Ocean and the Law of the Sea

Contribution of the Intergovernmental Oceanographic Commission of UNESCO to the Report of the Secretary-General

DEVELOPMENTS IN THE FIELD OF OCEAN AFFAIRS AND THE LAW OF THE SEA

Pursuant to United Nations General Assembly resolution 74/19 of 10 December 2019, entitled "Oceans and the law of the sea" the information below represents the contribution of the Intergovernmental Oceanographic Commission of UNESCO (IOC) to the report of the Secretary-General.

I. SUMMARY OF KEY DEVELOPMENTS

A key focus of the IOC over the last year has been the preparation of the Implementation Plan for the United Nations Decade of Ocean Science for Sustainable Development 2021-2030. The Implementation Plan explains the rationale for the Decade and the desired state of the ocean at the end of the Decade. It contains a framework to guide the design and implementation of Decade Actions including a set of Ocean Decade Challenges and objectives for the Decade. It presents the criteria and process for the endorsement of Decade Actions and the principles to guide data management, capacity development, and engagement with stakeholders. Finally, it describes the proposed governance and coordination arrangements of the Decade, the mechanisms for resource mobilisation, and the process to measure progress. Throughout the preparation of the Plan over 1500 participants have been engaged through in-person and virtual global and regional meetings that have generated comprehensive information on scientific and capacity development priorities, and initiated discussions of partnerships to advance implementation of the Decade. The UN-Oceans contact group for the Decade has been engaged in these global and regional discussions and has made significant contributions to the development of the Plan. The Plan has undergone a first round of peer review to which over 230 submissions were received. A revised version of the Plan is currently being reviewed by IOC Member States and members of UN-Oceans prior to presentation to the UNGA at its 75th session.

Significant progress was made in the development of the methodology to support implementation of, and reporting on, two SDG target indicators for which the IOC has been assigned the custodianship role i.e. 14.3.1 related to ocean acidification and 14.a related to investment in ocean science. The methodology for indicator 14.3.1 has been formally endorsed by IAEG-SDGs and upgraded to Tier II. The second Global Ocean Science Report which is nearing completion is the main mechanism to report on progress under indicator 14.a.1.

As part of IOC's work to advance knowledge on the role of the ocean in the climate system, the IOC Working Group on Integrated Ocean Carbon Research held its first meeting as part of a process to develop an integrated research and observation agenda in the context of the Ocean Decade, and in support of relevant efforts by the UNFCCC and its SBSTA.

IOC continues to lead scientific and capacity development efforts related to deoxygenation and multiple ocean stressors through meetings of its working groups on these issues. IOC has also launched a new project to analyse the status of knowledge of the four main Eastern Boundary Upwelling Systems and to identify the priority gaps to be filled through research and observation for the sustainable management of these highly productive zones thus enhancing their contribution to a sustainable ocean economy. Work on Harmful Algal Blooms (HAB) continues with the development of the first Global HAB Status Report, a new initiative focused on sargassum in West Africa and the Caribbean, and continued capacity development. A new initiative 'Pacific Islands Marine Bioinvasions Alert Network' will work with Pacific SIDS to develop national invasive species monitoring systems and early warning decision support tool.

IOC continues to contribute to negotiations of a new international legally-binding instrument to conserve and sustainably use marine biological diversity in areas beyond national jurisdiction. IOC has prepared a non-paper to describe existing and future services of the IOC that could support a future internationally legally binding instrument (ILBI) for BBNJ including coordination of a Clearing House Mechanism, as envisaged in the draft ILBI negotiation text. The non-paper is intended to inform on-going negotiations and will be presented at a dedicated side event at the fourth meeting of intergovernmental conference.

The two millionth profile taken by an Argo float in November 2018 was emblematic of the sustained

operation of the Global Ocean Observing System (GOOS), and the continuous challenge of coordination and advocacy for the system. A 'Roadmap to the Implementation of the Global Ocean Observing System 2030 Strategy' was published to complement the 2030 GOOS strategy that was adopted in 2019. The "OceanObs'19 Conference" (16–20 September 2019) was a major milestone for future GOOS development and included a significant component related to the integration of indigenous and local knowledge in ocean observations. 86 countries are now involved in ocean observations, and collectively measure 18 ocean and 9 atmospheric essential ocean variables. The GOOS Biology and Ecosystems Panel has advanced development of the monitoring system for ecological and biological essential ocean variables and the definition of the attributes of biological observing networks within the global system.

One hundred and thirty-seven Member States, of which 33 Small Island Developing States (SIDS) and nine African countries, have now established National Tsunami Warning Focal Points/National Tsunami Warning Centres. After more than four years of international collaboration coordinated by IOC, the South China Sea region has now its own dedicated Tsunami Advisory Centre (SCSTAC), serving as a warning system for nine countries in the region. The performance-based community recognition programme "Tsunami Ready" is now piloted in three regions (Caribbean, Pacific and Indian Ocean), with over 20 communities in 15 countries have already met criteria and been recognized by the end of 2019. More than 26 SIDS Member States are using the ecosystem-based management approach for managing the transboundary living marine resources.

There has been significant progress in data and information management through the development of ODISCat – a catalogue of sources for all ocean data products, and the commencement of the OceanInfoHub project that will have a Clearing House Mechanism function and contribute to the transfer of marine technology by creating a digital ecosystem within which stakeholders can provide, access and use diverse content and services. There has been continuing expansion of the renamed OBIS - Ocean Biodiversity Information System which now has 58.7 million records, and which celebrated its 20-year anniversary in March 2020.

IOC continues to partner with the European Commission to implement the Joint Roadmap on Maritime / Marine Spatial Planning though a significant number of technical and training workshops and the convening of the fourth Global MSP Forum in November 2019. The IW:LEARN and LME:LEARN projects continue to provide significant technical and coordination support to GEF-funded international waters and large marine ecosystem projects. Activities have focused on peer-to-peer capacity development, partnership development and capacity development. Development of the next phase of these projects has commenced.

IOC continued to focus on developing the capacities of its Member States, in particular through its regional subsidiary bodies—WESTPAC, IOCARIBE, IOCAFRICA and IOCINDIO. The second phase of the Ocean Teacher Global Academy has commenced and will include new initiatives to support the 2030 Agenda and its SDGs as well as the implementation of the UN Decade of Ocean Science for Sustainable Development. A strong focus will be given to the use of the Ocean Teacher e-Learning Platform. With the support of the Swedish Government, IOC launched the Ocean Literacy Platform and produced a toolkit, tested in schools of 36 countries through the UNESCO Network of Associated Schools (ASPNet).

The Covid-19 pandemic has had an important impact on IOC's operations. While certain activities – including the finalisation of the draft Implementation Plan for the UN Decade of Ocean Science for Sustainable Development – have been completed through adoption of revised meeting formats and schedules, other core activities have suffered more significant effects.

GOOS delivers the essential information needed in four main application areas: (i) early warning of tsunamis; (ii) climate assessments, mitigation and adaptation policy; (iii) extended weather forecasts including of tropical cyclones and other hazards, as well as ocean forecasts that support the growing ocean economy; and (iv) monitoring of the evolution of ocean ecosystem health as a foundation for finding sustainable development pathways. As a result of the pandemic, the first surveys conducted by the IOC within the observing community show a drop of 15% in data flow from the network based on commercial vessels, as demand for global shipping has dropped and ships are idled; and the drop of 5% from the autonomous drifters. Weather and ocean forecasting systems and early warnings of hazards continue to operate normally, supplied with the ocean data they need. However, the risk of service interruption increases with prolonged periods of confinement. Autonomous platforms measuring

the ocean degrade and need regular maintenance and redeployment that is now being cancelled or postponed. This will eventually result in gaps in observations and capital losses in terms of equipment. Coupled with shore-based ecosystem surveys being largely on hold at the moment, this will result in gaps in climate records that will be impossible to go back in time to measure again. IOC anticipates repeating surveys on impact as the pandemic evolves through 2020, to better understand the risks as they evolve and to share best practices in recovery operations.

The same approach has been taken with respect to tsunami warning systems, also dependent on an efficient detection network of seismic and sea level sensors. While nations prioritize Covid-19-related responses, multi-hazard episodes continue to occur, increasing the pressure on our partners in civil protection and disaster management agencies. As an example, tropical cyclone Harold significantly affected Pacific Region SIDS in early April and immediate relief efforts were delayed by quarantine measures. Working groups under the four IOC-coordinated regional Tsunami Warning Systems have developed a set of dedicated 'Guidelines on Tsunami Services and Evacuation/Sheltering Considering Physical Distancing Practices'. A set of local guidelines was developed for Indonesia in collaboration with the Indian Ocean Tsunami Information Centre supported by the Indonesian government.

With significant resources being diverted to the management of, and recovery from, the pandemic, the resulting potential reduction of ocean science funding will negatively affect our collective ability to mitigate and adapt to future ocean change. To evaluate the potential short-term impact term IOC is exploring the feasibility of conducting a complementary assessment (to be published in 2021) to the second Global Ocean Science Report. In the longer-term, the third edition of the Global Ocean Science Report will allow a fuller assessment, including the impact of the pandemic on the collective ability to implement target SDG 14.a on marine scientific research capacity and transfer of marine technology.

