conservation, sustainable use, access and benefit sharing in managing its biological resources, including the mangrove ecosystems.

An example of effective management of these ecosystems is Matang mangrove forest in Perak. It was listed in 1901, signifying the beginning of the mangrove forest management regime in Malaya. Since then, the forest has undergone a continuous series of systematic cutting and planting, and has become a significant global showcase for mangrove forest silviculture and for the study of various aspects of mangrove ecology and management.

Matang Mangrove Forest Reserve is the benchmark of sustainable forest management for other mangrove forest sites within Malaysia and for the world, particularly in terms of the maintenance of forest cover, and the continuous sustainable production of timber for poles and charcoal.

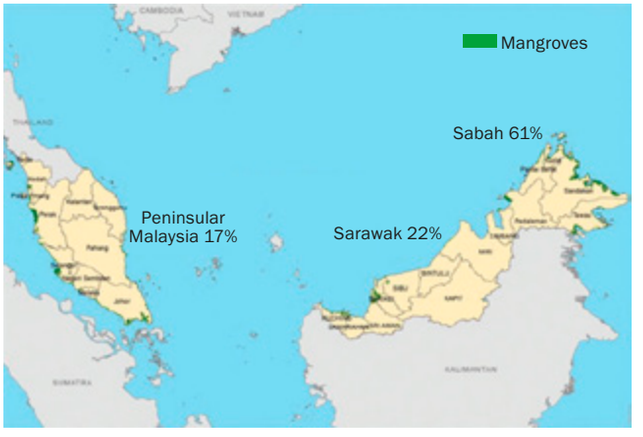
With proper planning and strict regulation and monitoring, forested areas such as Matang demonstrate that the protection of forest areas and the sustainable production of forest resources are not mutually exclusive processes, and that conservation is also development.

Mangrove ecosystems also have high non-use value, or existence value, representing their value in an unharmed state. The existence value is derived using the Contingent Valuation Method. For instance, in 2013 and 2016 at Kelantan Delta Mangrove Forest and Selabat Mudflats Nature Reserve in Sarawak, surveys were carried out among visitors on their willingness to pay to visit the area. It was found that respondents were willing to contribute to the conservation of these areas and could generate an annual revenue about US$ 1 million and US$ 9 million respectively. Determination of the economic value of natural resources, particularly mangrove ecosystems, is useful in comparing the benefits of various development projects or programmes and serves as a guide to policymakers in deciding the best alternative uses of these resources. This augments science policy and provides policymakers with valuable information on the impact of any decision made for these ecosystems.

Mangrove management in perspective

Malaysia, formed in 1963, is a federation of 13 states that became independent in 1957. The supreme law of the country is the Federal Constitution, where some areas of consideration pertaining to natural resource management, such as with land and forest, fall under the responsibility of each state government. In the early years of building the country's economy, the main focus was agriculture resulting in land areas, including some mangroves, having to be cleared to enhance productivity. Nevertheless, the country still has over 55 per cent forest cover (2019).

While mangrove management has long been established, the effect of a natural disaster has augmented efforts to further enhance mangrove forest management. In December 2004, Malaysia and other countries around the Indian Ocean were hit by the Boxing Day tsunami. It was the first ever tsunami recorded to hit Malaysia, claiming 68 lives.



Mangroves in Malaysia — approximately 629,038 ha of coverage

Image: FRIM

The first year of mangrove establishment using an innovative planting method combining breakwater structures and improved planting techniques that reduce wave and current velocity, allowing mangroves to be planted in highly eroded areas

The loss of life and the extreme damage caused by the giant waves sparked a sudden increase in awareness of the importance of the mangroves. Since then, many efforts have been made to rehabilitate damaged and disturbed mangroves, including restoring them within abandoned shrimp ponds, and listing several mangrove areas as forest reserves. The return of mangrove forests in some successfully restored sites have benefited many coastal communities, especially small-scale fishermen.

Habitat connectivity

Mangroves and their adjacent habitats such as seagrasses, mudflats, corals, estuaries, beaches, islands and lagoons form a complex network of ecologically crucial coastal zones. These habitats are home to a myriad of unique and specialized plants, birds, fish, marine fauna, benthos and microorganisms.

Coastal zones are dynamic and fragile areas where risks from disturbance, either natural or anthropogenic, are high. Coastal zones are also the meeting points of the best and the worst from both land and sea — intermediate ecological landscapes that are highly affected by environmental influences from both sides. Rivers carry freshwater, silt and nutrients to fertilize these areas, while incoming tides slow down the flow to stabilize the zones and assist in shaping the dynamic hydrological environment.

As a result, highly productive ecosystems are formed, offering numerous ecosystem services including the provisioning of important resources such as fisheries and fuel wood, regulating key environmental cycles such as nutrients and water, and providing panoramic landscapes and other cultural value. These circumstances, however, demand delicate control and utilization. A change due to anthropogenic activity occurring in any part of the dynamic mangrove ecology process may have large consequences affecting the ability of coastal habitats to perform their roles and services effectively. Climate change augments these issues, and the loss of mangrove habitat triggers loss of coastal security and an increase in coastal vulnerability. Various research has quantified the effectiveness of coastal forests in providing a buffer and protection to the land from strong winds, waves and typhoons. Studies on the Indian Ocean tsunami of 2004 have also shown the different scales of impact on areas with and without the protection of mangroves.

Mangrove distribution in Malaysia

Mangrove covers approximately 629,038 ha, 1.7 per cent of the total land area in Malaysia — the third largest area of mangroves in the Asia-Pacific region after Indonesia and Australia. The country is divided geographically into two regions: East Malaysia and West Malaysia (Peninsular), where the major towns and cities are located, usually close to river mouths and estuaries, and these urban areas are all expanding. Approximately 83 per cent of the total mangrove regions are located in East Malaysia, covering approximately 518,085 ha, with the remaining 17 per cent located in Peninsular Malaysia. The country has reserved about 535,000 ha, 85 per cent of the total area of mangroves, as permanent forest reserves and state or national parks. The remaining 15 per cent remains as state and alienated lands.

Mangrove and Coastal Tree Planting Programme
Between 2005 and 2018, the Technical Committee on Planning and Implementation, led by the Forestry Department Peninsular Malaysia (FDPM), planted a total of 6,624,919 coastal and mangrove trees, covering an area of almost 3,000 ha. All planting was done by the state forestry departments, and the programme continues to receive funding each year from the federal government to aid the planting effort. A small portion of funding is also allocated to NGOs to organize a communication, education and public awareness programme, with local community and student involvement as the programme's main focus.

Mangrove planting in areas prone to erosion
Since the areas suitable for planting using conventional means are becoming scarce, the Technical Committee on Research and Development, led by the Forest Research Institute Malaysia (FRIM), has developed an innovative method using a combination of breakwater structures and improved planting techniques that reduces wave and current velocity and allows the mangroves to be planted in highly eroded areas. A case study using this technique was done in Kampung Sungai Haji Dorani, Sabak Bernam. Before planting, four geo-tubes, which act as a breakwater structure, are placed approximately 100 m seaward, parallel to the coastline. Each of the structures measures about 50 m in length, 3.7 m wide and 1.8 m high, and is filled with sand. The geo-tubes are positioned about 2 m apart. The structures trap sediment, slowly making the liquid mud behind the geo-tubes (landward) firmer and more solid. The stabilization process may take years before the area is suitable for planting — for this particular case study, about three years elapsed between breakwater construction and planting, which utilized the comp-mat and comp-pillow technique, making use of compacted coconut husks. To date, the area is successfully rehabilitated with mangrove, and is visible on satellite images.

The National Coastal Information System
To better monitor planting activities, the FDPM and Malaysian Space Agency have developed a web-based application that uses remote sensing, GIS and ICT technology through a dedicated portal[1]. The system serves as a database for recording, storing and providing integrated information, including high resolution satellite images, to assist in obtaining the information needed for the planning, implementation and monitoring of national coastal conservation and rehabilitation activities. Through this system, forest managers can view areas that have been rehabilitated, as well as the width of the buffer zone in coastal areas in order to plan for the next planting activity.

Image: FRIM

Mangrove growth shown seven years after planting

Image: Ahmad Aldrie Amir

The luxuriant and totally protected mangrove forest of Selat Dayang Bunting In Pulau, Langkawi, Kedah

Accounting values and sustainability

The pressure for land and resources in mangrove areas is expected to increase with the expanding population and economic growth, thus intensifying the challenge to sustain coastal habitats. Understanding the importance and dynamics of coastal systems and processes would benefit Malaysia environmentally, economically and socially as it involves the security and well-being of coastal communities.

To ensure balance and sustainable growth, strict enforcement of protection for coastal land and resources and solid control of development have been incorporated in many of the key actions of the National Policy on Biological Diversity. Through the Common Vision on Biodiversity, Malaysia has mainstreamed biodiversity in the country's planning and development agenda. These interventions are extremely important in their translation at all levels of government to ensure that these important and fragile ecosystems are conserved and used wisely.

Carbon and climate change

We also now realise through scientific findings and evidence that mangroves possess crucial intangible values, in particular as the most efficient terrestrial ecosystem to sequester atmospheric carbon. Therefore, protecting and restoring mangroves is crucial in helping to combat climate change.

Regardless of their importance as a fish habitat, and for the massive amount of carbon trapped by their sediments, mangroves have typically been viewed as an intermediate habitat between land and sea, escaping the focus of marine resource governance. But Malaysia is now in a position to advance initiatives such as Reduced Emissions from Deforestation and Forest Degradation (REDD+) in addressing global climate change issues. Besides leveraging global carbon credits and potentials, protected mangroves are also a significant asset and natural attraction. Mangrove forests and other tropical coastal habitats are primary attractions for tourists both locally and globally, and Malaysia has them in abundance. As such, the application of economic instruments such as payment for ecosystem services could be introduced to boost national income generation from the global tourism market as well as create alternative income for indigenous and local communities.

Considering their numerous environmental roles, social benefits and economic return, mangroves should be regarded as a national treasure, and protecting mangroves should be seen as a great investment. As a fast growing economy, Malaysia balances the need for environmental protection and socioeconomic development as enshrined in the five-year Malaysia Plans as well as key sectoral policies. The challenge now is the need to increase awareness of this important ecosystem. Wetlands such as mangroves should not be seen as wastelands. Creating awareness of how these ecosystems interlink with ecosystem services, and mainstreaming that to all levels of government and society, is important for the long term conservation and sustainable use of mangroves.

As Malaysia evolves into a high-income economy, it has emphasized the importance of managing biodiversity and natural heritage such as mangrove ecosystems to ensure that a holistic and sustainable development trajectory is achieved.

International cooperation for the conservation and sustainable management of coastal ecosystems

Noriaki Sakaguchi, Senior Advisor; Takahiro Morita, Senior Deputy Director General, Department of Global Environment, Japan International Cooperation Agency (JICA)

Most developing countries are in tropical or subtropical areas, with coastal ecosystems such as coral reefs, seagrass beds and mangroves extending along the coastlines. The benefits obtained from ecosystems are known as ecosystem services, and those of a coastal type can be split into four categories.

Provisioning — Coral reefs, seagrass beds and mangroves are the most important services for fishery resources. Most fish species living in coastal areas depend on such habitats for at least part of their lifecycle. Mangrove trees are also utilized as materials for construction and fuel.

Regulating — In their ability to weaken wave energy, coral reefs and mangroves protect shorelines from erosion as well as reducing disaster risk from storm waves and tsunamis. For instance, it has been posited that mangrove forests reduced the impact of the Indian Ocean Tsunami that was triggered by a magnitude 9.15 earthquake, 150 km off the west coast of North Sumatra, Indonesia on 26 December 2004.[1]

Cultural — The unique biodiversity and seascape of coral reefs and mangroves attract a large number of tourists who enjoy diving, snorkelling and kayaking. A valuation of the Hawaiian economy in 2002 estimated the economic value of tourism at US$ 3.4 million/year, which was much higher than that of fishing (US$ 0.25 million).[2]

Supporting — Photosynthesis, water and nutrient circulation, carbon storage, and organic matter decomposition, all act in support of other services. Coral reefs, seagrass beds and mangroves generate habitats for a variety of organisms in service to the richest biodiversity and the highest productivity among the world's ecosystems.

Challenges to conservation and the sustainable use of coastal ecosystems

Despite providing many valuable benefits, mangroves and coral reefs have been deteriorating rapidly. Mangrove coverage declined globally by 4 million ha (21.3 per cent) from 18.8 million ha in 1980 to 14.8 million ha in 2015.[3,4] Approximately half of the coverage of live coral on reefs has been lost since the 1870s, with accelerating losses in recent decades due to climate change, thus exacerbating the impacts of other drivers.[5]

Nearly 2.4 billion people, about 40 per cent of the world's population, live within 100 km of a coastline. Intensive human activities in these areas, especially overexploitation by fisheries, land/sea use change and land/sea based pollution, have resulted in rapid loss and degradation of coastal ecosystems. Global climate change has begun to drive negative impacts on coastal ecosystems, such as coral bleaching through a rise in seawater temperature and destruction of mangrove trees and coral by large storm waves and high tides created by extreme events. Coral reefs are particularly vulnerable to climate change and are projected to decline to between 10 and 30 per cent of their former cover at a warming of 1.5°C, and to less than 1 per cent of their former cover at a 2°C warming.[5] With a business-as-usual scenario, the sea level in the late 21st century (2081–2100) is expected to have risen by between 0.45 m and 0.82 m from 1986–2005 levels.[6] This projected rise will cause significant damage to coastal areas and to people through coastal erosion, flooding, salt damage and the submergence of coastal areas. Developing countries and small island developing states are particularly vulnerable to these events.

Necessity of ecosystem-based and integrated management approaches to address multiple drivers

The implementation of ecosystem-based management (EBM) is essential for addressing multiple drivers simultaneously under conditions of uncertainty and complexity, and for conserving and sustainably managing coastal ecosystems. Effective implementation applies adaptive management that monitors selected indicators on multiple ecosystem functions and services, and analyzes their relationships so as to facilitate informed decisions. It is therefore possible to identify

Ecosystem-based management of a coastal ecosystem

Mangroves, seagrass beds and coral reefs create a connected coastal ecosystem. In order to manage it properly, it is essential to apply Ecosystem-based Management (EBM) that recognizes the interactions among ecosystem components, including species, habitats, ecosystem services and humans.

Connectivity of coastal ecosystems

- In trapping sediments issuing from streams and rivers, and abating eutrophication, mangroves reduce sedimentation and ensure the translucency of sea water, allowing photosynthesis in seagrass beds and coral reefs.
- Many fish species living in coral reefs spawn, grow and forage in mangroves and seagrass beds.

Many fish species living in coral reefs spawn, grow and forage in mangroves and seagrass beds

synergies or trade-off relationships, and find effective intervention (or leverage) points for effective solutions.

The relationships between available ecosystem services, conditions and utilization can be summarized as:

- In a protected area, coastal ecosystems are maintained in a healthy condition. Supporting and regulating services, such as primary production, carbon sequestration and disaster risk reduction, are maintained in the highest condition, while provisioning services such as fish catch are unavailable since their utilization is restrained.
- When provisioning services are sustainably used, the conditions of supporting and regulating services are still maintained in a high condition. However, once provisioning services exceed a sustainable level due to overuse, there is a trade-off between those services and supporting and regulating services, with the subsequent decline of both.
- If overuse is continued, supporting and regulating services exceed their threshold levels, and all three services will decline with the result that the ecosystem would be degraded.

In order to manage a coastal ecosystem sustainably, the indicators on important ecosystem services should be closely monitored to evaluate their condition and availability, after which fisheries and other utilization activities should be regulated so as to optimize provisioning and other services at sustainable levels.

Since negative impacts on coastal ecosystems are imposed from both marine and terrestrial areas, a variety of multi-sectoral stakeholders must be involved in their management. Integrated management by cross-sectoral stakeholder participation provides opportunities to recognize and understand the relationships between them, such as conflicts of interest and trade-offs, and to reconcile multiple interests, values and protocols in the use of resources through information sharing and consultation.

International cooperation for the conservation and sustainable management of coastal ecosystems

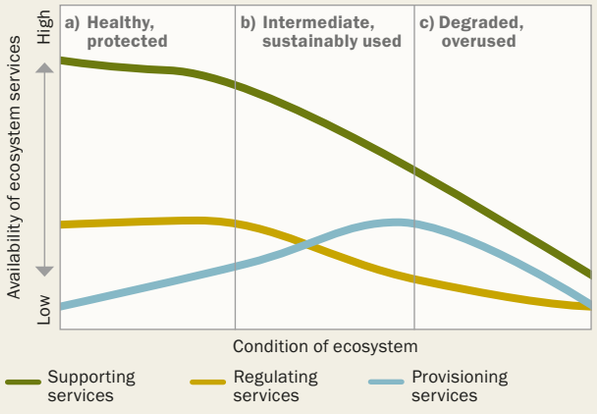
Assessment and conservation of blue carbon ecosystems and their services in the coral triangle (Blue CARES)

Of all the biological carbon captured in the world, 55 per cent is through marine living organisms, and this is known as blue carbon.[7] Moreover, the carbon sequestration rate in sediments of marine coastal vegetated ecosystems is much higher than that of terrestrial forest soil.[8] Also, mangrove stores carbon above ground at the same rate as terrestrial forests, but the storage of carbon under ground is achieved at a much higher rate in mangrove than in terrestrial forests.[9]

Targeting the Philippines and Indonesia, within the Coral Triangle, the Blue CARES Project is assessing blue carbon

In trapping sediments issuing from streams and rivers, and abating eutrophication, mangroves reduce sedimentation and ensure the translucency of sea water, allowing photosynthesis in seagrass beds and coral reefs

The relationship between ecosystem condition and availability of ecosystem services[9]



dynamics and other associated services within the coastal ecosystems. Based on the assessments, the project will develop and recommend a blue carbon conservation strategy as well as developing a network system for nationwide monitoring of blue carbon and the implementation of the strategy. The Blue CARES project aims ultimately to contribute to climate change mitigation and adaptation, and to conservation in the coastal ecosystems of the Coral Triangle area. At the UN Ocean Conference of 2017, aiming at accelerating the implementation of SDG 14, the Japanese government registered Blue CARES as one of its voluntary commitments to support the achievement of the goal.

Technical cooperation for sustainable management of mangroves in Indonesia

Using Bali as an operational base, the Japan International Cooperation Agency (JICA) and the Indonesian government conducted a four-phase series of technical cooperation projects between 1992 and 2014, aiming at the rehabilitation and sustainable management of mangroves, along with the capacity building necessary for implementation.

Phase 1 (1992–1999) — The establishment of a mangrove nursery centre. Manuals were developed and published to guide the rehabilitation techniques and establish the models used for sustainable mangrove management in Indonesia. A total of 253 ha of degraded mangrove forests were rehabilitated — 189 ha in Bali and 64 ha in Lombok.

Phase 2 (2001–2006) — The Mangrove Information Centre was established as a hub for the conservation and sustainable management of mangrove ecosystems. Environmental education and ecotourism programmes were developed there and relevant training implemented.

Phase 3 (2007–2009) — Guidelines were developed and capacity building carried out to support mangrove conservation and sustainable management activities at site level throughout Indonesia.

Phase 4 (2011–2014) — Workshops were held for stakeholders in Indonesia and other Member States of the Association of Southeast Asian Nations (ASEAN) to share good practices and lessons learned on mangrove ecosystem conservation and sustainable use. The ASEAN Mangrove Network (AMNET) was developed as a cooperation mechanism for shared learning throughout the ASEAN region.

Future strategy for conservation and sustainable management of coastal ecosystems

A nature-based solution for climate change adaptation and disaster risk reduction

The projected frequent extreme events and sea level rise driven by climate change will inflict tremendous damage on people living in coastal areas. This has already become a more serious issue in coastal areas of developing countries and small island developing states. Hard infrastructures, such as dyke construction and wave-dissipating block installation, can reduce disaster risk, given certain sea levels, but the trade-off is that they destroy coastal ecosystems and decrease fishery and tourism resources. Such infrastructures are also costly to continuously maintain. Therefore, to accommodate both disaster risk reduction and the maintenance of fishery resources and other benefits, nature-based solution (NBA) approaches, such as ecosystem-based adaptation to climate change (EbA) and ecosystem-based disaster risk reduction (Eco-DRR), are valued by policymakers, NGOs, research institutions and local communities.

An analysis of the effectiveness of mangrove against the Indian Ocean Tsunami of 2004 suggested that mangrove forests with trees of more than 20–30 years of age reduced damage more effectively than those comprising 10 year-old trees when the tsunami inundation depth exceeded 4 m.[11] This demonstrates that healthy coastal ecosystems are resilient to tsunamis, storm waves and high tides. However, as already mentioned, coral reefs, mangroves and other coastal ecosystems in developing countries are rapidly declining due to overexploitation, land/sea use change, water pollution and climate change. Loss and degradation of coral reefs and mangroves therefore increase the risk of disaster from high tide, storm waves and the erosion of shorelines, making their restoration to a healthy condition paramount in strengthening resilience against projected extreme events by climate change and natural disaster. It is therefore essential to integrate NBA approaches into the conservation and sustainable management of coastal ecosystems.

Partnership with the private sector

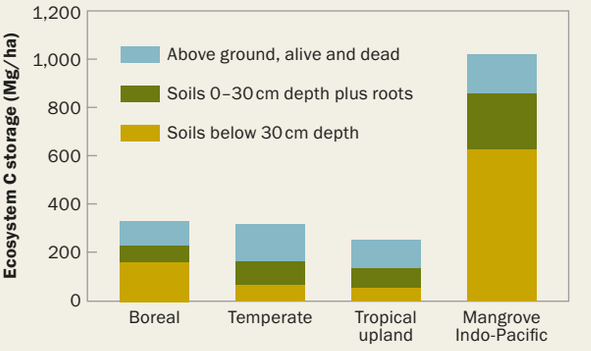
Responding to widespread environmental, social and governance financing from institutional investors, private corporations are currently accelerating their activities to conserve and use natural resources sustainably. These corporations consider those resources as natural capital and that their sustainable use will ensure viable economic development. A number of Japanese corporations are taking an interest in the multiple benefits from mangrove and coral reef ecosystems, such as fishery resources, carbon storage and disaster risk reduction. Therefore, collaboration with these corporations for the conservation and sustainable management of coastal ecosystems is significantly important for the effective implementation and sustainability of projects and the achievement of SDG 14.

It has been established that coastal ecosystems, including coral reefs and mangroves, bring multiple benefits to people (ecosystem services), such as fishery resources, disaster risk reduction, tourism and carbon storage. EBM, based on the monitoring of ecosystem indicators and integrated management through cross-sectoral stakeholder participation, is an effective approach to accomplish project goals. An NBA approach for climate change adaptation and disaster risk reduction enables the accommodation of fishery resources and other benefits simultaneously within coastal ecosystems. Since a number of private corporations are taking an interest in the multiple benefits of mangrove and coral reef ecosystems, collaboration with those corporations is also an effective approach to ensure the sustainability of projects and spread activities to wider areas.

JICA will continue its technical cooperation with developing countries for the conservation and sustainable management of coastal ecosystems through these effective approaches, contributing to the achievement of SDG 14 and other relevant targets.

Mangrove has the highest carbon storage capacity among the world's forests

In comparison to terrestrial forest ecosystems, mangrove ecosystems store the most dense carbon, regardless of climate zone. Importantly, carbon storage under the ground in mangrove is much higher than that of terrestrial forests.[10]



Mangrove forest in the Philippines

The Coral Triangle Initiative — cooperation to ensure food security through sustainable management of coral reef ecosystems and fisheries

M Kushairi M Rajuddin; Sharifah Nora Syed Ibrahim; Gregory P Bennett; Janet Polita; Rumanti Wasturini; Ayodya Anggorojati, CTI-CFF Regional Secretariat

The Coral Triangle (CT) is the global centre of marine biodiversity, with the highest number of corals and fish species worldwide, surpassing that of the Great Barrier Reef and the Caribbean. The CT region is home to over 500 species of fish and corals, as well as almost all marine turtle species and other threatened species including marine mammals such as dugongs, dolphins and whales. The large areas of corals, mangroves and seagrass beds are important to the functioning of ecosystems and fisheries, serving as fish spawning areas, nurseries, refuges, aggregation areas and feeding locations.

Commercial fishermen, together with over 130 million people within coastal communities, depend on the marine resources in this region for their livelihoods. This is especially important to consider as the International Panel on Climate Change (IPCC) has projected a significant decline in tropical fisheries as part of the adverse impacts on tropical regions caused by climate change. The region is already experiencing massive coral bleaching where both continued pollution and a frequent elevated sea surface temperature decrease the chances of the corals' full recovery.

In 2009, recognizing the critical need to safeguard the region's food security and marine and coastal resources, the leaders of six countries in the Coral Triangle area, comprising Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor-Leste, launched the Coral Triangle Initiative — Corals, Fisheries and Food Security (CTI-CFF) — with a Leaders' Declaration. The initiative included a 10-year Regional Plan of Action (CTI RPOA) to ensure the food security and well-being of the region's coastal communities. The Coral Triangle Member Parties also agreed to apply people-centred biodiversity conservation, sustainable development, poverty reduction and equitable benefit-sharing.

The CTI RPOA seeks to address poverty reduction through sustainable economic development, food security, and sustainable livelihoods for coastal communities; and biodiversity conservation through the protection of species, habitats and ecosystems, embracing the Sustainable Development Goals (SDGs)[1], including SDG 14 on marine conservation. Apart from assisting its Member Parties with their international obligations under Agenda 2030, the CTI-CFF also assists them with the UN Convention on the Law of the Sea (UNCLOS) regarding the protection of the marine environment and the duty to cooperate.[2] It also assists with international obligations vis-à-vis the Convention on Biological Diversity (CBD), Aichi Targets including Target 11 on marine protected areas (MPAs) and other effective area-based conservation measures (OECM). CTI-CFF has also increased the number and area of MPAs as per CBD priority actions to achieve the Aichi Targets.

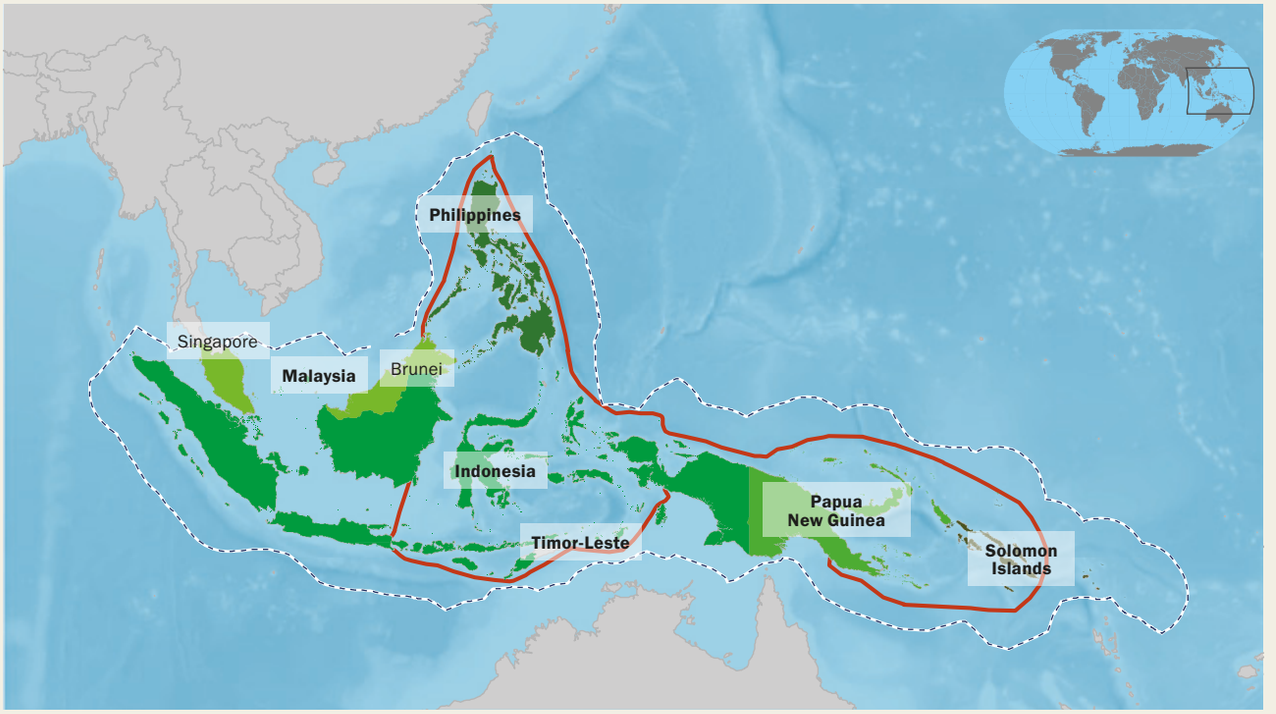
CTI-CFF is also assisting with meeting other international obligations such as the Port State Measures Against IUU Fishing; Code of Conduct for Responsible Fisheries; Right to Food Guidelines; Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests; and the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW).

