One Planet, One Ocean

The Intergovernmental Oceanographic Commission of UNESCO

United Nations
Educational, Scientific and
Cultural Organization

Intergovernmental
Oceanographic
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Image credit: Dave Allen

Published in 2017 by the United Nations Educational, Scientific and Cultural Organization

7, Place de Fontenoy, 75352 Paris 07 SP, France

Produced by: Flinch: www.flinchmarketing.com/ / **Design:** Philip Rosieur / **Editorial Team:** Julian Barbière; Albert Fischer; Vinicius Lindoso; Steve Menzies / **Cover Photography:** Stuart Chape / **For bibliographic purposes, this publication should be cited as follows:** One Planet. One Ocean: The Intergovernmental Oceanographic Commission of UNESCO. Paris. 2017. 68 pp. (English) IOC Brochure 2017-1

(IOC/BRO/2017/1)

Image credit: Dave Allen

Preface

This brochure highlights the central role the Intergovernmental Oceanographic Commission of UNESCO (IOC) plays in the sustainable management of our oceans. Outside the ocean science community many people are unaware of the critical services the IOC provides, from coordinating the global tsunami warning system, to supporting greater understanding of climate change, and sharing data on all marine life from bacteria to whales.

The IOC is a community of 148 Member States that work together to observe, understand and manage the shared marine environment that unites us all. The deep ocean may be the last frontier of the planet but, for over half a century, the ocean has also played a leading role in building greater international cooperation. Since it was first formed in 1960 the work of the IOC has evolved from the technological optimism of the space age to the more recent challenges posed by climate change and the increasing demands of a rapidly expanding human population.

The cumulative threats posed by warming sea temperatures, ocean acidification and pollution have created an even more urgent need for the critical services provided by the IOC. The ocean provides about half of the oxygen we breathe and it directly supports the livelihoods of about 500 million people, especially in the poorest nations. For many of these nations, ocean-related economic activities such as tourism and artisanal fisheries support up to 30% of national economies.

For over 50 years the IOC has worked behind the scenes to enable its Member States to work together to strengthen our scientific understanding of the ocean for the benefit of humanity. However, in recent years, there has been a growing need to highlight the unique intergovernmental value that it provides for Member States, the IOC community, the ocean environment and wider society.

The stories in this brochure demonstrate the considerable value that all Member States derive from their membership in the IOC. These stories also provide an opportunity for many different stakeholders to explain the tangible value that the IOC provides for the effective delivery of their work. From the global deployment of automated underwater robots to the development of systematic guidelines for Marine Spatial Planning, this publication takes us on a fascinating journey through the undersea world of the Intergovernmental Oceanographic Commission of UNESCO.

An Introduction from

The Chair of the IOC

Peter M. Haugan is the Chair of the Intergovernmental Oceanographic Commission of UNESCO (IOC). He is also a professor at the University of Bergen's Geophysical Institute and research director at Norway's Institute of Marine Research

The climate, the global economy and the livelihoods of billions of people all depend on the health of our ocean. Because of the growing pressure we are putting on our marine resources, the world needs a global organization that can support science-based decision-making on the key issues affecting our shared ocean environment.

The global ocean is far too big for any one country to manage and oceanography is, by necessity, an international discipline. If we really want to sustainably manage our ocean resources, and reduce ocean-related hazards, we need to find ways to support sustained observations of our ocean systems at a global scale.

The IOC is the critical intergovernmental organization that enables all Member States to work together in support of global ocean science for the benefit of the global community. The purpose of the IOC is to promote international cooperation among its 148 Member States in order to learn more about the nature and resources of the ocean and coastal areas and to apply this knowledge for the sustainable development of the marine environment.

The IOC of UNESCO has long been the only agency within the United Nations system that has the ability to coordinate marine science so that other

"The IOC is the only organization with the ability to ensure that developing countries have the scientific capacity needed to achieve the United Nations Sustainable Development Goal 14 to conserve and sustainably use their ocean and marine resources."

Member States, UN organizations and agencies can collaborate effectively with regard to ocean science, observations and data exchange. The IOC provides the information and advice needed by Member States to inform the development of their effective marine policies and to help manage the ocean areas beyond national jurisdiction (ABNJ).

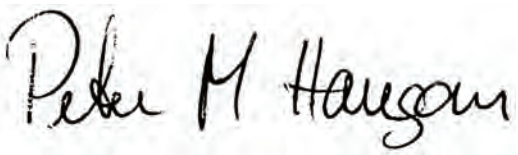
This brochure demonstrates the critical intergovernmental value that the IOC provides to marine science and global ocean governance. It also shows how the IOC is providing tangible benefits for its Member States in a range of critical policy-making and management areas including climate change, coastal hazards and the sustainable use of ocean resources.

The IOC also enables its Member States to achieve real value for money by leveraging the shared resources and investments of all nations. Some IOC Member States have invested billions into the development of national ocean science initiatives. By working with the IOC these countries can leverage truly global value from their national investments and developing countries can benefit by increasing their scientific capacity and accessing marine technologies.

The reality is that the IOC is the only organization with the ability to ensure that developing countries have the scientific capacity needed to achieve the United Nations Sustainable Development Goal 14 to conserve and sustainably use their ocean and marine resources. Many Small Island Developing States (SIDS) are already benefitting from the IOC's capacity building and technology transfer activities.

After looking through this brochure I'm sure you will agree that the IOC is playing a critical role in helping to provide the information and ocean services needed to protect vulnerable communities and to improve the management of our vital marine resources.

Let us all continue to work together so we can harness the full power of the IOC in our shared efforts to become better stewards of a healthy ocean environment that we can pass on to future generations.



Argo

Charting the Unknown

Image credit: Mamaca/Dugornay, Ifremer

"The IOC has been absolutely essential in enabling us to build a global observing system like Argo."

Dr Susan Wijffels

Co-Chair of the International Argo Science Team

Image credit: NIWA

Charting the Unknown

When the Greek hero Jason sailed his ship, the Argo, into unknown seas in search of a Golden Fleece, legend has it that her prow contained a magical piece of timber which could see into the future. But the ancient Greeks could never have predicted that thousands of robotic Argo floats would one day magically beam data to a series of Jason satellites, giving scientists a revolutionary, real-time view of the world's oceans.

Today about 3,800 of these golf-bag-sized floats are now scattered across the globe. They spend most of their life drifting up to two kilometres below the surface, before rising every ten days to transmit their data. For up to eight years the Argo floats make about 200 of these cycles before their batteries finally run out.

Argo is considered to be one of the most ambitious and successful international marine observing programmes ever undertaken. This international, open-access collaboration is supported by more than 30 countries and forms a key part of the IOC-led Global Ocean Observing System (GOOS). It is also revolutionizing our understanding of how heat is being stored and transferred throughout the world's oceans.

Image credit: Craig Macaulay

“Argo is the ultimate energy cop.”

Dr Susan Wijffels

Co-Chair of the International Argo Science Team

With over 90% of the total heat from global warming being absorbed by the ocean and with sea levels rising about 3 millimetres a year, and accelerating, developing a better understanding of the warming ocean will be critical for guiding action on climate change.

Dr Susan Wijffels, the lead scientist for Australia's contribution to Argo and Co-Chair of the International Argo Science Team, says the system has helped support and challenge the computer models that are needed to predict climate change.

"Argo is the ultimate energy cop. As the international community starts to try and mitigate carbon emissions it's going to tell us whether we've actually been successful in slowing down warming or whether it continues to accelerate. It's a very hard target for our climate modelling community and it's a very powerful metric to help validate the models that we use for climate projections," she says.

Dr Wijffels says the strength of the warming signal in the ocean provided by Argo has taken even scientists by surprise.

"I expected to wait 15 years before we could see it but it's just leapt out in about 7 or 8 years because it is so strong and because Argo measures globally and deeply enough that the signal is extremely clear," she says.

The Argo programme is now testing the technology that will enable Argo floats to be sent to depths of up to 6,000 metres, allowing scientists to develop an even better understanding of the energy imbalance at the deepest levels of the global oceans. Dr Wijffels says Argo also provides countries with a range of immediate and practical benefits such as the ability to better predict tropical cyclones and improve shipping navigation. She is quick to add that none of this would be possible without the support of the IOC.

"The IOC has been absolutely essential in enabling us to build a global observing network like Argo because without it there would be whole vast areas that we would be locked out of. The IOC has hundreds of member nations and it was the only forum that would allow us find a solution for Argo's need to measure globally," she says.

While Argo relies on a model of free and open data sharing and coordination, some countries continue to have concerns about providing access to information that they believe might compromise their national security or the management of key resources such as fisheries and oil.

Dr Wijffels says that only the IOC could have brokered the intergovernmental political framework needed to support Argo by passing a special resolution that allowed it to operate in the Exclusive Economic Zones of its Member States. The IOC also established an intergovernmental Argo Information Centre in Brest, France, as part of a joint technical coordination centre with the World Meteorological Organization (WMO). The Argo Information Centre ensures that the array is transparently and independently tracked and that all data collected by the floats is freely available

Today Argo still faces a range of challenges, such as collecting much-needed data from politically sensitive areas like the East Asian seas, and operating in sea ice zones where the floats cannot surface during winter. One of the biggest challenges the programme faces is in finding the sustained funding needed to maintain or expand it into new areas such as the deep ocean. Argo currently costs between USD 25-30 million a year to operate but, for many nations, the programme is supported by national research programmes that are under the constant threat of budget cuts.

Despite these ongoing challenges Dr Wijffels is confident the IOC will keep working to support the modern Argo to provide the critical data needed to imitate its mythical Greek namesake and help us to chart a safe course through the unknown seas of the future.

"I still don't think many people understand what the IOC is or why it is so important. It is like a quiet achiever working away in the background helping enable these really important services for society. But, because we've made such incredible progress over the last few years, I think many countries will start to really celebrate Argo and the IOC as one of our best examples of international collaboration," she says.

Global Ocean Observing System

Image credit: Marine World Heritage

The Global Ocean Observing System (GOOS) is a collaborative platform that delivers the IOC's Member States with sustained observations of the global ocean. Coordinated by the IOC and its partners, GOOS provides information that supports a wide range of services such as climate research, ocean forecasts, and even search and rescue operations, such as efforts to find the wreckage of the Malaysian Airlines flight MH370.

The intergovernmental coordination supported by GOOS means that all IOC Member States benefit from a combined global investment in ocean observations of around a billion dollars every year. Many studies suggest there is a significant return on this investment across multiple sectors of the global economy. In the United States alone it is estimated that the improved El Niño forecasting supported by information from GOOS could be worth at least USD 100 million a year to the producers of staples such as wheat and corn.

Through an interconnected system of ocean data-collection platforms, including tide gauges, research and commercial ships, ocean buoys and the Argo array of drifting floats, GOOS is able to monitor physical measures such as temperature and salinity, surface winds, and biological and biogeochemical variables such as plant and animal plankton, oxygen and carbon.

This global system connects experts working across all aspects of ocean observations but it also relies on the volunteer support of scientists, researchers and marine managers to maximize the impact of these ocean observations. The data collected can then be processed into vital knowledge 'products' such as climate and weather forecasts. GOOS also serves as the ocean component of the Global Climate Observing System (GCOS), which supports the Intergovernmental Panel on Climate Change (IPCC).

Image credit: Monica Allen

"This complexity requires organizations like the IOC, and partners such as the World Meteorological Organization, to help bring together the nations of the world to develop that system and operate it effectively."

Dr David Legler

Chief of NOAA's Climate Observations Division

Dr David Legler is the Chief of the Climate Observations Division at the National Oceanic and Atmospheric Administration of the United States (NOAA) and he co-chairs the Observations Programme Area of the Joint IOC-World Meteorological Organization (WMO) Technical Commission for Oceanography and Marine Meteorology (JCOMM). Dr Legler believes the IOC plays a critical role in coordinating global ocean observations.