II. OCEAN RESEARCH

Foster ocean research to strengthen knowledge of ocean and coastal processes and human impact upon them

IOC continues to provide active support to nations in developing capacity to act towards, and to report on, SDG Indicator 14.3.1, which focuses on ocean acidification. In its capacity as custodian agency for the indicator, the IOC has successfully developed the SDG indicator methodology, which was formally endorsed by the IAEG-SDGs and has since been upgraded to Tier II. IOC continues to promote the application of the methodology to guide scientists and governments on how to carry out measurements following the best practices established by the ocean acidification community. This introduction to the methodology and associated training courses were achieved through dedicated activities in the Caribbean, the Middle East, East Africa and Asia, and by relying on the expertise and support of the Global Ocean Acidification Observing Network (GOA-ON), which counts more than 730 members from 100 countries, including 18 SIDS and 23 African countries. IOC continued to provide the function of the technical secretariat of the GOA-ON, together with the International Atomic Energy Agency (IAEA). Capacity development tools being developed by IOC include a manual on the 14.3.1 methodology, an Ocean Teacher Global Academy (OTGA) online curriculum on ocean acidification and a dedicated online data portal to assist Member States in their annual reporting on the Target. The data portal, a tool for submission, collection, validation, storage and sharing of ocean acidification data and metadata submitted towards the Sustainable Development Goal 14.3.1 Indicator, has first been used for the global data collection in 2020, with the resulting data products submitted to the UN Indicator Report.

The IOC Executive Council agreed to establish a new IOC working group focusing on integrated ocean carbon research (IOCR) and encompassing expertise from IMBeR, SOLAS, IOCCP, WCRP/CLIVAR and GCP. A first meeting of the IOCR initiative took place on 28–30 October 2019 at the IOC premises in Paris. The goal of this initiative is to design an integrated research and observation agenda in the context of the UN Decade of Ocean Science for Sustainable Development and in support of relevant efforts by the UNFCCC and its SBSTA.

IOC co-organized and co-sponsored the International Blue Carbon Initiative (BCI) annual meeting in September 2019 in Denmark. IOC further supported several side events during the UNFCCC COP25 highlighting the potential of Blue Carbon Ecosystems as a nature-based solution to be applied in the NDCs to mitigate climate change.

IOC continues to co-sponsor GESAMP Working Group 41 on Geo-engineering in the Marine Environment, which provides for a continued interagency focus on the challenges and possibilities in marine geo engineering (also referred to as 'carbon dioxide removal and negative emissions techniques'). GESAMP WG41 is reconvening in 2020 with revised Terms of Reference with an enhanced focus on and wider societal implications of different marine geoengineering approaches on the marine environment. IOC will facilitate the contribution of GESAMP WG41 to the work of the United Nations Framework Convention related to 'negative emissions' (carbon removal and other similar techniques) as part of the element on climate mitigation of the Convention's programme of work.

In March 2020, the Secretariat of IOC presented its submission to the Ocean and Climate Change Dialogue to be convened by the Subsidiary Body for Scientific and Technological Advice of the United Nations Framework Convention on Climate Change, according to decision 1/CP.25 of the Conference of the Parties at its 25th session, held in Madrid in November–December 2019. IOC's contribution informs how ocean research can contribute to relevant topics and workstreams under the Convention and its Paris Agreement. IOC has also prepared its contribution to the UNFCCC SBSTA Research Dialogue, which focuses on research and systematic observation (Article 5 of the Convention).

In December 2019, the World Climate Research Programme (WCRP) celebrated its 40th anniversary. IOC is a co-sponsor of WCRP and brings the oceanographic constituency to WCRP, as the ocean is an integral and central part of the climate system. As the current joint Memorandum of Understanding between the WCRP co-sponsors—IOC, the World Meteorological Organization and the International Science Council—dates 1993, and in light of the above-mentioned developments, the three co-sponsors are finalizing a new MoU for consideration by their respective governing in 2020.

IOC is leading scientific and capacity development efforts related to deoxygenation through its Working Group 'Global Ocean Oxygen Network (GO_2NE)'. The first GO_2NE Summer School was held in September 2019 at the Xiamen University's Xiang'an Campus, which hosts the State Key Laboratory of Marine Environmental Science, was attended by 37 students from 19 countries, including participants from Africa. The IOC Secretariat contributed to the production and launching at the UNFCCC COP25 of a major book on ocean deoxygenation coordinated by IUCN. IOC co-organized with IOCCP a scoping meeting to discuss the features of and requirements on an ocean oxygen data portal on 11–12 November 2019 in Sopot, Poland, which saw the participation of more than 20 experts from 11 countries.

The IOC group of experts to study the effects of climate change on plankton communities (TrendsPO) continued the systematic compilation of phytoplankton time-series (data sets), related analyses, and a synthesis of the findings through a drafting workshop held in early 2020 and hosted by CSIRO, Australia. This work also informs modelling efforts under the WCRP.

The first meeting of the IOC Working Group on Multiple Ocean Stressors took place on-line and refined further the Scientific Summary for Policy-makers introducing the issue of multiple stressors on marine ecosystems: *Ocean under Stress: A changing ocean at all locations*. The WG will in its work assess and define experimental challenges related to multiple drivers experiments; identify links between physiological responses and ecosystem impacts; identify ecosystem-level reference points related to multiple stressors; develop indicators for systematic observations on multiple stressors; communicate arguments for the integration of the multi-stressor approach in ocean models and predictions and, finally, identify management requirements in relation to multi-stressor research.

The workshop on "The Canary Current Eastern Boundary Upwelling System (EBUS)" was held in Mindelo, Cabo Verde, on 10–12 March 2020 and was attended by 20 experts from Cabo Verde, Gambia, Guinea, Mauritania, Morocco, Senegal, France and Spain. A data archive compiling primary production data from the four main EBUS was produced and a resource list of capacity development activities for the Canary Current region was produced. IOC co-sponsored the ICTP-CLIVAR Summer School on Oceanic EBUS (13–17 July 2019, Trieste, Italy,). IOC has launched a new project, funded by Spain, on the status of knowledge of the main four EBUS and gaps to be filled through research and observations for the sustainable management of these systems and to enhance their contribution to the blue economy.

The Second International Indian Ocean Expedition, which is co-sponsored by IOC, began its second 5-year phase to 2025. The breadth and depth of high-quality science produced continues to significantly increase. As has been customary since the IIOE-2's inception in 2015, it worked in integration with a number of other Indian Ocean science alliances across both the oceanic and climate research sphere, including: Indian Ocean Global Ocean Observing System (a GOOS Regional Alliance); Indian Ocean Region Panel of CLIVAR/IOC-GOOS; Sustained Indian Ocean Biogeochemistry and Ecosystem Research of IOGOOS/IMBeR; Indian Ocean Observing System Resources Forum of IOGOOS; and IOC Regional Committee for the Central Indian Ocean. Together, they have developed in December 2019 *IndOOS-2: A roadmap to sustained observations of the Indian Ocean for 2020-2030* (IOC/INF-1384).

III. OBSERVING SYSTEM/DATA MANAGEMENT

Maintain, strengthen and integrate global ocean observing, data and information systems

This section focuses on sustained ocean observing and data management activities, encompassed in the Global Ocean Observing System (GOOS) and regional activities through GOOS Regional Alliances and the IOC Sub-Commissions, and the International Oceanographic Data and Information Exchange (IODE) and its regional activities. These programmes are focused on sustained observing activity and data delivery, with global networks and global approaches. They provide the basic infrastructure that enables a significant amount of oceanographic research, and the application of knowledge towards operational information services, and addressing challenges related to climate and the sustainability of marine ecosystem health.

The Global Ocean Observing System

Building on work developed by a Joint WMO-IOC Consultation Group on the reform of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), IOC Resolution XXX-2 (2019) decided to incorporate appropriate JCOMM functions and activities on observation and operational ocean forecasting systems into GOOS. The Observations Coordination Group—incorporating 12 major ocean observing networks, from the Voluntary Observing Ship marine meteorological network to Argo to animal-borne sensors, and including the work of the Joint WMO-IOC centre for oceanographic and marine meteorological observing programme support (JCOMMOPS)—and the Expert Team on Operational Ocean Forecasting Systems, focused on best practice and service delivery from ocean forecasting systems, are now incorporated into the work of the other GOOS components. The resolution also established the Joint WMO-IOC Collaborative Board as a high-level coordination mechanism with broader engagement of the key relevant bodies of the WMO and IOC.

A core Strategic Objective of the GOOS 2030 Strategy that was approved in June 2019 is to strengthen partnerships to improve delivery of forecasts, services, and scientific assessments. To that end, a *Roadmap for the Implementation of the Global Ocean Observing System 2030 Strategy* has been published to add substance to the 11 Strategic Objectives of the 2030 Strategy, laying out the issues, implementation ideas, and highlighting how they will act together to guide development of an integrated system. Some of the Strategic Objectives encompass core GOOS programme activities, and others will likely be led by partner organizations—achieving the strategy will require cooperation, coordination and the commitment of many organizations beyond the core of GOOS. It will also require a new system of governance for partnerships.

IOC and GOOS were co-sponsors, along with dozens of other relevant organizations, of the "OceanObs'19 Conference" (16–20 September 2019, Honolulu, USA), the third decadal conference on global sustained ocean observations. The OceanObs'19 Conference had the input of nearly 2,500 contributing authors for its Community White Papers, and nearly 1,500 attending in person. For GOOS, it was an important opportunity to listen to community discussions and identify priorities for the implementation of the *Global Ocean Observing System 2030 Strategy*. At the "OceanObs'19 Conference", the indigenous peoples' perspective on ocean observing was a welcome new dimension. A coastal indigenous people's declaration, the *Aha Honua*, is an important reflection on the consideration of indigenous communities as stakeholders with clear needs, and as partners for the observing community.