The original CTI RPOA goals are to: strengthen the management of seascapes; promote an ecosystem approach to fisheries management (EAFM); establish and improve effective management of marine protected areas (MPAs); improve coastal community resilience to climate change through climate change adaptation (CCA); and protect threatened species (TS). Several working groups are assigned to oversee those goals with responsibility for monitoring and evaluation, and cross-

Image: CTI-CFF/Ministry of Marine Affairs and Fisheries, Indonesia

The declaration of the leaders of the six countries — Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste — as custodians of the Coral Triangle. This is a commitment to the sustainable development agenda

Implementation area of the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF).



CTI-CFF Implementation Area
This boundary is based on the Exclusive Economic Zones (EEZ) of the CTI countries
Note that internal boundaries are not shown, disputed boundaries exist in this geography, a boundary for Brunei is not known, and Singapore and Brunei are not members of the CTI-CFF. Boundaries are only for illustration and are not legally binding in any way.

Coral Triangle Scientific Boundary

Source: Nate Peterson, The Nature Conservancy. EEZ source data from Flanders Marine Institue (VLIZ) 2011

cutting initiatives such as the Women Leaders Forum. The working groups collaborate with Local Governments Network, sustainable business forums, strategic partners, collaborators, universities and local communities including women and youth, to achieve many important milestones, as follows:

Seascapes
The Seascapes General Model and Regional Framework for Priority Seascapes has been created and translated into three languages (English, Bahasa, Tetum) to guide various stakeholders on the ground including all levels of government, local communities and the private sector on managing large, multiple-use, coastal and marine areas towards biodiversity conservation and human well-being. Three transboundary priority seascapes have been recognized by CTI-CFF — the Sulu Sulawesi Seascape, the Bismarck Solomon Seas Seascape, and the Lesser Sunda Seascape. GIZ, WWF, CI and the Australian Government are some of the strategic partners and collaborators assisting seascapes.

Ecosystem approach to fisheries management (EAFM)
Accomplishments include the recent draft on a sub-regional Fisheries Management Plan on EAFM; training at regional and local levels adopting the EAFM training module; improvement against IUU fishing with strengthened national fisheries legislations and policies, including piloting electronic Catch, Documentation and Traceability systems (e-CDTs) with strategic partners and local communities in Bitung (Indonesia) and General Santos (Philippines), and with plans for the Pacific Member Parties.

CTI-CFF also made progress on improving tuna governance and the Live Reef Food Fish Trade (LRFFT). With the new Regional Action Plan (RPOA 2.0), and the Sustainable Coastal Fisheries and Poverty Reduction Initiative (COASTFISH) programme, the CTI-CFF will focus on food security and sustainable livelihoods linked to EAFM. Another active initiative is the Expanding the Reach of Community-based Resource Management in the Solomon Islands (ERSI) project that supports communities to better protect their coral reefs and establishes lasting systems to continue supporting communities in protecting the marine environment. Research on larval dispersal and movement patterns of coral reef fish, and the implications for marine reserve network design, was also carried out by strategic partners and CTI-CFF. Among the strategic partners in EAFM accomplishments are the Southeast Asian Fisheries Development Center (SEAFDEC), United States Agency for International Development including USAID RDMA, USAID Oceans project, USAID-SEA, US DOI, National Oceanic and Atmospheric Administration (NOAA), the Australian Government, WWF, CI and TNC, as well as Universities Partnerships.

CTI Women Leaders' Forum (WLF)

The Women Leaders Forum (WLF) began with a working paper in November 2013, proposing that coastal and marine resources are more effectively managed with the increased engagement and empowerment of women in decision-making processes at all levels in the Coral Triangle (CT) region and in the various CTI-CFF bodies. The CTI WLF was therefore established as the region's peer learning network established with a clear strategic focus, effective leadership, committed membership, annual activities and adequate resources.

The CTI WLF strives to generate recognition of the achievements of women leaders at all levels (community, national and international), and serves as a platform to build the capacity of women from the region for leadership roles. It promotes the sharing of tools and good practices that integrate gender principles into CTI projects and into CTI-CFF structures and activities, and participation at CTI-CFF decision-making meetings. In May 2014, the CTI WLF was officially adopted at the 5th Ministerial Meeting in Manado, Indonesia. Since then, the CTI WLF has accomplished much on the ground, including:

1. Six Countries InterGenerational Mentor-Mentee Programme:
The CTI-CFF WLF's Women's InterGenerational Leadership Learning Forum was implemented by the Coral Triangle Center (CTC) and the US Department of the Interior-International Technical Assistance Programme (USDOI-ITAP) with funding support from USAID RDMA, in collaboration with the CTI-CFF Regional Secretariat and the CTI-CFF national coordinating committees. The forum aimed to create a knowledge sharing platform between senior marine conservation women leaders in the six CT countries who served as mentors to a younger generation of early career women who showed both potential and interest in developing leadership qualities. The intent of the programme was to build a cadre of next generation young women leaders from the CT countries who are empowered to lead marine conservation programmes in support of the CTI-CFF goals, and beyond. Each mentor-mentee pair succeeded in finding practical solutions to some of the most pressing marine conservation issues in the CT. The six pairs worked for two years on the following conservation challenges:

Indonesia
Reducing the mining of corals and sea sand in the Banda Sea Marine Protected Area through community approaches.

Malaysia
Protecting green turtle nesting sites and increasing green turtle populations in Pantai Teluk Dalam, Pulau Redang, Terengganu.

Papua New Guinea
Establishment of a community-based Fish Aggregating Device (FAD) in the Central Province of Papua New Guinea.

Philippines
Advocacy geared towards the conservation of our oceans and seas.

Solomon Islands
Developing a best practice model of sustainable financing for conservation and sustainable development efforts for KAWAKI (Kia, Wagina and Katupika) Women's Network.

Timor-Leste
Restoring reef productivity by awareness raising and waste management in Atauro Island.

2. Other on-the-ground interventions with communities
Indonesia
a) Women's groups in Bitung: smoked skipjack training on commercial smoking and liquid smoke innovation with help from university researchers of Sam Ratulangi University; vacuum packing, and alternatives.
b) Financial management training
c) e-CDT training.

Malaysia
a) CTI project: Sustainable Alternative Livelihood Programme (Sea Cucumber Culture) where single mothers were provided with technical training (basic data management, sea cucumber biology, processing, nutrition and environmental management), aid (sea cucumber seeds, tanks to collect rainwater, provision and construction of pilot pens), and DoF Sabah with appointed resource person worked closely with the women to monitor sea cucumber growth and harvest.
b) CTI Project: capacity building for women in Semporna including workshop for seaweed-based products where 14 women involved in the live reef fish trade underwent training and were given aid such as appliances to create seaweed-based products e.g. seaweed ice cream and drinks, which can be sold to generate extra income.
c) CTI EAFM training 2013–2019: 23 training courses in which 497 people (201 Women, 276 men) from government, NGOs, universities and local government including researchers, university students, women, fishermen and youths were trained in traditional fisheries such as anchovies, cage culture and hook and line. Representatives met to exchange ideas and forge business links between the women in cage culture and anchovy fisheries for the benefit of future business.

Papua New Guinea
a) TNC and WWF worked with women's groups to provide capacity building and financial support, with help from the Madang Province Microfinance Village Savings and Loan Concept.
b) Exploring markets for mangrove products, helping local women's groups to build and grow appropriate businesses with development and pilot projects, finding markets and investors, financial management training.
c) Scaling up women's participation in mangrove management, project recently completed. Locally Managed Marine Area (LMMA) plans for three villages were developed under this project.
d) Rolling out of 15 community based fisheries management projects in three districts of Madang Province (Madang, Sumkar, Bogia).
e) Five village savings groups established.
f) Training module developed for field officers — a guide on how to establish savings groups.

Solomon Islands
a) With WWF: Building Capacity for Women by Women in Western Province of Solomon Islands: Working with and through local partners to establish microfinance mechanisms; self-sustaining and self-governing mechanisms; act as a catalyst for small business opportunities for women; over 1,000 women in savings clubs across Western Province involving 33 communities. Approximately US$ 50,000 saved; 150 loans disbursed.
b) 120 new business initiatives.

Timor-Leste
a) Fisherwomen involvement in board committee in managing LMMA in Adara-Atauro island.
b) Fisherwomen and men share fish house in Ililai-Lautem for various activities.
c) Women's group in Beacou produces sardines in jars and fish powder for household income and food security.
d) First ever national Forum for Women in Fisheries held in 2018.
e) Training for fisherwomen and fishermen: management group, basic skills for business, dry fish, water conservation, home garden and seaweed (Uaroana and Akrema) Atauro.

3. Women Leadership Competency Module
A Regional Leadership Training module was developed in 2019 for current and existing women leaders in marine and coastal resource management, and to promote women's empowerment and gender equity within CTI-CFF and globally.

WLF lessons learned and way forward
Thousands of women were trained in CTI-CFF. In future, CTI WLF urges that gender equity policy be embedded in CTI-CFF and beyond, and that substantial investments must be made for capacity building, training women leaders, increasing roles in management, and encouraging the economic and technical empowerment of women.

Image: CTI-CFF/Department of Fisheries Sabah, Malaysia

The Sustainable Alternative Livelihood Programme showing the involvement of women in harvesting natural resources (sea cucumber), Sabah, Malaysia

Marine Protected Areas (MPAs)

One of the main achievements so far is the increasing coverage and number of MPAs and OECMs including locally managed marine areas and other community-based managed areas in the CTI-CFF. Aichi Target 11 and SDG 14 Target 14.5 could well be exceeded in the near future by the CTI-CFF region. Other accomplishments are the Sustainable Marine Tourism Task Force and the Coral Triangle Marine Protected Area System (CTMPAS) along with capacity building. More work needs to be done in order to fully utilize the CTMPAS to include OECMs, and also to consider the next steps of improved management towards gaining world heritage status under UNESCO for CTI-CFF flagship MPAs. Several of the strategic partners and collaborators include USAID, WWF, TNC, CI, and Universities Partnerships.

Climate Change Adaptation (CCA)

The Region-wide Early Action Plan (REAP) and the Local Early Action Plan (LEAP) manuals for climate change adaptation have been available since 2015, in collaboration with CCA CTI-CFF country focal points, development partners and other stakeholders. The REAP and LEAP are used in conducting activities and training at local levels. For instance, mangrove replanting projects and sustainable alternative livelihoods programmes have been successful. Additionally, ongoing projects include the establishment of a virtual Centre of Excellence, and an executive course on CCA designed for training local leaders in making their communities resilient to climate change. WWF, GIZ, TNC and LGN are among the main strategic partners and collaborators.

Threatened Species

Some of the main achievements have been capacity building and practical training on threatened species; involvement in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Migratory Species (CMS) platforms where additional species are proposed to be added to the lists; producing a distribution/migration map of certain threatened species; the compilation of national and region-wide conservation plans for sea turtles, marine mammals, sharks and rays; as well as creating the outline for the region-wide assessment on threatened species in the Coral Triangle region. WCS and WWF are among the strategic partners providing technical support.

Some of the accomplishments of the RPOA goals on the ground involve cross-cutting initiatives such the Women Leaders' Forum (see box on WLF).

Coral Triangle Atlas

The Coral Triangle Atlas (currently undergoing reactivation and redesign) assists managers and scientists in more efficient planning for marine resource conservation. The atlas comprises an online GIS database on fisheries, biodiversity, natural resources and socioeconomics, and has been collected over decades by scientists and managers of the Coral Triangle region. Plans are underway to work with other regional marine database platforms to widen the reach of the atlas.

The start of 2020 has seen an intensified development of the CTI-CFF's refreshed and innovative strategic Regional Plan of Action (RPOA 2.0) which addresses cross-cutting themes in sustaining the extraordinary marine and coastal resources

Image: CTI-CFF Department of Agriculture and Fisheries, Timor-Leste

Image: CTI-CFF Department of Agriculture and Fisheries, Timor-Leste

A capacity building programme conducted among local women on marine conservation and plastics recycling-upcycling projects, Atauro Island marine protected area, Timor-Leste

Image: CTI-CFF Papua New Guinea Centre for Locally Managed Areas

Upscaling women's participation in mangrove planting, Kairuku District, Central Province, Papua New Guinea

within this global core of marine biodiversity to ensure food security and well-being of its coastal communities in the face of climate change. Threats to the CT, and efforts to address them, may impact men and women differently. Programmes and projects that do not factor in gender aspects may be inappropriate for, or inaccessible to, a large proportion of the target communities, and may even amplify existing social inequalities within these communities, according to international studies on food security by FAO, ECE and others.

For accomplishing the Sustainable Development Goals of Agenda 2030, achieving SDG 5 on the empowerment of women and girls is crucial. Thus, the intensified focus of the RPOA 2.0 is an increased resilience of ecosystems and local communities for sustainable livelihoods and food security, including women and youth. Emerging issues affecting food security such as plastics and marine litter (waste management), currents and larval connectivity are also to be addressed. As crucial decisions need to be made now, it is important to work together with strategic partners and others. The CTI-CFF therefore calls on everyone — governments, the private sector, local communities, universities and NGOs — to support its efforts and increase cooperation and commitment towards achieving sustainable development, food security and improvements to ocean governance.

Successful science-based fisheries management in the South Pacific

Dr. Sebastián Rodríguez Alfaro, Executive Secretary; Osvaldo Urrutia S., Chairperson, South Pacific Regional Fisheries Management Organisation (SPRFMO)

The resurrection of jack mackerel fisheries in the South Pacific, following a virtual collapse in the mid-2000s, is a success story that demonstrates how efficient fisheries management is underpinned by science-based decisions.

The story began in 2006, when participating states in a series of international consultations established a regional fisheries management organization in which effective conservation and management measures are based on the best scientific information available, together with the application of a precautionary and ecosystem approach to fisheries management.

The Chilean jack mackerel (*Trachurus murphyi*, Nichols 1920) is widespread throughout the South Pacific, chiefly along the shelf and oceanic waters adjacent to Ecuador, Peru and Chile, as well as the Subtropical Convergence Zone, in what has been described as the "jack mackerel belt", stretching from the coasts of Chile to New Zealand within a 35º to 50º S variable band across the Pacific.

In the mid-1980s, owing to large recruitment influxes, the jack mackerel stock size reached approximately 14 million tonnes of spawning biomass, one of largest fish stocks in the world, sustaining catches up to 5 million tonnes per year until the mid-1990s. However, due to the large fishing fleets operating in the area in combination with low recruitment, the stock size began to diminish and, by the mid-2000s, the stocks were badly overfished and heading for collapse. A population once estimated to be reaching 14 million tonnes dropped to less than 2 million tonnes in just two decades.

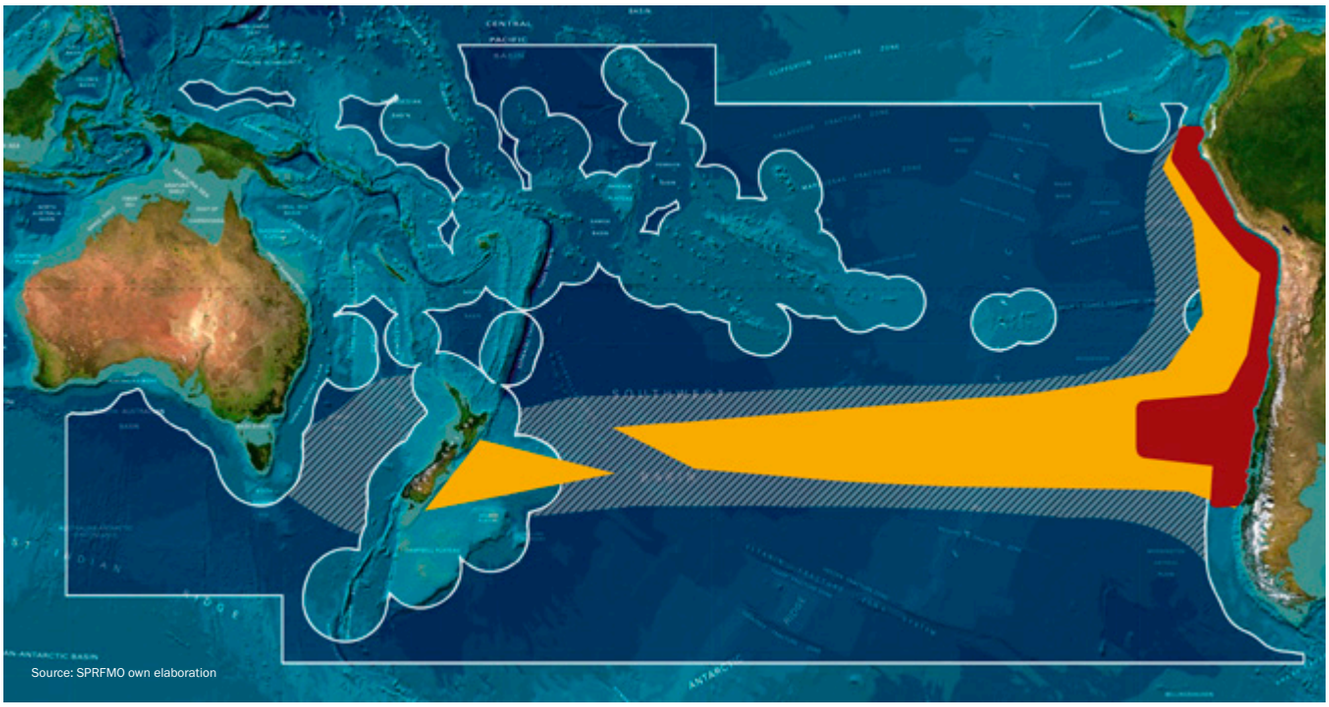
The fate of jack mackerel therefore became a case study of the consequences of lacking a robust international management regime. As a consequence, in 2006, Australia, Chile and New Zealand initiated a process of consultation to enable states to cooperate in addressing the gap in international conservation and management of non-highly migratory fisheries, and the protection of biodiversity in the marine environment in high seas areas of the South Pacific Ocean. The process resulted in a series of international meetings with the objective of discharging the duty of states under international law to cooperate in the conservation and management of living resources in those areas of the high seas. Through these international meetings participants decided to establish a regional fisheries management organization with the ongoing responsibility for this task.

In 2009, the 8th International Meeting adopted the Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean, together with a resolution to hold a preparatory conference to assist the efficient onset of the work of the Commission of the South Pacific Regional Fisheries Management Organization (SPRFMO) established by the Convention. The SPRFMO was officially established and entered into force in 2012.

A paradigm shift

The first Commission meeting of the SPRFMO was held in New Zealand in 2013, at which point the jack mackerel stock was seriously overfished, with levels ranging between 8 and 17 per cent of estimated unfished levels. The SPRFMO Commission expressed concern at the poor state of the stock and decided that catches in 2013 needed to be restrained to levels that, in accordance with scientific advice, provided a reasonable

Phase plane or "Kobe" plot of the estimated trajectory for jack mackerel under high and low productivity, with reference points set to F_{msy} (the maximum rate of fishing mortality — the proportion of a fish stock caught and removed by fishing, eventually resulting in a population size of B_{msy}) estimated for the time series 1970–2015, and B_{msy} (the biomass that enables a fish stock to deliver the maximum sustainable yield) set to 5.5 million tonnes



Spatial distribution of the Chilean jack mackerel based on catches data (yellow) and survey index (red). The white outline represents the Jack mackerel belt[1]

likelihood of an improvement in the spawning biomass. The SPRFMO Commission adopted an explicit rebuilding strategy, and catches in 2013 were constrained across the southeast Pacific Ocean to a maximum of 440,000 tonnes. Furthermore, the Commission adopted its first Conservation and Management Measure for *Trachurus murphyi*, CMM 1.01.

For the first time, SPRFMO members and cooperating non-contracting parties (CNCPs) agreed on management measures for international waters. Only fishing vessels duly authorized could participate in the fishery, and effort management limitations in terms of total gross tonnage were implemented. The SPRFMO Commission also set catch limits with the possibility of transferring all or part of catch entitlement among members. Data collection and reporting provisions were agreed, along with obligations to submit annual scientific reports to the Scientific Committee (SC).

Members and CNCPs participating in the fisheries implemented a vessel monitoring system. The SPRFMO Commission also made the assurance that a minimum of 10 per cent of trips should be given scientific observer coverage for vessels participating in jack mackerel fishery, and a roadmap for the scientific committee was approved.

All members and CNCPs participating in the fishery were tasked with providing a report describing their implementation of CMM 1.01.

The First SPRFMO scientific committee meeting was held in 2013. Concerning the jack mackerel fishery, the Commission has always accepted and fulfilled the SC's recommendations throughout the range of the stock, which has ensured its rebuilding.

Based on discussions and analyses conducted at SC meetings, a robust assessment of progress takes place annually. Given that there are a number of competing stock structures and at least five jack mackerel management units, each associated with a specific fishery in the southeast Pacific, the SC has been able to provide advice concerning the entire range of the stock. Subgroups such as the Jack Mackerel Sub-group or the Habitat Monitoring Working Group have carried out substantial scientific work in broad areas of knowledge.

Data collected on the environment in relation to the fisheries serves a single purpose, that the conservation and management measures concerning jack mackerel are based on the best scientific information available, including:

- Specific catch data — length, length composition, age-length keys, length frequency, catch per unit of effort and standardization thereof, effort to account for changes in fleet behaviour, abundance index, and others
- Fisheries independent data — observers onboard fishing vessels, surveys using hydro-acoustics to estimate jack mackerel biomass, egg and larvae surveys
- Biological parameters — reproductive biology, maturity-at-age, ageing, and natural mortality.

Scientific Committee (SC) recommendations to ensure the rebuilding of fishing stock

Year	SC Advice	Commission	Catch
2014	440,000	440,000	410,703
2015	460,000	460,000	394,332
2016	460,000	460,000	389,067
2017	493,000	493,000	404,609
2018	576,000	576,000	526,323
2019	591,000	591,000	Not yet available
2020	680,000	Not yet available	Not yet available

Measurements in tonnes

Source: SPRFMO

Image: Instituto del Mar del Peru (IMARPE)

The scientific research ship *Humboldt* carrying out hydroacoustic evaluation to determine biomass, distribution and the various biological aspects of jack mackerel and other pelagic resources

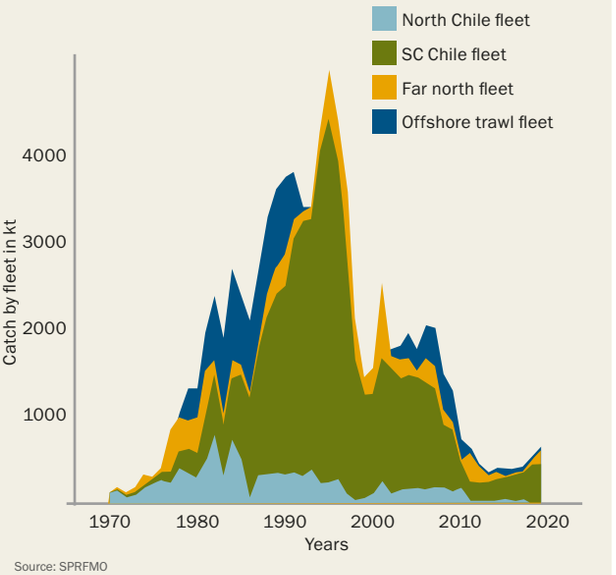
Today, southeast Pacific jack mackerel shows a sustained recovery since the time-series low point in 2010. The population trend is estimated to be increasing. The indications of stock improvement are: a higher abundance observed in the acoustic survey in the northern part of Chile; better catch rates apparent in some fisheries; and an increase in average age in the Chilean fisheries.

Assessment models showed similar trends with an increasing overall biomass, high recruitment in recent years, and low fishing mortality. The estimated biomass has increased in all model configurations and is now well above B_{MSY} (the biomass that enables a fish stock to deliver the maximum sustainable yield). Jack mackerel has therefore been rebuilt to the third tier of the proposed harvest control rule.

Currently, fishing for jack mackerel in the southeast Pacific is conducted sustainably by fleets from the coastal states of Chile, Peru and Ecuador, and by distant-water fleets from various countries including China, Cook Islands, Cuba, European Union Member States, Faroe Islands, Korea, Russian Federation and Vanuatu, all of them operating beyond the Exclusive Economic Zone (EEZ) of the coastal states. At present there is no directed fishery for *T. murphyi* in the central and western South Pacific and around New Zealand, where, if any, incidental catches are very small. Coastal states' vessels undertake their activities with purse seiners while the distant-water fleets consist exclusively of pelagic trawlers.

SPRFMO has steadily grown both in membership and in its reach. Its major success has been the progressive recovery of the jack mackerel stock in the eastern Pacific Ocean, based on the precautionary approach. Much of this success is due to the Commission heeding the advice of the SC, the recovery of the jack mackerel stock having required difficult decision-making throughout.

Catch of jack mackerel by fleet



Source: SPRFMO

After eight years of sustainable fisheries management, the jack mackerel fishery in the South Pacific is returning to safe levels. The latest SPRFMO SC advice shows that stocks are improving significantly and, in 2019, the SC estimate was 55 per cent higher than in 2014, a testament to the importance of independent scientific advice. This demonstrates that transparent and proactive Regional Fisheries Management Organizations such as SPRFMO, capable of adopting binding conservation and management measures at the regional level, are a successful tool for fisheries regulation in the high seas.

Towards sustainable blue economy development — the Malaysian case

Cheryl Rita Kaur, Head, Centre for Coastal and Marine Environment, Maritime Institute of Malaysia (MIMA)

The sea is now a host to many more activities than ever before. Ocean and coastal management have long ceased to be entirely concerned with fishing and navigation, but now also encompass the management of a myriad of activities coexisting in the sea and coastal areas. The increasingly complex structure of ocean uses demands changes in marine and coastal management objectives and approaches. This change has taken many different forms in many countries, but the approach is always intended to resolve conflicts among the different uses of the sea, promote economic development, and protect the marine environment and coastal communities.

Malaysia is a maritime nation by virtue of its geography and dependence on the sea and coasts. This dependence is reflected in the socioeconomic functions of the country's seas and oceans. Malaysia, comprising Peninsular Malaysia, Sabah and Sarawak, is located in the Indo-Pacific, with its coastline bordering the Andaman Sea, Straits of Malacca and Singapore, Gulf of Thailand, South China Sea, Sulu Sea and Sulawesi Sea. In terms of ecosystems and habitats, Malaysia's coasts and seas comprise the three main tropical marine ecosystems — coral reefs, mangroves and seagrass beds. These ecosystems provide goods and services including valuable fisheries resources while protecting the coasts from storms and coastal erosion. Malaysia is among the richest countries of marine biodiversity in the world, and marine resources provide essential contributions to the livelihood and sustenance of the people.

Image: MIMA

Malaysia's rich marine diversity

These seas provide a wealth of goods and services to Malaysians — with essential parts of the nation's multifaceted fabric comprising interlinked social (economy, security and culture) and natural parameters. These aspects are interlinked, and influenced by internal as well as external factors such as international trends, conventions and treaties. In this sense, the maritime sector is dynamic and continuously changing, affected by ongoing innovations and utilization of the coastal and marine resources. The management of Malaysia's seas is therefore aimed at balancing the need to continue or perpetuate the provision of goods and services from the sea while allowing for sustainable development and economic activity.

In cooperation with the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), an assessment of the state of the country's oceans and coasts was carried out by MIMA, between 2015 and 2017, to:

- Provide a better understanding of Malaysia's coasts and seas, as well as of the threats from human activities and climate change, and the challenges of managing these areas
- Aid policymaking, planning and management of the coastal and marine areas of the country, including the resources, environment, economic activities and investments, and foster inter-agency collaboration
- Contribute to the blue economy assessment, and to monitoring the implementation of the Sustainable Development Goals (SDGs), Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) and other international agreements, as well as national laws and policies.

The assessment showed that Malaysians benefit from the coastal and marine areas in various ways. The seas surrounding the country contain productive and diverse natural ecosystems including mangroves, coral reefs, mudflats and seagrass beds, providing many important goods and services, and contributing significantly to human, food, economic and environmental security. The local communities are dependent upon healthy ecosystems and habitats which supply many species of plants, animals and microorganisms that provide food, medicines and other products for use on a daily basis. This, in part, explains why the Malaysian Government has become a party to several multilateral environmental agreements such as the Convention on Biological Diversity (CBD), the Convention on Wetlands of International Importance,

Image: MIMA

Marine resources provide essential contributions to the livelihoods and sustenance of the people

especially as a Waterfowl Habitat (Ramsar Convention), and others. Alongside its obligation under the CBD, Malaysia has been promoting biodiversity conservation as an integral part of sustainable development, a policy theme since the Seventh Malaysia Plans from 1996–2000 and thereafter. Within the initial period, a national policy on biodiversity conservation was adopted.