"There is an underlying complexity of a system that operates globally but has to work in concert with a large number of countries that collect ocean data. This complexity requires organizations like the IOC, and partners such as the World Meteorological Organization, to help bring together the nations of the world to develop that system and operate it effectively. It's such a powerful concept to have the IOC as a neutral, interested party where the governments can get together and agree that the ocean is a priority, develop an observing strategy, make it work and make the data accessible to all," he says.

Without GOOS, Dr Legler says, it would be very difficult for national scientists to really understand the changes taking place in the global ocean environment.

"The ocean is a pretty important part of the climate system and we can't rely simply on observing our own waters. For example, I can't imagine that we would have a very accurate forecast of El Niño, if we didn't understand what was going on in the far western parts of the tropical Pacific which is entirely out of our territorial domain," he says.

As we look to the future Dr Legler believes the promise of autonomous vehicles will help to strengthen GOOS even further by extending the system into the deepest parts of the ocean to study things that have never been observed before.

"There is an increasing demand for information and I think our challenge is how to keep the system growing. We need to embrace these new opportunities and to take full advantage of the new technologies and sensors to provide better information in critical areas such as ocean acidification, sea level rise and the development of climate and marine services," he says.

Image credit: Great Barrier Reef Marine Park Authority

Improving Management of the Great Barrier Reef

Australia's Integrated Marine Observing System (IMOS) is one of thirteen GOOS Regional Alliances. It provides a wide range of satellite and *in situ* observations that are used to support marine management services for Australia's iconic Great Barrier Reef, which is a UNESCO World Heritage site.

The Great Barrier reef Marine Park Authority is using observation data from IMOS to support the development of the eReefs oceanographic model. This model also incorporates monitoring data to provide managers with information on water quality, sea surface temperature and other conditions across the Great Barrier Reef from estuaries and lagoons to the open ocean.

The eReefs model will be used in the Great Barrier Reef World Heritage Area to develop scenarios to determine how changing farm practices can improve water quality in the Great Barrier Reef lagoon and the health of seagrass and corals. It also provides a platform to assess and predict the cumulative impacts of multiple pressures facing the Reef, such as extreme weather and bleaching, to guide strategic investment in reef recovery.

Global Tsunami Warning System

Coordinating the Global Tsunami Warning System

Many people remember exactly where they were on 26 December 2004 when they first learned about the devastating Indian Ocean Tsunami that claimed around 227,000 lives in 14 Indian Ocean countries. Over 2,154 people from almost 50 countries outside the region also lost their lives including 543 Swedes and 539 Germans. Today, despite the sheer enormity of this terrible tragedy, very few people are aware of the critical role the IOC plays in protecting lives through its coordination of the Global Tsunami Warning System.

The IOC first established the Pacific Tsunami Warning System in 1965 and, following the 2004 tsunami, it was tasked with coordinating the development of three additional tsunami warning and mitigation systems for the Indian Ocean, the Caribbean and the Northeastern Atlantic, and the Mediterranean and Connected Seas. Many of IOC's Member States have made significant investments in the development and operation of these new regional tsunami warning systems.

The Indian Ocean Tsunami Warning and Mitigation System (IOTWMS) alone cost approximately USD 450 million to establish and every year it requires between USD 50-100 million for operation and maintenance. The IOTWMS now includes three regional centres in Australia, India and Indonesia including: the Joint Australian Tsunami Warning Centre (JATWC), operated by Geoscience Australia (GA) and the Bureau of Meteorology (BoM); the Indian Tsunami Early Warning Centre (ITEWC), which is operated by the Indian National Centre for Ocean Information Services (INCOIS).

Image credit: Stuart Chape

Germany invested approximately EUR 50 million in the development of the Indonesian Tsunami Early Warning System (InaTEWS). Monika Breuch-Moritz, the President of Germany's Federal Maritime and Hydrographic Agency, says scientific staff from several German Institutions were seconded to the UNESCO Office in Jakarta and to IOCs Tsunami Unit in Paris to support the quick operationalization of the system.

"Around most oceans and seas the technical systems are now more or less established but a key challenge remains the required level of public awareness. Tsunamis are quite rare events but it is crucial to constantly maintain and upgrade the technical infrastructure of the tsunami early warning systems worldwide," she says.

The Tsunami Early Warning and Mitigation System in the Northeastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS) serves 39 countries where an estimated 130 million people live on the coast. These numbers swell when tourists descend on the beaches during the summer months. In recent years one of the main achievements of the NEAMTWS has been the establishment and accreditation of four Tsunami Service Provider centres in France, Italy, Turkey and Greece.

Dr Gerassimos Papadoupolos, the Research Director of the National Observatory of Greece, led the development of the Hellenic National Tsunami Warning Centre. He says that, because their national centre has been developed as a core part of the NEAMTWS, it has also benefited a great deal from the support of the IOC.

"In the future I think the work of the IOC will only increase because it is the only organization that brings together all the nations involved in ocean issues. Here in Greece we want to keep working with the IOC to activate more civil protection authorities and increase the level of public awareness," he says.

In recent years another major success in the Global Tsunami Warning System has been the development of the Caribbean and Adjacent Regions Early Warning System (CARIBE EWS). The tsunami threat was widely under-recognized in this basin prior to 2004 but now the annual tsunami exercise, CARIBE WAVE, has experienced a dramatic expansion in community participation. In 2016 more than 330,000 participants from all the CARIBE EWS Member States took part in this exercise and the number of "Tsunami Ready" municipalities has also increased to 51. Although all Member States have participated in tsunami standard operations training, only 5 of the 48 CARIBE EWS States and territories are recognized as Tsunami Ready, demonstrating that much work still remains to be done.

In the Pacific region Filomena Nelson, the Chair of the IOC's Intergovernmental Coordination Group (ICG) for the Pacific Tsunami Warning System, says the IOC has helped to design a number of programmes to help communities to be better prepared and protected. However, she is quick to add that much more investment is needed to strengthen the technical systems for many Small Island Developing States (SIDS).

"Monitoring and detection equipment is very expensive and it's often very difficult for small island nations to seek the financial resources needed to procure and operate this kind of equipment. This is when the IOC can help these Member States to improve access to funds needed to support the implementation of warning systems and the capacity to operate these systems," she says.

On 27 February 2010, an earthquake measuring 8.8 struck off the coast of central Chile causing a tsunami that killed 525 people and caused USD 30 billion worth of damage. Rear Admiral Patricio Carrasco, the Director of the Chilean Navy's Hydrographic and Oceanographic Service, says the IOC helped to strengthen Chile's National Tsunami Warning System following this event.

Admiral Carrasco says the IOC helped to develop a new operations centre where staff can now train on a daily basis and constantly simulate possible events in order to improve tsunami warning times. He firmly believes that belonging to the IOC is a "must" for all nations because it can help governments to increase the value of national investments in infrastructure, operations and public awareness.

"We are constantly exploring new ways to reduce the reaction time needed to analyse and issue timely and reliable information after the occurrence of an event. But I personally believe that education is the most important component in the tsunami warning system and the IOC plays a crucial role in this area," he says.

Indonesian school children take part in tsunami warning drills. Photo courtesy of the World Bank

"Education is the most important component in the tsunami warning system and the IOC plays a crucial role in this area."

Rear Admiral Patricio Carrasco
Director of Chile's Hydrographic
and Oceanographic Service

Ocean Acidifica

"The IOC is central in helping to bring together different countries, identifying the major issues and facilitating responses."

Dr Bronte Tilbrook
Co-Chair of the Global Ocean Acidification Observing Network

An early warning about the economic impacts of ocean acidification came in 2005 when an upwelling of low pH water on the Northwest coast of the United States threatened the region's USD 300 million shellfish industry. When a drop in pH from 8.1 to 7.6 led to the death of billions of oyster larvae, the emerging issue of ocean acidification captured the attention of oyster-loving politicians and legislators from the United States and around the world.

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Image credit: Commonwealth of Australia (GBRMPA)

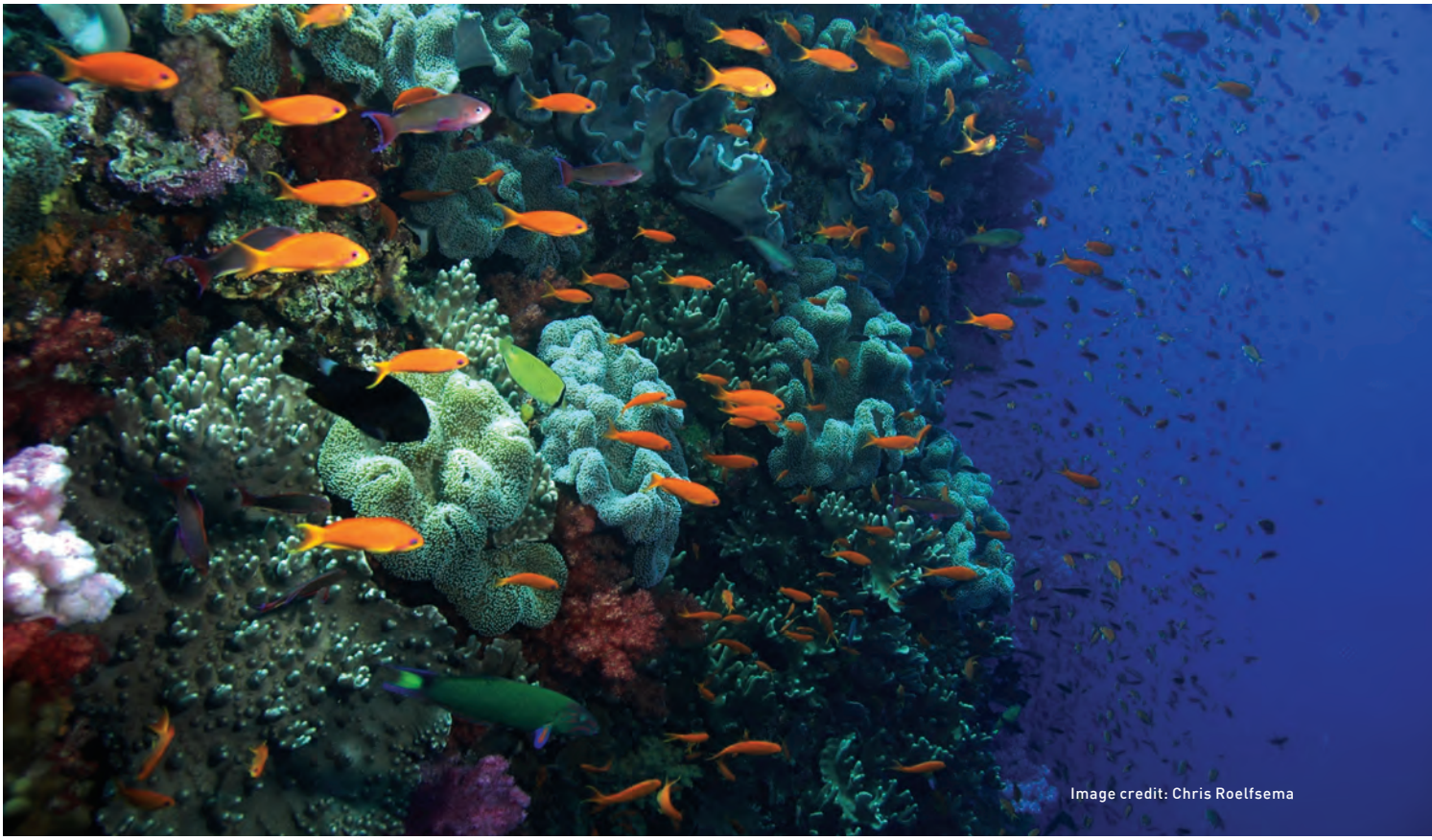


Image credit: Chris Roelfsema

Remarkably, in this particular case, scientists and legislators were able to work quickly with the industry to identify the problem and to raise pH levels of those waters back above 8.1, thereby reducing the stress on shellfish hatcheries. But this event also allowed many scientists and policymakers to get a glimpse of the disruptive impacts that ocean acidification is likely to have on the world's coastal regions in the coming years.