GOOS held an experts' workshop on ocean observations in areas under national jurisdiction (12–13 February 2020, UNESCO, Paris, France; GOOS Reports, 246) to highlight potential concerns and

potential solutions spaces to facilitate the taking of sustained ocean observations in EEZs, and to suggest areas of work on defining or demonstrating the value and impact of the needed observations.

The *Ocean Observing System Report Card 2019* reports on the status of global ocean observing networks, and highlighted ocean acidification, scientific collaboration and partnership in support of sustained ocean observations in GOOS, as well as challenges and issues. It highlights that 86 countries are involved in ocean observations, measuring 18 ocean and 9 atmospheric Essential Ocean or Essential Climate Variables. Nearly 9,000 *in situ* observing platforms report, enabling thousands of scientific papers and hundreds of thousands of weather forecasts that have assimilated *in situ* ocean observations.

In the space of monitoring of ocean ecosystem health, the GOOS Biology and Ecosystems Panel was funded by Future Earth to identify the existing monitoring backbone for each biological and ecological Essential Ocean Variable, identify the extensions needed for these backbones in the next 10 years, and to define the attributes of biological observing networks within a global system.

The Covid-19 pandemic and the related restrictions on human movement have had impact on both the GOOS programme and the ocean observing system. The immediate impact on the real-time flow of ocean observations in the first months of global restrictions (March and April 2020) has been limited, with a 15% drop in observations reported from commercial vessels, and a 5% drop in observations from surface ocean drifters measuring temperature, ocean currents, and in many cases atmospheric pressure. The supply of ocean data for weather and ocean forecasting systems and early warnings of hazards can continue to operate normally, however airborne observations have been very critically reduced. However, the ability of ocean observing implementers to work is severely limited during this pandemic, creating future risks of gaps and holes in ocean observations. Research vessels have in large part been called back to port, and it is impossible to travel. The autonomous platforms measuring the ocean are degrading, and need regular maintenance and redeployment which is now being cancelled or postponed. Batteries will run down, and instruments and data will be lost. The risk becomes greater with longer periods of confinement.

GOOS has surveyed anticipated impacts and risks of the Covid-19 pandemic, and early results include predicted gaps in observations and anticipation of a strong risk of capital losses from lost instruments that break free or stop communicating. Shore-based ecosystem surveys are largely on hold at the moment. There will be a loss of continuity of data from critical climate records because it is impossible to go back in time to measure again. GOOS anticipates repeating surveys on the impact of the Covid-19 pandemic throughout 2020, to better understand the risks as they evolve. The impacts, the risks, and the response amongst ocean observing networks, will be communicated and best practices in recovery operations will be shared, including a platform to learn, share, and to develop partnerships and joint work to recover and redeploy ocean observing instruments.

The “Ninth meeting of the GOOS Steering Committee”, originally planned 22–24 April 2020 in Zanzibar, Tanzania, was transformed into an online session covering parts of the agenda. It addressed developing partnerships for delivery, working on coastal integration across GOOS, best practice on evaluation and review of observing systems, and improving the fitness for purpose of GOOS components.

GOOS also engaged fully with the planning process of the UN Decade of Ocean Science for Sustainable Development 2021–2030. It prepared an input for the Ocean Decade’s Strategic Action Framework, identifying the close link between the implementation of the 2030 Strategy and the objectives of the Ocean Decade.

Global Sea-Level Observing System (GLOSS)

Knowledge of sea level gradients is essential for understanding the ocean circulation. Sea level data are of great practical importance to coastal populations in applications such as flood defence and navigation. Given the multi-dimensional, multi-purpose nature of tide gauge observations, there is considerable benefit to be gained from well-designed sea-level observing networks that support a broad research and operational user base. The Global Sea-Level Observing System (GLOSS) provide such a service. GLOSS provides oversight and coordination for global and regional sea-level networks in support of, and with direction from, the oceanographic and climate research communities. These

communities are served by the four GLOSS data centres (i) the Permanent Service for Mean Sea Level (PSMSL, UK); (ii) the University of Hawaii Sea Level Centre (UHSLC, USA); (iii) the Système d'Observation du Niveau des Eaux Littorales (SONEL–University of La Rochelle, France); and (iv) the Sea Level Station Monitoring Facility (hosted at the Flandern Institute of Marine Research, Belgium). Many of the sea level science publications based on data from GLOSS enter into the review of the IPCC and contribute to for instance the IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (published in September 2019) and which provided new upwards revised projection for global sea level rise by 2100. Aside from scientific publications, operational products are also generated based on the sea level data availability. As an example, the IOC Sea Level Station Monitoring Facility tracks some 920 (858 in 2018) active stations that deliver data in real time (e.g. for tsunami monitoring). The SLSMF registered 3.6 billion web hits (1.94 billion in 2018) for 2019, and approximately 25 TB (21 TB in 2018) of data was downloaded during 2019.

GLOSS organized its first ever Workshop on Sea level Data Archaeology (10–12 March 2020, Paris). Historical tide measurements are among the oldest direct observations that provide relevant information regarding the long-term evolution of mean sea level. In many countries, systematic sea level observations have been carried out since the early to mid-1800s. Despite this rich historical legacy, documents with these records are hidden in archive centres. Most of these analogue documents are not adequately inventoried. The workshop covered: (i) historical sea level data inventories and data at risk; (ii) Methodology for transfer of paper records to digital data; (iii) Auxiliary historical archives relative to sea level; (iv) Applications and knowledge products from recovered data; and (v) Cooperation perspectives. The workshop was very successful and had 55 registered participants (including many young scientists), and adopted a set of recommendations to guide future sea level data rescue activities and coordination. Recommendations and report are available from http://www.ioc-unesco.org/workshop-sea-level-data-archaeology .

GLOSS finalized the *Manual on Quality Control of in situ Sea Level Observations* (Vol. I: A review and progress towards automated quality control). The objective of this manual has been to compile and update the standards and best practices on quality control of tide gauge data. Although related Information has been included in the IOC Manuals on Sea Level Measurement and Interpretation (Volumes I, II, III, IV, V: IOC, 1985, 1994, 2002, 2006, 2016), this is the first time that detailed information on quality control procedures has been assembled into one document, addressing new issues like automation, for management of hundreds of long-time series, or near-real-time quality control procedures, for operational applications.

Data management

In order to enhance the role of marine information management, the International Oceanographic Data Exchange (IODE) programme of IOC at its 25th session adopted the concept of "IODE Associate Information Units" (AIUs), and an application form and associated review criteria are now available. By the end of 2019, five marine libraries have joined the IODE network as AIU. At the end of 2019, the IODE network comprised nine accredited National Oceanographic Data Centres (NODCs), one accredited Associate Data Unit (ADU), 67 NODCs, 29 ADUs and 5 AIUs.

As an IODE contribution to the UN Ocean Decade, the IODE Secretariat has invited members of the UN Oceans task group (ESCAP, FAO, ISA, UNDP, UNEP, UNEP-Grid, UNFCCC, WCMC, WMO) to contribute descriptions of their online ocean-related data and information products and services to ODISCat. An online meeting was held in April 2020 as a first step towards a UN-wide mapping of such sources and towards sharing the UN Decade-relevant data and information across the UN family. In addition, the inter-sessional working group started its work with a view to propose a strategy on ocean data and information stewardship for the UN ocean decade (IWG-SODIS).

The Ocean InfoHub Project was successfully submitted for funding to the FUST (Flanders UNESCO Science Trust Fund) and implementation commenced in April 2020 and will: (i) establish and anchor a network of regional and thematic nodes that will contribute to the transfer of marine technology (TMT) by enhancing shared scientific and technical capacities to render a wide range of data and information products and services; (ii) develop a proof-of-concept for an underlying Ocean Data and Information System (ODIS) architecture to enable scalable development of the global Ocean InfoHub and interoperability with local, regional and thematic data and information infrastructures; (iii) promote and

foster awareness and collaboration with established organizations and systems providing enabling support to the marine community, connecting contributors and users with the resources to support their efforts. The project will create an ecosystem wherein stakeholders can provide, discover and use diverse content and services in a coherent and easily implementable manner. The project will thus promote closer interaction across regions and themes, leading to improved mutual understanding and collaboration as well as to strengthening of inter-, multi- and transdisciplinary science, technology and innovation systems and policies. The proof-of-concept for an underlying Ocean Data and Information System reference architecture (ODIS-Arch: ODIS proof-of-concept reference architecture) will be applicable for the UN Decade of Ocean Science for Sustainable Development.

The IODE OceanBestPractices (OBPS) Steering Group of international experts was established and met for the first time in December 2019 to guide OBPS development. The IOC Ocean Best Practices System (OBPS, oceanbestpractices.org) supports the creation, publishing, discovery and access (FAIR Principles) to ocean related methods, best practices and standards. It includes: (i) the permanent repository, hosted by IODE, enhanced with natural-language processing capabilities, coupled with semantic interoperability solutions and metadata indexing. At present it provides open access to 970 methodologies (March 2020); (ii) a peer review journal publishing outlet Frontiers in Marine Science RT: Best Practices in Ocean Observing; (iii) a strong community engagement strategy; and (iv) a training resource leveraging community capability organized through the Ocean Teacher Global Academy and other training organizations. Together, these capacities are improving the discoverability and quality of ocean methods and best practices and will eventually link them to the data and information they generate. OBPS is a partner in scientific projects such as H2020 EuroSea, JERICO S3 and CAPARDUS, and benefits from direct involvement with the international research community.