Malaysia advocates a development path that emphasizes conservation while maintaining economic development. Despite encouraging such a development strategy, the country faces serious challenges for conserving and protecting the total biodiversity of Malaysia. This is being further emphasized in the planning of the twelfth Malaysia Plan (2021–2025), including a focus on the blue economy development.

Various studies focusing on the valuation of ecosystem services have also been conducted to make the case for treating ecosystems as capital goods that generate values, thereby helping to justify biodiversity protection on economic grounds. For instance, total economic valuation studies have been carried out in the major national marine protected areas, with the values recorded to be between US$ 9.3 million and US$ 850 million. The total value of ecosystem services for the country is projected to be about US$ 17.7 billion.

The blue economy concept has evolved from the broader green movements as well as a growing awareness of the threats imposed on ocean ecosystems by human activities such as overfishing, habitat destruction, pollution and the impact of climate change. The concept is increasingly gaining in importance as governments adopt and implement a more sustainable balance between economic growth and the maintenance of ocean health. While the term is only recently gaining momentum in Malaysia, the focus on the blue economy has gained enormous drive at the regional and international levels. There is no single definition of the blue economy but the one provided by the World Ocean Summit in 2015 has described it as a sustainable ocean economy that emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support the activity and remain resilient and healthy.

The blue economy concept focuses on development of the existing ocean sectors to further generate employment, promote entrepreneurship in new areas of economic activity, facilitate the interconnectedness of the regional economy, and contribute to sustainable development and climate change mitigation. In a broader sense, the concept should be able to show the critical role and contribution of ocean economic activities and coastal and marine ecosystems to national economies, provide evidence for a region-wide ocean policy and decision making on related areas, and examine the benefits, costs and impacts at the international and local levels. These have created opportunities for industries to transit to more environmentally sustainable practices

and for new and innovative investments to be focused on promoting and restoring ocean health.

An important issue of the blue economy is to understand and better manage the many aspects of coastal and oceanic sustainability, ranging from sustainable fisheries and ecosystem health to pollution. A second significant issue is to realize that the sustainable management of ocean resources requires collaboration among the various stakeholders and across the public-private sectors, and most likely on a scale that has not been previously achieved. Major priority areas identified include fisheries and aquaculture, ocean energy, ports and shipping, oil and minerals exploitation, and sustainable tourism activities through various platforms at the national and regional levels.

The contribution of the ocean economy to the country's GDP was valued at 23 per cent in 2015 alone, with about 4 per cent of the total employment share invested in the ocean sectors. The same was reported to be only about 13 per cent of the country's GDP in 2005.

Ports and shipping contribute the highest share to GDP, followed by coastal and marine tourism, and fisheries and aquaculture. The ocean sector, which is crucial to Malaysia's economy through its resources and ecosystem services that support trade and industries, requires proper management and conservation strategies to achieve maximum economic, environmental and social outcomes. This will involve participation from the relevant stakeholders and assessment of the physical and human resources required; investment in

Image: MIMA

Image: MIMA

Blue economy initiatives drive sustainable development

Fisheries and aquaculture

Fisheries

The marine fisheries industry in Malaysia contributes significantly to the national economy in terms of income, foreign exchange and employment, with production of marine fish from the Malaysian waters valued at US$ 2 billion in 2015. Sustainable management of fisheries resources is being ensured through the implementation of fisheries licensing and a zoning system as well as the enforcement of the 1985 Fisheries Act. An essential component of this is the establishment of marine protected areas that safeguard the spawning and feeding grounds of commercially important species.

Aquaculture

The Malaysian Government has identified aquaculture as a major source of fish production to both meet domestic demand and expand export potential. In 2014, aquaculture production was approximately 520,514 tonnes with a value of US$ 800 million, accounting for 26 per cent of total fish production. Aquaculture has shown rapid development with an average annual growth rate of 8 per cent per annum during the past ten years. Most aquaculture activities are concentrated within the mangrove areas along the west coast of Peninsular Malaysia. Cockle production is a major contributor to the value of coastal aquaculture, with the long mudflat areas along the west coast providing suitable habitats for local cockle production.

Coastal and marine tourism

Marine parks

Most of the marine parks and unique resources have attracted many tourists to Malaysia. They have a remarkably high level of biodiversity with significant ecological and social values that can contribute toward research and development, and enormous economic growth through sustainable tourism. Marine tourism is a diverse sub-sector of the tourism industry and offers a wide range of attractions and activities, such as recreational fishing, yachting, cruising, island tourism, beach tourism, snorkelling, diving and water sports.

Cruise tourism

As an attraction for coastal and marine tourism, cruise tourism has become one of the sectors identified in the national key economic areas. The Cruise and Ferry Integrated Seaport Infrastructure Blueprint for Malaysia has been prepared as an outline for the cruise tourism sector in Malaysia to achieve international standards. The cruise terminals are located in Penang, Pulau Indah (Selangor), Kota Kinabalu (Sabah), and Langkawi Island (Kedah).

Ports and shipping

One of the world's most strategic and important navigational lanes is the Straits of Malacca, the second highest chokepoint for the transportation of crude oil and petroleum products in the world after the Straits of Hormuz — up to 27 per cent of world maritime oil trade.

Around 95 per cent of Malaysia's trade by volume is seaborne, and there are around 39 ports in Malaysia. Among them are the major federal hubs of Port Klang, Johor Port, Port of Tanjung Pelepas, Kuantan Port, Penang Port, Bintulu Port and Kemaman Port. Those in Sabah and Sarawak are under the jurisdiction of the state governments of those states. Some of the federal ports are among the world's busiest container ports by throughput handled. Bintulu Port is the world's largest export terminal for liquefied natural gas, and Johor Port is the world's largest palm oil export terminal. Most Malaysian ports are constantly increasing their options for logistics and connectivity, as well as improving their services. Apart from their role in trade and business, the ports are also important for cruise tourism.

Image: MIMA

The Tioman Island Marine Park

research, science and technology; collaboration; and review and formulation of policies. Some of the initiatives that could be undertaken include developing a blue economy profile and conducting pilot studies of the ocean to help define and refine Malaysia's conception of a blue economy; and promoting the use of ocean economy data in marine planning at the national level to facilitate further engagement by Malaysia with other countries in the region on related areas.

As with the coastal zone and sea worldwide, Malaysia's marine ecosystems, biodiversity and coastal zone are nevertheless threatened by human activities, such as the conversion of ecosystems to other uses, overfishing, use of destructive fishing methods, and urbanization and development, which threaten coral reefs, mangroves and seagrass. For instance, Malaysia's overall ocean health index (OHI) score is 65, compared to the overall global OHI score of 70. Malaysia's OHI score ranks it at number 143 among 221 Exclusive Economic Zones in 2018. This indicates that more can be done to ensure that the ecosystems services are preserved and delivery of future benefits from the oceans are sustainably ensured.

The Government of Malaysia appreciates fully the need to address the threats and issues, and has put in place the necessary legal and non-legal instruments, such as guidelines and the development of many projects and programmes, to protect the country's coasts and seas from degradation of ecosystems and pollution. These include formulating protocols such as the National Policy on the Environment, and the National Policy on Biological Diversity, and enacting laws such as the Environmental Quality Act 1974, the Fisheries Act 1985, and many subsidiary items of legislation at the Federal, State and Local Government levels. However, national efforts can achieve success only within the boundaries of the country. More will need to be done at the regional level to promote joint management of shared ecosystems, habitats and resources.

The conservation of these ecosystems, and coastal and marine biodiversity in general, has ensured a continued supply of fisheries products, which constitute a major source of protein for Malaysians, whose per capita consumption of fish is one of the highest in the region.

Malaysia's fisheries sector is well regulated with adequate legal and management provisions such as a fisheries zoning system, and supported by a network of marine protected areas in the form of marine parks, forest reserves, sanctuaries, and fisheries prohibited zones. Ecosystem conservation also plays a key role in sustaining Malaysia's burgeoning tourism industry, which is partly based on coastal and marine resorts and parks.

It is envisaged that blue economy initiatives would further drive sustainable development at the national level. The overall management of Malaysia's seas should henceforth focus on balancing the need to continue or perpetuate the provision of goods and services from the sea while allowing for sustainable development.

Sailing towards a plastic-free ocean — action on SDG 14 to increase understanding of ocean debris

Holly Griffin, Associate Programme Officer, UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC); Sanae Chiba, Senior Scientist, Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Marine plastic pollution is considered one of the most serious global environmental challenges, impacting marine life in every corner of the ocean. From surface waters to the deepest ocean trenches, and from polar extremes to tropical coral reefs, it is estimated that 45 million tonnes of plastic is currently circulating in the ocean. The estimated economic cost of marine ecosystem services lost due to marine plastic pollution reaches over US$ 1 trillion every year.

Ambitious targets have been set to tackle this global problem. Target 14.1 of the UN Sustainable Development Goal (SDG) 14 calls for coordinated efforts to "prevent and significantly reduce marine pollution of all kinds" by 2025. Beyond SDG 14, the issue of marine plastic pollution is also relevant for other global policy goals. For example, addressing marine plastic pollution also contributes to good health and well-being (SDG 3), clean water and sanitation (SDG 6) and responsible consumption and production (SDG 12).

At the national scale, many countries have been urged to introduce policies and management plans to reduce the flow of plastic waste into the ocean. However, countries are facing two key challenges in tackling marine plastic pollution.

The first is a lack of knowledge of marine plastics. Policies to address marine pollution should be designed based on scientifically robust evidence. However, there is currently limited information about the lifespan of marine plastic and, in particular, its transport, disintegration and accumulation processes in the ocean. A project run by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) sought to contribute to the knowledge base in order to support the design of effective management policies.

Microplastics in the ocean

Microplastics are non-biodegradable. In the ocean, they release chemical additives into water and attract waterborne toxins and bacteria that stick to their shiny surface and appear similar to food. These microplastics can then be eaten by the smallest marine organisms, leading to poisoning and blocked digestive tracts. Toxins then work their way up the food chain, where they can eventually be consumed by humans.

Image: Holly Griffin

Trawling for microplastics with a Neuston net, in sight of Mount Fuji

The second problem is a lack of public engagement. While momentum is gathering at a national level to mitigate marine plastic pollution, there is still work to be done on increasing public engagement with the issue. Globally, there is a need to increase recognition among the general public of the impact of its behaviour on the ocean. People can feel disconnected from the marine environment, particularly if they do not live close to it, or interact with it on a regular basis. Education and communication can provide a way of overcoming this challenge, by exposing young people to the issues facing the ocean and empowering them to make environmentally and socially responsible decisions.

Image: Yurie Seki

Sanae Chiba teaching young people from Palau about microplastics research equipment

The 'Sailing Towards a Plastic-Free Ocean' project took action to address these challenges in the western North Pacific.

On 29 December 2019, an international, all-female research team boarded the Japanese sail training ship *Miraie*. They embarked on a 17-day expedition covering 3,000 km from Yokohama, Japan, to Koror, Palau. The mission was to collect marine plastic pollution data in the western North Pacific. This area is expected to have a high density of microplastics, but data are currently scarce.

Microplastics are very small pieces of plastic that float in the water column. The researchers on the *Miraie* used two approaches to sample the microplastics during the cruise: a semi-automatic sampler allowed continuous sampling in all weathers for microplastics smaller than 300 micrometres, while daily samples of larger than 335 micrometres were collected using a Neuston net. A Neuston net is towed at the side of a vessel, and is often used to collect plankton, but in this case, the net was used to collect microplastics.

Once they have entered the ocean, plastics are transported by ocean currents and distributed worldwide. An estimated 45 million tonnes of plastic are currently circulating around the global ocean. However, available global observation data account for only 440,000 tonnes — a mere 1 per cent of the total estimated volume of plastic in the ocean. The remaining 99 per cent is unaccounted for. It is suspected that it can be found in the deep-sea or in under-surveyed areas. In some places, ocean gyres (large circular currents) lead to an increased density in plastic. One of these gyres south of Japan is assumed to be gathering large amounts of plastic from Asian regions. However, there are currently limited ocean observation data available in the western North Pacific to confirm this.

Sampling undertaken during this project is contributing to an understanding of the status of microplastic pollution in the western North Pacific. When all laboratory analyses are completed, the data will help solve the mystery of the missing plastics, and fill the information gap of global marine plastic distribution.

Microplastics were easily spotted by eye in the Neuston net samples from 12 of 14 tows, showing that plastics were widespread throughout much of the voyage. Exceptions to this occurred closer to land during the last two tows, which were conducted in the Marine Protected Area of Palau, where organic matter such as mangrove leaves dominated the samples collected.

By addressing an existing knowledge gap regarding microplastic pollution in the western North Pacific, this project was able to contribute to tracking progress toward SDG Target 14.1 on microplastics. A detailed analysis on the distribution and composition of the microplastics obtained during

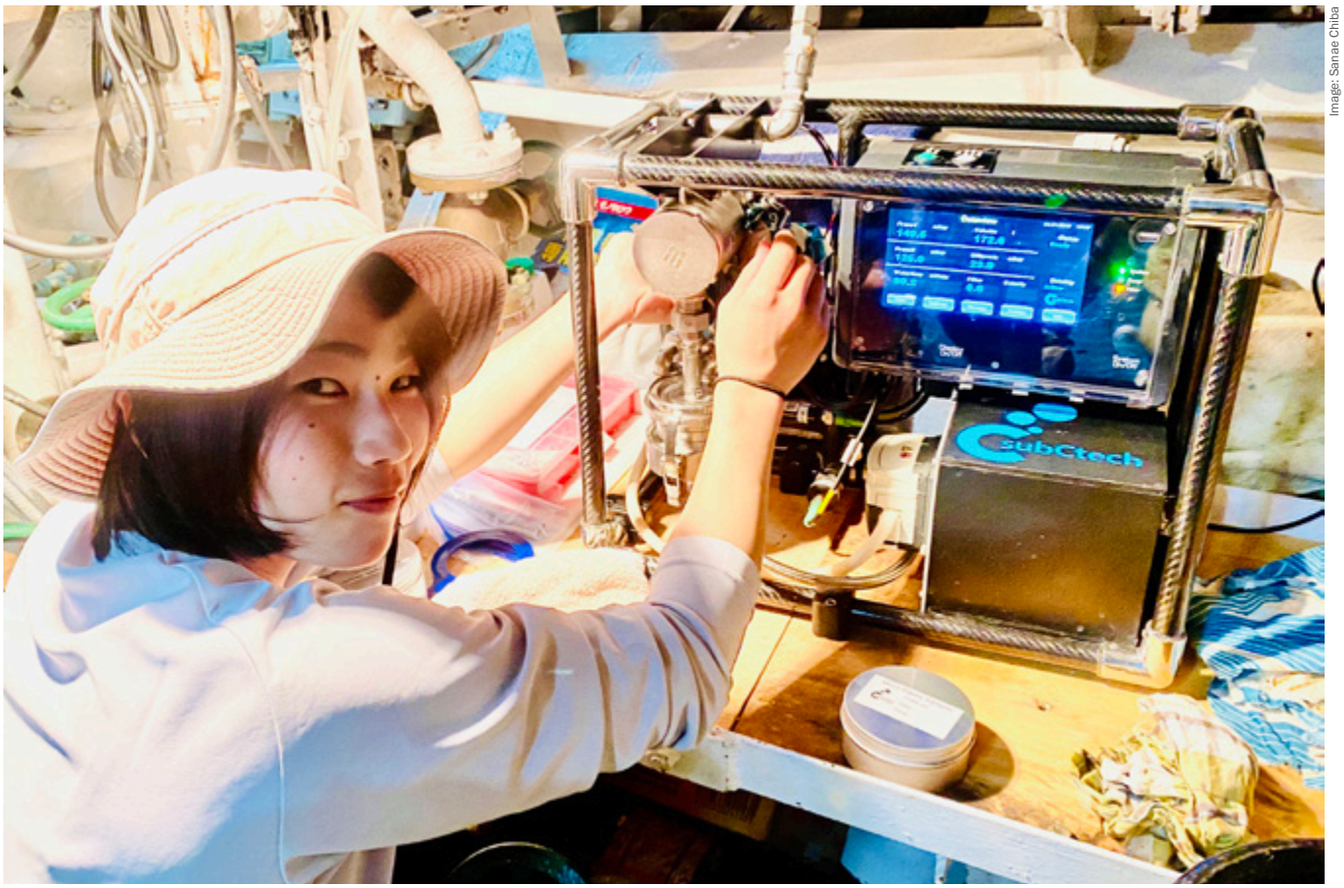


Image: Sanae Chiba

Yurie Seki changing the microplastics filters in the onboard semi-automatic sampler

the cruise will be undertaken by JAMSTEC, and published by early 2021.

The 'Sailing Towards A Plastic-Free Ocean' project further aimed to educate young people about ocean science and conservation, aligning with Target 4.7 of SDG 4 by delivering the education required for sustainable development and global citizenship. For this purpose, the research team was joined on board the *Miraie* by a group of young Palauans and their parents. As well as supporting the research team in collecting water temperature and salinity measurements, the young people also took part in a series of interactive learning sessions to understand issues that the ocean is facing beyond plastic pollution, and elements of ocean science. This involved exploring a range of topics including industrial fishing, coral reef ecology, ocean giants and Marine Protected Areas. They also completed a mini-project to design their own ocean-friendly city.

Through a tailored learning plan, the young people were able to learn about the impacts of plastic on people and the planet, as well as sustainable alternatives. This presented an opportunity to help develop the next generation of ocean leaders, equipping them with facts and inspiration to consider the challenges that the ocean is facing, as well as practical solutions.

Beyond SDGs 14 (Life Below Water) and 4 (Education), links can also be drawn between the 'Sailing Towards A Plastic-Free Ocean' project and SDGs 5 (Gender Equality) and 17 (Partnerships For The Goals).

Encouraging gender equality in ocean science is essential, as was promoted through the theme of the 2019 World Ocean Day. Women are underrepresented in science, technology and engineering, particularly in Asian countries. This was highlighted by the IOC-UNESCO Global Ocean Science Report (2017), which identified an uneven gender balance in Japan in the number of experts attending selected international conferences and symposia in the ocean technology and engineering and ocean observation and marine data fields.

As an all-female research team, Sanae Chiba (JAMSTEC), Holly Griffin (UN Environment Programme World Conservation Monitoring Centre) and Yurie Seki (Yamaha) were pleased to be able to demonstrate to young people, both on the sail training ship and beyond, that science is for everyone and to encourage girls to pursue careers in ocean science and technology.

Partnerships to generate positive change were crucial to the success of this project, which contributed to SDG 17 through a bilateral scientific collaboration between Japan and the Republic of Palau, facilitated by the many partnerships established between the organizations and participants involved.

To start understanding the dynamics of plastics in the western North Pacific and contribute to overcoming the data gap, the project team led by JAMSTEC partnered with the Japan to Palau Goodwill Yacht Race organizing committee, and specifically the racing yacht *Trekkee* which was fitted with microplastic samplers.

The success of the project offers inspiration for future collaborations between the scientific and yachting communities. With the scale of current challenges and people's desire to contribute to solutions, this collaboration presents a unique, engaging and enjoyable opportunity to further understand the scale of marine plastic pollution and to increase engagement with the issue. Such opportunities are particularly valuable for the next generation who will play a major role in the delivery of the SDGs, as demonstrated by this project.

Further partnerships are necessary to advance progress toward tracking and reducing marine plastics in the ocean. The proposed official indicator for tracking plastics and other marine debris — SDG 14.1, Index of coastal eutrophication and floating plastic debris density (14.1.1) — is currently unavailable due to insufficient data, making it difficult to assess progress toward the 2025 deadline. To overcome this hurdle, the international ocean science community is currently working to establish an integrated global marine debris monitoring system by developing partnerships between existing observation programmes, and promoting data sharing among them. This monitoring system aims to contribute to global indicator 14.1.1, and thereby provide useful information for policymaking in a timely manner.

This global monitoring system is unlikely to be achieved by the scientific community alone, and will benefit from cross-sectoral collaboration. JAMSTEC, together with international colleagues promoting the global marine debris observation system, intends to increase collaboration with the shipping and recreational boating industries, to collect data in remote areas of ocean that are visited on a regular basis to contribute to global ocean observation data. As this is a global and societal problem, collaboration between scientists and citizens is key to overcoming data gaps and mobilizing efforts to find a solution to the plastic pollution crisis.

Finally, partnership-building with Small Island Developing States, as demonstrated by the work of this project in strengthening scientific partnerships between Japan and the Republic of Palau, will be key to understanding the state of marine plastic pollution. Local and traditional ecological knowledge is likely to play a large role in policymaking in the coming years, and can provide an extremely valuable source of data. Furthermore, working with countries to increase capacity for leadership in the ocean science and conservation space, especially among women, will help to develop the next generation of ocean leaders and to address gender balance in the ocean science and conservation fields.

As the world enters the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), increased knowledge of the state of the ocean through observations, combined with awareness raising and engagement with the public through ocean literacy, will be vital to generate the progress required. High-quality data help understanding of the status of plastic pollution and, when accompanied by ocean literacy campaigns, can provide information necessary to educate global leaders, politicians, decision makers and the public. Understanding the link between human behaviour and the health of the ocean is key to catalysing the change and international partnerships necessary to manage a globally shared resource effectively.

Image: Yurie Seki

All-female research team pictured with the First Officer of the *Miraie*

Image: Sanae Chiba

Holly Griffin teaching ocean conservation to young people from Palau on the deck of the *Miraie*

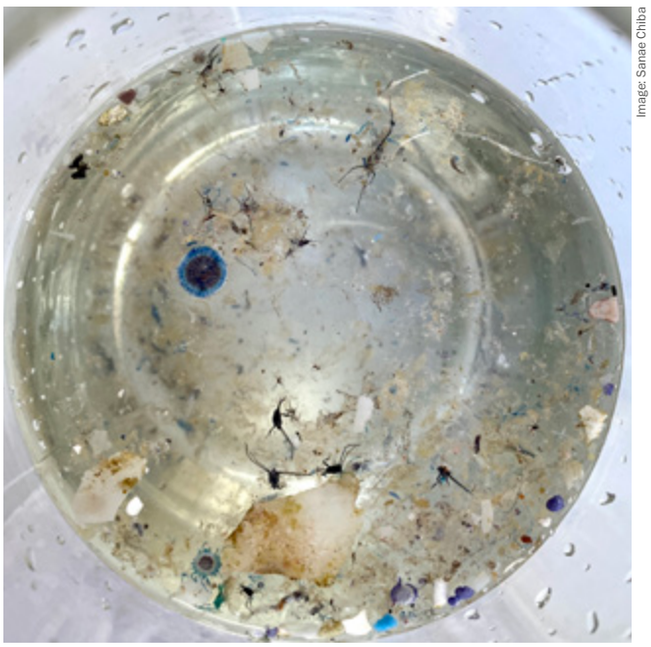


Image: Sanae Chiba

A sample collected using a surface water net on the *Miraie*

Becoming plastic neutral — a circular economy for plastics to protect the oceans

Dr Geoff Brighty, Senior Sustainability Advisor, Mura Technology Ltd.; Marco Graziano, Postgraduate Researcher, Centre for Ecology, Evolution and Conservation, School of Biological Sciences, University of East Anglia

The production of plastic is growing, as is the amount of plastic disposed of. Globally, around 260 million tonnes (Mt) of plastic waste is produced each year and, with a predicted increase in plastics demand, the global annual production of waste plastic is estimated to almost double by 2030[1]. Approximately 4,900 Mt of the estimated 6,300 Mt plastics produced has been disposed of either in landfills or elsewhere such as energy-from-waste[2] or into the environment[3]. That represents a considerable waste of resource, and is leading to environmental impacts at the global scale[3], translated into a release of between 4 and 12 Mt into the environment[4].

With ocean plastic pollution becoming ever more visible in the media, and thus to the public, and rapidly rising on the global environmental, social and political agendas, the international and regional commitments to reduce contamination of marine habitats by 2025 and beyond have been outsourced, involving governments, industries and NGOs such as the United Nations Environment Programme, GESAMP, Commonwealth Clean Oceans Alliance, UK Research and Innovation/Policy Connect, and Plastics Europe. If plastic waste is not managed, it will silently penetrate into the marine environment[5] through a variety of routes.

Many actions and efforts to reduce or manage plastics entering the oceans show potential, but to date have been fragmented, incremental or uncoordinated, lacking both impact at scale and the bedrock of rigorous research and innovation[6]. It is also clear that even in developed countries, the scale of plastic recycling is less than optimal[4,7]. In the UK, plastic recycling has been reported to be at 46 per cent[8], yet it is known that all plastic is recyclable. So why has the current recycling approach failed to deliver? Where a waste management system is in place for plastics, it is substantively a linear model that follows the route of production, use, mechanical recycling (for some polymer types), incineration or landfill.

Recycling plastics at scale is a very complex challenge. Contamination from food or soil cannot be removed entirely, and mechanical recycling processes do not address the complexity of all packaging types, including: colour, multi-layered pouches, films and flexible plastics. Using mechanically recycled plastic in higher value applications is technically challenging and leads to increased process rejects and a generally lower quality of product. It is not a simple task to replace virgin polymer with mechanically recycled content in any plastic manufacturing operation regardless of the application, for instance: blown film, injection moulding, blow moulding, and extrusion. Compared with virgin or chemically recycled polymer, mechanically recovered polymer has:

- Lower strength
- Varying processing characteristics, such as density
- Lower clarity/retaining colour of the original product
- Unknown concentrations of additives such as flame retardants, masterbatch mixtures, chalk fillers, and persistent organic pollutants (POPs).

Also, there is no great market demand for products made from low-grade plastic derived from the recycling system, and food grade plastic cannot be produced from the vast majority of mechanically recycled plastics. The current linear model for plastics, considered to be disposable after one use, has driven this issue[9], but the benefits accrued from single use plastics — medical safety, food safety and reduction of food waste — should not be dismissed.

Yet, the limited understanding of solving the waste management challenge, and how to change the broken system[10] to a more circular approach, is inhibiting progress towards several United Nations Sustainable Development Goals (SDGs)[11], as the numerous positive and negative feedbacks have not yet been investigated comprehensively or scientifically[12,13]. The idea of moving to a more circular economy[14] to create a business model where plastic is recycled back into plastic or other recyclable materials has been widely supported. The ability to recycle materials at end-of-life needs to be hardwired into the products at the start of their design — the material, the use and the system which the product enters are all critical considerations that need to be put in place before a product enters use. Also, treatment systems need to be able to sort and process the material at end-of-life in a way that gives it the best chance of being recycled efficiently, and not at an unacceptable environmental cost. The aim will be to see material flow kept within a productive system, with no losses to the environment that cause pollution, retaining the quality and value of the material and avoiding the wider costs of disposal and damage to ecosystem health and services.

What will be the outcome?

If the circular economy is the system, then what is its outcome? This is emerging as a critical question. The high

Image: Mura Technology Ltd.

Plastic in the oceans: a wasted resource causing considerable ecosystem damage on a global scale

aspirations of the circular economy set the system to be as near to a closed loop as possible, but it is clear that there are losses through the system, including:

- Energy: for collection and transport of waste plastics; sorting and baling; heating water; mechanical washing; cutting and preparing for reprocessing; treatment of wastewaters
- Resources: water for washing soiled plastics, other materials for baling plastic waste
- Emissions: to air, land and water, for instance CO_2 emissions from transportation and processing of plastic waste.

Processes can be optimized through the application of tools such as Life Cycle Assessment (LCA) and efficiencies in process to reclaim heat and recycle and reduce water consumption. So, is it a false declaration that a material, or a system, is truly circular? The example of aluminium as the world's most recycled material would suggest that this comes at a very high cost in terms of energy for reprocessing, notwithstanding the initial environmental impact of its mineral extraction. LCAs therefore can be misleading or, if LCA is used, then the basis of each LCA needs to be clear to all.