Every year the ocean absorbs about a quarter of man-made carbon dioxide (CO_2) emissions, increasing acidity as this CO_2 dissolves in the seawater. This change is seriously threatening the health of the world's oceans, and the significant economic benefit they provide, by making it difficult for organisms such as corals and molluscs to produce their shells or skeletons. This is extremely concerning for communities in places like Southeast Asia where up to 70-90% of fisheries are dependent on coral reefs. Also, because waters in the Polar Regions are already naturally rich in CO_2 , the Arctic Ocean is likely to be one of the first areas affected by ocean acidification.

While national observation programmes are now emerging in several countries, their value is greatly enhanced when they are brought together at global and regional levels. In 2012, following Rio+20, the Global Ocean Acidification Observing Network was established by a number of organizations including the IOC, the International Atomic Energy Agency (IAEA) and the U.S. National Oceanic and Atmospheric Administration (NOAA).

Dr Bronte Tilbrook, the Co-Chair of this network, believes the IOC is playing a critical role by bringing together the resources of different countries and organizations to understand and tackle the problem.

"The IOC is central in helping to bring together different countries, identifying the major issues and facilitating responses. By understanding what's changing in the ocean and how the organisms are responding we can start to develop adaptation strategies. But, until we get to that fundamental understanding of what's changing, it's very hard to manage," he says.

He adds that a key focus of IOC's work has involved efforts to improve monitoring work by facilitating activities such as "peer to peer" exchanges between scientists from developing countries and some of the more experienced scientists from countries like the United States.

"It's important that we understand what's happening in the ocean from local to global scales. We need to bring together all these groups to get working on the same problem and have common techniques and ways of reporting data so we can compare different regions. The IOC has been a really important part of developing this collaborative effort," he says.

Dr Libby Jewett, the director of NOAA's Ocean Acidification Programme and Co-Chair of the Global Ocean Acidification Observing Network, says it's the countries with the least resources that may be "blindsided" by rapid ocean acidification if they don't start working to monitor and assess the potential consequences.

Image credit: Philip Rosieur

"Until more research and monitoring is conducted no one can know what the economic and food security implications of ocean acidification will be. But the IOC Sub-commission for the Western Pacific (WESTPAC) has been instrumental in organizing training for scientists in the Western Pacific region so that experts from organizations like NOAA can assist international efforts to improve monitoring and track changes in coral reef ecosystems," she says.

Dr Somkiat Khokiattiwong is the Chairman of WESTPAC, which has 22 Member States that stretch from the eastern Indian Ocean to the islands of the South Pacific. He says the lack of research and long-term monitoring means the ecosystem responses to ocean acidification are still very poorly understood in the region. But he believes the recent adoption of a Sustainable Development Goal focused on ocean acidification has helped countries to appreciate the seriousness of the issue.

"Without the ability to develop meaningful projections on future impacts of ocean acidification on marine ecosystems, especially on coral reefs, our fisheries managers and policymakers cannot develop effective long-term mitigation and adaptation strategies for the people of the region," he says.

Dr Khokiattiwong says WESTPAC has been focusing on standardizing the approaches needed to monitor the ecological impacts of ocean acidification on coral reef ecosystems across all countries in the region.

"We need to think globally, but act locally and regionally with a view to building a global network of research and monitoring which can generate data and information in a systematic, consistent and comparable manner," he says.

While it is critical to improve data collection and analysis, Dr Jewett insists that greater urgency is needed at the political level to help countries prepare for likely impacts of ocean acidification.

"The IOC has done a great job but the governments of the world need to engage directly from the political levels down. In the light of our growing knowledge I'd like to see the IOC use its clout as an intergovernmental forum to hold a special session of the membership to present and discuss the actions we really need to take," she says.

Small Islands & Sustainable Development Goal 14

Q&A with Peter Thomson

President of the United Nations General Assembly

Many Small Island Developing States (SIDS) believe they should be called 'Large Ocean States' because they have vast ocean spaces within their Exclusive Economic Zones. These ocean areas are, on average, around 28 times greater than their actual land space.

The 14th of the United Nations' 17 Sustainable Development Goals (SDGs) is to conserve and sustainably use the oceans, seas and marine resources. However, most SIDS still lack the capacity to collect and use the data needed to build effective ocean policies and strengthen the sustainable management of their ocean resources.

On 13 June 2016, the United Nations General Assembly elected Fiji's Peter Thomson to serve as President of its seventy-first session, which runs from September 2016 to September 2017. In this brief Q&A we ask Mr Thomson about the importance of building greater capacity in ocean science in all SIDS.

Why is it important for Small Island Developing States to build capacity in ocean science?

Many SIDS are custodians of some of the world's richest biodiversity and marine resources but they continue to face the major challenge of insufficient human and institutional capacity in ocean management, research, and data collection. Building capacity in ocean science will enable SIDS to make informed decisions on how to conserve, protect, manage and sustainably use the ocean and its resources. This is an essential component of our action to implement and report on SDG14.

Marine science and technology can contribute towards more informed decision-making on a broad range of ocean and marine resource issues. Scientific activities provide the necessary data and information to allow SIDS to effectively designate managed and protected areas, enhance integrated coastal management, and strengthen the sustainable management of their marine resources.

Why is it important to support efforts by SIDS to meet SDG14?

The adoption of SDG14 as part of the 17 universal SDGs of the 2030 Agenda was a watershed moment for the momentum needed to push action to reverse the decline in the health of our ocean. SDG14 demands the authoritative assistance and knowledge the IOC provides in ensuring the effective management of ocean resources and coastal ecosystems. Therefore IOC's efforts in the implementation, follow up and review of SDG14 will be crucial, especially for SIDS given their existing capacity and resource constraints.

Image credit: UN Photo/Rick Bajornas

"SDG14 demands the authoritative assistance and knowledge the IOC provides in ensuring the effective management of ocean resources and coastal ecosystems."

A key opportunity is the upcoming UN Ocean Conference on the implementation of SDG14 which will be held from 5-9 June 2017 at the United Nations in New York. It is hoped that this conference could be a game changer in reversing the decline of the health of our oceans. It will bring to the UN key decision-makers and stakeholders including: UN Member States; civil society; the private sector; and philanthropic organizations, to produce the projects and partnerships that will ensure the implementation of SDG14. This provides an ideal opportunity to present IOC's critical role in addressing ocean issues to key decision-makers.

How can IOC support SIDS to measure their performance against SDG14?

The IOC has an important role to play in key areas needed for implementing SDG14, particularly capacity development and technology transfer. Tracking progress on the SDGs requires collection, processing, analysis and dissemination of a large amount of data and statistics at the national, regional and global level. This will be difficult for many countries, even for large developed states, so it will be particularly challenging for SIDS given their existing capacity constraints.

It is important to identify the specific needs through discussions with those institutions already working to build the capacity of SIDS to measure their performance on SDG14. In the SAMOA (SIDS Accelerated Modalities of Action) Pathway document these states have called for the support of the international community through launching new partnership initiatives or scaling up existing initiatives. They have asked for assistance in the provision of appropriate financial and technical support and capacity building to improve the data collection and statistical analysis required to enable them to effectively plan, follow up on, and evaluate the implementation of internationally agreed development goals.

In the SAMOA Pathway SIDS have highlighted the need to undertake marine scientific research and develop technological capacity through the provision of technical assistance and the establishment of dedicated regional oceanographic centres. SIDS can also benefit from building capacity to use ecosystem valuation as a tool for the protection and management of fragile ecosystems in coastal areas. Supporting greater cooperation on scientific ocean research among SIDS and developing ocean science programmes in universities will also be important steps in institutionalising the capacity building support within all SIDS countries.

How can SIDS develop the scientific capacity needed to strengthen national ocean policies?

It is important that the development of strong national policies is driven by the countries themselves. IOC assistance should be welcomed and encouraged but the lack of ocean science experts is just one factor. We need to look at how IOC support for capacity building in SIDS assists with implementation of the SDG14, and at the same time helps with implementation of the other SDGs. Given the important role the ocean plays in addressing the environmental, economic and social dimensions of SIDS' sustainable development needs, emphasis should be given to the need for a more coordinated approach at the national level to address oceans issues.

Image credit: Stuart Chape

“IOC’s efforts in the implementation, follow up and review of SDG14 will be crucial.”

Peter Thomson

President of the United Nations General Assembly

“I have now used the (IOC) guide for our on-the-ground work in Canada, Seychelles, and Indonesia, and to support MSP discussions in Mexico, Caribbean nations, Australia, South Africa, New Zealand, and Mauritius,”

Dr Jo Smith

Marine Spatial Planning Science Manager
Global Oceans Team at TNC Canada
(The Nature Conservancy)

Marine Spatial Planning

An ecosystem-based approach

Image credit: Philip Rosieur

Since 2006 the IOC has played a central role in helping countries develop marine spatial plans that today cover about 10% of the worlds' Exclusive Economic Zones (EEZs). Experts now predict that by 2025 at least 35 countries could have marine spatial plans that cover more than a third of the world's EEZs.

Marine spatial planning (MSP) is the public process of analysing and allocating the spatial and temporal distribution of human activities to achieve ecological, economic, and social objectives. In 2009, the IOC published *'Marine spatial planning: A step-by-step approach toward ecosystem-based management'* which has now become the international standard to assist countries in the development and implementation of plans for their marine regions. This guide has now been translated into six languages.

Professor David Fluharty, from the School of Marine and Environmental Affairs at the University of Washington, says the IOC guide provides countries with a positive and realistic approach to MSP. He says it provides "a sophisticated recipe to help jump start marine spatial plans" and a set of "common sense" elements that different planners and organizations can easily utilize.

Dr Jo Smith, the MSP Science Manager for the Global Oceans Team at TNC Canada (The Nature Conservancy), believes that no other publication has had as much impact or reach as IOC's step-by-step guide.

"I have used the guide for our on-the-ground work in Canada, Seychelles, and Indonesia, and to support MSP discussions in Mexico, Caribbean nations, Australia, South Africa, New Zealand, and Mauritius," she says.

The 1st International Marine Spatial Planning Workshop was organized by the IOC in 2006 at UNESCO headquarters in Paris. When this workshop was held only three countries had approved a marine spatial plan. Over the past 10 years the IOC's outreach and communications activities have encouraged around 50 countries to initiate MSP activities. Today the IOC continues to document the international practice of MSP around the world, synthesizing lessons learned, updating technical guidance and training the next generation of MSP practitioners.

Despite its rapid expansion, Professor Fluharty says there are often misconceptions about the role of MSP.

"A common mistake is to think that MSP is designed to achieve only conservation goals as opposed to implementing broader societal goals for economic development or the reduction or avoidance of conflicts," he says.

Dr Nguyen Chu Hoi, the former Deputy Administrator of the Vietnam Administration of Seas and Islands, says the IOC guide was used to help draft Vietnam's national marine planning laws. For example the IOC's MSP approach has been integrated into Vietnam's 2012 Law of the Vietnam Sea and the 2015 Law of Island and Marine Resources and Environment.

Dr Nguyen says his participation in the 1st International Marine Spatial Planning Workshop helped him to realize that MSP was the best approach to help Vietnam implement integrated coastal and marine governance and management.

"Engaging in effective decision-making about the use and management of marine space through an MSP process is a key need for integrated governance, particularly for the coastal and marine business community. Proactive, constructive and coordinated participation in MSP by informed coastal and marine communities is critical to achieving value in this work," he says.