The World Ocean Database (WOD) is the world's largest collection of vertical profile data of ocean characteristics available internationally without restriction. The World Ocean Database was first released in 1994 and updates have been released approximately every four years. By the end of 2019 the database contained nearly 17 million casts (sets of profiles).

The OBIS steering group unanimously approved the proposal to change the name of OBIS from Ocean Biogeographic Information System to Ocean Biodiversity Information System, while keeping the same acronym. Between June 2019 and March 2020, 2 million presence records were added to OBIS from 121 new datasets, providing 2,340 new marine species to OBIS. In total, OBIS now has 58.7 million occurrences of 127,804 species from 3,126 datasets. A milestone in 2019 was the switch to the new OBIS infrastructure and technology stack (OBIS2.0). The system is now also fully aligned with the World Register of Marine Species (WoRMS). The information portal also provides details on quality issues and a more powerful mapper allows the users to visualize, filter, explore and download millions of records.

During the eighth session of the IODE Steering Group for OBIS (5–8 November 2019) in Santa Marta, Colombia, an OBIS Data Quality Assessment and Enhancement Project Team was established to finalize work on documenting the logical data flow through the OBIS system from source data processing at OBIS Nodes to the data processing pipeline into the OBIS integrated database. This will also help the OBIS Capacity Development Task Team, who will, in collaboration with the Ocean Teacher Global Academy, organize a "Training of Trainers" certification course, to level up the capacities of the node managers and data managers in the new OBIS technologies and methods. The OBIS vocabulary infrastructure project team, in collaboration with the Biodiversity Information Standards (TDWG) group, will review, evaluate and produce a registry of vocabularies in use in OBIS. This will contribute to the best practices of the biological and ecosystem Essential Ocean Variables (EOVs) of GOOS. On the 22 May 2020, OBIS celebrated its 20th anniversary.

IV. EARLY WARNING AND SERVICES

Develop early warning systems and preparedness to mitigate the risks of tsunamis and ocean-related hazards

Tsunami Warning Systems

Support for the intergovernmental coordination of regionally harmonized tsunami warning systems

Governance meetings and technical working group meetings set the strategic directions and facilitate the ongoing development, guidance and harmonization of the four regional tsunami warnings systems. In the IOTWMS, integrated meetings of the Working Groups, Task Teams and Steering Group were organised during 29 September–2 October 2019 hosted by Indonesia at BMKG, Jakarta. ICG/NEAMTWS held one ICG meeting (2–4 December 2019 Cannes, France). Due to the Covid-19 global health emergency the ICG/CARIBE-EWS postponed to 2021 the holding of its annual meeting originally scheduled on 4–7 May 2020, and replaced it with a virtual Officers Meeting on the same dates. The ICG/PTWS cancelled its biannual PTWS Steering Committee meeting 15–19 June 2020 and replaced it with a virtual meeting on the same dates. Planning is ongoing for the ICG/PTWS-XXIX session to be hosted by Japan from 15 to 18 March 2021.

National and sub-regional Tsunami Warning system developments

Active investments of nations and/or their concerted actions contribute substantially to the development of the Tsunami Warning Systems. The Portuguese Sea and Atmospheric Institute (IPMA) has gone through the ICG/NEAMTWS accreditation process in 2019 and has met the requirements to be a Tsunami Service Provider, becoming the fifth in NEAM region. Turkey and Greece enhanced their tsunami early warning system at the local level with the support of the European Commission (EC) and the Joint Research Centre (JRC) Last Mile Projects following the Bodrum-kos Tsunami (20 July 2017). This included capacity development in support of local tsunami warning, awareness, and mitigation, infrastructure, research, new sea level instrumentation and provision of measurements in Kos (Greece) and Bodrum (Turkey). The Last Mile Projects implemented have helped to develop procedures for local Tsunami Risk Assessment and Preparedness in Kos and Bodrum. The South China Sea Tsunami Advisory Centre (SCSTAC) became fully operational on 5 November 2019, coinciding with the World Tsunami Awareness Day. The primary mission of SCSTAC is to provide timely advisories on potentially destructive tsunamis to officially designated National Tsunami Warning Centres (NTWCs) and Tsunami Warning Focal Points (TWFPs) in Brunei (Negara Brunei Darussalam), Cambodia, People's Republic of China, Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam. The Ninth Meeting of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (WG-SCS) originally scheduled on March 2019, in Guangzhou, China, was postponed to November 2020, due to the Coronavirus global health emergency. The ICG/PTWS Working Group for the South East Pacific—CPPS Grupo de Trabajo de Alerta de Tsunami del Pacifico Sudeste—met on 29–31 October 2019, hosted by Colombia. The group objective is to enhance the capacities of the National Tsunami Warning Centres (NTCW) across the South East Pacific Tsunami Warning Member States, based on the Sendai Framework for Disaster Risk Reduction 2015–2030.

IOC has received funding from UNESCAP to implement a project on “Strengthening Tsunami Early Warning in the North West Indian Ocean region through Regional Collaboration”. Implemented in India, Iran, Pakistan and Oman, this project aims to strengthen end-to-end tsunami warning SOPs to suit a near-field tsunami threat from the Makran region and develop a unified Probabilistic Tsunami Hazard Assessment (PTHA) for the Makran region. Activities in the inter-sessional period include: (i) high-level conference on near-field tsunamis in the Makran region (Muscat, 1–2 September 2019); (ii) Expert meeting for establishment of a regional working group on risk knowledge (Muscat, 3–6 September 2019); (iii) Expert meeting for development of a Probabilistic Tsunami Hazard Assessment for Makran region (Hyderabad, 2–4 December 2019); and (iv) SOPs for Tsunami Early Warning (Karachi, 28–28 February 2020).

Tsunami Exercises

Tsunami exercises and drills help to increase tsunami preparedness and awareness of coastal communities. Regular exercises are essential to maintain operational readiness of response agencies and exercises test communications, review agency standard operating procedures, and promote emergency preparedness. Exercise CARIBE WAVE 20 took place on 19 March 2020 at 14:00:00 UTC with the following two hypothetical earthquake and tsunami scenarios: (a) a tsunami generated by a magnitude 8.0 earthquake located on the Enriquillo-Plantain Garden Fault Zone in Jamaica, and (b) a transoceanic tsunami generated by a magnitude 8.5 earthquake located off the coast of Portugal. Due to the Covid-19 global health emergency, the exercise was limited to communications test only. Planning for Exercise Indian Ocean Wave 20 (IOWave20) that is scheduled to be held on 6, 13 and 20 October 2020 is underway with guidance from the IOWave 20 Task Team. Planning is also underway for NEAMWave 20 Exercise (2–5 November 2020).

Strengthening the work of regional Tsunami Information Centres

Tsunamis happen infrequently and community awareness of tsunami risk and preparedness is essential. In each of the four regional tsunami warning systems Tsunami Information Centres (TIC) have been established. The role of TICs are to provide awareness information on tsunami and other sea-level related hazards to the general public and communities. The Tsunami Information Centres also facilitate the "Tsunami Ready"—an IOC pilot community recognition programme that promotes tsunami hazard preparedness as an active collaboration of national and local emergency management agencies, community leaders and the public. The International Tsunami Information Centre (ITIC) hosted by the NOAA National Weather Service of United States continued to play a key role in the reinforcement of capacities of key stakeholders in the Pacific Tsunami Warning and Mitigation System (PTWS), through the co-organisation of several trainings together with and in the framework of the IOC Tsunami programme. With financial support from the European Union, the Caribbean Tsunami Information Centre (CTIC) and the Caribbean Disaster Emergency Management Agency (CDEMA) hosted a Regional Tsunami Training Workshop in Barbados on July 23–26, 2019, with 30 participants from over 10 countries.

Within the CARIBE-EWS key activities were implemented to enhance Member State capacities in the development and operations of their tsunami early warning systems. UNESCO/IOC and its CTIC provided continued support to Member States in the implementation of the ICG/CARIBE-EWS Community Based Tsunami Performance Pilot Programme (Tsunami Ready) which resulted in the recognition of 5 new pilot communities in Antigua and Barbuda, Barbados, Dominican Republic, St. Vincent and the Grenadines and Trinidad & Tobago. The Indian Ocean Tsunami Information Centre (IOTIC) supported under the BMKG-IOC partnership continued to play a key role in co-organisation of capacity development activities including IOTR piloting, trainings on Standard Operating Procedures (SOPs) and national trainings on UNESCO-IOC Tsunami Ready piloting. A strategy for NEAMTIC was developed in 2018 to guide the future development of NEAMTIC. The strategy provides an action plan with three phase implementation: (i) NEAMTIC website maintenance and updates; (ii) redevelopment of NEAMTIC website; and (iii) development of NEAMTIC as a training centre/platform. Phase 1 is now completed and phase 2 has started, while phase 3 will depend on additional funding and organisation.

World Tsunami Awareness Day

In commemoration of 15 years of the 2004 Indian Ocean tsunami and World Tsunami Awareness Day (WTAD-2019), an Indian Ocean regional workshop on strengthening tsunami warning chain to critical infrastructure (ports, harbours and coastal airports) was organized by the IOTIC, ICG/IOTWMS and BMKG in Jakarta during 20–22 November 2019. The workshop highlighted that many ports, harbours and coastal airports bordering the Indian Ocean do not have an assessment of tsunami hazard and risk to their facilities. Knowledge of official warning products and direct access to official tsunami warning information from the National Tsunami Warning Centres (NTWCs) is limited. There is a need for guidance and capacity to develop actionable warning products for key stakeholders, tsunami standard operating procedures, emergency response plans as well as preparedness and awareness initiatives. The workshop highlighted the urgent need for critical infrastructure facilities to work closely with relevant experts and national authorities to bridge these gaps.