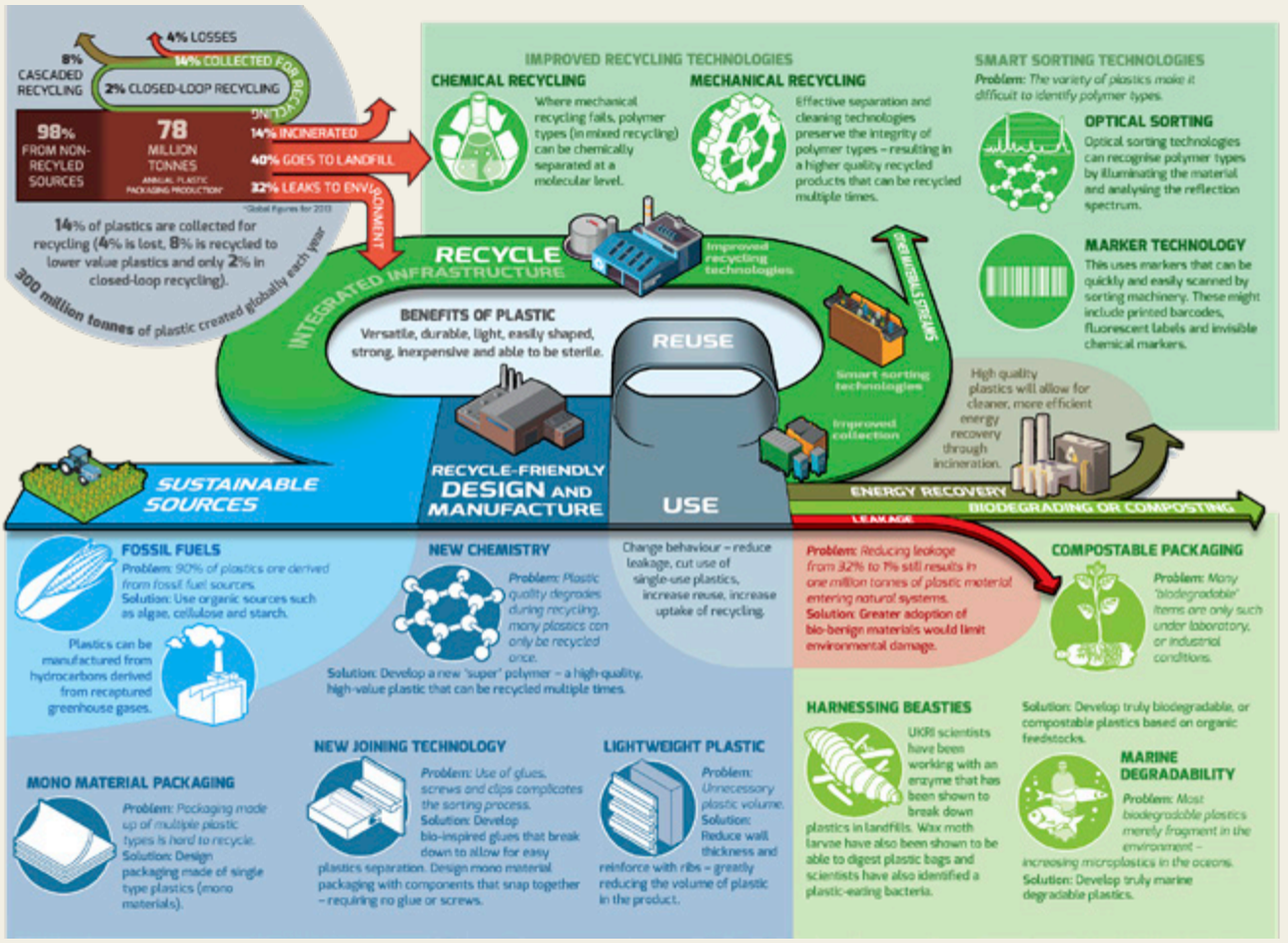
There must be more clarity on what the outcome of a circular economy from a plastic material viewpoint should be. If it is to be the conservation of the plastic within a system, while acknowledging the additional costs linked to the processing of the material, provided that as much of it as possible has been recycled with no avoidable losses from the system, then, for practical purposes, a circular economy has been achieved. Clarity should also be sought on the product of the plastic recycling system. The limitations of mechanical recycling are seldom discussed, but if the amount of virgin plastic entering the market is to be reduced, and more of what is already in the system is recycled, then the focus should be on the quality of the product of a circular economy and how to achieve that.

How can that outcome be described?

The outcome of the plastic circular economy would be defined as: the maximum amount of plastic retained within that system through reprocessing, or exported to a related, circular system, without attritional losses that lead to wider environmental impacts.

A term that has been used in recent years to signify that outcome has been 'plastic neutral'[15]. The term draws from that used in the management of carbon cycling. It embodies the notion that a material can be moved from one state to another, reflecting wider externalities that impact on, and take from a system, and describes an overall outcome on

The circular plastic economy — working towards a zero plastic waste solution



Infographic: Ben Gilliland. Sources: Ellen MacArthur Foundation, UKRI: https://www.ukri.org/research/themes-and-programmes/tackling-the-plastics-problem/

material flow for an entity, so it can be so-called carbon positive, negative or neutral. For example, to be carbon neutral:

- A domestic householder uses fossil fuel energy to drive their car, but they are able to 'offset' their carbon release to the environment by supporting a tree planting scheme, which will sequester that carbon into a biotic form
- A business purchases its energy from renewable sources such as wind or solar so that it is not creating a carbon footprint at the point of consumption.

Achievement of plastic neutrality should perhaps be based on the following principles:

- The management of material flow within the system to be maximized, assessing the system, inputs and outputs
- Avoiding all losses from the system that lead to wider ecosystem costs
- Not drawing additional fossil fuel-derived virgin polymer into the system, but instead only replacing existing plastic with plastic polymer recycled from elsewhere.

From these tenets, a related set of principles for various entities can be defined as follows:

For a manufacturing business to be plastic neutral means:

- All plastics that are used in its manufacturing would be taken from 100 per cent recycled plastic sources
- Fossil fuel-derived virgin feedstock would not be drawn in
- Products would be designed to optimize the downstream recyclability of the plastic.

This approach helps to create a commercial incentive for plastic recyclers to provide that recyclate, increases the value of recyclate and drives innovation to be able to recycle the plastics that are not currently recycled, such as film and flexibles.

For a country: for example, an island state

- The country would export only recycled plastics as recycled polymer either in product, or as a processed raw material (not as plastic waste) that could enter directly into another plastic economy, thus avoiding losses of plastics from the global system
- All plastic imported and made within a country would be able to be reprocessed within its plastic recycling systems to generate recycled polymer of a valued grade, whether using mechanical or chemical recycling means, that would be either retained within that country, or exported

- No plastic would be used for energy from waste, nor be sent to landfill
- To increase the recycling rate further and to progress towards 100 per cent material flow, previously lost plastic in waste facilities such as landfill or the wider environment is actively scavenged or mined to add to the reprocessing volumes in order to become a net economic positive contributor of plastic feedstock to the system, and that can then be recycled
- Offsetting by third parties could support enabling works such as new infrastructure, but in a time-limited manner.

For a householder or domestic waste authority collection
- All plastic products entering the house can be recycled
- All plastic is placed with the appropriate domestic waste collection streams and can be reprocessed by the local municipal waste authority
- The materials recycling facilities are able to draw out mechanically recycled plastics, and that plastic which is residual to enter chemical or other beneficial waste processing streams
- Biodegradable plastic polymers are separated and processed in an adequate composting waste stream.

Plastic neutrality — how is it achieved?
While the term plastic neutral is attractive, further work and debate are required to drive towards:

Improving recycling processes
For plastic, the material flow rates in mechanical and chemical recycling environments vary. Mechanical recycling rates are around 46 per cent in the UK[8], whereas chemical recycling processing plants can achieve a yield of up to 80–90 per cent. Therefore, to achieve rates approaching 100 per cent recycling, mechanical, chemical and other technologies will need to be used in combination.

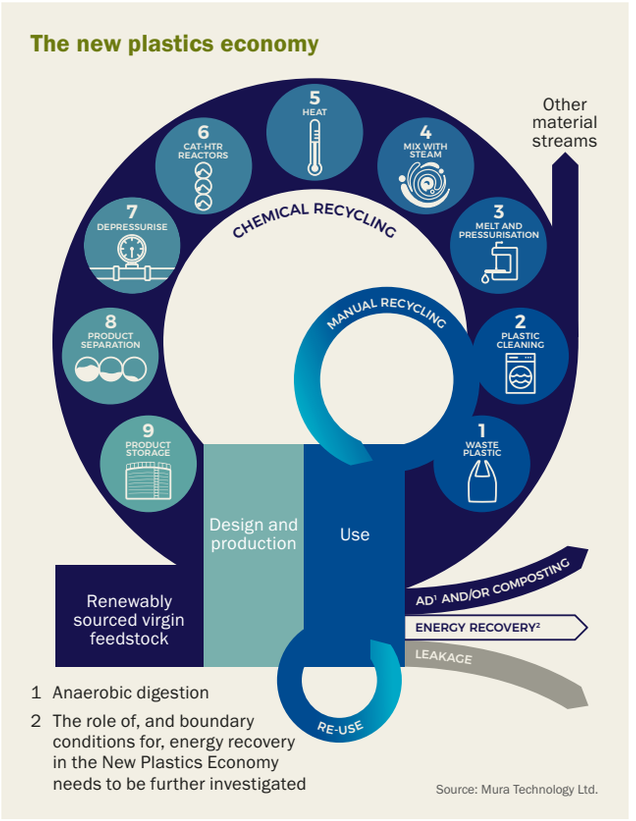
Of the chemical recycling technologies that are able to meet these ambitious recycling rates, Mura Technology's Catalytic Hydrothermal Reaction (Cat-HTR™)[16] is a low-emission, high-efficiency[17] process that can convert plastic packaging feedstock to a range of products — waxes, oils and ethylene gas — which can then be used as intermediates in the chemical process value chain, to create food- and other high-graded plastics. The Cat-HTR™ technology can process plastics contaminated with food and other materials, as well as take a range of plastic types such as multilayered, coloured and a broad range of polymer types, and even ocean plastic. This chemical recycling technology offers the potential to process waste plastic that would previously be sent from mechanical recycling facilities to energy-from-waste, or landfill. The chemical recycling plants can also be scaled in 20,000 tonne units to meet local supply needs, and generate chemicals that are genuinely recycled from plastic, and thereby support a viable circular economy. These units could easily be grouped around existing waste or petrochemical refining infrastructure, or be placed individually on islands[15] to serve island groups, and create an export industry. Turning waste plastic into a valued commodity, and reducing environmental impact particularly in sensitive environments, is the kind of elegant win-win solution required to help meet SDG 14.

Advances in chemical recycling processes will be needed at scale if the quantity of waste plastic sent for energy recovery, to landfill or to escape into the ocean, is to be reduced. Also, the chemical recycling processes must have an environmental performance that is comparable to that of mechanical recycling, so that the environmental cost is not excessive, and that can be deployed in a cost-effective way compared with other waste infrastructure such as materials recycling facilities. Chemical recycling must also be used to complement mechanical recycling, so that, together, both sets of technologies provide a comprehensive solution at the system scale to the recycling of all plastics, in order to regain the value and prevent plastic from escaping to the oceans. But through the Cat-HTR™ there is now the potential to be able to recycle all plastic within an economy.

The ambition of the schemes behind achieving plastic neutral status
If plastic neutrality is to be meaningful, then it should be related to the whole plastic system in the same way that carbon neutrality signifies not adding to the atmospheric carbon load. The world is facing increasing growth in plastic production and consumption, therefore the ambition of plastic neutrality at the global system level is to stem that growth, and seek to reduce fossil fuel-dependency over time

Image: Mura Technology Ltd.

Mura's plastics recycling process uses Catalytic Hydrothermal Reactors (Cat-HTR) to transform waste plastics into valuable oils, a game changer in processing waste plastic and reducing ocean plastic pollution



How chemical recycling can transform plastic recycling at the system scale to achieve plastic neutrality

to a production that is considered acceptable (influenced by capacity of the waste management system, and environmental impacts from production, use and disposal).

Accepted environmental outcomes

Plastic neutrality needs to have a visible and real impact on the environment. This needs to be defined around increasing the recycling rates of plastics while reducing environmental pollution. There will need to be the aspiration that plastic should be optimized for recycling to avoid the wider environmental impacts of wasted materials, recovery for energy, additional extraction of fossil fuels and adding to the carbon burden of the Earth.

A regulated approach to balancing the opportunities

Monitoring of the material flow will require an audit and declaration approach that is currently not widely accepted, although schemes exist for carbon[18].

Plastic neutrality would help drive the materials market for regulatory instruments such as Extended Producer Responsibility and, by creating demand, help to grow ready markets for post-consumer and industrial/commercial plastics, and generate the opportunity to exceed minimum recyclate targets.

The role of offsetting

For plastic neutrality to be supportable, offsetting cannot be the only or main means of reducing plastic pollution or increasing recycling, but there could be a place for offsetting as part of the mission. In this example, a business can offset its unavoidable plastic consumption by reducing plastic pollution elsewhere, through a registered offsetting scheme. The scheme should also involve that business committing to a programme of plastic reduction. However, the offsetting schemes already advertised online need to be able to demonstrate how offsetting uplifts others, and incentivizes the individuals and companies paying for it to move towards true neutrality within the bounds of their system. Clear limits for offsetting will be needed in order to stop abuse of the system. However, of concern are the already marketed schemes developed to offset plastic consumption[19,20], with removals elsewhere from the planet.

Are there exceptions?

Separate consideration will be needed for hazardous plastic waste from medical and industrial sources as well as waste that has a risk of infectivity, such as category 1 catering waste. In general, these wastes are either processed via deep landfill or taken for energy recovery from waste. However, there is a need for these wastes to be assessed for their ability to be processed, their plastic components removed, and their design rethought when possible in order to enable efficient component separation and recycling. Use of waste separation systems and treatments such as autoclaving could be readily applied to achieve polymer recovery.

Plastic neutrality could be the right approach to describe the outcome of a circular plastic economy.

The above points aim to create a stakeholder discussion in order to aid development and transformation of the current linear thinking to a more focused system approach at the global scale, by reducing growth in plastic production, and through better stewardship at national to local scales.

The challenges within these waste streams should not withhold the ambition to drive the recycling of plastic as high as possible for the vast majority of plastics in use, so as to sustain value and material flow.

Mechanical recycling systems have so far failed to achieve the levels and quality of recycling needed to make this viable. However, this deficit in recycling is the ideal technology 'pull' towards other recycling sectors such as chemical recycling, which has the potential to develop polymer recycling at scale and generate feedstock that is very flexible for the market and the products needed.

Plastic neutrality looks not only to optimize the management of the current inflows and outflows of plastics, but also to incentivize and encourage the capture of plastic already lost to the waste stream, such as landfill and plastic at sea, so as to achieve the highest possible recycling rate of around 85 to 100 per cent.

Above all, plastic neutrality seeks to be a unifying, aspirational and achievable outcome that focuses on reducing the growth of the consumption of virgin fossil fuel-based plastic, and engages stakeholders at all levels and sectors to make the plastic economy sustainable for the long term. Advanced chemical recycling processes such as Mura's Cat-HTR™ will need to be at the heart of this ambition, if this is to be achieved and the global ocean is to be better protected.

Predicting weather, climate and ocean hazards through sustained ocean observations

Indonesian Agency for Metorology, Climatology and Geophysics

The Earth's proportions of land and sea are reflected in miniature in Indonesia — an archipelago whose surrounding waters amount to approximately 70 per cent of the total area under its jurisdiction. The country also has the third longest coastline in the world — nearly 100,000 km — as well as over 17,000 islands.

As an archipelagic country located on the equator, Indonesia is strongly influenced by the relationship between ocean and atmosphere, and is home to the most significant climate drivers in the tropics. The country is also the centre of global multi-scale interactions involving global mean circulation and a wide range of phenomena including strong convective activities, encompassing various timescales such as diurnal, synoptic, intra-seasonal, seasonal, inter-annual, decadal, and longer periods. The interaction has a profound impact on the state of the Pacific and Indian Oceans as well as on air-sea thermal exchanges, thus modulating climate variability over a wide range of time scales.

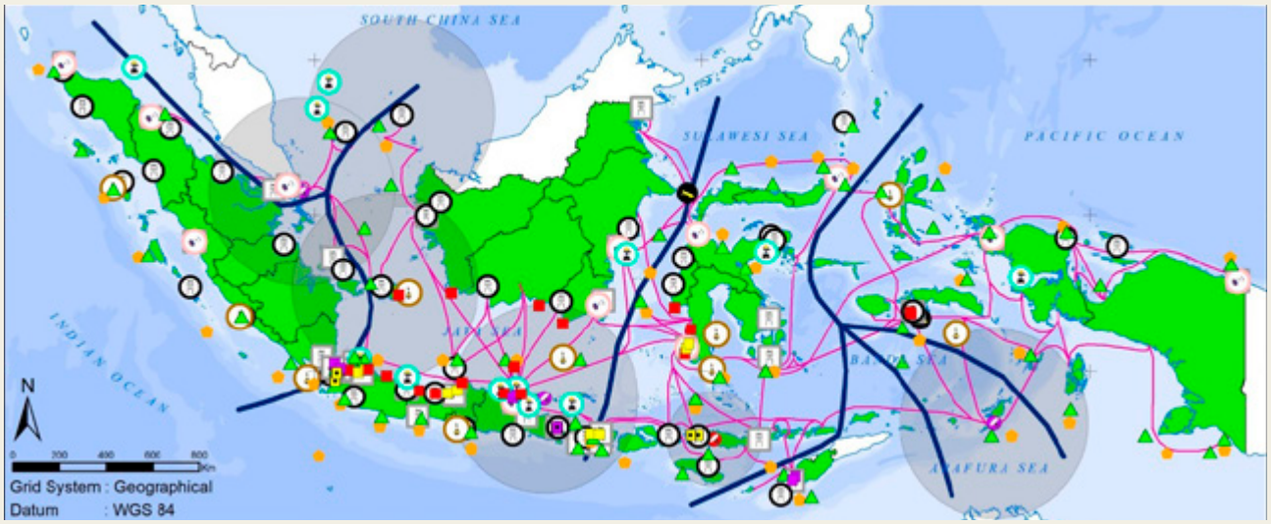
Some major climate phenomena, such as the Indian Ocean Dipole (IOD), Indonesian Throughflow (ITF) and Madden-Julian Oscillation (MJO), arise and develop in the Indonesian archipelago. The IOD, which is one of the dominant modes of interannual variability in the Indian Ocean, is characterized by the cooling anomaly of sea surface temperature over south-west Sumatra-Indonesia. The ITF has an important role in channelling the water mass of the Pacific Ocean to the Indian Ocean through Makassar, Lombok and Timor strait. The strongest intraseasonal variability in the tropic is the MJO, which propagates from the Indian to the Pacific Ocean, always passing over the maritime continent.

Even though all of those phenomena occur within Indonesia, the impacts are experienced further afield. For example, the recent IOD that retreated at the end of 2019, besides affecting the late onset of the rainy season in Indonesia, also caused severe drought and huge bushfires in Australia. Similarly, even though the ITF occurs in Indonesia, it plays an important role in global ocean dynamics because it transports water from the western equatorial Pacific Ocean, which is relatively warm and has lower salinity, to the Indian Ocean. When the throughflow enters the Indian Ocean it is advected towards Africa within the Indian South Equatorial Current. There it eventually exits the Indian Ocean through the Agulhas Current, around South Africa and into the Atlantic Ocean. So the ITF transports a significant amount of Pacific Ocean heat into the south-west Indian Ocean — approximately 8,800 km from Indonesia.

Conversely, Indonesia is one of the most disaster-prone countries in the world, regularly experiencing earthquakes, tsunamis, landslides, flooding, storm surges and sea level rises. Spread across 6,000 inhabited islands, communities in Indonesia face numerous hazards, as well as differing levels of disaster response capacity, posing a challenge to preparing for and responding to disasters. Poverty, population growth and rapid urbanization exacerbate these vulnerabilities, along with climate change and the resulting changes in rainfall patterns, storm severity and sea level. Based on The United Nations Office for Disaster Risk Reduction (UNISDR), the Indonesia Coastal Flood Hazard is classified as Medium, according to information currently available. This means that there is more than a 20 per cent chance of potentially damaging coastal flood waves occurring in the next 10 years. Based on this information, the impact of coastal flooding should be considered over various phases of any project for activity located near the coast. Generally, coastal flood in Indonesia, caused by the combination of rising sea levels, high tide and land subsidence, will move the coastline inland, further increasing the risk of flooding. A study published in 2007 by Indonesia's Institute for Technology in Bandung illustrated that the total area of north Jakarta affected by inundation in the year 2050 would be about 40, 45, and 90 km^2, given a sea level rise of 0.25, 0.57, and 1.00 cm per year.[1] If land subsidence continues, these sea level rises are expected to increase.

Over the past few years, storm surges caused by wave propagation from remote areas have inundated Indonesia's low lying areas such as southern Java and western Sumatra. For example, the storm tide of 7th to 8th June, 2016 resulted from the combination of a spring tide and the propagation of a high swell generated from an extra tropical cyclone in the southern Indian ocean. According to data from the National Agency for Disaster Management (BNPB), 23 cities in Java and Bali were hit by the that particular storm tide. Hundreds of buildings, including houses, gazebos, stalls, beach embankments and beach constructions were damaged. The same storm tide also hit the apron area of Ngurah Rai International Airport, Bali, while 15 coastal tourist areas on the south coast of Yogyakarta suffered damage from waves as high as five to seven metres. In the coastal tourist area of

Marine Meteorology Observation Network over the maritime continent — existing and planned



Administrative Region of Indonesia
National Boundary
Provincial Boundary
Coastal line
Line of ALKI
Coverage of Radar

Ocean Observation Plan:

HF Radar 5 MHz (9 pairs)
HF Radar 13 MHz (4 pairs)
HF Radar 25 MHz (3 pairs)
Drifter (60)
Float (40)
Wave Recorder (12)
Coastal Buoy (10)
AOCP (12)
Marine AWS (40)
Surface Glider (2)
Sub-surface Glider (3)
Radar S-band (4)
Radar C-Band (1)
Track of Vessel AWS (30 Ships)

Ocean Observation Existing:

HF Radar 13 MHz (2 pairs)
HF Radar 25 MHz (1 pair)
Marine AWS (35)
ADCP (5)

Data Source: Map of Administrative Region (Badan Informasi Geospasial). Location plan of ocean observation during STR2. Line of ALKI (Alur Laut Kepulauan Indonesia). Existing location of ocean observation

Gunung Kidul and in Kulon Progo, both on the south coast of Java, much collateral damage was done. BNPB estimated the economic losses from the disaster to have reached many millions of dollars.

Technological development

The Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) is tasked to supply information on weather and climate prediction in Indonesia, including maritime weather. In 2016, the agency established the BMKG Ocean Forecast System (BMKG-OFS) to improve the supply of information on marine meteorology.

Designed especially for Indonesian seas, the BMKG-OFS is a modelling system based on meteorology and oceanography, and is used to support forecast information. Its main purpose is to provide accurate meteorological ocean analysis and prediction. BMKG-OFS is a part of the BMKG Meteorological Early Warning System, established to provide a 10-day forecast on wind, waves, swell, currents, sea temperature, salinity, tide, sea level, trajectory and coastal inundation. The BMKG-OFS was also developed to fulfil community needs in various sectors such as sea transportation, fisheries, mining, energy, marine tourism, industry, search and rescue, maritime services, small island area resources, and research. BMKG-OFS consists of three primary components — an ocean wave model (INAWaves), an ocean circulation model (INAFlows), and an ocean dynamic and drifting model (INACIFS and INADrift).

INAWaves has been developed to improve the performance of BMKG's previous wave model, Windwaves-05, that used a Limited Area Model and is therefore not optimized to predict waves and swell in open seas. InaWaves is based on the global wave model, Wavewatch III, that can compute waves based on spectrum energy evolution in 2D, as a function of direction and frequency. The result is the utilization of wave parameters such as significant wave height, mean period, peak period, mean direction, and direction of peak waves.

INAFlows is built to meet the needs of the marine community for information on ocean circulation such as ocean currents, sea temperatures and salinity from the surface to a depth of 250 m. The technology is based on the Finite Volume Community Ocean Model (FVCOM), which is computation software for fluid dynamics applied to geophysical flow in coastal regions. FVCOM has been developed using an unstructured grid that is suitable for analyzing the flow of oceans in coastal regions, archipelagos and estuaries.

The Indonesia Coastal Inundation Forecasting System (INACIFS) has been developed using locations in Jakarta and Semarang to pilot the project. The technology uses Delft3D modelling to simulate hydrodynamic parameters, waves, storm surges and inundation. Data on atmospheric forcing was supplied by the European Centre for Medium-Range Weather Forecasts (ECMWF), wave data was obtained from INAWaves, and data on tidal forcing from the Indonesia Geospatial Information System was used as the astronomical component.

INADrift is an oil spill and trajectory object monitoring system based on the particle tracking model, MEDSLIK-II, which was originally developed by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The purpose of the INADrift BMKG model is to support fast and accurate decision making concerning accidental release of crude oil from tankers, offshore platforms and drilling rigs. INADrift can also be used to predict the distribution and trajectory of objects at sea in support of search and rescue.

Yet, with all of these systems in place, no significant observations of the sea have yet been made for operational purposes in order to validate the models or assimilate the data into the models to improve the process of prediction. It is therefore important for Indonesia to emphasize the significance of ocean observation, to better understand the processes and the predictability of meteorological and oceanographic phenomena. However, there is now an increase in maritime activities in accordance with the work plan of the Government of Indonesia, with a focus on developing integrated ocean observations and analysis to fulfil the requirements of more accurate weather and climate prediction. Between 2020 and 2025, Indonesia will enhance and modernize its meteorological and oceanic observations, conducting continuous, real-time data monitoring while processing the data using an integrated system.

In order to ensure that BMKG's stakeholders, including fishermen, can access marine weather information, the agency provides that information through its website, Android application, Twitter, BMKG's local station, local radio, and at major transportation and fishing ports — especially at fish landing sites where fishermen meet the buyers.

Fishermen need guidance-related weather, sea state and fishing ground information to support their fishing activities. Since 2015, BMKG has been running a weather and climate field school for fishermen. The agency also collaborates with the Indonesian Ministry of Marine Affairs and Fisheries to enhance fishermen's knowledge and awareness of met-ocean parameters, extreme weather, fishing grounds, and climate change adaptation. To that end, BMKG has so far reached over 1,000 people comprising extension workers and fishermen with the ambition to change the mindset from "seeking" to "catching".

Enhancing and modernizing meteorological and oceanic observations on the maritime continent

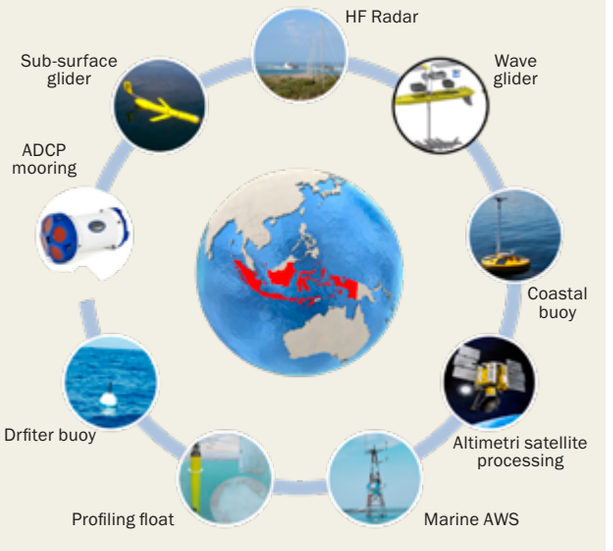


Image: Indonesian Agency for Metorology, Climatology and Geophysics

BMKG's automatic weather station installed on commercial vessels

Image: Indonesian Agency for Metorology, Climatology and Geophysics

Progress and challenges in marine plastics pollution

Jennifer L. Lavers, Lecturer in Marine Science, Institute for Marine and Antarctic Studies, University of Tasmania; Alexander L. Bond, Senior Curator, Bird Group, Department of Life Sciences, The Natural History Museum, UK

Pollution of aquatic and terrestrial environments with plastic debris is rapidly becoming one of the most urgent, and widespread, environmental threats, acting as a lightning rod for community engagement and advocacy. Despite growing awareness of this issue, governments and industry continue to invest in plastics manufacturing, through increased production and financial subsidies, which contributes to this increasing problem. However, demand for many of these products stems from individual reliance on single-use items, relentless marketing, plastic packaging that is practically unavoidable, and a lack of understanding of appropriate waste management. Clearly, sustainable development will not be achieved without industry transformation, but addressing the needs and behaviours of individuals is also a key factor.

Tackling the plastics crisis requires a detailed understanding of the scope and severity of the issue so that we can measure progress relative to our goals. The first sub-goal of SDG 14 is "By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution". Community science has proven successful at gathering various types of plastics data, such as the type and its origin, over large temporal and spatial scales. For example, the Australian Marine Debris Initiative (AMDI) database houses over 13 million records of debris abundance, with data contributed by more than 2,000 community scientists over the past 15 years. Thanks to these data, we can try to understand the effectiveness of key international policies, such as MARPOL Annex V, which are tasked with preventing debris from

Image: Emma Washer, Big Barge Art Co.

Plastic debris found on the Cocos (Keeling) Islands' beaches is used to create artefacts, which are sold at the Islands' Big Barge art centre

Image: Ian Hutton, Lord Howe Island

Volunteers counting plastic on the forest floor of a shearwater breeding colony on Lord Howe Island

entering our oceans, and suggest substantial improvements to strengthen and enforce our commitments to international environmental policies.