The IOC guide also played an important role during the development of the Emirate of Abu Dhabi's coastal and marine framework plan. Abdulla Al Sahi, Executive Director for the Planning and Infrastructure Sector of the Abu Dhabi Urban Planning Council, says the development of its 'Plan Maritime 2030' was based on the need to better manage the Emirate's critical marine areas, 2,435 km of coastline and some 215 islands.

The IOC guide supported the development of Abu Dhabi's Coastal and Marine Framework Plan, the first marine spatial plan in the Arab-speaking world.

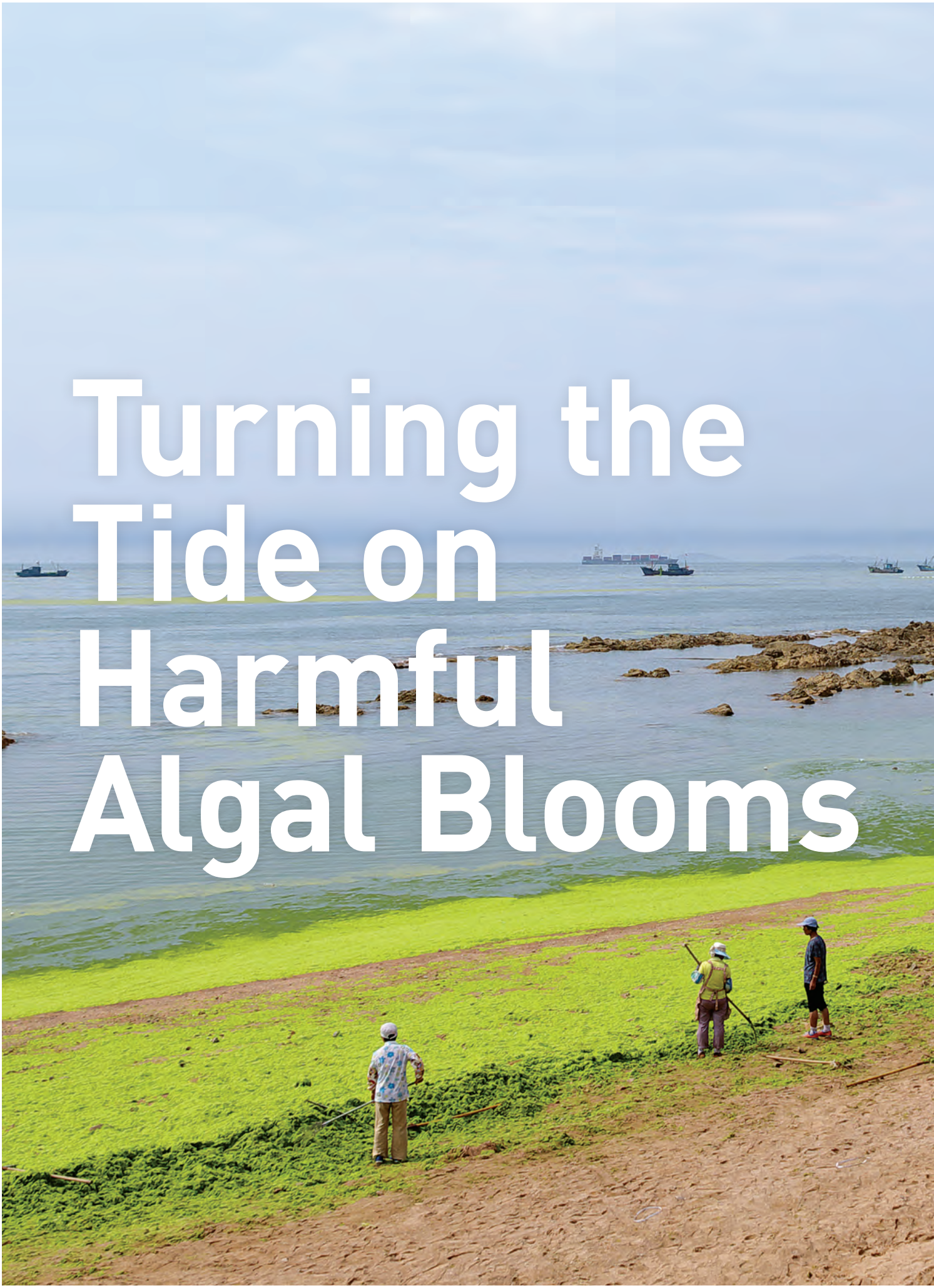
"Much of the success of Abu Dhabi, and indeed the UAE as a whole, is directly linked to its marine areas, therefore ensuring a balanced approach to developing the maritime and coastal areas to enhance economic growth while at the same time protecting these natural assets is vital," he says.

'Plan Maritime 2030', Abu Dhabi's Coastal and Marine Framework Plan, is the first marine spatial plan to be completed and approved within the Gulf Region and the Arab-speaking world. The plan has been created to provide guidance to achieve a balance of compatible uses and activities while minimizing conflicts and avoiding impacts on precious natural and cultural resources.

The IOC will continue to play an important role in helping to promote MSP globally to help Member States provide greater order to the often conflicting needs that our societies place on marine resources. The ecosystem-based management approach supported by MSP will continue to provide an effective framework as Member States work to achieve the Sustainable Development Goal 14 to conserve and sustainably use the oceans, seas and marine resources.

Vietnam's Dr Nguyen hopes the IOC will be able to meet the growing need to develop marine spatial plans at the regional level.

"The focus of MSP is now moving to not only the national, but also the regional or sea basin level, for example the Baltic or the Southeast Pacific. This means that the success of the MSP process at the national level is now creating both the need and opportunity for the IOC's Member States and marine stakeholders to get organized at the regional scale," he says.



Turning the Tide on Harmful Algal Blooms

Image credit: Wang-Junqi

In October 2015 Clara Belmont was working at the Seychelles Fishing Authority when she first heard news of a possible harmful algal bloom (HAB). Unlike previous smaller blooms this one appeared to cover a much larger area and several reports had been received of dead fish washing up on local beaches.

"The toxicity of the algae had caused fish kills and this stirred up panic. Because of the lack of public knowledge about algal blooms the authorities suddenly found themselves pressured to provide relevant information about the event," she says.

Fortunately for these local authorities Clara had been funded to attend a training course at the IOC Science and Communication Centre on Harmful Algae in Copenhagen on how to identify the specific species responsible for different types of toxic blooms.

"Because of the training I received I was able to help collect and analyse water samples of the bloom and we confirmed that it had been caused by the marine dinoflagellate Cochlodinium polykrikoides. The responsible authorities carried out necessary procedures to collect samples and send them abroad for further analysis," she says.

Today virtually every coastal country in the world is affected by harmful algal blooms of microscopic algae or phytoplankton. These blooms can kill marine life and even cause death in humans. Although they occur naturally, the recent increase in these events is likely to be related to human activities such as the release of sewage effluents and transport of HAB species in ballast water.

The goal of the IOC's International Harmful Algal Bloom Programme is to foster and organize the management and scientific research in order to understand the causes, predict the occurrences, and mitigate the effects of these events. The sheer diversity of species presents a significant challenge for all stakeholders working to address the wide ranging impacts of this phenomenon.

The IOC's international Harmful Algal Bloom Programme has helped to bolster research, monitoring and management capacity at the national level and boost funding opportunities for scientists in many countries. To deliver the missing understanding and knowledge to improve monitoring and management of HABs the IOC has a long term partnership with the Scientific Committee on Oceanic Research (SCOR) through the research programme GlobalHAB. Building capacity and training in species identification, toxicity testing, and monitoring and management strategies has been one of the greatest needs identified by IOC Member States.

Dr Pat Tester is a career NOAA scientist who now runs Ocean Tester LLC. Her company helps to field test new products such as the kits used by community groups to determine when samples need to be sent to the lab for more precise analysis. She says many government agencies often fail to appreciate the vital role of the IOC in addressing problems posed by harmful algal blooms.

"No other organization can do what the IOC does. HABs are a global problem and cannot be studied or managed effectively on a country-by-country basis. So the role of the IOC to both inform, coordinate workshops for standardizing methods, advocate for new technologies, provide an international context for discussions and regional management strategies is crucial," she says.

Dr Tester says it can be difficult for single nations to maintain the necessary funding and support needed to reduce the impact of HABs.

"The far reaching effect of HABs are little appreciated until an area experiences a devastating HAB. Then the response is,

'Why isn't anyone doing something about this?' It is difficult to sustain interest and funding with events that can be unpredictable so it's important for decision-makers and the public to have a better understanding about the consequences of HABs and how they can be managed," she says.

IOC's Harmful Algal Bloom Programme is helping to support the development of Namibia's emerging mariculture industry.

Image credit: Frikkie Botes

Dr Tester says the IOC's communications tools, such as the *Harmful Algal News*, are helping to share practical ideas on how countries can deal with this issue. "For example, how you use clay to disperse the blooms or how you advocate for where proposed aquaculture facilities should be located so they won't be a bloom in the making," she says.

At Namibia's Ministry of Fisheries and Marine Resources the Chief Fisheries Biologist, Dr Frikkie Botes, says the IOC's Harmful Algal Bloom Programme is playing an important role to protect the healthy development of his country's mariculture industry.

He says the capacity development support provided by the IOC is helping to improve the management of HABs and ensure that its national water quality monitoring programme meets international standards. Dr Botes believes the development of a harmonized and integrated seafood safety monitoring programme will enable Namibia's mariculture products to be readily accepted by any international market.

"A number of challenges within our monitoring programme for HABs have proven to be a major stumbling block in efforts by Namibia's mariculture industry to penetrate lucrative international markets," he says.

Dr Botes says the IOC support for the delivery of HAB training courses, and the development of a phytoplankton identification guide for Namibia, means that staff now have the skills needed to accurately identify most phytoplankton species found during the regular sampling under the water quality monitoring programme.

While this training has helped to boost the confidence of staff members he also believes it will have an even bigger impact on supporting the development of the Namibia's emerging mariculture industry and the wider economic development of this sparsely populated African nation.

Ocean Science in Africa

A Q&A Professor Micheni Japheth Ntiba

Principal Secretary of Kenyan Ministry of Agriculture, Livestock & Fisheries

Since 2008 Professor Micheni Japheth Ntiba has been the Principal Secretary of Kenya's Ministry of Agriculture, Livestock & Fisheries with responsibility for the development and implementation of national fisheries policy. Prior to this, Professor Ntiba was Chairman of the University of Nairobi's Department of Zoology and the first Director of its School of Biological Sciences. In this short Q&A he talks about the importance of Kenya's membership in the IOC and its participation in the Second International Indian Ocean Expedition.

Why is the Second International Indian Ocean Expedition important for Kenya?

The Second International Indian Ocean Expedition is very important for all the countries around the Indian Ocean and many of the people who live along these coastlines are among the poorest in the world. Kenya has worked for a long time with the IOC of UNESCO so that we can develop a greater understanding about the functioning of the Indian Ocean and its contribution to Kenya's economy. That's a big part of the reason why we wanted to base IOC's Sub-Commission for Africa and the Adjacent Island States (IOCAFRICA) at the United Nations Office at Nairobi in Gingiri.

In 2014, Belgium donated the research vessel, *RV Mtafiti,* to Kenya's Marine and Fisheries Research Institute. Why is this vessel important for the development of marine science in Kenya?

To understand any aquatic ecosystem you need a vessel that can take scientists and their instruments to study the ecosystem and its resources. For many African countries this has long remained a mirage. While they have Exclusive Economic Zones they have no data about their own ocean areas. Whatever data that exists has been collected by others, either on transit or short term expeditions. The *RV Mtafiti* came in at the right time for Kenya because the entire world has begun talking about the sea as the next frontier for economic development.

The Blue Economy initiative is important for Kenya and we now have the ability to map our living and non-living marine resources. We have worked with Belgian marine scientists since the mid 1980's and the *RV Mtafiti* will help to boost continued collaboration between our two countries.

How will the Second International Indian Ocean Expedition help to improve community livelihoods?