Targeted capacity development and technical assistance

Human and national capacity to deal with tsunamis are still unevenly spread among nations. Since its start, the Tsunami programme has contained a strong capacity development component. The aim of these activities is to enable Member States to understand its risk and know ways in which they can mitigate the hazard, provide warning to its populations in a timely manner, and be able to carry out awareness and preparedness activities to sustain knowledge and ability-to-respond across generations.

The ICG/IOTWMS undertook several focussed capacity development activities including trainings/workshops on SOPs and Hazard Assessment. In support of implementation of UNESCO-IOC Tsunami Ready piloting in the Indian Ocean, a national training programme and verification visit of Tsunami Ready indicators was organized by the IOTIC and ICG/IOTWMS in Hyderabad and Odisha, India, during 10–14 December 2019. Following the piloting of Tsunami Ready indicators in six communities in India and one community in Oman during IOWave18, Boxipalli and Noliashahi

communities in Odisha province of India have now requested for UNESCO-IOC Tsunami Ready recognition. The ICG/IOTWMS continues to conduct biannual communications tests in June and December each year with the most recent test in December 2019 attracting participation of 25 active National Tsunami Warning Centres.

In the framework of the last phase of the European Union funded DIPECHO project "Building resilient communities and integrated Early Warning Systems for tsunamis and other ocean related hazards in Central America" (2016–2017), trainings and workshops were organized between July and October 2019 in Costa Rica, El Salvador, Honduras, Guatemala, Nicaragua, and Panama, which included development and/or reinforcement of tsunami Standard Operating Procedures, community level tsunami drills and elaboration of tsunami educational materials jointly with their ministries of Education. This contributed to better prepare participating national agencies and beneficiary communities towards coastal hazards in particular tsunami. The project was key to complete Tsunami Ready pilot recognition for 10 Central America Municipalities: Corn Island and Bluefields (Nicaragua), La Libertad and Tamanique (El Salvador), Omoa and Tela (Honduras), Sipacate and San José (Guatemala), Playa Hermosa (Costa Rica) and Puerto Armuelle (Panama).

The PTWS Regional Working Group on Tsunami Warning and Mitigation System for the South China Sea Region (WG-SCS) organised the IOC South China Sea training for seismic and sea level operators: enhancing the capacity of tsunami observation and data sharing in the South China Sea region, 21–25 October 2019, Hangzhou, China. The South China Sea Tsunami Advisory Centre (SCSTAC) in collaboration with the IOC, and the National Oceanic and Atmospheric Administration (NOAA), United States, organized the training, hosted by the National Marine Environmental Forecasting Centre (NMEFC) of the Ministry of Natural Resources (MNR) of China. Twenty-three participants from six countries attended this training.

With funding from the European Civil Protection and Humanitarian Aid Operation (ECHO), in the framework of the project "Strengthening capacities of early warning and response for tsunamis and other coastal hazards in the Caribbean", a sub-regional tsunami response coordination plan for CDEMA Participating States focusing on the CDEMA-led Regional Response Mechanism (RRM) was developed. Several trainings, workshops and drills were organised on National Standard Operating Procedures (SOPs), Emergency Response Plans and Tsunami Ready recognition processes, in Antigua and Barbuda, Barbados, Dominican Republic, St. Vincent and the Grenadines and Trinidad & Tobago.

Training courses were organised on PTWC Enhanced Products and Standard Operating Procedures (SOPs) on 5–8 August 2019, in Port Moresby, Papua New Guinea, and on 14–24 October 2019, Nuku'alofa, Tonga. These trainings follow the tsunami warning chain from detection and threat analysis to warning dissemination, and cancellation. Topics include earthquake and tsunami science, warning centre operations, use of the Pacific Tsunami Warning Centre products and decision-support tools, and public information or media engagement. Emphasis is on the importance of Standard Operating Procedures (SOPs) for enabling consistent and rapid tsunami warning.

The 2019 annual ITP-ITIC-IOC training course (3–13 September 2019) was hosted by the International Tsunami Information Centre (ITIC), in collaboration with the Pacific Tsunami Warning Centre and technical and emergency management partners in Hawaii (USA). The ITP-Hawaii demonstrated a working example of an end-to-end tsunami warning and mitigation system centred in Hawaii, with PTWC as its local tsunami warning centre. ITIC is hosted by the US National Oceanic and Atmospheric Administration and the Hydrographic and Oceanographic Service (SHOA) Chile in partnership with IOC.

A regional training course on TEMPP1 (Tsunami Evacuation Maps, Planning and Procedures, course 1) was organized on 30 September–4 October 2019, in Nadi, Fiji. The training was jointly organised by the Pacific Community (SPC), ITIC and IOC. TEMPP1 covers the explanation and use of inundation models for evacuation modelling. Topics include earthquake tectonics, tsunami science, bathymetric and topographic grids, earthquake source parameters, forecast methodology, tsunami modelling, tsunami hazard assessment and use of the MOST model and ComMIT interface tool. The TEMPP training course is intended to be a standardized course and process for the production of reliable and practical community-level tsunami evacuation maps. The direct outcomes are communities that know what to do and where to go when a tsunami warning is issued, or when self-responding to the natural

warning signs of a tsunami. Upon completion, countries should have the capability and tools to replicate the community evacuation map process elsewhere in their country.

Several Member States of North-Eastern Atlantic, the Mediterranean and Connected Seas Tsunami Warning and Mitigation Systems (NEAMTWS) commemorated the World Tsunami Awareness Day in 2019. A Tsunami exercise was organized in Latina, Italy on 10 October 2019. The exercise tested standard operating procedures of institutions and municipalities that manage a tsunami risk emergency. As part of the Tsunami Last Mile research project funded by the European Commission DG ECHO, Turkey and Greece carried out several tsunami activities aligned with the World Tsunami Awareness Day. Turkey carried out two tsunami awareness raising and preparedness seminars and one table-top exercise. The tsunami awareness-raising seminar occurred in a primary school in Bodrum, Turkey, while a preparedness seminar was held at a hotel. In Kos, Greece, an earthquake and tsunami preparedness exercise was organized. The exercise tested the effectiveness of a new series of technological solutions, developed by the Joint Research Centre (JRC) to provide tsunami early warnings to the local population, its integration into the municipality emergency management plan and procedures, and its interface with the national tsunami warning system.

Support for enabling research and policy development

Ongoing improvements of Tsunami warning systems and mitigation efforts are important. They contribute to sustain the system, reduce costs and uncertainty, and maintain public trust. The Tsunami community has contributed actively to the development of the Implementation Plan for the UN Decade of Ocean Science for Sustainable Development. The community has participated in several of the regional planning meetings and the community has outlined the transformational steps that should be undertaken to develop more timely and accurate tsunami detection, measurement, and forecasts over the next decade (see Angove et al., 2019, *Ocean Observations Required to Minimize Uncertainty in Global Tsunami Forecasts, Warnings, and Emergency Response*, Frontiers of Mar. Sci., 25 June 2019, https://doi.org/10.3389/fmars.2019.00350).

IOC, through IOTIC, IOTWMS Secretariat and the Republic of Indonesia, organised the symposium on Lessons learnt from the 2018 Tsunamis in Palu and Sunda Strait on 26–28 September 2019 at BMKG, Jakarta, Indonesia that was attended by 270 participants from 24 countries. While tsunami warning systems have proven to be effective in mitigating the impact of tsunamis globally, Palu and Sunda strait tsunamis highlighted the challenges that we continue to face in handling tsunamis from non-subduction, aseismic and near-field sources. The Symposium emphasized the urgent need to update hazard assessments, strengthen warning capabilities and enhance community preparedness to deal with such events. It is important to assess the possibilities and limitations of scientific knowledge and technology vis-à-vis the information needs of disaster managers, and make continuous improvements in both technical and social components of tsunami early warning systems. The symposium statement is available at https://unesdoc.unesco.org/ark:/48223/pf0000372721.locale=fr .

The IOC and the Government of Ecuador organised the ICG/PTWS Scientific meeting of experts to understand tsunami sources, hazards, risk and uncertainties associated with the Colombia-Ecuador Subduction Zone, 27–29 January 2020, Guayaquil, Ecuador. The purpose of this meeting was to identify sources of tsunamis that may affect the coastline of Colombia and Ecuador, and to assess the risks that arise from a local tsunami. The meeting focused on exploring tsunami sources in the Colombia/Ecuador coast, and more specifically on the Nazca-South America plates subduction zone.

Harmful Algal Bloom programme

IOC priorities and actions on Harmful Algal Blooms are set by the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB) and the programme is implemented via number of global and regional initiatives. The research component under IPHAB, GlobalHAB, which is jointly sponsored with SCOR, has implemented a number of initiatives from its *Science and Implementation Plan*. The IOC Science and Communication Centre on Harmful Algae at the University of Copenhagen serves as an implementation mechanism and fundraising partner for HAB and GlobalHAB activities. An international GlobalHAB workshop on evaluating, reducing and mitigating the cost of harmful algal blooms was organized in Victoria, British Columbia, Canada on 17–19 October 2019 as part of the Annual Meeting

of the North Pacific Marine Science Organization (PICES) and received additional co-sponsorship from NOWPAP, ISSHA and US NOAA. GlobalHAB has formed an editorial board to develop a 'Best Practice Guidelines for the Study of HABs and Climate Change' to focus research on the occurrence of HABs under changing climate conditions. The draft chapters were in review by end 2019. GlobalHAB is also focusing is on HAB event modelling with a strong training component including development of an online textbook on HAB modelling. This was scheduled for May 2020, but has been postponed to May 2021. GlobalHAB is also covering brackish and freshwater HABs and has published a scientific summary for policy-makers entitled *Solutions for managing cyanobacterial blooms*.