While there are several existing regional and national strategies aimed at preventing and mitigating plastic pollution, such as prohibiting plastic microbeads in cosmetic products, many are voluntary or contain no binding commitments, and few exist at the international level. Even for legislation with set reduction targets, enforcement and compliance are often hampered by a chronic lack of resources. Together, this has created the 'perfect storm' where current legislation fails to keep pace with the rapid acceleration and global magnitude of the plastics problem due to limited resources to ensure compliance and a lack of meaningful commitments. This is in stark contrast to other forms of pollution, such as persistent organic pollutants, which are the focus of an international treaty — the Stockholm Convention — that restricts the production and use of compounds.

Like many atmospheric contaminants, ocean plastics move freely via currents and are not constrained by national boundaries. More than 50 per cent of the oceans' area is classed as international waters, including the infamous 'garbage patches' where up to 396,000 plastic items/m^2 have been reported. Much of this debris accumulates in vast quantities on beaches, such as those of the uninhabited Henderson Island in the remote South Pacific Ocean or Inaccessible Island in the South Atlantic. Individual debris items on these beaches originated from myriad sources, including commercial fishing and shipping, and countries from the other side of the world, making it difficult to identify a single, effective solution. But, this is true for countless locations around the globe where debris washes up from a multitude of sources. Locations like Henderson highlight how addressing the plastics issue will involve tackling challenges that occur on a grand scale. Successful approaches must carefully consider a range of industries or sources, and both external and local expertise to ensure cooperation across regions.

At the local level, beach clean-ups are a common tool for removing accumulated debris due to their relatively low cost and added values, such as waste education and involvement in community science activities such as AMDI. However, governments and other agencies have recently been criticized for relying on volunteers for clean-ups as this places a lower value on the contribution that individuals make.

Lord Howe Island, Australia

On Lord Howe Island, community support for initiatives — such as imposing a strict cap on the number of hotel beds — has ensured that tourism doesn't overwhelm infrastructure and impact on sensitive habitats for which the island is renowned. Despite being located 600 km offshore of eastern Australia, Lord Howe has become a leader in small island waste management[1], with composting facilities as well as glass, cardboard and aluminium recycling and a small second-hand shop for household goods.

Numerous small changes have been implemented with pride to help the island obtain eco-certification status. For example, butter is served in porcelain dishes (not single-use wrappers or containers), local cafes have only paper straws, and all grocery stores are free from plastic bags.

Image: Ian Hutton, Lord Howe Island

Recyclable metal compacted on Lord Howe Island

Image: Ian Hutton, Lord Howe Island

Image: Ian Hutton, Lord Howe Island

University students on a field course (top) examining beach debris at the Lord Howe Island Museum, and (above) searching the beach for microplastics

Recent data also suggest that clean-up events are unlikely to generate long-lasting benefits for wildlife, aesthetics or economy, i.e. less visible plastic on tourist beaches. For example, on Henderson Island, at least 3,500 new debris items are estimated to wash up on the beaches every day, rendering clean-up efforts ineffective, especially in remote regions where the logistical costs can be prohibitive. Plastics found on remote beaches away from traditional recycling facilities also have a transport cost if they are to re-enter the waste stream. Local or national regulations may also prohibit outside waste from entering municipal recycling programmes, particularly in high volumes such as those generated by beach clean-ups. However laudable, beach clean-ups are a poor mitigation measure at the global scale required to tackle plastic pollution, and progress will only be made when dependency on plastics can be reduced.

Changing individual behaviour towards plastics by altering consumption patterns can be difficult, especially in small communities, or remote areas, where access to infrastructure and other resources such as education and alternative products can be limited. Alternative products with less plastic may also have environmental costs in other areas, such as manufacture or transport, and may be more expensive than a plastic equivalent. Despite these hurdles, some of the most inspiring stories of individual and community leadership in waste prevention and education often originate on remote islands and in developing nations where isolation drives innovation, resourcefulness, and creativity.

Image: Silke Stuckenbrock, Two Hands Project

A water bottle filling station on Lord Howe Island

Image: Kylie James, Cocos Adventure Tours

Tourists record community science data on the type of beach-washed fishing nets on the Cocos (Keeling) Islands during a Cocos Adventure Tour

The problem of plastic pollution is daunting, seemingly intractable, and often overwhelming — plastics are everywhere — and despite the rapid rise in its public profile, there is still much about the problem that we do not know, ranging from its impacts to its sources, and ultimately its sustainable solutions. These challenges are felt acutely in remote island communities, such as Lord Howe Island in the Tasman Sea, and Cocos Islands in the Indian Ocean, where communities have implemented their own solutions, whether the goal is to reduce plastics used by the communities themselves, like on Lord Howe, or to increase education and highlight the interconnectedness of the global problem, such as on Cocos.

Unlike many other pollutants, plastics are not a single type of product or compound, originating from countless sources ranging from diverse heavy industry and commercial operations to households. Their ubiquity is unparalleled, with production increasing exponentially, but they are also easily visible, and a catalyst for community environmental movements. Solving the plastic pollution problem will require diverse solutions from diverse communities and stakeholders, and will not always be easy, but a sustainable future depends on it.

Cocos (Keeling) Islands, Australia

The Cocos (Keeling) Islands comprise a low-lying atoll of 26 islands in the Indian Ocean. Characterized by palm trees, turquoise waters, and nearly 30,000 nesting sea turtles, Cocos is the perfect postcard destination for holidaymakers.

Recently, Cocos has also become known for the inundation of its beaches with more than 414 million items of plastic debris. It can be imagined that a tour operator on Cocos would take guests to pristine beaches where the beauty of the islands is on display. But, remarkably, that is not always the case, with local tour operators choosing instead to highlight the plastics problem by incorporating the debris into their tour activities.

On a kayak adventure tour, guests are taken to a debris accumulation zone where they can participate in a clean-up and engage in conversation about the origin of the debris and what they can do at home to make a difference. Debris items collected by tourists during the clean-up — or during morning beach sunrise walks — can then contribute to community science data such as AMDI as well as be incorporated into hand-made artworks as part of the courses offered by one of the many local artists-in-residence on Cocos. The two activities, debris kayak tour and debris art-making, are enormously popular with tourists and are evidence of islanders responding positively to their site-specific challenges.

Monitoring of the ocean acidification crisis, and intervention to combat climate change through adaptation of coral reefs

Dr. Nobuko Nakamura, Research Fellow; Dr. Atsushi Watanabe, Senior Research Fellow,
The Ocean Policy Research Institute of the Sasakawa Peace Foundation

Dubbed by some researchers as the evil twin of climate change, ocean acidification (OA) is expected to have an unfavourable impact on calcifying organisms such as molluscs and reef-building corals. Coral reefs are seriously threatened by climate change, especially by warming, such that recovery intervention options should be pursued in tandem with mitigation measures. Such challenges are prevalent around Japan and the Pacific islands.

Ocean acidification is a result of increasing CO_2 in the atmosphere, and is most pronounced where temperatures are lowest, such as in the polar regions, or where CO_2-rich water is brought to the ocean surface by upwelling.[1] Acidification can also be influenced by the presence of effluent from natural or disturbed coastal land use[2], plankton blooms[3], and the atmospheric deposition of acidic materials[4]. These sources may not be directly attributable to climate change, but they may amplify the impacts of ocean acidification.[5]

Ocean acidification due to increased CO_2 has resulted in a 0.1 pH unit (hydrogen ion exponent) decrease since the pre-industrial period, representing a change unprecedented in the last 65 million years. At present, marine ecosystems, especially coral reefs and polar ecosystems, are at risk from acidification. Highly calcified molluscs, echinoderms and reef-building corals are more sensitive to environmental change than are crustaceans and fish. From the IPCC AR5 future prediction, the impacts on individual species and the number of species affected in species groups increase from RCP4.5 to RCP8.5.[6] Ocean acidification acts together with other global changes, for instance warming and progressively lower oxygen levels, and with local changes such as pollution and eutrophication, leading to interactive, complex and amplified impacts on species and ecosystems.[6]

Among measures to address these problems, the establishment and cooperation of international monitoring networks are being promoted. Also, in each country, integrated coastal management (ICM) and the mitigation of greenhouse gas emissions are being called for. At the same time, promotion of public awareness about ocean acidification is important.

International network for ocean acidification monitoring

IAEA Ocean Acidification International Coordination Center (OA-ICC)

The International Ocean Carbon Coordination Project (IOCCP)

European Project on Ocean Acidification (EPOCA)

IOC-UNESCO Global Ocean Observing System (GOOS)

Global Ocean Acidification Observation Network (GOA-ON) (Around Pacific Region)

The North Pacific Marine Science Organization (PICES)

IOC-UNESCO Sub-Commission for the Western Pacific (WESTPAC)

Pacific Islands & Territories Ocean Acidification(PI-TOA) Network

New Zealand Ocean Acidification Observing Network (NZOA-ON)

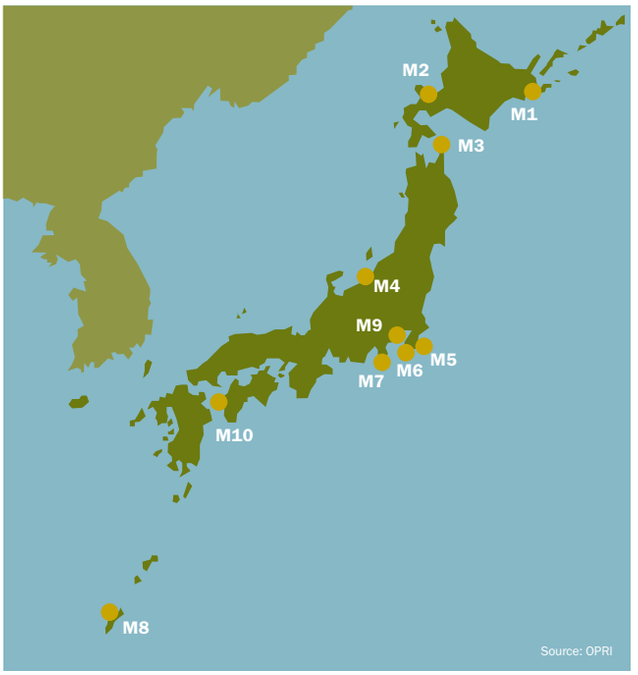
The Japanese case

As a member of The North Pacific Marine Science Organization (PICES), Japan is contributing to summarizing information on the present status of pH measurement among Pacific countries, including methods of measurement and calibration that vary with each monitoring environment, making comparison difficult.

In Japan several investigators have voluntarily convened a Japan Ocean Acidification Network (JOAN) as a platform for information exchange and collaboration in measurement and analysis. Information from 10 coastal monitoring sites is currently reported to PICES, with several stations having been incorporated into the global Ocean Acidification Observing Network (GOA-ON).[7]

Using water quality data collected at 289 monitoring sites in Japan between 1978 and 2009 as part of the Water Pollution Control Programme, the long-term trends of in-situ pH in the coastal seawater were evaluated at ambient temperature. It was found that the annual maximum in-situ pH had decreased at 75 per cent of the sites but increased at the remaining 25 per cent. Nevertheless, it is thought that the ICM concerning anthropogenic eutrophication around the coastal landscape has high potential to regulate coastal acidification.[8]

However, ocean acidification cannot be evaluated simply by pH value as shown by the carbonate equilibrium in the ocean. Another parameter of carbonate chemistry concern-



Monitoring stations maintained by members of the Japan Ocean Acidification Network

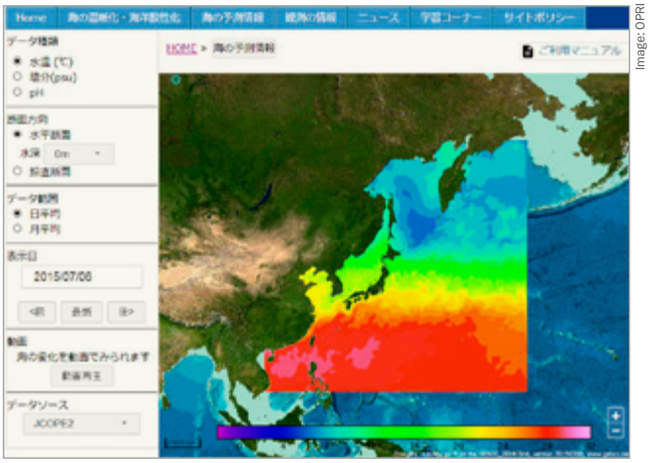


Image: OPRI

The OPRI website: Marine Crisis Watch[9]

ing alkalinity, total inorganic carbon and CO_2 is necessary to take into account, although those values cannot be easily measured by electrodes. For instance, alkalinity directly shows a decrease in a carbonate saturation state, and thus a continuous autonomous measurement system deployable to buoys is strongly awaited.

In 2018, the third version of Japan's Basic Act on Ocean Policy was revised and a measure concerning ocean acidification was included. In 2017, the Ocean Policy Research Institute (OPRI) of the Sasakawa Peace Foundation offered policymakers a proposal on combating ocean warming and acidification, using a fact sheet based on scientific evidence. OPRI also continues to host international symposiums on ocean acidification, with the aim of connecting scientists and stakeholders through dialogue.

Ocean acidification is an issue that must be made public, with school children instructed to understand its serious consequences. A fundamental literacy in seawater carbonate chemistry is necessary to ensure full appreciation of the possible futures. For instance, OPRI was given the opportunity to deliver special lectures on ocean acidification and carbonate chemistry at fisheries high schools in Japan. Students have been able to watch water quality tests in the field, with pH measurements taken with the help of researchers, demonstrating the importance of long-term monitoring.

To raise awareness of ocean warming and acidification among the general public, OPRI created a website "Marine Crisis Watch", providing an explanation of acidification along with pH data supplied from observations made in the ocean around Japan by the Meteorological Agency, Japan Agency for Marine-Earth Science and Technology, and universities. The website also gives future predictions of pH and saturation state data, simulated by JCOPE_EC and CMIP5 models. Recent news and educational content about ocean warming and acidification are also included on the site.

Furthering its educational mission, OPRI has translated and added Japanese subtitles to the animation "The other CO_2 problem" produced by The European Project on Ocean Acidification (EPOCA), with public high school students attempting to dub the film into Japanese. Using these materials, students are able to play various marine characters and consider the acidification problem through role-playing, making this good teaching material.

Image: OPRI

Image: OPRI

Special lectures on ocean acidification at a fisheries high school

Image: Google underwater street view

Coral Farming in Onna Village, Okinawa

Image: OPRI

Recovering green snails and giant clams in Vanuatu

Image: OPRI

Coral reefs and human intervention for sustainable use of resources

Global warming and ocean acidification both have serious negative impacts on coral reefs, with warming having already caused repeated bleaching of reefs around the world. IPCC's special report, *Global Warming of 1.5°C*, warned that coral reefs are projected to decline by a further 70–90 per cent at 1.5°C warming above preindustrial levels, with larger losses (>99 per cent) at 2°C with high confidence.[10] Small-scale fisheries in tropical regions are expected to face growing risks at 1.5°C of warming because of loss of habitat associated with coral reefs. The reefs are major sources of food and livelihoods for tropical coastal communities, thus deterioration of the reef environments will require these communities to take adaptation options such as the diversification of livelihoods and the development of new sustainable industries to reduce the dependency on coral reefs.[11]

We will need to take proactive and transformative actions to reduce CO_2 emissions to achieve the Paris Agreement and stabilize warming below 1.5°C but, in parallel, we need to pursue recovery intervention options[12] such as reproduction and recruitment enhancement and adaptation support alongside conventional management efforts. The Ocean Policy Research Institute (OPRI) of the Sasakawa Peace Foundation has paid great attention to a coral reef restoration programme in Onna Village in Okinawa Prefecture. OPRI has also assessed a community based coastal resource management project conducted in Vanuatu by the Japan International Cooperation Agency (JICA).

Coral reef farming and multi-stakeholder engagement in Onna Village, Okinawa

Onna Village, Okinawa, in the southern part of Japan attracts many domestic and international tourists because of the beach resorts and many large hotels. Aquaculture and the processing of seaweeds such as Sea Cavier (*Caulerpa lentillifera)*, Mozuku (*Cladosiphon okamuranus TOKIDA)*, Ito-Mozuku (*Nemacystus decipiens)*, and Hitoegusa (*Monostroma latissimum*) has generated large incomes for local communities. However, corals in Onna Village were seriously damaged by bleaching in 1998 and again in 2001. In 1998, the local fishermen began to plant corals mounted on metal supports (the

pole-culture method)[13], the same method used for seaweed cultures, and continued the activity for 20 years, creating a unique underwater seascape. Farmed coral colonies began mass-spawning in 2013, and a local university, the Okinawa Institute of Science and Technology, has confirmed that the genetic diversity of farmed coral is as high as wild coral.[14]

The coral restoration activities have been joined by multiple stakeholders such as divers, schoolchildren, farmers and seaweed consumers. Mozuku seaweed is sold nationwide through a consumer cooperative, and approximately 1 per cent of the revenue is transferred to a Mozuku fund which is used for coral restoration activities such as coral outplanting, eradication of coral-eating seastars, and preventive measures for soil runoff which damages corals. Divers, tourists and schoolchildren also participate in the coral planting activities. This multi-stakeholder engagement in coral restoration activities contributes to a forward-looking attitude within the community, with Onna Village announcing in 2018 that it had become the first coral village in Japan.

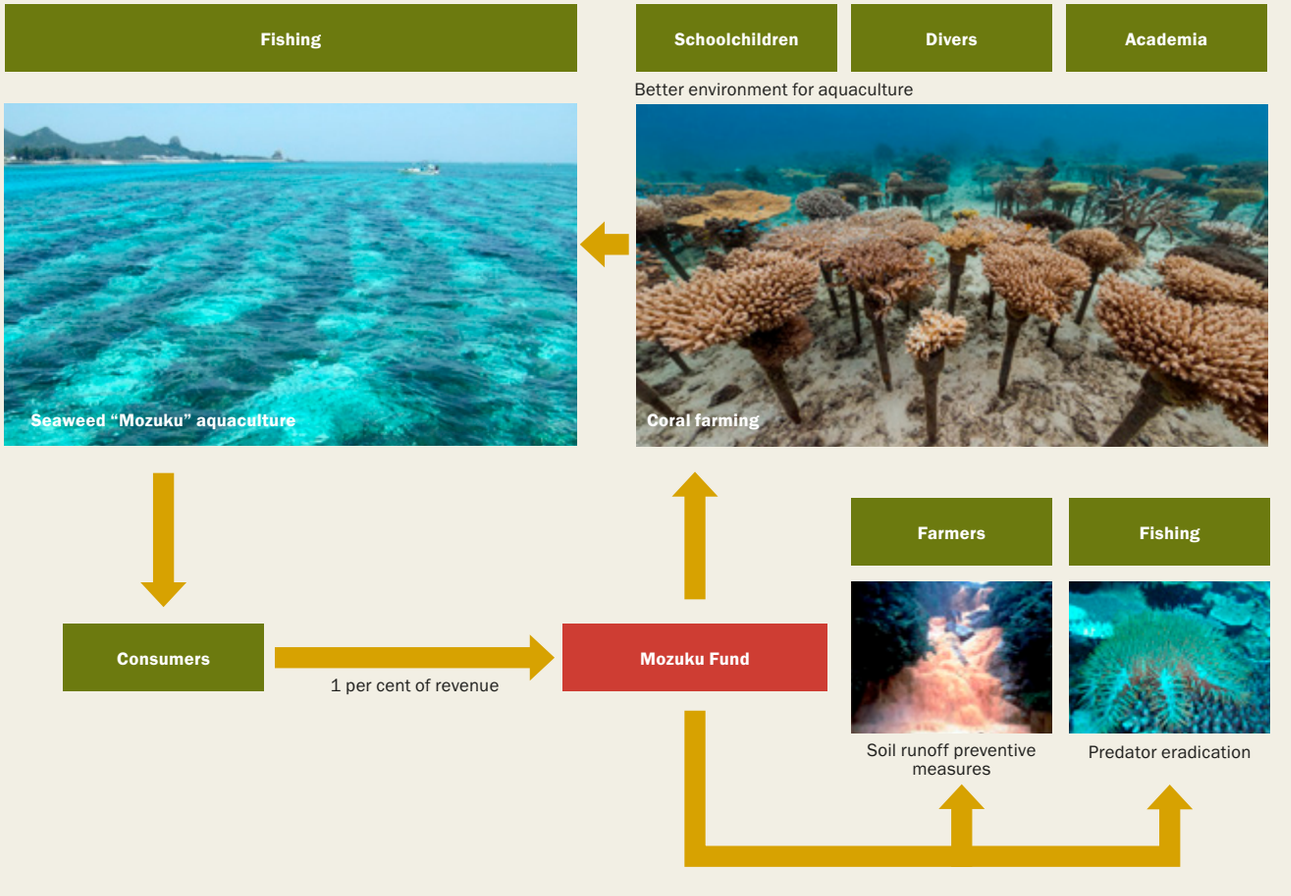
Vanuatu community-based shellfish resource management

In Vanuatu, South Pacific, JICA has been conducting a community-based coastal resource management project since 2006, aiming to recover the prevalence of coral-dwelling shellfish. At Mangaliliu, Efate Island, the numbers of green snails (*Turbo marmoratus*) were heavily depleted due to overfishing, but snails have now been brought from Aneityum Island in the southern area of Vanuatu, where the resource was maintained, thus ensuring future protection. Now the species reproduces in the coastal area adjacent to the community of Mangaliliu, and several generations co-exist.[15] The Vanuatu Government banned the harvesting and sale of green snail shells and meat for 15 years from 2005–2020, which has also contributed to the recovery of the resources.

Also, giant clams (*Tridacna gigas*) were previously depleted in the area but specimens were brought in from Tonga in 2007 and are now growing to a healthy size, and have also begun to reproduce near to the coast, attracting tourists. The visible recovery of these sessile shellfish offers the local people clear evidence of their achievements, motivating them to continue their ecologically-focused activities. The local women in the village have learned how to carve the shells and produce saleable handicrafts, with new livelihoods expected to be created as a result.

JICA's expectation of the Vanuatu project is that it will continue for some time, with positive results becoming evident relatively slowly, although the local people already regard the project as practical and worthwhile. It is expected that the initiative will expand to other Melanesian and Pacific Island states.

Coral restoration multi-stakeholder engagement in Onna Village, Okinawa



Managing New Zealand's marine estate

Barbara Hayden, Chief Scientist Coasts and Oceans,
National Institute of Water and Atmospheric Research Ltd (NIWA), New Zealand

In common law, the term 'estate' refers to a person's property, entitlements and obligations. 'Marine estate' can be similarly used to refer to marine property that contains natural resources and, in the case of New Zealand, resources that the population is entitled to use, and over which it has obligations of care and stewardship on behalf of future generations.

Although New Zealand is a relatively small South Pacific island nation, its marine estate is vast and complex, comprising a Territorial Sea extending 12 NM from the coast; the world's fifth largest Exclusive Economic Zone (EEZ) extending out to 200 NM; the recently accepted extension to New Zealand's legal continental shelf (ECS); and the Ross Sea Dependency over which New Zealand has entitlements. Totalling 5.7 million km^2, the area of the marine estate is more than 22 times larger than the country's land area.

Not only is the maritime region large, it has a complex seabed and diverse range of habitats, is influenced by major ocean currents and riverine inputs, and supports a globally unique and diverse biota. It contains vast natural capital including oil, gas, mineral and energy resources, and wild fisheries.

New Zealand's coastline is approximately 15,000 km long — equivalent to more than a third of the circumference of the earth — and comprises beaches, tidal inlets, river mouths, harbours, lagoons, fiords and open coasts.

Deeply embedded in these diverse biophysical features and economic assets are the cultural, spiritual and recreational values associated with the sea by New Zealand's population, 75 per cent of which lives within 10 km of the coast and 16.5 per cent of which identifies as Māori.

Māori and the sea

Māori, the tangata whenua or indigenous people of New Zealand (Aotearoa), are understood to have arrived from eastern Polynesia in the 13th century. Europeans arrived much later and in 1840, New Zealand's foundation document, Te Tiriti o Waitangi (the Treaty of Waitangi), was signed by representatives of the British Crown and Māori chiefs acting on behalf of their hapū (subtribes). The Treaty confirmed formal European settlement in New Zealand, but language barriers meant that the two parties had different understandings and expectations as to what they had signed and what authority they would exercise. Unfortunately, what followed was years of legislation- and policy-driven systemic colonization including the taking of Māori land and resources, and continual Māori protests at treaty violations. Then in 1975, the Waitangi Tribunal was established under a new Act of Parliament. The Tribunal is a permanent commission of inquiry that makes recommendations on claims brought by Māori relating to Crown actions that breach the promises made in the Treaty.

Among many other important decisions, the Tribunal introduced a set of principles that embody the intention of both Government and Māori in an attempt to mediate the differences in the two Treaty interpretations. The three "Ps", as they are often called, involve working together to develop management strategies (Partnership), positive Māori involvement at all levels (Participation), and active protection of Māori knowledge, interests, values and other tāonga

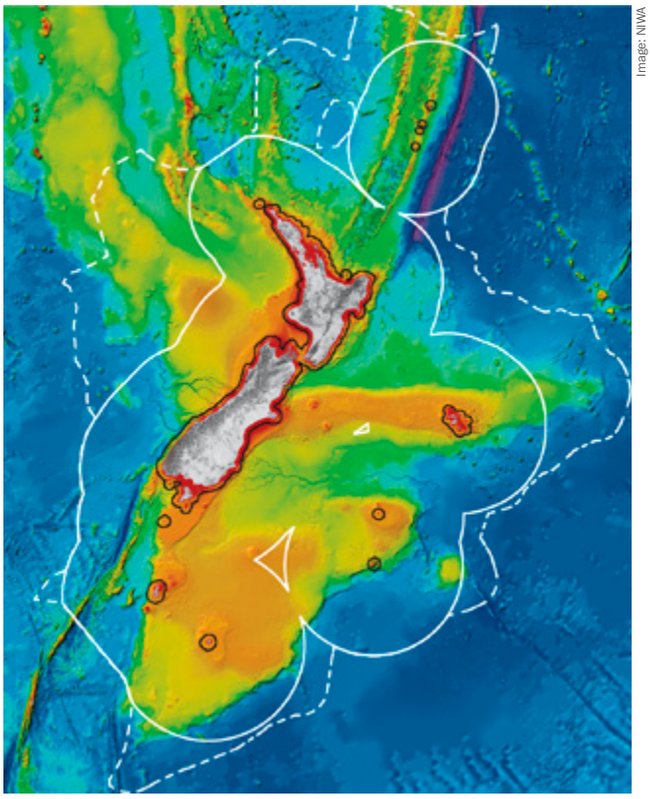


Image: NIWA

New Zealand's marine estate includes the Territorial Sea (black line) extending 12 NM from the coast, and the Exclusive Economic Zone (EEZ) (solid white line) covering those areas of the sea, seabed and subsoil that lie between 12 NM and 200 NM from the coast. Most of the continental shelf (CS) seabed and subsoil overlaps the EEZ. The recently accepted extension to New Zealand's legal continental shelf (dashed white line) includes those parts of the CS that extend beyond the 200 NM limit of the EEZ

Image: Barbara Hayden

New Zealand's extensive coastal waters and estuaries provide valuable goods such as seafood and minerals as well as ecosystem services, many recreational opportunities and spiritual sustenance for all New Zealanders

or treasured things such as the Māori language (Protection). Importantly, public policy must now give expression to these principles of the Treaty and government agencies must now be culturally responsive to the aspirations of the Māori. The tribunal process is not perfect, but it has provided the context for some innovative co-governance mechanisms to be developed, including the effective management of natural resources, and many constructive relationships established between iwi (tribes) and government agencies. Māori have very strong connections to the sea. Today, it is not possible to consider how best to manage activities in the marine estate without recognizing the values and aspirations of iwi, hapū, whānau (families) and Māori communities, particularly those whose rohe (tribal territory) is adjacent to the coast.

Strategies for managing activities in the marine estate

How then is such a complex marine estate best managed? The main article of legislation that sets out how the environment should be managed is the Resource Management Act 1991 (RMA) and regulations under that Act.[1] The RMA is based on the principle of sustainable management and involves considering effects of activities on the environment now and in the future when making resource management decisions. It covers air, soil, fresh water and coastal marine areas from the coastline to 12 NM offshore (New Zealand's Territorial Sea).

The RMA ensures that New Zealand's natural and physical resources are managed in a sustainable framework, with a raft of environmental bottom-lines. It includes items such as restrictions on the use of the coastal marine area; restrictions on aquaculture activities in the coastal marine area and on other activities in aquaculture management areas; discharge of contaminants into the environment; dumping and incineration of waste or other matter in coastal marine areas; discharge of harmful substances from ships or offshore installations; adverse effects assessments; and the required duty to avoid, remedy or mitigate adverse effects.