Communities should benefit in terms of food security, the creation of jobs, new opportunities, and wealth in terms of trade. The expedition will increase the understanding of our marine resources and help people to understand their relationship with the sea. Understanding of the sea ecosystem is important for the community in terms of how they relate to the marine environment and resources needed to support their welfare, food, trade, tourism and the development of new economic opportunities. For example, I recently went to the coastal region of Kwale and met with some women's groups that are farming acres and acres of seaweed. We know there is potential in areas such as biofuels, pharmaceutical industries, the paint industry, biodegradable plastics, and all of this provides potential wealth for our coastal communities.

Why is it important for Kenya to build capacity in ocean science?

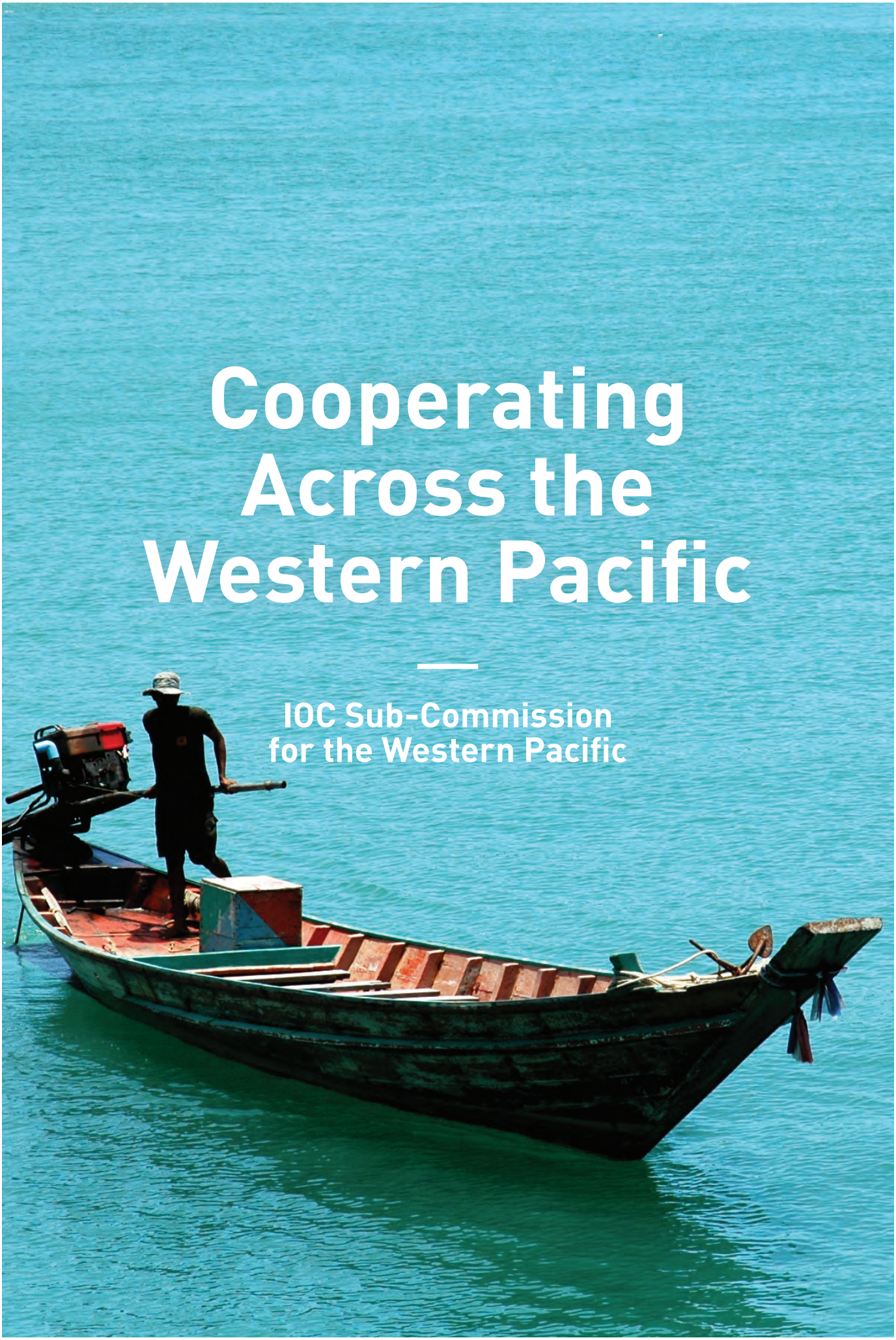
Most ordinary people live their daily lives without thinking about the way they rely on the health of the ocean. The ocean is a driver of the world's living ecosystems; it provides the oxygen we breathe and it regulates the heating capacity of the atmosphere. The terrestrial ecosystem is now facing increasing pressure from human activities and it is starting to reach its productive capacity. Kenya has not yet utilized many of the resources provided by its marine ecosystem and we need to find more effective ways to use modern science and technology to generate new sources of food and energy. But we need to ensure that we do this in a sustainable way.

Image credit: Frikkie Botes

"The Blue Economy initiative is important for Kenya and we now have the ability to map our living and non-living marine resources."

Professor Micheni Japheth Ntiba

Principal Secretary of Kenya's Ministry of Agriculture, Livestock & Fisheries



Cooperating Across the Western Pacific

IOC Sub-Commission for the Western Pacific

The IOC's regional work is greatly enhanced by the presence of three Sub-Commissions in Africa (IOCAFRICA), the Caribbean (IOCARIBE) and the Western Pacific (WESTPAC).

IOC's WESTPAC enables a diverse range of 20 Member States, including countries such as China, Sri Lanka, Fiji and the United States, to collaborate effectively on ocean science despite many of the complex political issues that exist in the region. WESTPAC is also helping many developing nations to access the support and technology needed to address common issues affecting the marine environment across this huge region.

Dr Feng Jun is Deputy Director of China's Division of International Organizations in the Department of International Cooperation for the State Oceanic Administration. He says IOC WESTPAC is one of the most important international organizations for China's engagement in international cooperation on marine science and technology.

"As the main vehicle under the UN framework the IOC has the authority on management, cooperation, resources and expertise for marine science and technology. All of these areas are very helpful to China, which is still a developing country, and in the process of strengthening our cooperation with other Member States on marine issues," he says.

Dr Zainal Arifin, the Deputy Chair of the Indonesian Institute of Sciences, says although strong economic growth has brought prosperity to the region it has also had a damaging impact on the marine environment. While the Western Pacific is the centre of the world's marine biodiversity he says little research has been undertaken on how best to manage these valuable resources.

"The Western Pacific seas are shared by multiple countries in the region, therefore our efforts to advance ocean science and protect marine ecosystems in this region would be futile without joint regional cooperation. It is the IOC WESTPAC, as the intergovernmental body on ocean science, that makes it possible for our countries to work together on understanding and protecting our oceans," he says.

Dr Arifin says IOC WESTPAC's Regional Training and Research Centres are a good example of how countries with more advanced knowledge on a particular issue help to lead capacity building efforts for the benefit of all member countries. He says China's Regional Training and Research Centre on the role of ocean dynamics in climate has now benefited over 260 young scientists from almost 33 countries.

Professor Yasuwo Fukuyo, from the University of Tokyo, also believes that training and capacity building is the key area where IOC WESTPAC can deliver the greatest value for the entire region. However, he says the region still needs to find more effective ways to support the development of those young scientists who will be so crucial to the sustainable development of its marine resources.

"Unfortunately we don't have enough young scientists who can help to develop effective blueprints that are based on scientific knowledge. We urgently need to find ways to provide these young scientists with more training, more research opportunities and more opportunities to share their knowledge and ideas," he says.

Professor Fukuyo believes that Japan has learned the importance of utilizing science as the foundation of its approach to the management of marine and coastal resources.

"In Japan the natural resources from the sea are thought of as a precious gift from nature. We know that no amount of time or money can bring back a degraded coastal environment so we realize the need to set up good management plans for all of our coastal areas," he says.

Professor Fukuyo has dedicated more than 40 years of his life to research on harmful algal blooms and he played a leading role in the establishment of the IOC's Harmful Algal Bloom Programme. He says the WESTPAC HAB has played a significant role in the investigation of HAB events that have caused negative socio-economic impacts in the region for more than 20 years.

"WESTPAC HAB is one of the longest standing projects in the region and it is supported by many scientists and stakeholders because it helps to clarify HAB biology, ecology and toxicology and it directly helps countries to avoid human illness and economic losses," he says.

Professor Fukuyo says that many countries in the region are now facing the consequences of poorly managed aquaculture operations that are directly polluting the coastal environment. He believes there is an urgent need for all coastal development plans to recognize the basic importance of monitoring key factors such as water quality, fish stocks and the occurrence of harmful algal blooms.

Today he believes that IOC WESTPAC is helping countries to work together to develop the science needed to support the daily lives of people living throughout the region.

"For example some people get poisoning after eating seafood that contains natural bio-toxins and in our region the chance of poisoning is higher because Asian people prefer seafood more than meat. Good science can help to clarify the mechanisms of the poisoning but it can also help to provide countries with effective management plans that will help them to increase the chance of avoiding the poisoning in the first place," he says.

The Second Indian Ocean Expedition

A Q&A with Dr. Shailesh Nayak

Secretary of the Indian Ministry of Ocean and Earth Science from 2008-2015

From 2015-2020 the Second International Indian Ocean Expedition (IIOE-2) is designed to increase our understanding about the influence of the Indian Ocean upon the climate, its marine ecosystems and its contribution to the Blue Economy. The IOC's Programme Office in Perth, Western Australia, is helping to bring together the many organizations and individuals that are working together to improve knowledge and build scientific capacity for those countries that are dependent on the resources provided by the Indian Ocean. In this short Q&A Dr Shailesh Nayak, the Secretary of the Indian Ministry of Ocean and Earth Science from 2008-2015, reflects on India's membership of the IOC and its role in IIOE-2.

How does India benefit from its membership in the IOC?

The work of the IOC is critical for all countries because the ocean controls weather and climate, provides food, mineral resources and energy, and sustains an ecosystem for biota to survive. India cooperates with the IOC in key areas such as the development of the Indian Tsunami Warning System, the Indian Ocean Global Observing System and other key areas such as the Harmful Algal Bloom Programme (HAB). Recently India also signed a memorandum of understanding with the IOC to build a training facility to support capacity building activity for operational oceanography at a cost USD 20 million.

Why was the first International Indian Ocean Expedition (1959-65) so significant for India?

The IIOE-1 actually led to the initiation of oceanographic research in India. Besides attempting basin-wide oceanographic coverage it also sought to identify potential fishing zones against the backdrop of general protein deficiency in the people of the Indian Ocean Rim countries. It also worked to understand the role of the northern Indian Ocean in effecting the monsoonal changes and to determine the limits on the use of the oceans for dumping human and nuclear waste.

In the 50 years since the IIOE-1 some fundamental changes have taken place in our understanding of all these issues. India has initiated Potential Fishing Zone Services, mainly based on satellite-based sea surface temperature, sea surface height and chlorophyll, for the countries in the region. This service alone brings annual benefits of USD 7 billion to India, apart from the social and environmental benefits.

Image credit: Courtesy of Geospatial World

"The work of the IOC is critical for all countries."

How will IIOE-2 build on the first International Indian Ocean Expedition (1959-65)?

The discovery of the Indian Ocean Dipole, the difference in sea surface temperature between the western and eastern Indian Ocean south of Indonesia, has proved the global relevance of the Indian Ocean. The IIOE-2 will help to advance our knowledge about the Indian Ocean and its role in modulating global climate.

The IIOE-2 will also seek to establish a firmer foundation of knowledge for future research on which policymakers can make more informed decisions on sustainable management of the Indian Ocean ecosystems, its living and non-living resources and a better assessment and mitigation of the risks to Indian Ocean Rim populations. Capacity development will also represent a critical component for the delivery of societal benefit in the context of IIOE-2. That is why India, along with the IOC, has invested heavily in capacity building in operational oceanography

Why is the work of the IOC important for the IIOE-2?