A new GlobalHAB initiative is addressing the mass occurrences of the macro algae Sargassum in both West Africa and the Caribbean. A sub-committee is established with an initial focus to join a GESAMP Task Team on Sargassum in organizing an Open Science Meeting (OSM) on Sargassum. This will involve the GESAMP technical secretaries of the sponsoring agencies that have indicated an interest in this topic (IOC, UN Environment, FAO, UNDP, WMO, IAEA) It is intended that the results of the OSM will be published as a white paper or peer-reviewed journal and will form the basis for GlobalHAB's and GESAMP's future engagement in the Sargassum issue. The dates for the OSM to be held in Mexico are pending the current Covid-19 situation.

The comprehensive undertaking to develop the first Global HAB Status Report (GHSR) based on data compiled in IOC/HAEDAT, OBIS and the literature continues with the collaboration of IAEA, ICES, and PICES and with the financial support of Flanders (Kingdom of Belgium). The GHSR launch was foreseen for May 2020 but has been postponed due to the Covid-19 situation.

The IOC-IAEA-FAO-WHO Inter-agency Joint Strategy on Ciguatera Fish Poisoning is being further developed and implemented though joint workshops and alignment of agency workplans and a draft Memorandum of Understanding was signed by IOC in 2019.

Through the IOC Science and Communication Centre on Harmful Algae Blooms the longstanding opportunities for capacity enhancement in monitoring of HABs continue with several annual courses. Concluding examinations give the trainees certification in identification of HAB causative species. All courses are run within the IOC Ocean Teacher platform and include a combination of preparatory e-learning, hands-on practical courses and an examination. The IOC Centre collaborates with the Marine Institute (Ireland) in operating the International Phytoplankton Inter-calibration (IPI), which in 2019 had 98 participants from 50 laboratories. The number of Member States participating is increasing. New laboratories from Cuba and Nicaragua were participating for the first time. There is an increase of participation from South America and Africa as well. IPI is also established within the Ocean Teacher platform. Accreditation of the IPI under ISO17043 is being prepared.

Marine invasive species

One million species are on the verge of extinction and the introduction of non-indigenous species (NIS) to new environments is listed as one of the five key drivers affecting biodiversity, according to the recent IPBES global assessment. Small Islands Developing States (SIDS) are particularly vulnerable to such a risk, which also creates a real biosecurity risk for human health and the sustainability of livelihoods. It is widely recognized that ship's ballast water and vessel biofouling, including the surge of new (or larger) marine structures linked to the unfolding and fast-growing blue economy, are the main vectors for the introduction and spread of NIS in the marine environment. The Government of Flanders (Belgium), through FUST, is funding a 3-year (2020–2022) project named Pacific islands Marine bioinvasions Alert Network—PacMAN (https://pacman.obis.org/) to develop a national invasive species monitoring system as well as an early-warning decision-support tool for Pacific SIDS, offering a user-friendly dashboard indicating the potential presence of invasive species (including pathogens and pest species) or risk of invasions to support local management. The project will achieve this goal through a work plan that includes: (i) needs assessment and review of current best practices in detecting invasive species; (ii) training of local scientists in field sampling, sample processing, DNA sequencing and data management; (iii) establishing and operating national invasive species monitoring plans; (iv) building a bioinformatics pipeline to improve the availability of metabarcoding data from biofouling communities and feed these into global data infrastructures; and (v) developing the decision-support tool. Strong stakeholder engagement will ensure that the marine bioinvasions monitoring plan and the information and services of the decision-support tool contribute to and meet the requirements of local management (triggering

rapid response). The project is coordinated by the OBIS secretariat with the support from the Institute of Applied Science of the University of the South Pacific as the local implementing partner.

V. ASSESSMENT & INFORMATION FOR POLICY

Support assessment and information to improve the science-policy interface

Sustainable Development Goals (SDG)

In the context of the 2030 Agenda for Sustainable Development, several targets of SDG 14 are directly relevant to the work of IOC, particularly in the areas of marine pollution, ocean acidification, ecosystem-based management, as well as marine research capacity and transfer of marine technology. IOC is identified as the UN custodian agency by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs) for SDG indicators 14.3.1 (ocean acidification) and 14.a.1 (scientific knowledge and ocean research capacity). Significant progress was made in the collection of new data provided by Member States to IOC towards these Indicators. Member States followed IOC's invitations to contribute to the Global Ocean Science Report (GOSR) 2020 online questionnaire—the basis for 14.a.1 reporting and to the newly established ocean acidification data portal for 14.3.1 reporting, developed in collaboration between the Ocean Science Section and IODE. This new portal provides, hosted at IODE, helps Member States, NODCs, other organizations and individual scientists to submit ocean acidification data. IOC HQ and IODE will further develop a user-friendly GOSR data portal, which allows open access to all GOSR2020 data, and in particular the 14.a.1 information. In February 2020 IOC reported to the IAEG on both indicators. Several activities were undertaken to advance the methodology of indicators for targets 14.3 and 14.a, as well as in relation to target 14.1 on marine pollution (Nutrients).

Concern over the impacts of altered nutrient inputs, N, P and Si, to coastal waters led the UN to include an "Index for Coastal Eutrophication Potential" (ICEP) as indicator for SDG Goal 14.1.1 on eutrophication: *By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution*. UN Environment is the custodian agency for Indicator 14.1.1, and the IOC is responsible to develop ICEP as the indicator. To implement ICEP, it is required to develop a component on a dissolved silica model and evaluate the effectiveness of ICEP in predicting coastal impacts at the global scale. To promote and increase the understanding of the potential of ICEP as indicator, the IOC in 2019 produced an animation for YouTube https://youtu.be/qW2nV2bsyCs. The work to finalise the development of the methodology will require funding for two postdoctoral scholars and an expert workshop to validate models.

General Bathymetric Chart of the Oceans (GEBCO)

The 36th Meeting of the GEBCO Guiding Committee (GGC) and associated meetings took place in Portsmouth, new Hampshire, USA on 7–8 November 2019 back to back with the 'Map the Gap Symposium' which focused on global and regional mapping challenges and opportunities and emerging technologies for bathymetry. The GGC recommended that IOC be asked to assist in encouraging coastal States to allow the collection and publication of data gathered in their waters of national jurisdiction in support of Seabed 2030 and the IHO Crowdsourced Bathymetry initiatives. Further discussions took place on how to better align the Nippon Foundation-GEBCO Seabed 2030 project with the UN Decade.

The Nippon Foundation-GEBCO Seabed 2030 project, aimed at facilitating the complete mapping of the ocean floor by the year 2030 is proceeding with its implementation. The IOC Executive Secretary participated in a special event organised at the Royal Society, London, UK, on 22 October 2019, where the new 2019 GEBCO-Grid, which has been developed through the Nippon Foundation-GEBCO Seabed 2030 Project, was announced. All data from the GEBCO_2019 Grid can be downloaded from the GEBCO website (gebco.net). At the event, through the support of the Nippon Foundation, it was announced that Seabed 2030 will provide vessels around the world with data-gathering equipment to enable them to contribute to the project. These vessels will have data loggers installed to record bathymetric information, increasing mapping capacity and capability and establishing new connections between Seabed 2030 and owners of vessels including fishing fleets, tourist boats, and pleasure craft. Seabed 2030 will also champion the development of innovative, scalable new solutions to increase the efficiency, safety, and cost-effectiveness of deep-sea mapping, paving the way for public participation on the widest scale possible to meet the project's goals.

Ocean and coastal Atlases

Work on the Caribbean Marine Atlas (CMA), an IODE project, has progressed well in accordance with the workplan: the CMA is an online digital platform that supports the integrated coastal zone management (ICZM) and ecosystem-based management for Large Marine Ecosystems in the Wider Caribbean region—mainly Caribbean and North Brazil Shelf Large Marine Ecosystems (the CLME+ Region). The Atlas is supporting the implementation of the CLME+ Strategic Action Programme. During the reported period, INVEMAR continued to provide 24/7 operation services and support, including technical advice to expert users, especially to CLME+ project and CMA Member States. In October 2019, the CMA became a Member of the IHO Meso-American Caribbean Sea Hydrographic Commission (MACHC) Marine Spatial Data Infrastructure Working Group (MMSD). This Group seeks to promote the development of MSDI within the region in support of numerous non-navigation users of marine (hydrographic / charting) data. The CMA2 project, funded under the UNESCO/Flanders Fund-in-Trust has now started its final year.

Contribution to global ocean assessment processes

IOC continues to provide scientific and technical support to the World Ocean Assessment (WOA) process established under the UNGA. Financial support was provided to organise the meetings of the WOA Group of Experts in 2019 and 2020. Discussions with DOALOS (Secretariat of the Regular Process) have been conducted with regards to how the preliminary conclusions of the WOA-2, particularly in terms of knowledge and capacity gaps, could be addressed by the Implementation Plan of the UN Decade.