While the RMA provides an overarching guide to what is deemed best for the environment, with national direction on significant issues, it allows communities to make decisions on how their own environment is managed through regional and district resource management plans. Decisions on resource consents (e.g., to install a marine farm or built a jetty) are made with consideration to these plans, national direction and the objectives in the RMA. In some cases where there is uncertainty about potential effects of an activity, conditional consent to proceed may be given subject to monitoring in order to demonstrate that any effects are "no more than minor."

This framework means that most decisions on resource management, other than fisheries, in the coastal region are made by local government, which also has a wider planning role in related transport, infrastructure and economic development issues. The RMA also recognizes the Treaty of Waitangi in decision making.

The RMA jurisdiction covers only the area within 12 NM of the coast. How is the rest of the marine estate managed? Prior to 2012, the only activities in the EEZ and CS regulated for their environmental effects were fishing (under the Fisheries Act 1996)[2] and shipping (under the Maritime Transport Act 1994)[3]. Therefore, the EEZ and CS Environmental Effects Act ("the EEZ Act")[4] was developed in 2012 to address gaps in the management of New Zealand's marine environment not covered by the Fisheries Act, the Maritime Transport Act or the RMA.

The EEZ Act provides a management and decision making framework for managing the effects of activities in the EEZ and CS. The Ministry for the Environment is empowered to make regulations under the Act, including classifying activities as permitted, discretionary, or prohibited. Permitted activities can proceed, subject to compliance with any relevant conditions. Prohibited activities are effectively banned and no consent can be issued for them. Discretionary activities are subject to a marine consent application process, which is administered by the Environmental Protection Authority. Such activities also include matters of national, rather than merely regional, significance under the Resource Management Act.

The EEZ Act framework is largely based on the RMA framework but there are a number of significant differences. For example, the status of marine activities is defined in EEZ Act regulations with limited public involvement compared to the RMA, which requires a rigorous public process for its development.

The primary activities managed under the EEZ Act are those that relate to disturbance of the seabed and/or water column, including petroleum and mineral exploration and production, aquaculture, marine energy generation, and carbon capture and storage. Marine mammals and seabirds are protected under the Wildlife Act, 1953.

The sustainable management of fishing throughout New Zealand's territorial sea and EEZ is governed by the Fisheries Act 1996, the purpose of which includes sustainable use of fisheries resources. It also requires that three environmental principles be taken into account when management decisions are made. These are:

- Associated or dependent species should be maintained above a level that ensures their long-term viability
- Biological diversity of the aquatic environment should be maintained
- Habitats of particular significance for fisheries management should be protected.

Under the Act, fishing activity is categorized as either commercial, customary (non-commercial) or recreational. Most commercial fisheries are managed under New Zealand's quota management system (QMS), which has been lauded by several international fisheries science reviewers as the best in the world. The QMS requires the identification of fish stocks, which may include a single species or occasionally several similar species. A stock comprises the population of the species or species group within a defined quota management area (QMA). The boundaries of QMAs within the EEZ differ among species and are designed to facilitate the management of each stock. A single species may be managed as one, or up to ten stocks depending on the number of QMAs it is located within. Once a QMA is established, it can be changed only with the agreement of the owners of at least 75 per cent of the

Image: Nelson Boustead

Mussel and salmon farms in Hallam Cove, Marlborough Sounds. While the Resource Management Act provides an overarching guide on what is deemed best for the environment, it allows communities to make decisions on how their own environment is managed through regional and district resource management plans

Image: Tony Smith

Commercial oyster fishing in Foveaux Strait, New Zealand

affected quota, or if the Minister of Fisheries is satisfied that the change is necessary to ensure sustainability.

The Minister of Fisheries is required to set a total allowable catch (TAC) that can be taken by the combined commercial, customary and recreational fishing effort each year from specific stocks, while maintaining the stock's productive capacity as well as making an allowance for other sources of fishing-related mortality, including illegal fishing. The Minister is also required to set a total allowable commercial catch (TACC), specifying how much of the TAC can be harvested by commercial fishers. The Minister may also establish other sustainability measures such as restrictions on fishing methods, the size of fish taken, where and when fishing may be undertaken, and setting limits on fisheries-related mortality of marine mammals.

"Māori customary non-commercial fishing interests" are allowed for when the TACC is set, but the main mechanism for providing for such interests is through Customary Fishing Regulations under the Fisheries Act. These provide for Māori to manage "customary food gathering" through the appointment of kaitiaki (guardians) who can issue permits to authorize the harvest of fish in their rohe moana (tribal territory in the sea). The Customary Fishing Regulations also provide for the establishment of mātaitai reserves, which are recognized traditional fishing grounds, with which the local Māori have a special relationship. The reserve is managed by tangata tiaki/kaitiaki (guardians), chosen by the local Māori, who can restrict or prohibit fishing in the mātaitai reserve by recommending bylaws. Once a mātaitai reserve is established, commercial fishing is not allowed unless re-instated by regulation. Both Māori and non-Māori may fish in mātaitai reserves.

The Fisheries Act also facilitates the practical application of kaitiakitanga (guardianship) through the temporary closure of fishing areas and the establishment of taiāpure, which are tools for managing estuarine or littoral coastal waters — areas customarily of special significance to iwi or hapū either as a source of food or for spiritual or cultural reasons. The local Māori community is represented on a taiāpure management committee that advises on regulations to manage the area. These may include restrictions on the species and quantities that may be harvested, size limits, when fish may be taken, the fishing methods that can be used, and the areas from which species may be taken. Unlike in a mātaitai reserve, taiāpure allow commercial fishing.

Biosecurity measures

The threat from introduced non-indigenous species is recognized globally but New Zealand's Biosecurity Act 1993[5] provides a particularly powerful tool to help protect the marine estate from unwanted organisms. Vessels are the main pathway for unwanted marine organisms to reach New Zealand, either in ships' ballast tanks or as biofouling on vessel hulls. Up to 10 billion tonnes of ballast water is shipped around the world annually, with as many as one million zooplankters released every discharge event. More than 4,000 biofouling species have been found on vessel hulls, with as many as 200 different species on one vessel and up to one million individual organisms per vessel. However, transport of organisms on or in vessels from their source location to New Zealand ports is only the first stage of a 4-stage invasion process. Before they can cause ecological and/or human impact and spread further afield, organisms must transfer from the vessel into the recipient location where they must then establish a viable population.

The main emphasis of New Zealand's marine biosecurity system is therefore to minimize the chance of unwanted organisms being released into New Zealand waters. Two vessel-related border controls are deployed to achieve that.

Image: Kathy Walls

The Mediterranean fan worm, *Sabella spallanzanii*, and other biofouling being removed from a vessel hull

The first relates to the power under the Act to prevent the import of 'risk goods'. Part 3 of the Act deals with risks associated with the importation of goods and the entry of vessels of all types into New Zealand. A set of import health standards (IHSs) specify requirements to be met to manage risks associated with the importation of goods. These relate to the importing and exporting of plants, animals and other materials which may represent risk goods, but they also apply to ballast water and biofouling on vessels. The Act requires that the masters of vessels arriving from overseas should give notice of when and where they will enter New Zealand, so as to prevent uncleared 'goods' leaving the vessel without authorization from an inspector. The "Import Health Standard for ships' ballast water from all countries" was issued in 2005. Ballast water that has been loaded in an overseas port suspected of being contaminated with unwanted organisms, for example, can be classified as a 'risk good' and the vessel denied entry to New Zealand until it has complied with the ballast water IHS.

The second biosecurity border control measure is the Craft Risk Management Standard (2018) for Biofouling, which requires vessels arriving in New Zealand to have a 'clean hull', the definition of which depends on the proposed length of stay. For example, the hull of a long-stay vessel may have only a slime layer and goose barnacles. Short-stay vessels may have a small amount of other defined biofouling on arrival, but they remain under 'biosecurity surveillance' while in New Zealand territorial waters rather than being fully cleared for risk goods.

Inevitably, some organisms will slip through the border controls. The best chance of eradicating organisms that manage to cross the border and establish themselves in a port or marina is while they are still rare or in small isolated populations. Therefore the border controls are followed up by extensive twice-yearly surveillance for a catalogue of unwanted organisms at 13 high-risk ports and marinas.

The future

The above observations summarize the main tools used to manage activities in New Zealand's marine estate but there are many other pieces of legislation that fill in gaps and detail. Most legislation created to date has primarily focused on managing single species or single sector activities such as fishing or aquaculture, with no regard to other activities that may be taking place in the same area of ocean. Like several other countries, New Zealand is now striving to develop and implement Ecosystem Based Management strategies for integrated management of natural resources that recognize the full array of interactions, including human, within an ecosystem, and promote conservation and sustainable use in the context of global climate change.

Twenty new Marine Protected Areas — a science-to-policy success in South Africa

Kerry Sink, Marine Programme Manager and Principal Scientist, South African National Biodiversity Institute (SANBI); Ryan Palmer, Marine Platform Manager, South African Institute for Aquatic Biodiversity

The recent establishment of 20 new Marine Protected Areas in South Africa has made a key contribution to national plans for a sustainable ocean economy. The role of research in securing protection for the offshore environment has been invaluable, with key contributions made from scientists working in the marine biodiversity and environment sectors.

The South African National Biodiversity Institute (SANBI) contributes to South Africa's sustainable development by facilitating access to biodiversity data, generating information and knowledge, building capacity and providing policy advice. Over the past 14 years, SANBI's Marine section has been instrumental in leading a process to create a network of Marine Protected Areas (MPAs) in South Africa based on sound science and aimed at ensuring the sustainable development of South Africa's blue economy. The organization was established in 2004 with South Africa's first National Spatial Biodiversity Assessment, which included terrestrial, freshwater, estuarine and marine environments. The assessment reported that South Africa's offshore environment was the least protected of any realm, with 0.4 per cent of ocean territory protected compared with approximately 7.5 per cent of land. This sparked a dedicated research project that aimed to identify priority areas to form a network of offshore MPAs.

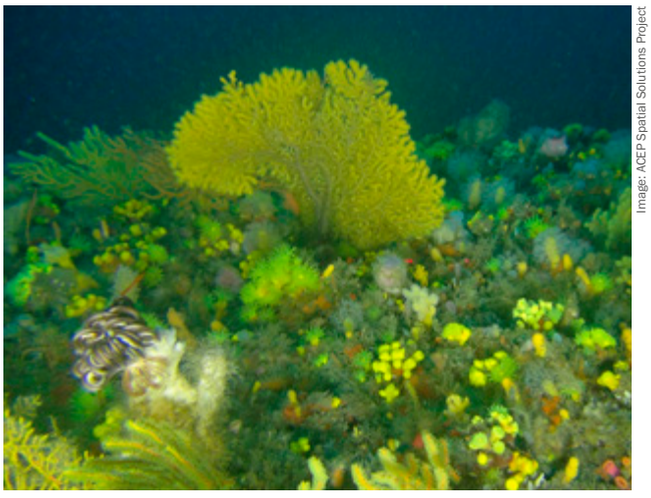


Image: ACEP Spatial Solutions Project

Mesophotic reef complexes on the uThukela Bank of the KwaZulu-Natal Bight are included in the new uThukela MPA

The Offshore MPA Project led by SANBI was initiated in 2006 and brought together industry and government stakeholders and relevant datasets to inform the development of a proposed new MPA network. Multi-level stakeholder consultation was needed to set agreed objectives for the network, review input data, determine design criteria and iteratively review planning results. The project accumulated more than 500 spatial data layers from numerous sectors to represent biodiversity patterns and industry pressures into a systematic conservation planning framework. However, in 2010 through departmental restructuring, South Africa's Marine and Coastal Management Department was separated into Fisheries and Environmental functions across two separate departments. This posed a challenge for MPA implementation as the integrated nature of the MPA network design included both biodiversity and fishery objectives, and the process stalled at this critical time.

During the following years, several collaborative research initiatives between scientists and industry were set up. Key inputs into data layers resulted from research into the effects of petroleum infrastructure, and seabed research to improve habitat management in trawl fisheries.

In 2008 the Convention on Biological Diversity set out criteria to identify Ecologically or Biologically Significant Marine Areas (EBSAs): "special areas in the ocean that serve important purposes, in one way or another, to support the healthy functioning of oceans and the many services that it provides". This led to the identification of several EBSAs in South Africa's waters, which were aligned with many of the areas identified for protection by the Offshore MPA Project. The areas identified included threatened ecosystems of limited extent, spawning and nursery grounds for endangered, overexploited and endemic species and important migration paths. This process strengthened the credibility of the need for protection of these identified focus areas and also focused an international spotlight on MPA work taking place in South Africa.

In 2014 the South African Government initiated Operation Phakisa, a multi-sectoral initiative to fast track South Africa's ocean economy though the development of industrial and commercial sectors including oil and gas, seabed mining, aquaculture, tourism and transport. From the outset it was recognized that, in order to develop the ocean economy, sustainable, responsible ocean governance and marine

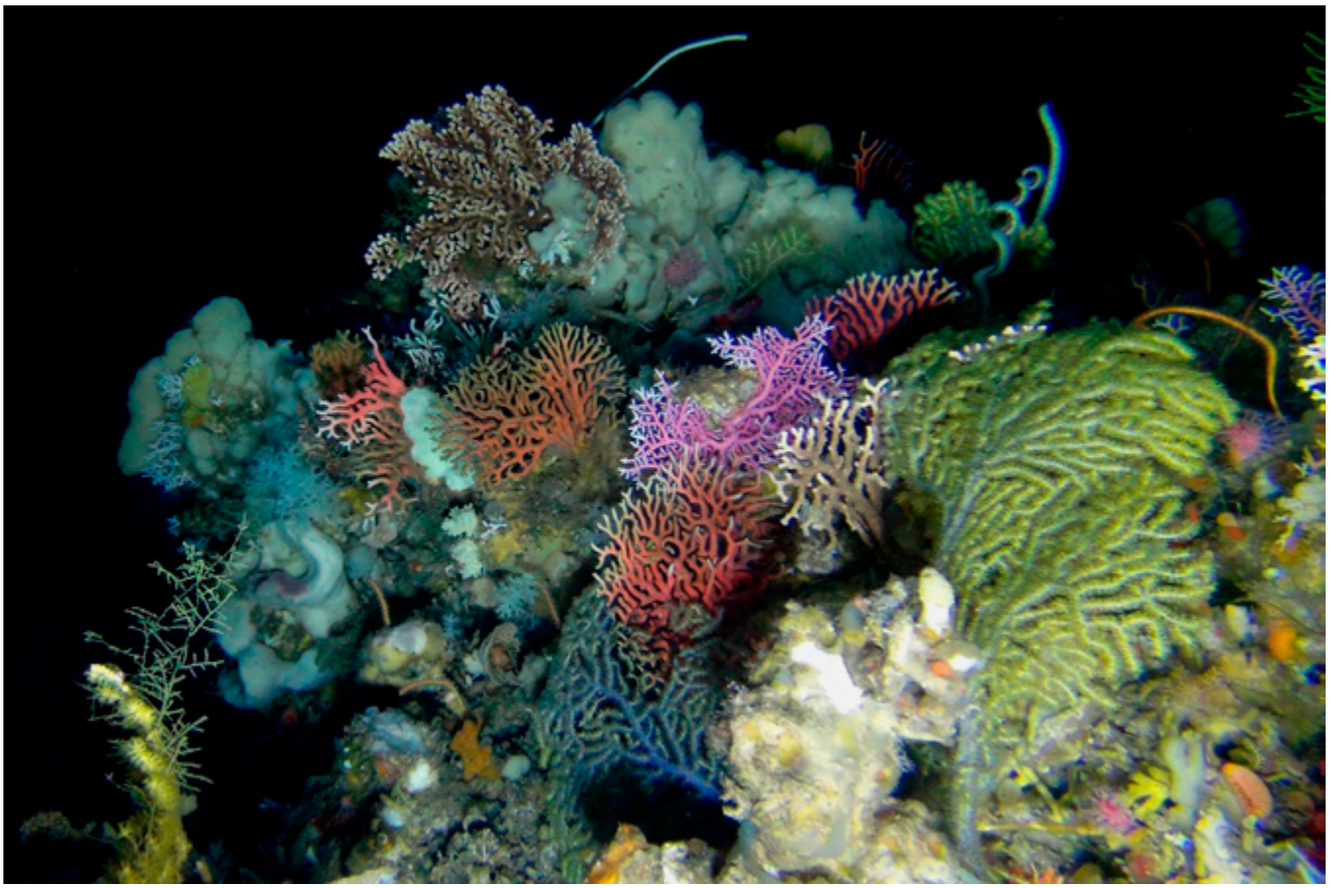


Image: ACEP Iminda Project

Delicate lace corals in the rocky shelf edge of the Agulhas ecoregion, now protected by the Amathole Offshore MPA

spatial planning were key to ensuring the orderly and coordinated use of the ocean for the benefit of all. One of the targets identified was the setting aside of 5 per cent of South Africa's ocean space for protection with the implementation of an MPA network. This was an ambitious task as, at the time, South Africa's ocean protection coverage was still below 0.5 per cent. Operation Phakisa provided the multi-sectoral platform needed to pull together work already done, focus dedicated research in priority areas, and coordinate multiple government departments in implementing protection.

The MPA component of Operation Phakisa was led by the Department of Environmental Affairs (DEA), but the then Department of Science and Technology (DST) also recognized the importance of MPA research and highlighted this priority within its marine and antarctic research strategy. This was then implemented by, amongst others, the South African Institute for Aquatic Biodiversity through its African Coelacanth Ecosystem Programme (ACEP). By directing funding and research infrastructure, ACEP steered research in support of priority areas for MPA expansion. This was done through ACEP's competitive 'Open Call' which prioritized projects that focused on relevant MPA research and applied collaborative, multidisciplinary approaches that strove to develop technical and human capacity in offshore research.

ACEP provided funding as well as technical support and access to research infrastructure including coastal research vessels; a remote imagery platform, including a Remotely Operated Vehicle (ROV) and various stereo underwater camera systems; a geophysics platform, including a multibeam sonar; and an acoustic tracking array platform — a network of underwater acoustic listening stations for tracking animal movement.

A partnership between DST and DEA, Phakisa Ocean Cruises, also allowed for access through ACEP to time onboard the *R/V Algoa*, the DEA's research vessel. Research conducted on several ACEP-supported projects provided useful information towards the implementation process of the Phakisa MPA network, particularly through ground truthing areas of the National Map of Marine Ecosystems enabled through multidisciplinary research including the first visual surveys of many ecosystem types in priority areas.

The multidisciplinary nature of the projects ensured that several layers of data were collected from each geographic area and allowed for an ecosystem approach to be taken. Projects collected physical and biological oceanography data, geological and geoscience information, foundational biodiversity knowledge including taxonomy and genetics and both benthic and pelagic ecology information. Several projects strove to inform marine spatial planning. This multidisciplinary approach has ensured that resources have been maximized and that different project components were linked, creating a value chain to provide sound information to policymakers.

As a result of the DST's response and subsequent funding for MPA research, four research teams lead by researchers from around South Africa designed projects to answer

Research along the Agulhas shelf edge and Agulhas Bank

In 2016 the SANBI-led ACEP Deep Forests Project undertook a Phakisa Ocean Cruise, traversing the Agulhas shelf edge and Agulhas Bank. Eight of the 20 new MPAs were studied during the Cruise — Robben Island, Browns Bank Corals, Browns Bank Complex, Southwest Indian Seamounts, Agulhas Bank Complex, Agulhas Mud, Port Elizabeth Corals and Amathole Offshore. The project team mapped the "Kingklip Ridge" within the Port Elizabeth Corals MPA, collected samples of deep water corals for taxonomic research and advanced inquiry towards understanding the role of coral as a habitat for fish such as the kingklip and jacopever, two commercially important species.

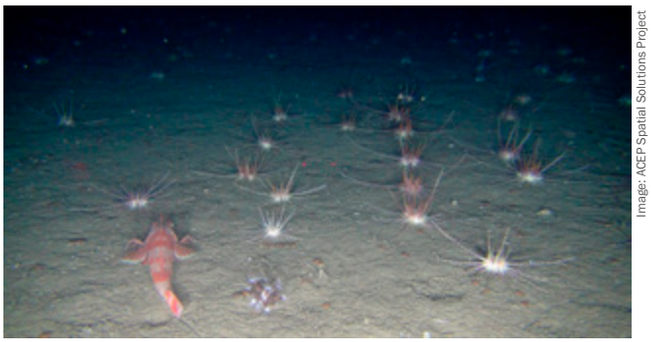


Image: ACEP Spatial Solutions Project

The sandy outer shelf with an abundance of fauna receives its first protection in the expanded Aliwal Shoal MPA

relevant questions to try to fill some of the knowledge gaps. One particular focus area was validation of existing data and the generation of higher resolution data towards ecosystem classification and mapping. With access to underwater visual sampling technologies for the first time, an emphasis was largely placed on biodiversity surveys in areas proposed for marine protection. These projects used visual techniques including ROV surveys, baited camera systems and deep water drop or tow cameras to reach up to 1000 m and reveal life within 11 MPAs, many of them for the first time.

Further to the scientific results achievable with such visual research technologies as baited camera systems and ROVs, images and video from the inaccessible submarine environment are a valuable tool for marine science engagement. These illustrate the complexity and sensitivity of the marine environment far better than any written content. Many of the visuals collected by ROV on these research projects were used in a short film and on a website dedicated to the South African MPA network[1]. These products are not only informative for the public but have also been a critical resource that helped to demonstrate the importance of the MPA network to the South African parliamentary cabinet during their decisionmaking processes concerning the implementation of the MPA network. They were inspired by the late Minister of Environmental Affairs, Edna Molewa, who recognized the value of this visual approach in communicating research and the societal benefits of MPAs.

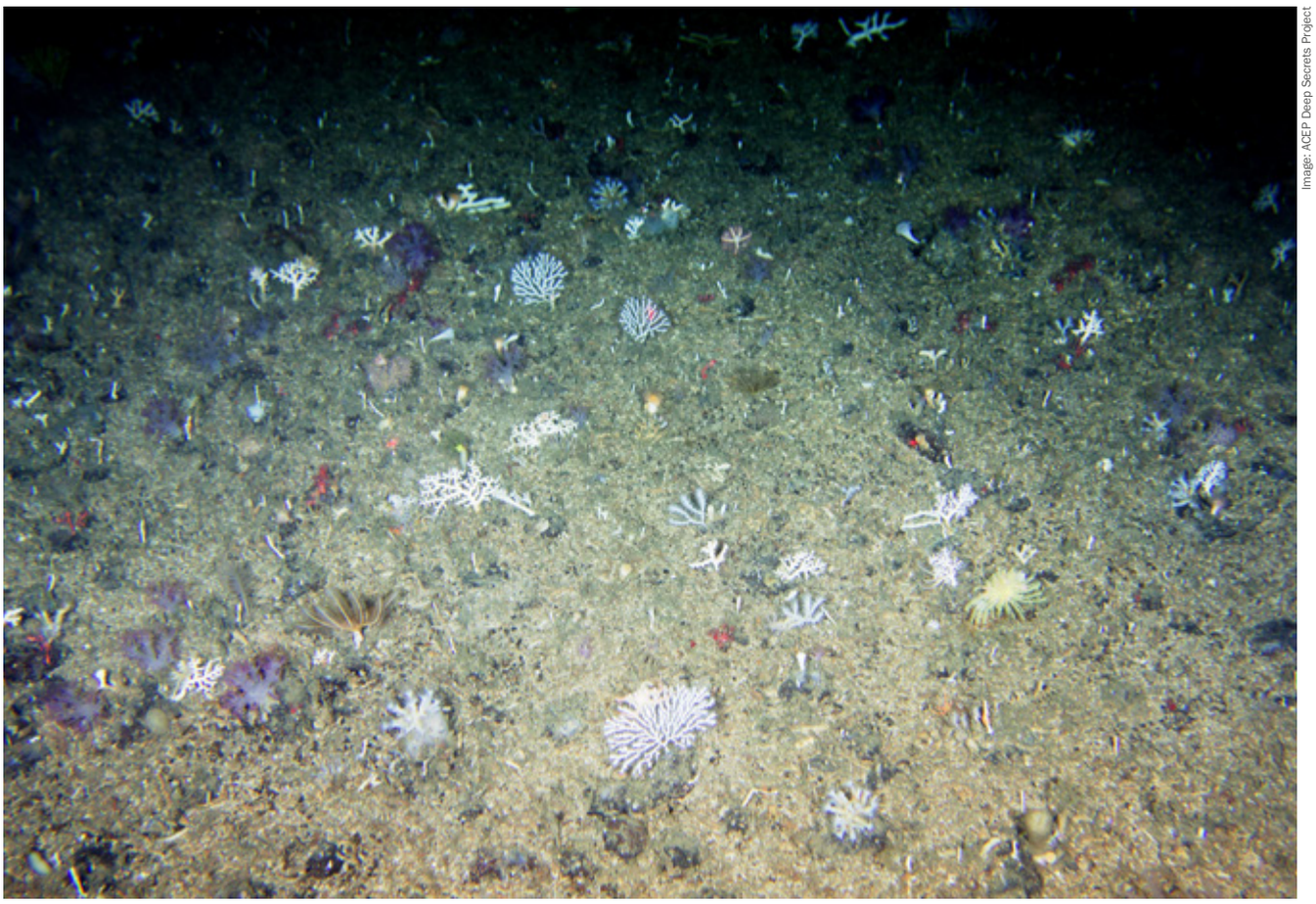


Image: ACEP Deep Secrets Project

The first protection of South Africa's slopes beyond the continental shelf was established in 2019

Image: SAEON Benthic Trawl Experiment

The Childs Bank MPA off South Africa's west coast. Deep, sensitive coral habitats such as these are vulnerable to impact from trawling and mining, but now receive some protection from South Africa's new MPA network

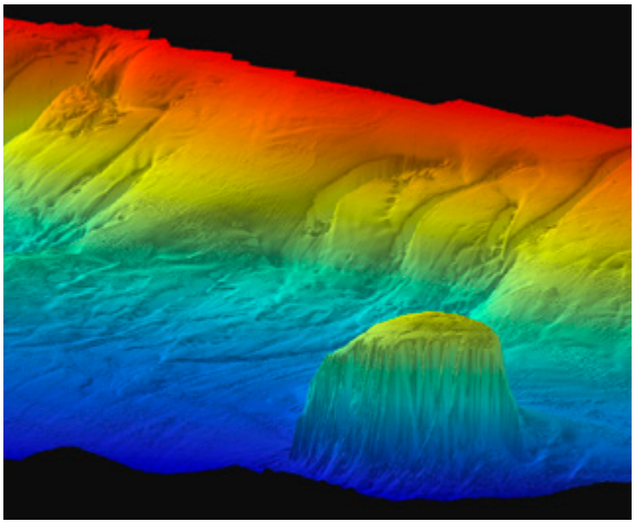


Image: Philip Desmet, ACEP Deep Secrets Project. Data provided by Anadar

South Africa's seamounts recently received their first protection with the establishment of the South East Atlantic Seamounts MPA

On 24 October 2019 the South African Cabinet approved the Phakisa MPA Network, adding 54,000 km^2 to South Africa's protected area estate through 20 new MPAs, advancing protection from less than 0.5 per cent to 5.4 per cent of the ocean territory around the country. The MPAs came into effect in August 2019 with management being implemented by various conservation and parks agencies around South Africa. This MPA network is spatially efficient with 87 per cent of South Africa's 150 marine ecosystem types receiving some protection. This has been achieved through a spread of dedicated research efforts and a science-based systematic planning process that has invested in research to help optimize MPA design.

Research will not stop here. It is important that monitoring takes place to establish the effectiveness of the protection afforded to these areas. Furthermore, Operation Phakisa has a goal of identifying a further 5 per cent of South Africa's Exclusive Economic Zone for protection to reach international targets. The successful implementation of the 20 new MPAs demonstrates the importance of sound research and meaningful stakeholder engagement in advancing protection.

Other key lessons learned through the process include the need for effective dialogue between scientists and decision makers and the value of targeted communication in demonstrating the benefits of protection. A well-coordinated, integrated approach that involves industry, communities, dedicated research and international support has been invaluable.

The importance of making science available to decision makers has been recognized in this work, as has the responsibility of scientists in ensuring that relevant research can inform sustainable development targets. Through such endeavours, researchers have the opportunity to make lasting contributions to national and international sustainable development goals.

Tunisia — an ecosystem approach towards a blue, circular and sustainable economy

Prof. Cherif Sammari, Former Head of Marine Environment Laboratory; Inès Boujmil, Fisheries and Environmental Engineer, Institut National des Sciences et Technologies de la Mer (INSTM)

The last decade has been marked by a clear resurgence of interest in the sea and marine science. While scientific and technological progress has made it possible to sketch reliable answers to the most significant questions relating to the oceans and their sustainable exploitation, a number of other questions remain unanswered, and this uncertainty is of concern not only to researchers but to everyone. Among these issues are those related to climate change and its impacts, the scarcity of living marine resources and the capacity of the oceans to fully play their role in the regulation of the thermal machine. Urban pressure and its impact on coastal areas is another subject of very high importance.