The main objective of IIOE-2 is to understand the role of the Indian Ocean in shaping our future to ensure sustainability. The IOC is playing a pivotal role in delivery of IIOE-2 by bringing together all countries in this region to fulfil a large canvas of objectives that transcends the Indian Ocean region. The Indian Ocean Rim countries together house about 40% of the world's population, around 55% of the known oil reserves, and around 40% of the world's gas reserves.

The advisory and coordinating role of the IOC complements the corresponding endeavours of the IIOE-2 by improving ocean governance, hazard mitigation measures, and the marine scientific research of its Member States as well as in promoting knowledge transfer, and sustainable development of the world ocean resources. One of the overarching goals of IIOE-2 is to contribute to the creation of more scientifically-informed societies in the Indian Ocean region through capacity development and improved availability and accessibility of oceanographic data from the region.

How can IIOE-2 help to improve understanding of the global role of the Indian Ocean?

The Indonesian Through Flow (ITF) provides for a substantial transfer of Pacific Ocean waters to the Indian Ocean and also strongly influences the heat and freshwater budgets of these two oceans. Variabilities in the heat transfer can therefore be expected to have more than a regional impact. Similarly, akin to the El Niño and the Southern Oscillation (ENSO), it has been suggested that the Indian Ocean Dipole is a significant contributor to rainfall variability in the region and could affect the climate of several countries surrounding the Indian Ocean.

Some recent studies also suggest that rising greenhouse gas levels can lead to an increase in the frequency of extreme positive dipole events, from once every 17 years as at present to once every six years or so. Such studies would place the Indian Ocean processes as a critical element in the global climate system. The IIOE-2 is also designed to look at the global coupled-ocean atmosphere system. For instance, the Indian Ocean has the world's largest meridional heat transport, associated with net heat gain from the atmosphere and vigorous diffusive heating and upwelling of deep and bottom waters. Recent studies indicate that this transport balances heat loss in both the Atlantic and Southern Oceans and is likely linked to decadal variability of Sea Surface Temperature (SST) and CO_2 fluxes which influence climate around the Indian Ocean.

Coastal Management in the Southeast Pacific

SPINCAM

Image credit: F. Félix

The five countries of Chile, Colombia, Ecuador, Panama and Peru share a coastline that stretches more than 8,000 km along the southeast coast of the Pacific. This extensive zone contains a great diversity of ecosystems such as mangroves, coral reefs and upwelling areas. Because of the rapid development of this region these countries need to find effective ways to protect coastal ecosystems while also supporting sustainable socio-economic growth.

The Southeast Pacific Data and Information Network in Support of Integrated Coastal Zone Management - or SPINCAM - is a project designed to support these countries to develop a science-based strategy for the sustainable growth of their coastal areas. This project was initiated in 2009 through the Permanent Commission for the South Pacific (CPPS) with support from the IOC and funding from the Flemish Government of the Kingdom of Belgium.

Julián Reyna, the General Secretary of CPPS, says there were efforts to develop an integrated coastal area management (ICAM) plan early in the 1990´s but the countries were unable to implement it in a coordinated way.

"The IOC's support to promote coastal development with a coordinated ecosystem approach has been warmly welcomed by all the countries and national institutions involved. The SPINCAM concept has now been internalized in national institutions because it promotes inter-institutional arrangements and an exchange of experiences with neighbouring countries," he says

SPINCAM's main objective is to support decision-making through improved data management and networking at national and regional levels. Establishing an ICAM indicator framework has helped to map out the state of the coastal and marine environment and related socio-economic conditions so that communities and governments have the information they need to improve the sustainable management of coastal and marine areas.

The SPINCAM project has produced a range of useful products to support better decision-making, including a series of interactive online atlases at the national and regional level. The project also promotes greater dialogue between governments, communities, scientists and resource managers. It has also provided training for 200 technicians in topics such as geographic information systems, data management, marine biodiversity and marine spatial planning.

Specially tailored training courses with the IOC's International Oceanographic Data and Information Exchange (IODE) in Ostend, Belgium have helped to strengthen national capacities for indicator development, management of oceanographic data, the development of spatial (national and regional) data atlases.

SPINCAM's indicators cover areas such as: marine protected areas; population density; artisanal fisheries; water quality; and vulnerability.
Mr Reyna says the concept of coastal management based on indicators is already improving the decision-making process in the participating countries. He says that SPINCAM allows countries to define their priorities, how to identify where to make interventions, and how to measure the impact of their management activities .

SPINCAM has helped the Southeast Pacific countries to consolidate national environmental indicators and it has helped some countries to start developing their first on-line tools to help communicate their

"The IOC is an institution with the capacity to bring together specialists from different marine science fields."

Julián Reyna

Image credit: F. Felix

Image credit: F Félix

progress in coastal management. The project also supports coordinated efforts by countries to meet shared regional goals in areas such as highly migratory species and the reduction of pollution.

Before SPINCAM there was no set of common national indicators for the Southeast Pacific Region. Each country has defined which indicators are appropriate for them but they are not necessarily the same in every country because countries use different formats and platforms to measure their progress. Through SPINCAM the five participating countries have now agreed to measure a set of regional indicators using the same units and formats that allow direct comparison at a regional level.

Mr Reyna believes CPPS, as an existing regional organization, has been key in fostering the IOC's work in the region. But he says that CPPS has also been strengthened through this cooperation with the IOC.

"The IOC is an institution with the capacity to bring together specialists from different marine science fields. An important achievement of SPINCAM was the creation of a network of experts, which has facilitated the exchange of information and experience across the region. This is something that would have been very difficult to achieve without a structured project framework provided by SPINCAM and the IOC," he says.

Exchanging Oceanographic Data and Information

Since 1961, the IOC's International Oceanographic Data and Information Exchange (IODE) has enabled researchers to exchange oceanographic data and information across all parts of the globe. The IODE network has collected millions of ocean observations and many researchers and scientists rely on this data to address the major challenges facing the health of our oceans.

IODE supports a global community of 65 National Oceanographic Data Centres (NODCs) but the rapid development of personal computing has recently helped to transform the world of ocean data management. An increasing number of research groups, projects, programmes and institutions now manage their own data services. Since 2013, the IODE network has welcomed 20 of these new data centres as "Associate Data Units". In the past, these data centres focused mainly on physical oceanography data but now IODE facilitates access to all ocean related data. For example, in 2009, the Ocean Biogeographic Information System (OBIS), the global knowledge base on the diversity and distribution of marine life, became another major addition to the IODE network.

Cyndy Chandler, an Information Systems Specialist at Woods Hole Oceanographic Institution, is also the Co-Chair of IODE. Over the last decade she says there has been a rapid transition from a reliance on one national data centre per country to the use of federated systems that are designed to enable open exchange of data and information within and between countries.

"Individual oceanographic research data sets are often relatively small in size, but when considered together they can support large research questions. Data contributed from Member States via the IODE network can be integrated and analysed as a whole. This is providing valuable information that we need to address the global science challenges of today and into the future," she says.

Ms Chandler says this is an exciting time to be an information and data manager in the marine research community.

"With rapid advances in communication, computer technology, and marine science progress today's data managers are definitely being challenged to keep pace with changing expectations about what we can achieve," she says.

As marine research programmes become more global and cross-domain in scope Chandler believes the IODE will continue to play a leading role in several essential areas such as data quality, standards, data publication and citation, and data preservation. Indeed a major and long-term commitment of the IODE Programme is the long-term accessibility and archival of oceanographic data, meta-data and information to safeguard present and future holdings against loss or degradation.

Mr Harrison Ong'anda, from Kenya's Marine and Fisheries Research Institute in Mombasa, also believes that IODE plays a critical role in developing much needed capacity in data and information management for developing countries around the world.

"The outcomes can be seen in the array of national data centres that have come into existence since the late 1990's thanks to IODE's Ocean Data and Information Network for East Africa (ODINEA) which later evolved into the Ocean Data and Information Network for Africa (ODINAFRICA)," he says.

As one of IODE's most successful projects, ODINAFRICA brings together more than 40 marine related institutions from twenty-five

ODINAFRICA enables many users to share critical ocean and coastal data.

countries in Africa to address the challenges faced in ensuring that ocean and coastal data and information generated in national, regional and global programmes are readily available to a wide range of users in an easily understandable format.

Around the globe IODE also directly supports a community of 44 librarians and other marine information professionals whose role has changed dramatically during the past few decades as they have become increasingly involved in guiding users through a growing forest of internet-based marine information sources. The creation of E-document repositories, such as the IODE, OceanDocs, is now also helping to provide full text access to science publications in oceanography and other marine sciences.

From serving mainly the oceanographic research community IODE has evolved into a service programme that serves all IOC functions including ocean research, observation, policy, early warning, sustainable management, governance and capacity building. Because of this evolving role IODE is becoming increasingly focused on the development of products and services that contribute directly to the sustainable development and management of our oceans and coastal areas.

The IODE also provides training for marine information specialists, particularly from developing countries. For example OceanTeacher is a training system for ocean data managers, marine information managers and marine researchers who wish to learn how to manage or use oceanographic data and information.

Since 2005, close to two thousand students from over a hundred countries attended courses at the IODE training facility in Ostend, Belgium. Since 2015, a network of Regional Training Centres (RTCs) spread across the globe have been using advanced information technology and multi-lingual training resources to deliver training courses in a range of topics from Integrated Coastal Management to Tsunami Warning Systems.

In the future, IODE will continue to expand its role as a global hub for collecting and sharing the ocean science data needed to address critical issues such as climate change. It will also work to ensure the development of consistent standards and protocols needed to support the effectiveness of ocean observation and science activities at a global level.

Global Marine Life Online

OBIS

Dr Sky Bristol, the Co-Chair of OBIS, says this largest single data repository for biological data from the world's oceans, includes over 50 million observations of 120,000 marine species from 2,000 datasets provided by nearly 600 institutions in 56 countries.

OBIS was established by the Census of Marine life and it now plays a vital role in providing baseline information for global assessments on the state of the marine environment, environmental impact studies and area-based management tools. Because OBIS holds data on all marine species, including non-commercial fishing species, it can also help to measure the impacts of activities in Areas Beyond National Jurisdiction.

Dr Bristol says OBIS continues to grow at a rate of around 3 million records per year, thanks to the continued support from many scientists and data managers around the world.

"OBIS provides a digital representation of life in the oceans that is held in trust by the IOC for the citizens of the world. It is not owned by any one nation but rather it is contributed to collectively by the nations of the world in active partnership to inform individual and collaborative national decisions about managing for biodiversity," he says.

It works to build and maintain a global alliance that collaborates with scientific communities to facilitate free and open access to biodiversity and biogeographic data on a huge range of marine life, from bacteria to whales. These datasets are also integrated so users can search and map them all seamlessly by species name, higher taxonomic level, geographic area, depth, time and environmental parameters.

OBIS is working to support the protection of marine ecosystems by helping to identify hotspots of marine biodiversity and large-scale ecological patterns in all ocean basins. OBIS is now also partnering with the Global Ocean Observing System's Biology and Ecosystems Panel and the Group on Earth Observation's Biodiversity Observing Network to provide sustained monitoring and reporting on the health of the ocean.

Dr Bristol, who is also the Chief of Science Information Services for the United States Geological Survey, believes that OBIS provides the global platform needed to build information products often for national conservation, management and security.

"Species distributions do not stop at the national border so you really need a global database if you want to manage your national resources. The advantage of OBIS is that government administrations do not need to maintain their own databases," he says.

Dr Bristol says that OBIS also facilitates the ability of countries to report on their international treaty and convention obligations by creating a shared database that helps us to understand historic, current, and changing life in the oceans.