The OBIS Secretariat contributed graphs and maps for two chapters of the second cycle of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects (i.e, World Ocean Assessment Report 2), namely Chapter 6: Trends in the biodiversity of main taxa of marine biota, subchapters (b) Marine invertebrates; and (c) Fish; and Chapter 7: Trends in the state of biodiversity in marine habitats, subchapter (o) Abyssal plains. The OBIS data and information products and scripts are available on https://github.com/iobis?utf8=✓&q=woa. The OBIS data access and enhancement services (r-packages robis and obistools) were also used in the creation of products for the European Atlas of Marine Life, for example in calculating the thermal affinities for European marine species, which is an interesting indicator to predict climate change impacts (global warming) on the distribution and composition of species communities. OBIS also provided statistics and maps of its HAB data for the Global HAB Status Report.

The IOC is a partner in the GEF-UNDP-IMO GloFouling Partnerships Project, an intervention at the global, regional and national levels with the aim to develop best practices and build capacity in developing countries for implementing the IMO and other relevant guidelines for biofouling management and to catalyse overall reductions in the transboundary introduction of biofouling-mediated invasive aquatic species. IOC has the lead in implementing and coordinating activities for the non-shipping aspects of the Project, including contributions from the private sector through the World Ocean Council.

VI. SUSTAINABLE MANAGEMENT & GOVERNANCE

Enhance ocean governance through a shared knowledge base and improved regional cooperation

UN Decade of Ocean Science for Sustainable Development

Preparation of the UN Decade of Ocean Science for Sustainable Development has continued throughout this period in a highly participatory manner. Over 1,500 stakeholders participated in 11 regional planning meetings across 10 ocean basins between June 2019 and March 2020. These meetings generated comprehensive information on the scientific research and capacity development priorities for each ocean basin, and catalysed discussions between stakeholders regarding regional partnerships to advance implementation of the Decade. A thematic workshop was held on the role of ocean literacy in the Decade, and Decade related sessions and side events were held at international meetings and conferences including OceanObs19 and the Ocean Sciences Meeting 2020. The Commission was present at the Our Ocean Conference in Norway in October 2019 and made a Voluntary Commitment for the establishment of the Ocean Decade Alliance, which will be a key resource mobilisation mechanism for the Decade focusing on significant voluntary commitments. The second meeting of the

Decade Executive Planning Group was held in Paris in January 2020 and provided valuable input to the drafting of the Implementation Plan. A dialogue with over 25 philanthropic and corporate foundations was held in Copenhagen in February 2020 and resulted in several foundations expressing interest in establishing formal partnership agreements related to the Decade. An informal working group of over 40 Early Career Ocean Professionals was established to coordinate the engagement of this stakeholder group in the Decade, and the group met regularly throughout this period. Regular meetings were held with the UN Oceans Contact Group for the Decade throughout the period. The Second Global Planning Meeting, which was originally planned for March 2020, was cancelled due to the Covid-19 situation and was replaced by two webinars to present the Draft Implementation Plan; these webinars were attended by over 550 participants. Communications activities including a regular social media presence, use of the Decade logo in a range of approved events and publications, and a Decade newsletter have continued to raise visibility across a broad audience.

The key output of the preparation phase during this period was the Zero Draft Implementation Plan for the Decade, which was released to Member States, UN Oceans members, and key Decade partners for peer review in March 2020. The comments received during this period have been received and are being integrated into a revised version of the draft Implementation Plan that will be reviewed by IOC Member States before being finalised and presented to the UNGA in late 2020.

The Implementation Plan explains the rationale for the UN Decade of Ocean Science for Sustainable Development and the desired state of the ocean at the end of the Decade. It contains a framework to guide the design and implementation of actions throughout the Decade including a set of Ocean Decade Challenges and objectives for the Decade. It presents the criteria and process for the endorsement of Decade Actions and the principles to guide data management, capacity development, and engagement with stakeholders. Finally, it describes the proposed governance and coordination arrangements of the Decade, the mechanisms for resource mobilisation, and the process to measure progress.

Biodiversity in Areas beyond National Jurisdiction (BBNJ)

The UN General Assembly decided in December 2017 through Resolution72/249 to organize an intergovernmental conference, scheduled over four meetings to be held over a three-year period (2018–2020) with the aim to finalise a new international legally-binding instrument (ILBI) to conserve and sustainably use marine biodiversity in areas beyond national jurisdiction (the High Seas and the Area) under the UN Convention on the Law of the Sea (UNCLOS). A revised draft text of an agreement was released in November 2019 by the President of the intergovernmental conference. Under Article 51—Clearing House Mechanims, a reference under sub-para. 6 is made with regards to a potential role for IOC to manage such a mechanism. IOC has prepared a non-paper to describe existing and future services of the IOC that could support a future internationally legally binding instrument (ILBI) for BBNJ including coordination of a Clearing House Mechanism, as envisaged in the draft ILBI negotiation text. The Non-Paper is intended to inform on-going negotiations and will be presented at a dedicated side event at the fourth meeting of intergovernmental conference originally planned for March 2020 but suspended due to the Covid-19 situation.

UN Framework Convention on Climate Changes (UNFCCC)

In the framework of the 25th Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC CoP-25) held in Madrid, Spain (2–13 December 2019), the World Meteorological Organization launched its annual report on the State of Climate. This report was produced with key contributions from IOC, via the Global Ocean Acidification Observing Network (GOA-ON) and the Global Ocean Oxygen Network (GO2NE). The report highlights that 2019 concludes a decade of exceptional global heat and high-impact weather and the Ocean, which acts as a buffer by absorbing heat and carbon dioxide, is paying a heavy price. Through the engagement of the IOC Chairperson and Executive Secretary and members of Secretariat, IOC participated in several events at CoP-25 such as Ocean Day at CoP-25, UN-Oceans side event, SDG 14 Community of Ocean Actions, amongst a few.

IOC Participation in the Nairobi Work Programme (NWP)

During this period, the IOC collaborated with the UNFCCC and partners on ocean component of the Nairobi Work Programme (NWP). The NWP works in collaboration with partners and experts to advance activities that produce usable knowledge products and catalyse partnerships for collaborative action in a wide range of thematic areas (e.g. oceans, coastal areas, ecosystems, etc.). The NWP is currently focusing on the topic of ocean. In line with the NWP knowledge-to action methodology, key steps were undertaken to close knowledge gaps on oceans that help scale up adaptation action. A Group of Experts was convened, and a scoping paper was produced in November 2019. IOC participates in the newly created Group of Experts. A virtual Group of Expert meeting was held on 21–22 November 2019 to co-design the thirteenth Focal Point Forum as well as plan collaborative follow up actions on oceans to fill knowledge gaps. The thirteenth NWP Focal Point Forum was held under the guidance of the Chair of the SBSTA as a side event at CoP-25, 6 December 2019, Madrid, Spain. The Focal Point Forum focused on four themes: Governance and Participation; Data and Methods; Restoration and Protection; Support (Technology and Innovation, finance and funding, capacity building and education). IOC led and moderated the Data and Methods session. A report is being prepared by the UNFCCC and NWP to capture the outcomes in terms of actions as a result of the findings in the scoping paper, Group of Expert meeting as well as discussions during the thirteenth Focal Point Forum. The report will include indicative collaborative actions of engaging experts, organizations and partners. IOC will continue collaboration with the NWP, Group of Experts and partners in 2020. The NWP partnerships, based on these collaborative actions will aim at addressing the knowledge gaps on this thematic area during the course of 2020. The progress made on these partnerships will be shared with Parties at SBSTA 52 (June 2020). In addition, the NWP intends to explore possibility of co-producing relevant knowledge products in the context of these collaborative actions as well as co-presenting the outcomes in various relevant events/meeting during the course of 2020.

Convention on Biological Diversity

IOC is progressively increasing its involvement in the negotiation process to develop a post-2020 global biodiversity framework under the Convention on Biological Diversity. IOC provided input to the process to define targets and indicators for the post-2020 global biodiversity framework, which includes recommendations to ensure coordination with ongoing initiatives as part of OBIS and the definition on biological and ecosystem Essential Ocean Variables (EOV) as part of GOOS.

Joint Roadmap on Marine/Maritime Spatial Planning (MSP)

IOC-UNESCO and the European Commission continue the implementation of the Joint Roadmap to accelerate Maritime/Marine Spatial Planning processes worldwide (#SDG OceanAction15346) as a follow-up to the 2nd International Conference on marine spatial planning (MSP) in March 2017. In the context of the MSPglobal Initiative (www.mspglobal2030.org), IOC promoted interaction amongst public and private sectors with dedicated stakeholder events and training activities. Up to 25 events were organized between July 2019 and May 2020 in Belgium, Brazil, China, Croatia, Colombia, Ecuador, France, Gabon, Italy, Latvia, Morocco, Panama, Peru, Portugal, Spain, Sweden and Turkmenistan, with more than 1,600 beneficiaries from 70 different countries. Ensuring gender, geographical and age balance was a priority in all of them, for both the invited speakers and participants. MSPglobal events were organized in collaboration with national authorities and counted on the co-financing of Member States, other project initiatives led by IOC and other partner institutions. IOC considers the use of all possible languages in events a priority: during the reporting period, events were organized in Arabic, English, French, Italian, Portuguese, Russian and Spanish.