Recognizing the importance of the subject, the United Nations has declared 2021–2030 as the decade of the oceans. The ultimate objective is to develop greater synergy between all actors, namely science, economics, social institutions and governance. It is imperative that citizen science emerges and thus increases the visibility of the results of academic research.

All of these issues affect the Mediterranean Sea, which can be considered, in some aspects, as a hotspot of the world ocean, of which the Mediterranean can be viewed as a scale model. Tunisia, located at the junction of the eastern and western basins of the Mediterranean, has always been oriented towards the sea and must implement a true ecosystem approach to develop a varied, circular and sustainable blue economy. Indeed, there is not only an awareness of the importance of preserving the sustainability of resources and mitigating the negative effects generated by human activity on coastal zones, but also a regional and international dynamic that encourages this direction.

Position of Tunisia in relation to the Mediterranean Sea

With more than 1,300 km of coastline, Tunisia occupies a central place in the Mediterranean, which has long made it a crossroads of civilizations, of which Carthage is one of the most famous symbols. If the Mediterranean can be considered a scale model of the world ocean, the same could be said of the Tunisian coasts for this semi-enclosed sea, particularly in terms of the richness of the unique biodiversity and mosaic of ecosystems and habitats.

Geomorphologically, the Tunisian coastline can be divided into four sub-entities, namely the northern coasts; the Gulf of Tunis, the Gulf of Hammamet and the Gulf of Gabes. Although these ecosystems have completely different hydrobiological, bathymetric, faunistic and floristic characteristics, they are all affected by intensive coastline development and a high demand on coastal waters. The coastline is the focus of a strong urban and tourist concentration: 65 per cent of Tunisian urban agglomerations are located there, home to approximately 5 million inhabitants, and more than 90 per cent of the country's hotels are in seaside resorts.

Almost all Tunisian industries are located on this coastal fringe. The vast majority of heavy industries and the largest power plants are also concentrated on the coast or on lakes that are connected to the sea, with direct inputs of pollution.

This state of affairs can have only negative impact by accentuating the fragility and degradation of the coastline. Climate change and in particular the risk of accelerated sea-level rise are likely to pose additional, serious threats in the future to an already fragile and coveted coastline.

Maritime activities in Tunisia

A recent study[1] carried out for the Blue Plan[2] not only inventoried the seven most prevalent maritime activities in Tunisia but also analyzed their socioeconomic importance and especially their interaction with the marine environment. From this study, the following information has been extracted.

Image: Abir Aouinet

The endorheic salt lake of Chott El Djerid in the south of Tunisia is the largest salt pan of the Sahara Desert

Fishing

The fishing sector in Tunisia has evolved from an ancient tradition and is deeply significant on the socioeconomic level. It is an activity largely anchored in Tunisian culture and traditions and more particularly among the coastal populations.

Fishery products largely contribute to the dietary protein balance of a large part of the population, with every Tunisian consuming, on average, 11 kg of seafood per year. Around 100,000 Tunisians live directly or indirectly from fishing and aquaculture activities. In 2017, fishing and aquaculture represented a turnover of approximately US$ 400 million for a production of just over 130,000 tons.

Aquaculture

Confronted with a rarefaction of species and especially with an increasingly growing demand, the aquaculture sector is thriving in Tunisia, with the production increasing from 3,400 tons in 2007 to 22,000 tons in 2017, representing approximately 16 per cent of the national fish production.

A total of 41 projects have been initiated, generating 2,000 jobs (direct and indirect). Production is expected to reach 45,000 tonnes in 2030, but fundamental questions are already being raised, the most important of which is the interaction of this activity with the environment and, above all, its integration into a sustainable coastal development plan.

Maritime transport

For a long period of its history, Tunisia has flourished on its trade in the Mediterranean basin. The tradition dates to the Carthaginian era during which Tunisia had a large maritime fleet that developed several trading posts on both shores of the Mediterranean.

Maritime transport is now a key sector of the national economy, since 98 per cent of the value of imports and exports and 71 per cent of tonnages depend on it, with transit through eight main commercial ports. Hydrocarbons account for about one-third of the business. Passenger transport is also an important activity, with 700,000 people (mainly of Tunisian nationality) using this mode of transport per year. Cruise activity has also been prosperous; before 2011, 6,000 cruise ships per year docked at the port of La Goulette.

Tourism

Due to its privileged location, climate and history, tourism is a very important economic activity, accounting directly and indirectly for 8 per cent of national GDP. Most tourist activity takes place on the coastal fringe, where the hotel capacity is approximately 200,000 beds.

Tourism is important for other sectors and has a significant multiplier effect on the national economy as a whole. The sector consumes 10.6 per cent of the country's food production, 3.8 per cent of its agricultural and fishing products, and just over 4 per cent of transport and telecommunication activities, and provides about 100,000 direct jobs and more than 300,000 indirect jobs.

Energy

This sector also makes demands on coastal and offshore waters, with three thermal power stations located along the coast directly connected to the marine ecosystem by pumping seawater for cooling. Also, offshore oil and gas extraction produces 67 per cent and 32 per cent (in 2012) of the total national oil and gas production, accounting for 5 per cent of national GDP. Although the sector generates few jobs, it is clearly of strategic importance to the country.

Marine resource extraction
These activities are poorly developed and limited to the extraction of salts, mainly around Sfax, Zarzis and Kerkennah in the Gulf of Gabes. The production of salt from salt marshes represents about 94 per cent of national production for a turnover of US$ 32 million. About 500 people work for the country's four main salt producers.

Telecommunications
The telecommunications sector is of strategic importance to the country's economy, accounting for 10 per cent of national GDP as well as 20 per cent of GDP from service activities. However, telecommunications activity depends on the sea.

The recent installation of two submarine cables has clearly contributed to improving the performance of the country's entire communication system, and these cables could well constitute an excellent vector for research activities, particularly in the fields of hydrodynamics, acoustics and the monitoring of cetaceans in the Mediterranean.

A reason for serious concern
From the brief description above, the economic and social importance of marine activity in Tunisia is evident. Although several studies have looked at the interaction of these activities with the environment as well as the costs[3] of anthropogenic degradation of marine and coastal ecosystems, fewer have focused on more in-depth topics such as the relevance and viability of the current pattern of coastal use and exploitation of marine resources.

A number of questions therefore need to be asked:
- Can the current model of exploitation of the sea be continued indefinitely?
- Do marine scientific research and the state of knowledge provide accurate answers to topics with high societal impact?
- Is there a real synergy between the world of research and the socioeconomic operators?
- How can the factor of temporality be overcome, which often prevents a better match between environmental constraints and socioeconomic imperatives?
- While each country has its own specificities and priorities, some issues have a regional dimension. Thus, at the level of the Mediterranean basin, jellification, acidification, the degradation of marine biodiversity and the accelerated rise in sea level are common issues shared by all Mediterranean people, and hence a regional dynamic is needed.

It is precisely in order to create a new Mediterranean dynamic based on mutual interests, mutualization and complementing the mechanisms already in place that a true citizen science must be launched and respond to questions of a strategic nature. It is imperative that these responses must consider temporality, especially given that an excellent background is already available, but must be strengthened throughout the integration of local and regional specificities. Moreover, initiatives such as BlueMed, initiated by the European Union, are among the mechanisms that can respond to this challenge and provide hope to the Mediterranean countries.

Image: Abir Aouinet

A rich ecosystem at Retiba, Tunisia

Image: Abir Aouinet

The beauty of the unspoilt coast, Takelsa, northeast Tunisia

Image: Abir Aouinet

The marine environment affected by industry and pollution, Ezzahra, Tunis

The BlueMed Initiative in Tunisia

The growing awareness of the intense pressures causing environmental degradation of the Mediterranean's natural wealth signals the need for a sustainable approach. Governance bodies have defined the tools and mechanisms for achieving development by ensuring the preservation and sustainable uses of the Mediterranean's natural capital. At this stage of economic reframing, a focus on the blue economy has emerged to foster the shift towards a marine-based sustainable economy. In this context, BlueMed Tunisia has identified the main priorities and initiatives led by citizens, associations, students, researchers and stakeholders as:

- Understanding pollution impacts, mitigation and remediation in the Mediterranean
- Linking tourism, tourists and environment
- Exploring the potential of blue biotechnology, including use of the blue crab.

Issues addressed

Three sectors of the marine and maritime economy are considered by Tunisia as of strategic focus:

- Fisheries, with the national strategy for artisanal fishing
- Plastic litter
- Valorization of invasive alien species such as blue crab.

Why were these issues chosen?

- To counter the increasing replacement of traditional materials used in fishing by cheaper, more convenient materials. For instance, earthenware octopus traps are being replaced with plastic pots, and the technique of Charfia[4] fishing is replacing its use of palm branches with PVC and nylon nets
- To fight plastic pollution by undertaking monitoring, governance and citizen science campaigns at local and national levels
- To tackle the blue crab population, which is growing fast and destroying Tunisian marine biodiversity.

Objectives

- Creation of a National Hub to work on plastic pollution by developing a network community
- Merging science with citizen science and increasing awareness on social media of the problems arising from marine litter
- Raising awareness at local and national levels.

The lasting effects of the BlueMed Initiative

- The National Hub will evolve into an observatory for long-term follow-up, with a purpose of collecting and disseminating information. The Hub will ensure the continuing promotion of blue growth through the collaboration of all national sectors
- The creation of a citizen science platform will guarantee the exchange of information on a long-term basis
- The objective is to increase awareness of the impact that abandoned fishing nets can have on marine life, and to promote the continuing education of fishing communities towards more sustainable fishing activities. The ambition is to recycle fishing nets and use ecological methods in every aspect of fishing.
- GoBlue hiking is one of Tunisia's initiatives to increase citizens' awareness of ecology through popular activity. It is expected that the idea will inspire several blue associations and follow the momentum created by BlueMed.

Combating marine pollution in Sierra Leone

Dr. Umar I. Kamarah, Senior Rural Development Economist[1]

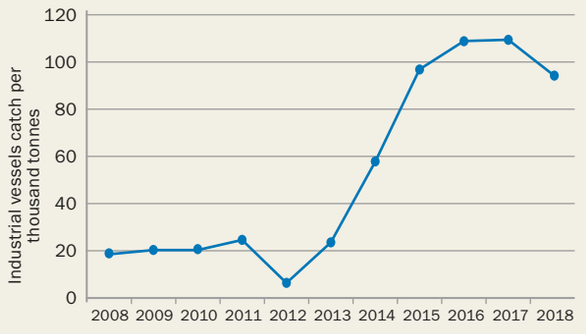
The death of a lost baby dugong after its rescue off Thailand in August 2019 gave international recognition to the serious threat posed by plastic pollution to the world's coastal communities. The realities of this threat have deeply affected Sierra Leone where plastic bags, plastic containers and aluminium cans constitute major pollutants.

This type of pollution occurs when plastics and other debris far inland are blown by the wind over long distances and end up on the shores of the Atlantic Ocean. This debris can be from natural occurrences such as dust and sand or man-made objects such as single-use plastics and other refuse. Most debris, especially plastics, do not decompose but remain suspended in the ocean's current for years.

Fish and other aquatic and amphibious animals can become caught in plastic structures or mistake the plastic for food, which kills them slowly over a long period. The animals most often the victims of plastic debris include turtles, dolphins, fish, sharks, crabs, sea birds and crocodiles.

New research[2] evidences the danger of plastic to turtles in particular. Turtles have a tendency to eat seaborne plastic objects, which then become snared in the alimentary canal, cannot be broken down by the animals' digestive enzymes and may ultimately kill them. It is widely assumed that this attraction to plastics is a matter of mistaken identity — drifting plastic bags, for instance, appear similar to jellyfish, which many types of turtles like to eat. Yet many plastic objects that have been discovered inside turtles have no resemblance to jellyfish. The notion that the smell of plastic flotsam might lure animals to their doom first emerged in 2016.

Industrial fish catch per thousand tonnes by species, 2008–2018



Source: Ministry of Marine Resources and Fisheries-Statistics Unit

Research[3] has recently discovered that certain chemicals, notably dimethyl sulphide, which are released into the air by micro-organism-colonized plastics, are those which many seabirds detect in order to track down food. These chemicals mark good places to hunt because they indicate an abundance of the algae and bacteria that lie at the bottom of marine food chains.

Impacts on fishery products

The Sierra Leone fisheries sector accounts for approximately 7 per cent of the country's GDP, provides 80 per cent of the population's protein intake and creates livelihoods for about one million people. The country's National Development Plan 2023 and Budget Speech 2020 both emphasize promoting sustainable management and maximizing the economic value of the industry, which is divided into two major sectors:

- Artisanal fishing operating in estuaries and inshore waters and extending from the shoreline to a depth of 20–40 m
- Industrial fishing, supposedly operating in the open, deeper waters, and whose fleets include trawlers, shrimpers, purse seiners, carriers and motherships.

The fish catch has declined very quickly over five years of observations in terms of volume and the type of species caught. As of 2020, catching fish is an ad hoc and irregular activity, with boats waiting for days or weeks without a substantial catch.

The indications are that, although the catch shows some fluctuation, the trend is a quick decline after 2016 for all ranges of fish species and trawlers. The catch figures for artisanal fishing are difficult to ascertain, although the Ministry of Marine Resources estimates that it constitutes 30 per cent of the industrial fishing catch for common types of fish.

The figures show that crustaceans and others face the threat of extinction if nothing is done to reverse the rapid rate of depletion of stock. The decline in fish catch is creating problems for artisanal fishermen, industrial trawlers, and the complex array of actors and interests, as their livelihood is being threatened.

Various factors have been cited for the decline in fish stock, including:

- Illegal fishing by trawlers
- Bad methods of fishing by artisanal fishermen
- Pollution and climate change.

Pollution and climate change have been seen as residual causes of the declining fish stock. If there is a lack of data

and scientific study to link the rise in sea temperature and declining fish stocks, there is still evidence that plastics and other pollutants fill our oceans.

Impacts on tourism

Sierra Leone has strong potential to attract tourism. There are good beaches, islands and mountains, a rich biodiversity with interesting wildlife, friendly people and rich socio-cultural heritage. The country also occupies a special place in the world history of the anti-slavery movement, and is known as 'the land of freedom' — hence the naming of the capital city, Freetown. The end of the civil conflict in 2002 led to a renewed phase of visits from business travellers, as well as members of the Sierra Leone diaspora returning to visit friends and relatives.

However, despite the country's attractions, particularly its proximity to Europe, tourism has developed relatively slowly. The ten-year civil war, the Ebola virus, floods and mudslides have been cited as causes of the low tourist numbers. But, since 2012, the emergence of sea weeds on the beaches — a direct result of pollution and climate change — has also caused a change in the desirability of those areas.

Mabella, Moo Wharf, Freetown, Sierra Leone. As of 2020, catching fish off the Sierra Leone coast is an ad hoc and irregular activity, with boats waiting for days or weeks without a substantial haul

Industrial fish catch per thousand tonnes by species, 2008–2018

Year	Cephalopod	Crustaceans	Demersals	Demersals/ semi Pelagics	Others	Pelagics	Total
2008	501	1,108	12,507	–	755	4,251	19,123
2009	269	1,104	15,043	–	393	3,370	20,179
2010	89	583	14,963	–	199	4,524	20,358
2011	58	607	11,525	1	242	11,181	23,613
2012	178	308	4,256	–	136	1,395	6,273
2013	137	466	10,335	1	93	11,960	22,993
2014	654	556	28,485	535	475	26,797	57,500
2015	931	662	34,451	3,139	509	56,141	95,834
2016	4,747	1,229	39,825	2,508	968	58,221	107,499
2017	2,049	1,161	31,670	3,158	353	69,823	108,214
2018	2,133	951	33,052	3,771	171	54,451	94,529
Total	11,746	8,736	236,111	13,113	4,295	302,115	576,115

Source: Ministry of Marine Resources and Fisheries-Statistics Unit

Funkia Wharf, Goderich, Freetown, Sierra Leone. Debris washed up on the country's shores includes man-made objects such as single-use plastics and other refuse. Most debris, especially plastics, does not decompose but remains suspended in the ocean's current for years

A sustainable approach to the management of the ocean

The increasing pressure on Sierra Leone's already stressed waste management system poses a significant threat to tourism and fisheries, both of which are cornerstones of the country's economy. The Freetown City Council has waste disposal sites, but those are exposed, and some of the untreated sewage waste ends up in the ocean, becoming a significant pollutant of the marine resources.

In 2008, the Government of Sierra Leone established the Environmental Protection Agency (EPA), responsible for policy development to mitigate environmental issues including pollution. This has been an effort to police the gaps in environmental pollution across the country. However, the Environmental Protection Agency Act of 2008 focuses on natural resources and environment management issues without addressing plastic pollution.

Although companies operating in heavy industries, such as the mining, construction and agriculture sectors, are required to conduct an environmental impact assessment under the EPA Act for approval before the commencement of operations, there are no laws or policies in place to limit the production, import and use of single-use plastics, rubber and cans in the country, leaving this aspect open to exploitation.

There are ongoing efforts to recycle waste in the country, and responsibilities have been apportioned for the collecting, processing and recycling of waste, principally plastics. However, such efforts are still not achieving their main objectives, with waste having been collected but yet to be recycled. Nevertheless, there are several ways in which positive action can be taken to solve marine pollution.

Conclusion

Marine pollution is a serious issue, and occurs in many forms. Oceans and rivers are now under direct threat from an increasing load of various pollutants such as the tonnes of plastic waste released every day. Policy actions are needed to fight against this, requiring the collaborative efforts of all relevant stakeholders including individuals, institutions, government and non-state actors. Such efforts will be life-saving, as pollution affects marine life and humans.

The key problems that Sierra Leone has identified in the fight against pollution of the ocean include:

- Weak collaboration among the institutions responsible for the management of ocean-related resources
- Absence of specific policies targeting marine pollution mitigation
- Absence of law or policy on plastics production and use.

The methods for reducing the pollution of the ocean from plastic waste in Sierra Leone can be categorized in three areas of consideration:

- **Reduction**: packaging directives; product bans or taxation; extended producer responsibilities; structural controls and other policies
- **Collection**: increased convenience mechanisms; collection and street sweeping optimization; litter education programmes; clean-up campaigns (for example, the existing Saturday cleaning exercise initiated by the Bio Government); litter laws; litter abatement grants; environmental courts; port reception facilities; ocean-based waste collection
- **Recycling and disposal**: mandatory recycling; recycling grants; advanced disposal fees; disposal bans; disposal limits; variable rate pricing; bottle bills; product take back/buy back; penalties; rewards; rebates; waste collection cessation; recycling education; environmentally preferred purchasing; organics management programmes; tax abatements; regulatory and financial solutions.

SDG14 and beyond — a regional approach to strategic marine ecosystem management and sustainable development in the Red Sea and Gulf of Aden

Ahmed S. M. Khalil, Regional Program Coordinator for Living Marine Resources and Climate Change, PERSGA

The Red Sea and Gulf of Aden are endowed with extensive coral reefs, seagrass beds and mangroves, representing key tropical coastal ecosystems that are consistently highlighted for the various ways in which they can support advances in sustainable development.

SDG 14's targets comprise several fundamental aspects of the overall sustainable development outlook, and play an integral role in promoting interaction with other components of the 2030 Agenda. UN Member States are cooperating to achieve those targets in the area, facilitated by the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA)[1].

Consistency in the regional approach, through coordination of policies and efforts, is necessary for achieving effectiveness and substantial outcomes, considering the connectivity of the adjoining coastal ecosystems over the entire region. It is fortunate, therefore, that the region's rich marine ecosystems offer cost-effective options to accelerate development outcomes, including climate actions. PERSGA is leading this regional approach in accelerating efforts to achieve SDG 14 targets, as well as to enhance the role of marine ecosystems in achieving other SDGs, including ecosystem-based actions to address climate change impacts, poverty reduction and food security in the Red Sea and Gulf of Aden region.

Significance of the marine environment throughout the PERSGA region

The coral reefs in the Red Sea are the best developed reefs in the western Indian Ocean, occurring in the form of various structures such as extensive fringing reefs around the mainland and islands; barrier reefs; atolls; submerged patch reefs; coralline red algal beds; and relic reef formations. Seagrass beds are also abundant along the Red Sea coast, occurring at depths of up to 70 m, and visible due to the characteristic high transparency of seawater in the area. Sea-grasses support fisheries and biodiversity, in addition to their role in reducing erosion and carbon storage. Mangroves also occur on the coastline throughout the region, representing the northernmost limit of their distribution in the greater Indian Ocean. Mangroves support fisheries, biodiversity, shoreline stability and carbon sequestration and storage; and provide animal fodders as well as sites for ecotourism in the region.

However, the impacts of climate change, and multiple stressors from coastal activities are causing degradation to the coral reefs, affecting livelihoods and increasing the need for investment in protecting shorelines, while coastal communities depend on the marine environment as a source of food and income, mainly through fisheries, tourism and maritime activities. Acclimated to extreme conditions of relatively higher temperatures and lower oxygen, and with the ability to maintain calcification, the Red Sea corals may possess merit as one of the few repositories globally to be able to endure the threats posed by the changing climate.

PERSGA SDG-related regional objectives and interventions

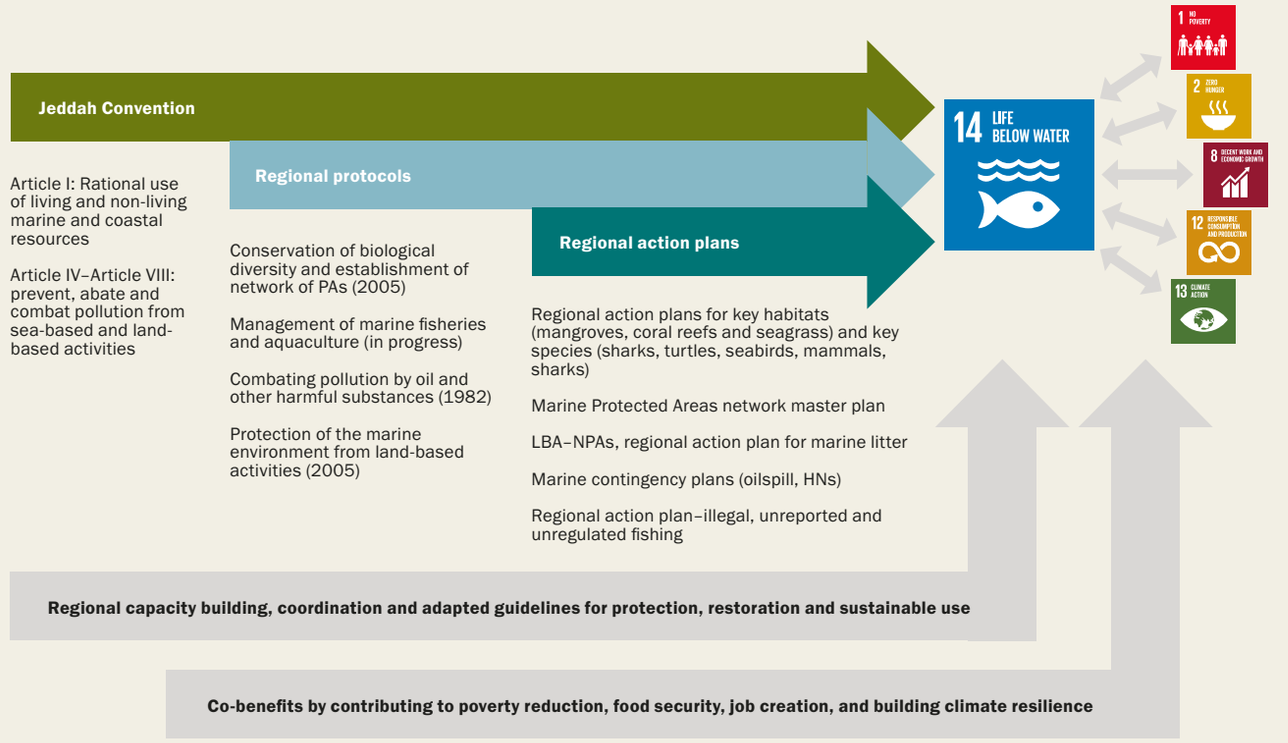
The objectives of the regional approach provide the necessary framework to accelerate the implementation of SDG 14, in addition to providing benefits to other aspects of the sustainable

Global significance of marine biodiversity in the PERSGA region

The Red Sea supports high species endemism compared to other regions of the world. According to PERSGA assessment reports[2], the proportion of endemic Red Sea fish is 14.7 per cent, ranking the Red Sea among the top three areas of high fish endemism in the world, next to the Hawaiian Islands and Easter Island. Furthermore, endemism is remarkably high among some fish families, e.g., for small benthic, territorial fish groups such as dottybacks (*Pseudochromidae*) and triple fins (*Tripterygiidae*), endemism reaches approximately 90 per cent, and for Red Sea butterflyfish (*Chaetodontidae*) it reaches about 50 per cent.

Among the Red Sea's invertebrate groups, 6 per cent of corals; 13 per cent of polycheates; 33 per cent of crinoids; 23 per cent of holothuroids; and 13 per cent of asteroids are considered endemic species. Many areas in the Red Sea support rich coral growths at moderate depths (20–30m), which could provide potential refugia in times of environmental stress. This gives Red Sea corals special importance, considering concerns from climate change scenarios that predict extensive loss of coral reefs globally.

The regional approach and objectives related to the Sustainable Development Goals in the Red Sea and Gulf of Aden



Source: PERSGA

development agenda. The rational use of marine and coastal resources and their protection from pollution and overexploitation are the central objectives of the Jeddah Convention and derived protocols that directly support the SDG 14 targets of marine protection, environmental restoration and control of overfishing. Regional coordination, detailed action planning and tailored capacity building, as well as the provision of guidelines, initiatives and demonstration activities provided by PERSGA programmes, support transformation into aligned and integrated policies for the marine environment that benefit other aspects of the sustainable development agenda, such as poverty reduction (SDG 1), food security (SDG 2), economic growth and employment (SDG 8), responsible consumption and production (SDG 12), and climate actions (SDG 13) in the Red Sea and the Gulf of Aden.

Following the transboundary diagnostic analysis and strategic action programme (2000–2004), PERSGA has gained practical experience, capacity and leadership in the region to adopt a strategic approach that intervenes at both regional and national levels in UN Member Countries.