"In an era where big data are becoming an increasingly important asset OBIS is making this comprehensive database of ocean life freely available for all uses, from the decision-making of nations to commercial development," he says.

For example, scientists from NOAA's National Marine Fisheries Service, used OBIS data to assess 82 fish species across a range of functions and habitat requirements in terms of their vulnerability to climate change. By drawing on these data they found that the highest vulnerability was among benthic, bottom dwelling species, and diadromous species that migrate between saltwater and freshwater.

Dr Bristol says these types of scientific conclusions, which are reliant on the availability of sufficient observational data integrated through systems like OBIS, can then be used by regulatory agencies to make climate-based management decisions about what types of exploitative fisheries should be allowed.

"The IOC is important because it offers a means for our data to reach the global scientific community."

Dr Amanda Bates

National Oceanography Centre,
University of Southampton

"OBIS is helping to produce active, near real time indicators of environmental change, and the goal is to use OBIS, along with other global data systems integrating additional observations and measurements to provide governments, policymakers, and the public at large with early warning systems that help societies to make wise decisions about conservation measures and other management actions," he says.

Dr Bristol also believes that OBIS will be crucial for supporting IOC's work on the Transfer of Marine Technology for Small Island Developing States.

"One of the major functions of OBIS is also to help repatriate data that has been collected by scientific institutions in the waters of developing nations, helping to increase the availability of data for decision-making in these countries," he says.

Dr Amanda Bates from the National Oceanography Centre at the University of Southampton also believes that governments can use OBIS data to make critical predictions about future ocean biodiversity patterns, including the fish stocks we rely on for food.

"We are increasingly turning to our ocean for blue growth opportunities, at the same time as gaining understanding for the critical role our oceans play in food production, tourism, coastal stability, and even production of the oxygen and cycling of nutrients. We require data and translation of these into knowledge to make decisions for human well-being. Without data platforms such as OBIS, this data would be lost or inaccessible," she says

Dr Bates says she is in absolutely no doubt about the value of OBIS and the IOC for enhancing the effectiveness of her organization.

"The IOC is important because it offers a means for our data to reach the global scientific community and it provides a direct pathway for our research to have societal impact," she says.

The Ocean and You

Most of us live our lives blissfully unaware of how our day-to-day actions impact on the health of the ocean, or how the health of the ocean impacts on our own daily lives.

Ocean literacy is defined as 'an understanding of the ocean's influence on you and your influence on the ocean'. The IOC is working to support ocean research institutions around the world to strengthen public engagement and build greater ocean literacy so we can all have a greater understanding of what we can do to protect the health of our ocean.

Jon Parr is Coordinator of the Sea Change project on ocean literacy funded by the European Commission. As a key partner in Sea Change the IOC is working to understand how the role of ocean literacy can help to strengthen marine governance.

"We believe that understanding is vital to the policy agenda and without this understanding our approach to marine governance may not be able to achieve what it could. The IOC is one of our key partners leading the policy area and their involvement can make a huge difference in promoting our aims," he says.

Marine biologist, Paula Keener, leads the Ocean Exploration Education Programme for the National Oceanic and Atmospheric Administration (NOAA). Her work involves finding innovative ways to help scientists and educators build greater levels of ocean literacy across the United States.

"Because of the ocean's power and enormity, it can seem overwhelming for one person alone to have any positive effect upon it. This is why celebrating ocean successes and public engagement in ocean activities is so important," she says.

Keener believes one of the most effective ways to reduce the impact of human behaviour on the ocean is to help people understand that their own health is inextricably linked to the health of the ocean.

"An ocean literate person understands this connection between human health and ocean health. They can communicate about the ocean in a meaningful way and make informed decisions regarding the ocean and its resources. Informed decisions regarding the links between human health and ocean health need to be key in the decisions that guide marine policy at every level of government," she says.

Jon Parr says Sea Change was initially established to try and instigate a change in attitudes to our oceans across Europe, but it is now working with partners such as the IOC to try and forge a collaborative and global approach to protecting the ocean.

"Our key objectives include advancing ocean literacy through education, community engagement and governance designed through the latest social research on citizen and stakeholder attitudes, perceptions and values," he says.

As part of its support for Sea Change the IOC undertook direct research with key stakeholders to understand how ocean literacy played a role in the process negotiating the Sustainable Development Goal 14 to conserve and sustainably use the oceans, seas and marine resources. This research found that there was a clear role for ocean literacy in ocean governance as a social and adaptive learning approach.

Paula Keener believes the long-term benefits of building a more ocean-literate world are directly tied to the role the ocean plays in our lives and those of future generations.

"The often devastating consequences of hurricanes and tsunamis, and the larger-scale consequences of global climate change, ocean acidification, and the collapse of commercial fisheries illustrate the powerful role the ocean plays in shaping the human condition," she says.

She also believes that the ocean itself can act as a medium to connect nations and create greater understanding about the critical role it plays in our everyday lives and our shared global heritage.

"When we have a deeper understanding of how we are connected to a larger ocean system and how it is connected to us, then we are more likely to make changes in our behaviour that translate into better management and care for a resource that is not our own," she says.

Keener is hopeful that continuing advancements in computer technology, robotics, telepresence capabilities, and the trend toward *in situ* biological and chemical sensors will open even greater opportunities for personal engagement with our shared ocean.

"Today we can explore our ocean from kitchen tables using laptops or simply walking down the street with our cell phones. Now is the time for the international community to dive deep into understanding humankind's intrinsic connection with the ocean and realize why the ocean is called the lifeblood of the Earth," she says.

Marine Scientists

The Backbone of the IOC

Dr Kim Currie is a marine carbonate chemist at New Zealand's National Institute of Water and Atmospheric Research (NIWA) who studies the role of the oceans in the global carbon cycle. Her work coordinating the longest running carbon chemistry time series in the southern hemisphere has helped to measure changes in pH that show the waters around New Zealand are becoming more acidic.

Since 1998, in collaboration with the University of Otago's Chemistry Department, Dr Currie has collected water samples every two months along a 65-kilometre line from the tip of Otago Harbour out into subantarctic waters. The series is invaluable because it covers the different subtropical and subantarctic water currents in a one-day trip; the only place in the world where this is possible.

In many ways Dr Currie is representative of many of the marine scientists from around the world that really form the backbone of the Intergovernmental Oceanographic Commission. She serves on the Scientific Steering Group for the International Ocean Carbon Coordination Panel (IOCCP) and the Biogeochemistry Panel of the Global Ocean Observing System (GOOS) where she represents surface ocean synthesis activities and she is also involved in a number of IOC committees that help to facilitate the global collaborative efforts that are needed to effectively study global ocean issues. Dr Currie believes she is just one of thousands of marine scientists who are contributing their own time towards this global enterprise.

"NIWA supports some of my time doing this but I also contribute some additional time, often in the middle of the night, when we have video conferences with participants from all around the world. But by serving on these committees I feel that I can also give back to this community. It is also fantastic to work with scientists from many countries, coming from different scientific and cultural perspectives. And being a part of the IOC also provides a real opportunity for small countries like New Zealand to be directly involved in international science programmes," she says.

Image credit: Dave Allen

"Being a part of the IOC also provides a real opportunity for small countries like New Zealand to be directly involved in international science programmes."

Dr Kim Currie

New Zealand's National Institute of Water and Atmospheric Research (NIWA)

How does the IOC work?

The IOC operates at multiple levels to promote, develop and coordinate marine scientific research programmes, ocean services and related activities such as capacity development.

At the national level the IOC works with the relevant marine, ocean and coastal management agencies to ensure that policymakers have access to the best possible ocean science and services.

The IOC provides all Member States with a range of critical services under one umbrella including:

- **Management of the Global Ocean Observing System (GOOS) which provides information and data exchange on the physical, chemical, and biological aspects of the ocean;**
- **Programmes to reduce risks from tsunamis, storm surges and other coastal hazards such as harmful algal blooms (HABs);**
- **Supporting the scientific research needed to address emerging issues such as new contaminants, invasive species and the cumulative effects of human activities;**
- **Supporting the use of new marine spatial planning tools to enable the ecosystem-based management of marine and coastal areas;**
- **Facilitating the exchange of critical oceanographic and biogeographic data via the International Oceanographic Data and Information Exchange (IODE) and the Ocean Biogeographic Information System (OBIS)**

At the regional level, the IOC's three Sub-Commissions and one Regional Committee, are recognized as key coordinating and facilitating mechanisms to promote ocean knowledge, sustained observations and services to respond to specific regional needs:

- **IOC Sub-Commission for Africa and Adjacent States (IOCAFRICA)**
- **IOC Sub-Commission for the Western Pacific (WESTPAC)**
- **IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE)**
- **IOC Regional Committee for the Central Indian Ocean (IOCINDIO)**

Diagram 1: IOC operates via:

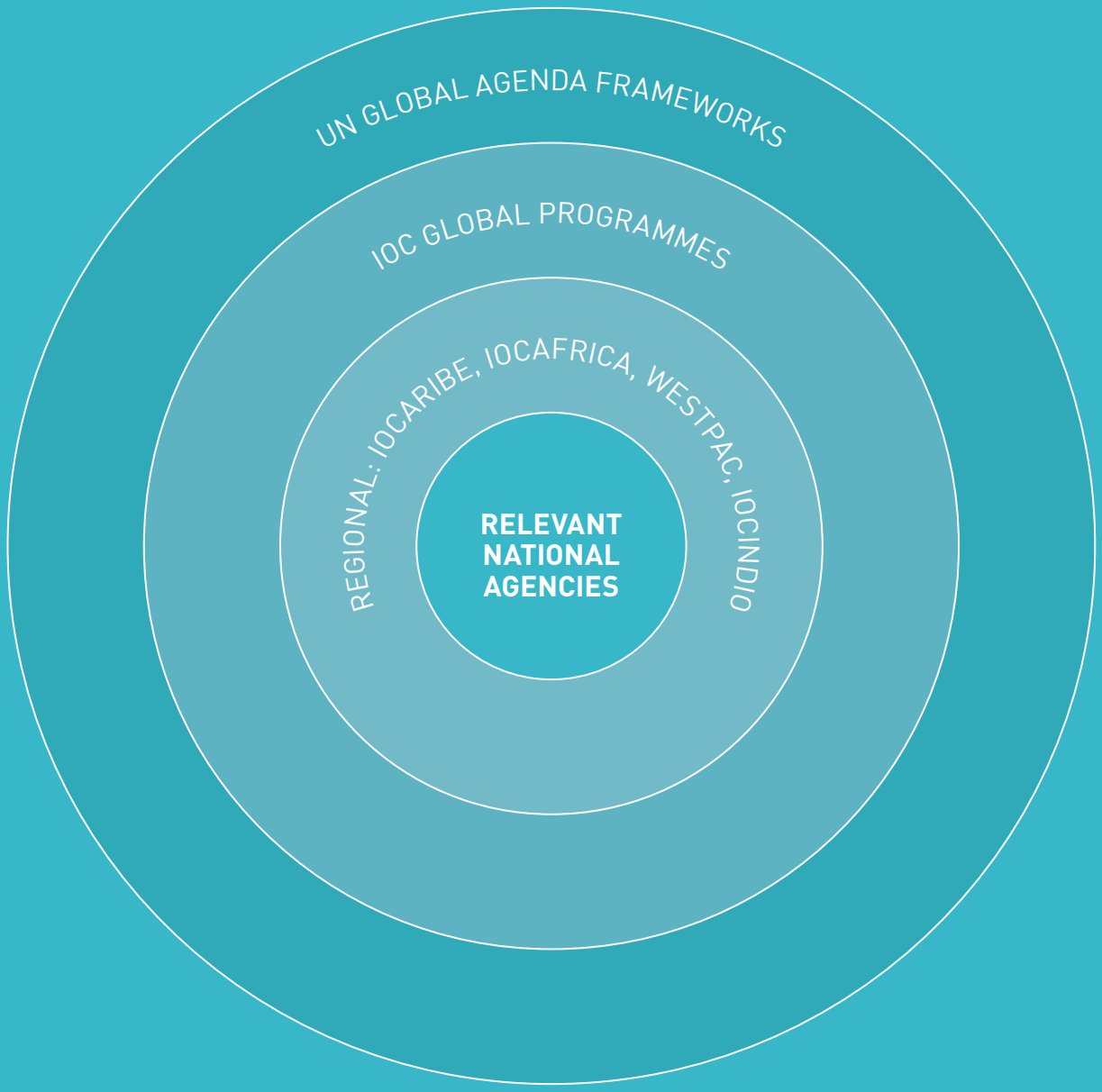
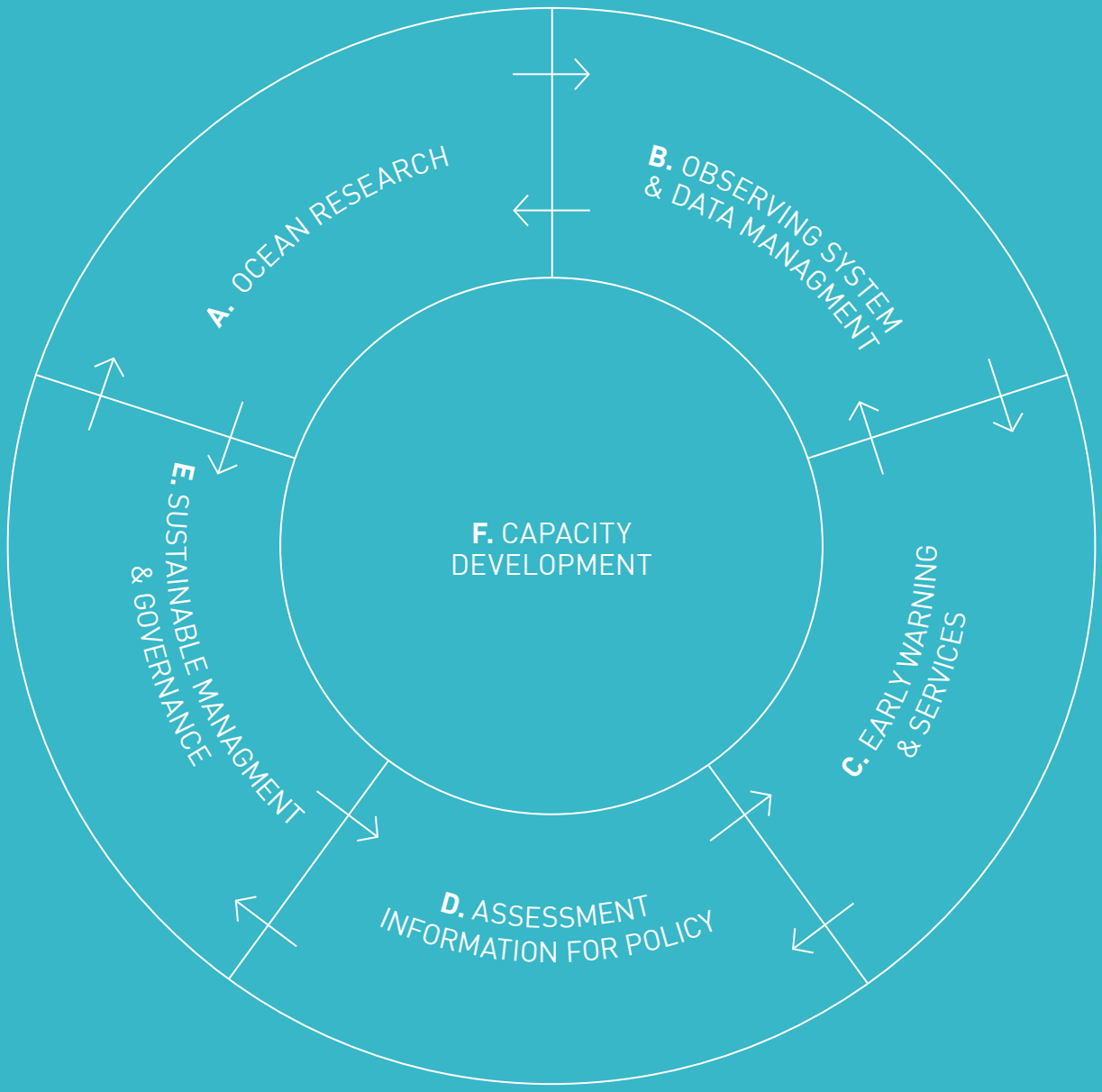


Diagram 2: Building scientific capacity lies at the heart of global efforts to achieve the IOC's Strategic Vision



BUILDING SCIENTIFIC KNOWLEDGE ⟷ APPLYING KNOWLEDGE FOR SOCIETAL BENEFIT ⟷ IMPROVING GOVERNANCE

The IOC's Vision & Strategic Objectives

The IOC's Vision in its Medium Term Strategy for 2014-2021 is that: "Strong scientific understanding and systematic observations of the changing world ocean climate and ecosystems shall underpin sustainable development and global governance for a healthy ocean, and global, regional and national management of risks and opportunities from the ocean".

In order to achieve this Vision the IOC is working to support Member States to achieve the following High Level Objectives:

1. **Healthy ocean ecosystems and sustained ecosystem services**
2. **Effective early warning systems and preparedness for tsunamis and other ocean-related hazards**
3. **Increased resiliency to climate change and variability and enhanced safety, efficiency and effectiveness of all ocean-based activities through scientifically-founded services, adaptation and mitigation strategies**
4. **Enhanced knowledge of emerging ocean science issues**

The IOC is also working to achieve its Vision through the following framework of key functions:

A. **Ocean research: To foster ocean research to strengthen knowledge of ocean and coastal processes and human impacts upon them;**

B. **Observing system / data management: To maintain, strengthen and integrate global ocean observing, data and information systems;**

C. **Early warning and services: To develop early warning systems and preparedness to mitigate the risks of tsunamis and ocean-related hazards;**

D. **Assessment and Information for policy: To support assessment and information to improve the science-policy interface;**

E. **Sustainable management and governance: To enhance ocean governance through a shared knowledge base and improved regional cooperation;**

F. **Capacity Development: To develop the institutional capacity needed to support all of the functions listed above.**

IOC in Figures

Member States	148
IOC Secretariat	Based in Paris, France
IOC staff are located In the following countries	France (Brest); Belgium (Ostend); Italy (Venice); Denmark (Copenhagen); Australia (Perth); Colombia (Cartagena de Indias); Thailand (Bangkok); Kenya (Nairobi); Samoa (Apia); Indonesia (Jakarta)
Annual Regular budget (2015)	USD 6 million (IOC Biennial Report, 2014-2015)
Annual Extrabudgetary Income	USD 4.9 million (IOC Biennial Report, 2014-2015)
Global investment in ocean observation	USD 2 billion (Source : Global Climate Observing System Report)

IOC-UNESCO

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Chairperson:

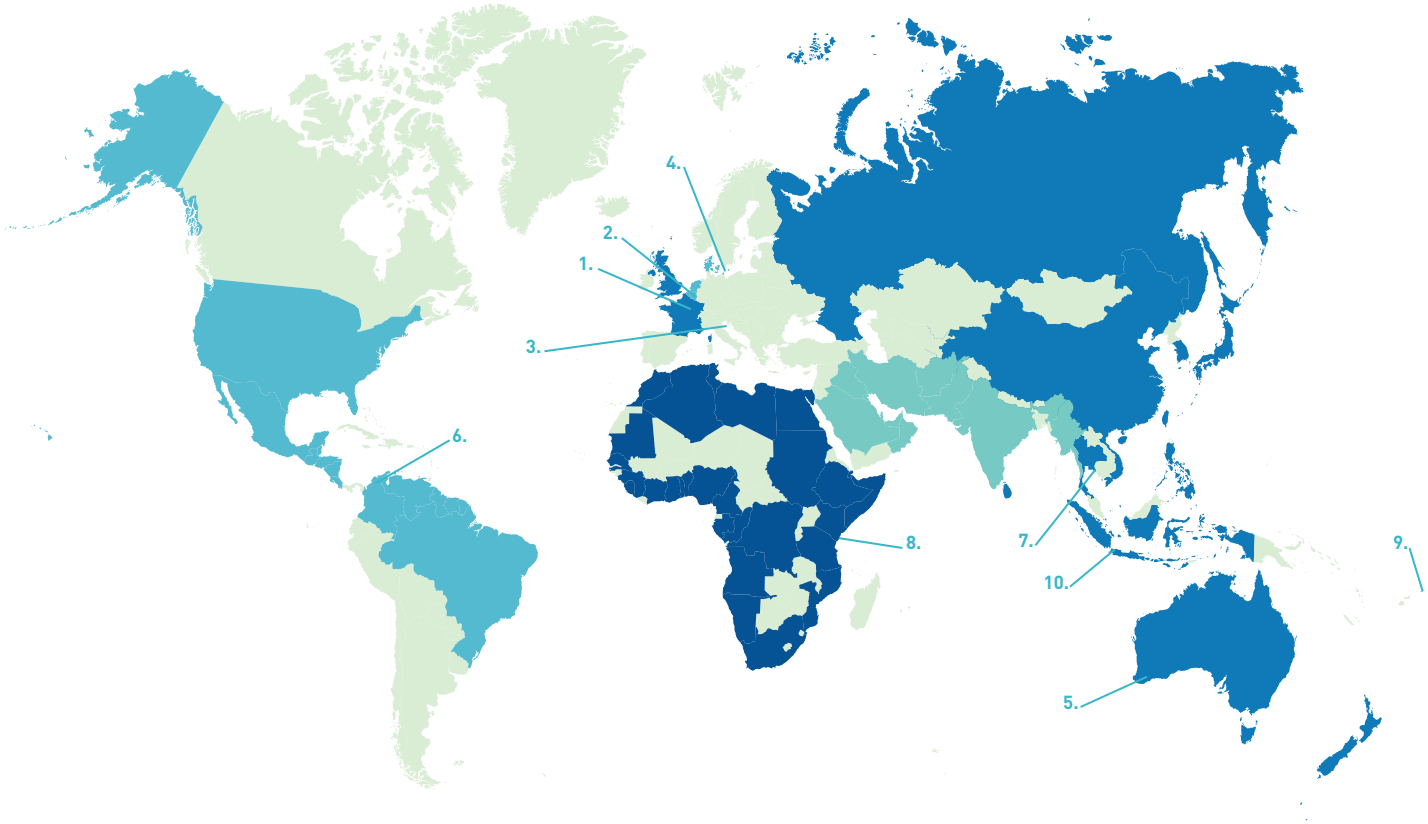
Peter M. Haugan (Norway)

Executive Secretary:

Dr Vladimir Ryabinin

Intergovemmental Oceanographic Commission of UNESCO

IOC Sub-Commissions, Programme and Project Offices



IOCAFRICA Member States

IOCINDIO Member States

WESTPAC Member States

IOCARIBE Member States

The boundries & names shown and the designations used on this map do not imply official endorsement or acceptance by the IOC-UNESCO.

This map should be taken merely as indicative illustration of IOC's global presence. Some countries may, in reality, be members to more than one Sub-Commission.

IOC Secretariat, Programme & Project Offices

1. France (Paris HQ, Brest)
2. Belgium (Ostend)
3. Italy (Venice)
4. Denmark (Copenhagen)
5. Australia (Perth)
6. Colombia (Cartagena de Indias)
7. Thailand (Bangkok)
8. Kenya (Nairobi)
9. Samoa (Apia)
10. Indonesia (Jakarta)

Image credit: Dave Aleen

United Nations
Educational, Scientific and
Cultural Organization

Intergovernmental
Oceanographic
Commission

**Sustainable
Development
Goals**

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