Regional level interventions

These involve PERSGA coordination and capacity building that are planned and conducted through focused regional programmes, including Living Marine Resources, Biodiversity and Protected Areas, Pollution from Sea-based Activities, Pollution from Land-based Activities, Climate Change, and Environmental Education and Awareness programmes. The main achievements of PERSGA interventions at regional level in support of the SDGs may include:

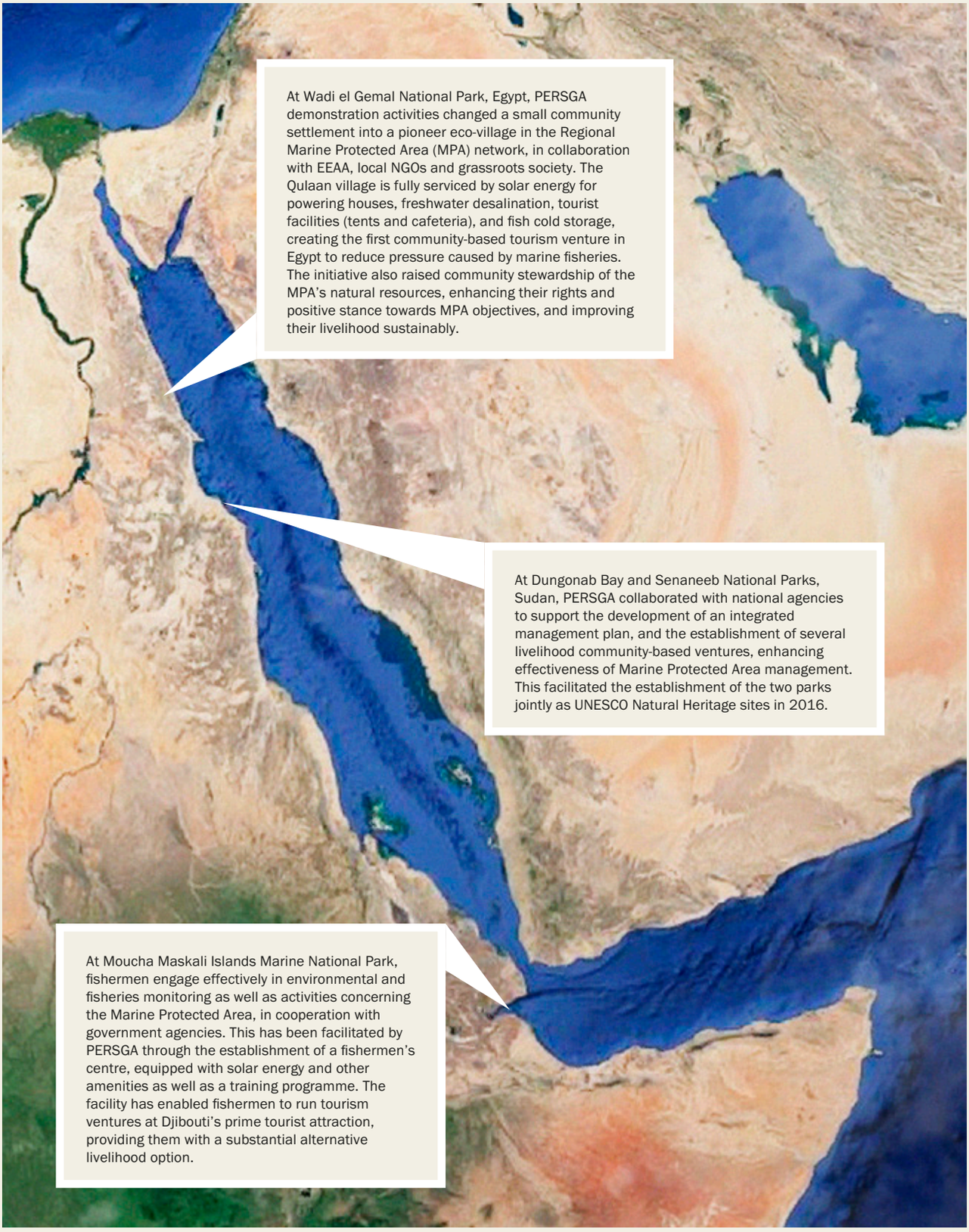
- Promoting regional legislation by supplementing the Jeddah Convention (1982) with protocols concerning oil and hazardous and noxious substances, land-based activities, biodiversity/Marine Protected Areas (ratified) and fisheries/aquaculture (in progress), which strengthens regional governance to achieve the SDG 14 targets of marine protection; rational use of living marine resources; ecological restoration; prevention of pollution from both sea-based and land-based activities; and the prevention of overexploitation and illegal, unreported and unregulated fishing
- Detailed action plans and tailored technical guidelines for coordinated actions and harmonization
- Provision of regional data systems and a monitoring programme, including a regional integrated assessment of the marine environment, to check progress using objective-based indicators
- Intensifying capacity building and knowledge sharing workshops to address the persistent need for capacity development, knowledge and technology transfer in the region.

National level interventions

These involve technical assistance to mainstream the regional and relevant international conventions in national policies and engagement, such as training, assessment and interagency coordination, besides implementing demonstration micro-projects that are based on a country's priorities and needs.

Micro projects executed at local levels have proved to be very effective in building partnerships with local community

Examples of PERSGA strategic ecosystem management project community-based interventions to enhance participation in Marine Protected Area conservation activities and alternative livelihood options



No.	Ecosystem-based management principle[3]	PERSGA strategic ecosystem management interpretation for alternative livelihood compliance
1	Public participation	Public participation underpinning the livelihood
2	Delegation of management	Management of use by the user
3	Transboundary effects	Livelihood takes note of transboundary effects
4	Economic context	Livelihood secures employment and wealth particularly in vulnerable and poorly represented groups
5	Conservation/sustainable use	Livelihood and the biological resources that support it are sustained
6	Carrying capacity	Livelihood operates within the carrying-capacity of the biological resources that sustain it
7	Spatial and temporal	Livelihood operates within objective spatial and temporal boundaries
8	Long-term management	The livelihood operates in the context of long-term management
9	Adaptive management	Livelihood can continue when subject to adaptive management (is adaptive and resilient)
10	Sustainable development	Livelihood supports sustainable development targets particularly in vulnerable and poorly represented groups
11	Evidence-based	Livelihood is knowledge based and is an extension of traditional knowledge/use
12	Participatory	Livelihood beneficiaries are involved in planning and management

Compliance of alternative livelihood schemes with an ecosystem approach: interpretation applied by PERSGA for assessment based on CBD ecosystem approach principles (modified from Shepherd 2016)[4]

organizations and generating tangible makeovers in realizing conservation and sustainable development objectives. Recognizing this, PERSGA has dedicated a substantial part of the post-SAP resources and interventions to community-based on-the-ground activities. For example, the recently implemented Strategic Ecosystem Management (SEM) project (2014–2018) in collaboration with the World Bank has focused on selected Marine Protected Areas (MPAs) within the Regional Network to implement community-based interventions that were considered a hallmark of project outcomes.

The SEM project has successfully considered practical strategies to make principles operational in the local context. This is important in order to select appropriate interventions, such as alternative livelihood options that comply with the sustainable development agenda and the ecosystem approach. For example, in addition to explaining positive and negative lists suggested by environmental and social framework assessments, local communities required simple interpretation of ecosystem approach principles to be considered for assessing compliance with their selected activity. However, community-based alternative livelihood interventions should also consider several other essential elements in their planning and implementation, such as local government endorsement and support, and strong partnerships with community grassroots organizations and potential NGOs, which strengthens ownership and mobilizes technical and capacity support for sustainability.

In addition to protection of the marine environment, other benefits from alternative livelihoods offered by marine resources need to be emphasized for decision makers and local community leaders, especially those supporting national development strategies and objectives, such as addressing poverty, health, food security and job creation.


Image: PERSGA


Image: PERSGA


Image: PERSGA

Pictured right (top) Qulaan MPA ecovillage at Wadi el Gemal National Park, Egypt; (centre) MPA management at Dungonab Bay, Sudan; (bottom) the fishermen's centre at Moucha Maskali Islands Marine National Park, Djibouti

Policies and programmes for sustainable integrated coastal zone and aquatic resources management in Egyptian waters

Suzan Kholeif, Ph.D, Professor of Oceanography, National Institute of Oceanography and Fisheries, Egypt, ICZM and EIA Consultant, Executive Planning Member (EPG) for UN Decade of Ocean Science

The Arab Republic of Egypt is a transcontinental country connecting northeast Africa to southwest Asia through the Sinai Peninsula. The population of almost 100 million is predominantly concentrated along the fertile valley of the Nile River and the coastal plains on the Mediterranean coast. The Egyptian coastline extends approximately 3,000 km along the Mediterranean Sea and Red Sea beaches in addition to the Suez and Aqaba gulfs. Fisheries in Egypt are therefore an important part of the country's culture and society.

Despite the comparatively small role played by the fishing sector in Egypt's economy, it is nevertheless locally important in providing an integral component of the traditional diet and as a support to food security. Domestic fish production therefore makes an important contribution to the national food supply and is of significant importance in coastal regions where it represents the main source of income and employment. Wild fish provide full-time employment to more than 250,000 families, mostly from coastal areas. Consequently, the sustainable development of the aquatic resources sector is an important consideration for Egypt, which has a significant target in meeting the high per capita demand for fish proteins from the country's increasing population.

The effective management of wild and farmed fish has proven instrumental in enabling countries to move to higher stages of development, fostering economic and social transformation. Nevertheless, the sharp inflation in food prices is likely to limit poverty reduction, and negative short-term effects could be felt across different income levels.[1] The challenge now is to sustain this sector not only to maintain food security but also for environmental stewardship, and to facilitate access to international markets, creating jobs and access to aid in economic crises.

Recently, aquaculture production increased from 400,000 tons in 2000 to 1.8 million tons in 2017, amounting to over 79 per cent of total fish production. It is worth noting that, over the same period, fish catches have been stagnating (about 6 per cent of total fish production), a trend that is somewhat widespread. Therefore, it is likely that Egypt will rely on an increase in aquaculture production rather than wild catches from both seas, since marine aquaculture is still in its infancy in the country, despite its great potential and the role it may play to increase fish production in a region with limited freshwater resources.

In comparison to the costs of freshwater culture facilities, the development of marine aquaculture is constrained by very high investment costs including those for infrastructure, feed and seed supply, and facilities maintenance. There are also legislative problems and complex land lease regulations in coastal areas, as well as competition for land use as tourism takes priority. Therefore, marine cultured species in Egypt — sea bass, sea bream, mullet, meagre and shrimp — are generally farmed by the private sector in brackish water environments.

Nile tilapia alone accounts for 61 per cent (557,049 mt) of total production, while carp and mullet represent 21 per cent and 13 per cent, respectively. Overall, these three species represent 94 per cent of total aquaculture production in Egypt. Most aquaculture activity is carried out in the coastal lagoons of Manzala, Burullus, Edko and Maryut, which are open to the Mediterranean Sea by narrow inlets.

The marked increased in cage culture of tilapia in the fresh and brackish lagoons has increased public awareness and created a debate among governmental authorities, academics and environmental protection bodies, with respect to their environmental impact. The Egyptian Government enforced the removal of the cages from the Nile, claiming that fish faeces and feed wastes from the cages were polluting the river and causing ecological impacts.

Environmental concerns have become an important issue as farming practices have intensified. These concerns require careful environmental evaluation and proper management and, within its strategy for water resources protection, the Ministry of State for Environmental Affairs has set a priority to protect the coastal lakes from pollution, to ensure the sustainability of fish resources, and to maximize their benefits. Several legislative tools have been developed by the Ministry of Environment concerning the catching of fish and marine animals, and regulating fish-farming activities through a licensing system for both recreational and professional fishing, as well as the establishment of fish farms. In addition, the regular monitoring of pollution sources, water quality and sediment is achieved by the National Institute of Oceanography and Fisheries.

Image: NIOF

Visit to a sea bass and sea bream fish farm organized as part of the Fisheries and Aquaculture-Oriented Research Capacity in Egypt (FORCE)

Image: NIOF

FORCE learning-by-doing capacity building activities in Ancona, Italy, run by the Institute of Marine Science (ISMAR-CNR). Selected NIOF researchers and members of GAFRD were involved in the practical training

Image: NIOF

FORCE learning-by-doing capacity building activities in Alexandria, Egypt, run by the Institute of Marine Science (ISMAR-CNR). Selected Egyptian researchers, members of GAFRD and members of the fishermen's organization were involved in practical training on fishing vessel technology

Currently, there is a government-led initiative to double farmed fish production and to promote fish as a viable export. New regulations will be implemented to ensure the creation of new aquaculture establishments and the renovation of existing businesses. Also, the Prime Minister of Egypt has announced an urgent plan to develop and rehabilitate coastal lakes, criminalizing the drainage of the lakes in order to ensure the quality and quantity of fish production.

Around 32 per cent of total national fisheries production is accounted for by fish caught from the Mediterranean Sea (approximately 19 per cent) and the Red Sea (about 13 per cent). Over the past decade, fisheries have experienced a 23 per cent decline in production as a result of overfishing[2] even though the national fleet has notably increased by 40 per cent. In addition, the sector is markedly affected by extensive illegal, unreported and unregulated (IUU) fishing practices such as use of illegally sized nets, harvesting of undersize fish and other destructive practices. Despite vigorous efforts through national legislation to address fishery management issues and establish regulations to supervise the sector, weak enforcement, low compliance and unregulated fishing suggest the need to restructure the management system.

The Egyptian General Authority of Fish Resources Development (GAFRD) has therefore prioritized mitigation of the exploitation of fisheries resources by using more sustainable and selective fishing gear. The impact of towed gears on the sea bed has been considered in assessing the reasonable management of different fishing activities in both seas. GAFRD has also set a national regulation to protect the fish nursery grounds in the Mediterranean and Red Seas by preventing and criminalizing all fishing activities in both Seas for three to four months every year. Also, to increase the efficiency of fishing boats and protect the environment, the Egyptian Government is starting to build new boats as well as improving the designs of existing boats to reduce fuel consumption.

The National Institute of Oceanography (NIOF) has played a prominent role in meeting some of the challenges to the sustainable development of aquatic resources through collaboration with the EU and Egyptian institutions. Innovative technology and expertise, based on the requirements of an ecosystem approach to fisheries and aquaculture management, has been transferred from EU institutions to Egyptian researchers, fisheries organizations and wider society. This has been effected through the implementation of the seventh framework programme (FP7) of the Fisheries and Aquaculture-Oriented Research Capacity in Egypt (FORCE).

This initiative has progressed significantly in increasing the capacity of Egyptian research institutes, selected fishery communities and local authorities through various channels such as training sessions; applying modelling tools for site selection and Environmental Impact Assessment of fish farms (carried out by Ca' Foscari University of Venice); enhancing methods for measuring and improving gear selection; improving methods for measuring and reducing vessel fuel consumption; assessing trawl gear performance; and assessing fishing effort and gear parameters (carried out by the Institute of Marine Science (ISMAR-CNR), Italy).

Stakeholders, fish producers and GAFRD members have contributed effectively to all capacity building activities. The

learning-by-doing sessions have improved the relationships and understanding between Research and Technological Development providers and the commercial sector in order to achieve buy-in from the stakeholders. The local fishing organizations have engaged during the entire project period, achieving a common understanding among researchers and stakeholders and providing valuable feedback from the external community, including those that are not in the first cycle of awareness. Improving the capacity of women to contribute effectively to a substantive development in socio-economic conditions and in the fisheries sector has been secured through training and capacity building programmes run by both the EU and FORCE partner, AQUATT, Ireland.

Image: NIOF

Training session on ICZM principles and tools for the FORCE and PEGASO projects. Participants shown are the coordinator of the FORCE project (left), a GAFRAD authorized member (centre), the PEGASO project coordinator (right)

Coastal area and legislation governing ICZM in Egypt

Integrated Coastal Zone Management (ICZM) is an interdisciplinary and comprehensive strategy or framework based on the best available science and governance to be implemented at both the community and national levels, targeting a sustainable ecosystem.

The 3,000 km-long Egyptian coastal zone encompasses more than 40 per cent of Egypt's industries. The region is therefore extremely important economically, drawing substantial capital investment. The dominant feature of Egypt's Mediterranean coast is the low-lying delta of the River Nile. It extends from Alexandria in the west to Port Said in the east and covers nearly 2,000 km of coastline. It is home to over 50 per cent of Egypt's population; is responsible for more than 80 per cent of the country's agriculture production; is a region of natural gas production; is the source of over 90 per cent of Egypt's fish; and is a pathway for migrating birds.

The Nile Delta contains a unique ecosystem which is very vulnerable to changes. There are two biodiverse wetlands, Idku and Burullus, as well as black sand with its economic value and agricultural fertility. Most of Egypt's economic activities — farming, mining, fishing, industry, archeological and resort tourism — take place in the Nile Delta.

Integrated Coastal Zone Management

Many initiatives have been categorized as Integrated Coastal Zone Management (ICZM) projects in the Mediterranean countries and elsewhere, but it is now widely recognized that ICZM is a process that takes many years to develop. Several ICZM projects and initiatives have been launched since 1990 to put into practice national and regional coastal zone management strategies, but they have so far not been implemented in a reliable way.

ICZM is used to regulate the spatial deployment of economic activities and to set up spatial planning systems for coastal areas. However, there is still a lack of experience in some countries, and little data and knowledge is available to policymakers and practitioners to ensure the successful development and/or implementation of ICZM.

The most significant problem now is how to make better use of knowledge and data on climate change within ICZM processes. The importance of improving knowledge transfer between countries is therefore considered a vital component of cooperation. Knowledge transfer involves all of the processes for collecting and sharing knowledge, skills, best practices and consultancy. Identifying the data and relevant information regarding the impact of climate change on coastal areas is required in order to prioritize resources, anticipate potential pressures, and develop synergies and a governance framework for ICZM.

The impacts of accelerated climate change on the region include the rising of the sea level on the Nile Delta's coastal area, flooding, storm damage, salt water intrusion, the loss of recreational beach facilities and a negative impact on tourism and local tourism-dependent livelihoods, the loss of coastal infrastructure such as ports and wastewater treatment plants, reduced productivity of fisheries, flooding of coastal agricultural land, among others. Scientists have estimated that, even with optimistic scenarios of climate change hazards and a rise in sea level, parts of substantial areas of land in the Nile Delta are expected to be inundated by 2030. All of the above issues will affect the social and economic conditions of the population, but the most vulnerable will be fishermen and farmers living in low-lying areas. An Integrated Coastal Zone Management plan is therefore crucial to preserve the ecosystem and vulnerable people and to achieve the sustainable development of coastal areas.

ICZM policies and governance

Egypt adopted the concept of coastal area management in the 1980s. The first comprehensive document on the subject, prepared in 1996, was the Framework Programme for the Development of a National ICZM Plan for Egypt, setting clear planning objectives and highlighting important characteristics of the coastal zone, with an overview of problems and issues. The first and second National Environmental Action Plans, of 1992 and 2002 respectively, identified coastal management in Egypt as a significant issue and challenge.

Any development of the coastal areas must abide by a number of regulations and national laws that set policies and strategies for the development of the zone, and direct the responsibilities for developing plans for the area's utilization. A law of 1994, together with its amendment in 2009, includes articles defining ICZM, and indicating that the Egyptian Environmental Affairs Agency (EEAA) should prepare an ICZM national strategy. The law also includes articles prohibiting the construction of any establishment within a 200 m setback of the coastline without the permission of the competent administrative authority in coordination with the EEAA. Also, the law prohibits measures that may affect the natural coastline or alter its configuration inwards or outwards, without the approval of the competent authority in coordi-

nation with EEAA. The National Committee of Integrated Coastal Zone Management (NCICZM) was established by ministerial decree for approving coastal development projects located in the 200 m-wide setback zone, and administering the related licenses to the investors, to ensure integration among national authorities and coastal stakeholders.

The Egyptian Government has also taken action to protect coastal waters from pollution, including:

- Applying the principles of integrated management of water resources
- Implementing regular monitoring programmes for coastal waters achieved by NIOF
- Amending laws and their executive regulations concerning the protection of water resources to deal with development and advanced technology used in the industry for wastewater treatment
- Providing economically and environmentally sound technology for sewerage network and treatment stations throughout Egypt
- Raising the efficiency of the existing network.

The PEGASO project

The PEGASO project was also initiated under FORCE FP7, and ran as a collaboration between 25 partners working between 2010 and 2014 to develop a common agenda and novel approaches to supporting integrated policies governing the coastal zone, and the marine and maritime realm of the Mediterranean and Black Sea basins. Since NIOF was a partner in PEGASO, the Nile Delta ICZM became one of PEGASO's case studies. The project helped develop tools to better appraise conflicting coastal zone issues, responding closely to the articles in the ICZM protocol, and focusing on the balance between urban development and natural capital maintenance. The initiative included analysis of the cumulative impacts of climate change and human activities, assessing risk vulnerability and adaptation, taking into account land and sea use maps, accounting methods, models and scenarios. Tools have been tested and validated in a multi-scale approach to integrated regional assessment through a Nile Delta case study.

The Nile Delta. The yellow line demarcates the coastal area within the PEGASO case study

The proposed Nile Delta ICZM plan includes two parts:

- A land-use plan for the east and north Nile Delta including fish farms, industrial zones, beaches rich in black sand, recreational beaches, new coastal cities, unused areas and shipping zones
- A shoreline management plan taking into account the management of the delta coastline by combining management plans, rates of beach changes, shoreline stability, protection works and natural resources.

All national, local Nile Delta stakeholders, authorities and policymakers were involved in the development of the PEGASO Nile Delta Case study throughout the process.

Image: NIOF

PEGASO partners during a site visit in 2012 for the Nile Delta case study

Measures to ensure ocean health around the Sultanate of Oman

Saud Salim Juma Al Araimi, Director of International Cooperation, Ministry of Environment and Climate Affairs, Sultanate of Oman

Oman's marine environment, with its beautiful beaches extending to over 3,000 km, is one of the most important economic, social and environmental elements of the Sultanate, with its natural resources and access to the Arabian Sea, Oman Sea and Arabian Gulf.

In order to achieve the goals aimed at protecting the marine environment and preserving marine biological resources, the Sultanate has given marine protection special importance by carrying out studies, establishing marine nature conservation areas, issuing legislation, implementing coastal zone management plans, rehabilitating dry watercourses and planting mangroves in several of the governorates. In addition, coral reef management plans have been implemented, campaigns have been conducted to clean up environments, and turtles and marine mammals have been monitored because of their importance to the sustainability and balance of the marine environment.

Oman's action priorities for protecting the marine environment and managing the coastal zone are currently:

- Preventing further degradation of the coastal environment and restoring degraded areas
- Conducting studies and research on the potential impacts on coastal areas and their natural resources
- Continuous monitoring of the coastal environment to ensure its preservation
- Coastal land use planning
- Public awareness and citizen involvement in protecting coastal resources.

Marine pollution

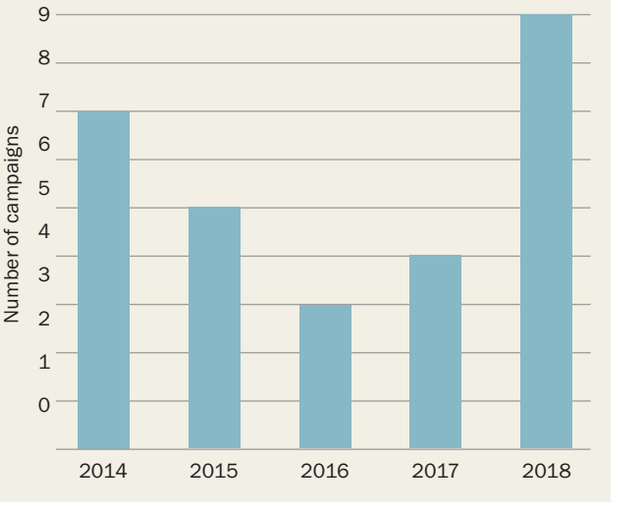
In order to achieve the goal of preventing and reducing marine pollution of all kinds, especially that resulting from human activity, the Sultanate issued a Royal Decree[1], the first of its kind in the environmental field, in its preparation of the 1985 national plan to combat pollution. This is being continuously updated to suit the changes taking place in the country, such as the expanding coastal facilities that may lead to oil spills, and it continuously monitors ports and industrial free zones, as well as the oil tankers that cross the territorial waters of Oman.

Now the Omani marine environment special economic zone has been approved, the Sultanate is seeking to obtain international approval to extend the borders of the continental shelf. The Sultanate has also realized the importance of environmental permits and their regulatory necessities. Regulations on waste discharge to the marine environment have therefore been set, and dumping and discharge permits for the marine environment are issued in accordance with the articles of the regulations, which affect the discharge of effluent to the marine environment, and other activities such as the transportation of liquids between marine facilities. The licensing process requires that companies provide periodic monitoring reports of the quality of effluent discharged, as well as laboratory reports to include chemical analyses of dumped solid materials, ensuring that they are free from pollutants and conform with the conditions of the two regulations governing the licenses.

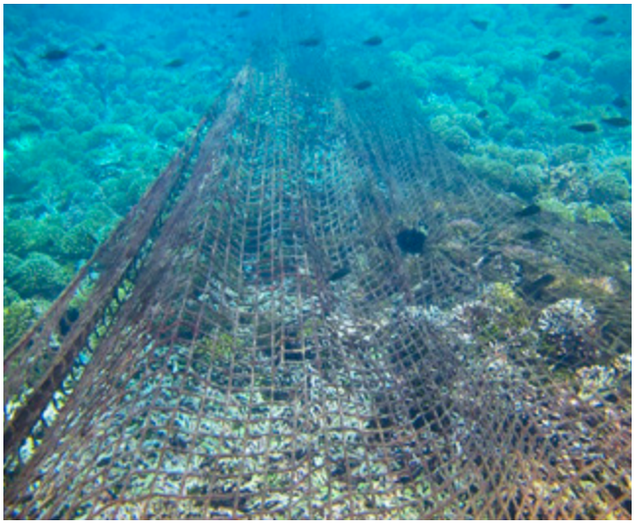
The occurrence of algal bloom known as red tide[2] is also being assessed in coordination with the Sultanate authorities and the regional organization for the protection of the marine environment through a comprehensive national plan to reduce its effects.

In addition, the Maritime Security Centre was established in 2014, tasked with managing and leading maritime security. Operations are located in port facilities, and monitor the coasts for maritime security threats, as well as combating marine pollution, climate change and threats to fisheries.

Coral reef cleaning campaigns, 2014–2018








Campaigns have been implemented to clean the reef environments where the discarding of nets and other fishing equipment has increased. Also, at the Al-Dimaniyat Islands Reserve, nearly 600 crown-of-thorns starfish have been removed through the implementation of four campaigns

Coral reefs

In order to achieve the goal of managing marine and coastal ecosystems in a sustainable manner, the Sultanate has paid special attention to marine ecosystems such as coral reefs and mangroves. The coral reefs are located in five main sites, all of which receive special attention, with campaigns implemented to clean the reef environments where the discarding of nets and other fishing equipment has increased.

Campaigns have been organized continuously since 2002 to clean the coral reef environments at various sites with a focus on the sites most affected due to heavy fishing activities. This has been done in cooperation with the various relevant authorities with a view to cleaning the coral reef habitats of all waste, especially fishing nets, as well as educating the locals regarding the importance of those biological resources. The campaigns involve gathering information to determine the status of the reefs, and are implemented with the participation of various stakeholders, including the Ministry of Agriculture and Fisheries, the Ministry of Tourism, the Royal Oman Police (Coast Guard Command), Sultan Qaboos University, Oman Environment Society, diving companies and clubs, and volunteer individuals, citizens and residents.

In the context of the Sultanate's participation in global efforts to protect the environment, and within the 'Clean Seas' campaign of the United Nations Environment Programme, an integrated plan for cleaning coral reef environments was implemented in 2018.

Due to the bleaching of many coral reefs, the consequent proliferation of crown-of-thorns starfish has been a problem at one of the Sultanate's most important sites of coral reef colonies, the Al-Dimaniyat Islands Reserve. Here, nearly 600 crown-of-thorns starfish have been removed through the implementation of four campaigns with the participation of volunteers from Oman diving clubs.

In view of the threats faced by coral reefs that limit their growth or cause deterioration, and continuing its approach to developing biodiversity, the Sultanate has recognized the success achieved by using artificial coral reef structures in several parts of the world to find an alternative to the lost ecosystems and manage the effect on complex food chains. Approximately 500 artificial reefs have been deployed so far on the island of Fahal, the Dymaniyat islands and Musandam Governorate, a project that has been evaluated and proven completely successful.

Nearly 500 artificial reefs have been deployed so far. The experiment has been evaluated and has proven completely successful

The planting of mangrove trees began in 2000 by establishing 4 nurseries. More than 600,000 seedlings had been planted up until the end of 2018

The Sultanate has launched a number of floating anchors at Bandar Al-Khiran, Bandar Al-Jissah, and the Al-Dimaniatiyat Islands Nature Reserve, with the aim of protecting coral reefs from boat mooring impacts

With a noticable increase in green areas of mangroves and the implications for biodiversity, several field surveys have been carried out to discover the extent of the success of the plantation project

Mangrove trees

Mangrove trees are one of the most significant components of Oman's marine environment. The species *Avicennia Marina* is especially able to cope with the nature of the local environment, and is distributed in several coastal regions, where the total area of mangrove coverage is approximately 1,030 ha. In order to preserve these trees, the project of planting began in April 2000, by establishing 4 nurseries in various governorates. This resulted in the planting of more than 600,000 seedlings up to the end of 2018.

Several field surveys have also been carried out to determine the extent of the success of the plantation project, as an increase in green areas and biodiversity has been noted. In addition, mangroves are considered highly efficient environments for storing carbon as well as providing habitats to attract large populations of endemic and migratory birds.

Marine biodiversity management

In Oman, there are many species of large whale and dolphin: 17 species of small to large dolphin, 3 types of Baleen whale, and sperm whales. Satellite studies and research have proven that Oman's humpback whale is non-migratory and remains in its habitats near the Omani coasts due to the seasonal climatic conditions that occur to the south of the country, and the variety of food sources available throughout the year. This behaviour is unlike other species of whales that live in the Southern Hemisphere and which migrate to Antarctica for foraging. This makes it a unique creature, and the numbers seen for this species are close to 100.

Oman also has in its surrounding waters five of the seven species of sea turtle: the green turtle, loggerhead turtle, hawksbill turtle, olive ridley turtle, and the leatherback. Following observations, a national team has been formed to study the causes of death and delinquency of mammals and sea turtles, a phenomenon that is considered one of the indicators of the health of the marine environment.

It is the case that these studies may sometimes detect marine animals that are unknown and have not previously been observed. But, most significantly, because marine mammals are among the essential elements in the marine ecosystem, some of which are endangered species, the importance of these studies is crucial to ensuring sustainability.

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Page 10: Towards strengthening management of high seas biological diversity

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1 The map is not part of the Convention text and has no legal status. Any opinions or errors are the sole responsibility of the authors.

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Page 85: Combating marine pollution in Sierra Leone

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Published in 2020 by Human Development Forum
www.humandevelopmentforum.org

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