Additionally, the Government of the Netherlands reinforced its institutional contribution to the implementation of IOC's Capacity Development Strategy in support of the Joint Roadmap to accelerate MSP worldwide and the MSPglobal Initiative. The Government Offices of Sweden provided additional support to assist the regional implementation of the Joint Roadmap with technical workshops and trainings on integrated coastal area management, marine spatial planning and sustainable blue economy in Central Equatorial Africa and in Latin America. The Government of Turkmenistan invited our Secretariat to actively participate in the 1st Caspian Economic Forum to further discuss marine spatial planning and sustainable blue economy.

The Directorate-General for Maritime Affairs and Fisheries of the European Commission (DG MARE) invited the IOC Secretariat to actively participate in the Blue Partnership Forum for the Oceans to ensure

the sustainable development of the ocean. The Joint Roadmap was presented as an example of cross-cutting tool to implement the Ocean Partnership in support to the implementation of the EU-China Ocean Partnership.

In the context of the collaboration between the MSPglobal Initiative and SPINCAM Project (co-funded by the Government of Flanders, Kingdom of Belgium), IOC jointly organized trainings on marine spatial planning and sustainable blue economy in the Southeast Pacific region during the second semester of 2019 in collaboration with IOC National Coordination Bodies. The initiative contributed to the regional workshop of the UN Ocean Decade 2021–2030, towards a sustainable use of marine resources in the region.

IOC strenghtened the collaboration with the Franco-Moroccan and Moroccan-Italian Co-Presidency of the Western Mediterranean, the Union for the Mediterranean and the Priority Action Programme/Regional Activity Centre of UN Environment for the Mediterranean with joint activities, exchanges of valuable experiences and transfer of marine knowledge.

The 4th MSPforum was jointly organized by DG MARE, IOC-UNESCO, VASAB Secretariat and the PanBalticScope Project in November 2019, bringing to Riga (Latvia) more than 300 experts from 50 different countries. The 5th MSPforum was expected to be organized in Athens (Greece) by the end of April 2020; however, in consultation with the Hellenic Authorities, the European Commission and IOC-UNESCO, it was postponed to September 2020.

The Covid-19 pandemic forced the Secretariat to cancel or to postpone a large number of events that were already agreed with our Member States and partners. The MSPglobal Initiative organized instead weekly online dialogues and thematic webinars in April and May 2020. These online events covered topics related to marine spatial planning and blue economy, including the implications of climate change in the planning process, the importance of public participation and gender, land-sea interactions and the use of remote sensing and earth observation for planning purporses, amongst other topics. These online events were alternatively organized in Arabic, English, French, Portuguese and Spanish with more than 100 registered participants per event and more than 1,000 beneficiaries from 100 different countries.

At national and local scales, IOC continued a productive dialogue with national authorities to increase cooperation amongst national stakeholders and experts from national institutions involved in MSP and blue economy processes. The Secretariat relied on the support of National Official Coordinating Bodies for liaison with IOC and competent authorities to jointly update the information available on the implementation status of marine spatial planning at national and regional levels. The results of this survey will effectively support the development of multilingual products, international guidance on marine spatial planning and strengthening of institutional capacity-building activities jointly organized with national authorities as well as regional and international partners.

The MSPglobal website is progressively integrating new content and all sections are now available in Arabic, English, French and Spanish. Guidelines and brochures are also available in Russian and Portuguese.

GEF International Waters Parnership and Large Marine Ecosystems

During this period, as part of the implementation of the GEF IW:LEARN project two training webinars were conducted in November 2019, one on communications and another on the various IW:LEARN Spatial Data Visualization and website tools. Peer to peer training events were implemented between the Caribbean IWECO and Pacific Ridge to Reef project, and by the Coastal Fisheries Initiative on the topic of Marine Spatial Planning. The first Central America Regional Roundtable on transboundary cooperation was conducted with 51 participants and representatives of the Ministries of Foreign Affairs and Environment (with one exception) in Tegucigalpa in July 2019. The final Southeastern Europe regional dialogue roundtable on strengthening considerations of the water-energy-food ecosystem nexus in the region's countries was conducted in October 2019 in Tirana. The project supported a second policy-maker roundtable on transboundary cooperation in shared water basins in Central America, in February 2020 in San Pedro Sula, Honduras.

The project carried out the final targeted workshop for GEF IW projects in Latin America & the Caribbean in Cartagena, September 2019, with seven GEF IW projects represented and 30 participants. The project completed the online gender platform at iwlearn.net, with relevant references and materials on gender issues and policies. The project supported a GEF International Waters booth and multiple sessions in the 2019 Stockholm World Water Week and sent two projects to the UNECE IWRM Working Group meeting in October 2019 to engage in Water Convention partnerships. The project continued expanding and populating the Learning Exchange Service Center and continued to support work on the development of a freshwater security massive online open course. Training materials on benefits sharing and preparing bankable projects were prepared and disseminated. The project embarked on enhancements to its publication catalogue as well as the re-launch of its training course and materials in support of the Transboundary Diagnostic Analysis—Strategic Action Program Methodology of the GEF.

The 4th Phase of IW:LEARN will soon close, and a 5th phase of the project is currently being prepared through the development of project proposal that will be submitted in mid 2020 to the GEF. Consultations with project partners are ongoing to develop this proposal.

During this period the GEF LME:LEARN project also continued efforts to strengthen the global governance of large marine ecosystems and their coasts. The LME21 Annual Consultation Meeting held in Cartagena (Colombia) on 18–20 September 2020 had a focus on partnership building and was attended by more than 80 participants, including project representatives, as well as representatives from the private sector and international organisations and NGOs. Discussions were held around the issue how to build a successful partnerships that will result in effective achievement of the SDG 14 targets and, in a long run, result in efficient use of marine resources at the LME level.

Inter-project collaboration opportunities between the Benguela Current Convention and the Barcelona Convention, focusing on Marine Spatial Planning in the Benguela Current and Mediterranean Sea LMEs, and the ICO between PEMSEA and the CLME+ project focusing on creating synergies and fostering capacity on the development of blue economies for sustainable ocean governance and the achievement of the 2030 sustainable development agenda, were both completed in October 2019. In October 2019, a twinning was also completed by the Pacific Ridge to Reef project and the America Samoa EPA in Pago Pago.

Six toolkits related to the incorporation of knowledge into policy-making were disseminated online and the *Data and Information (DIM) Guidelines and Action Plan*, together with the LME Metadata Catalogue and a List of LME Indicators, were finalized and discussed and approved at the DIM Working Group Meeting in Paris on 2–4 July 2019. A special LME session was conducted during the Marine Regions Forum 2019, in Berlin on 30 September–2 October 2019, with the participation of three LMEs (Mediterranean, Yellow Sea and Benguela Current). The purpose of the side event was to show how the Ecosystem Based Management approach could be utilized as the basis for the LME management. Similarly, a side event was conducted during the 30th IOC Assembly showcasing the work of LMEs and their utility to help achieve the Decade. Ten policy briefs were finalized and printed and the project is assisting in publishing the definitive volume on LMEs to be published by SCOPE in collaboration with University of Rhode Island.

The LME:LEARN project was completed in March 2020 and the final evaluation undertaken. The new project proposal that is being developed for the 5th phase of the IW:LEARN Project incorporates a set of ongoing activities to ensure continued support for and facilitation of collaboration between LME projects.

The Caribbean and North Brazil Shelf Large Marine Ecosystems Project (CLME+) is UNDP/GEF project supported and implemented by the following organizations: IOC of UNESCO, CARICOM Secretariat, UN Environment, CEP, OECS Commission, OSPESCA, CRFM, FAO-WECAFC, CCAD. CLME+ Member States have been participating in the discussions and in the process towards the establishment of the Coordination Mechanism, and in the development of a Sustainable Financing Plan for Ocean Governance through a series of meetings including: The Fifth Meeting of the of the CLME+ SAP Interim Coordination Mechanism (ICM) and the CLME+ Second Regional Consultative Meeting on a Coordination Mechanism and Sustainable Financing Plan for Ocean Governance, 29 July–2 August 2019, Panama); The Sixth CLME+ SAP ICM Meeting and Project Concept Note Development Workshop

(16–17 September 2019, Cartagena, Colombia); and Joint CLME+ SAP Interim Coordination Mechanism and Project Executive Group Meeting (18–20 March 2020, Miami, USA, held virtually).

Regional projects/ Activities

The **SPINCAM Project** (www.spincam3.net)—completed on 31 October 2019—achieved the expected milestones and deliverables agreed with beneficiary countries and the donor. At national level, SPINCAM partners maintained the linkages amongst public institutions and stakeholders in support of coastal and marine policy development and successfully strengthened the technical work in support of policy review, ecosystem processes and marine spatial pre-planning. The Project's publications on the *Compendium Of Regional Capacity Development Needs and Offers*, the *Compendium of Coastal and Marine Policies* and the report on data and information needs of users and responsible to implement marine spatial planning in the countries of the Southeast Pacific were finalized and disseminated amongst interested Member States only. SPINCAM organized trainings and technical workshops in all beneficiary countries in collaboration with other project initiatives led by IOC-UNESCO and national authorities. These trainings and technical workshops were dedicated to coastal and marine ecosystems (typology, classification, uses and human impacts and valuation), regional marine policy, marine spatial planning, sustainable blue economy and marine/maritime indicators.The trainings and workshops benefited 200 officials from the region.

IOC-UNESCO and the Permanent Commission for the Southeast Pacific (CPPS) strengthened the collaboration with other sister projects under implementation in the region and promoted South-South and South-North exchanges, including linkages with institutions and companies based in Flanders, Belgium.

A three-day technical workshop on coastal vulnerability in Central Africa, organized by IOC concluded with a series of recommendations for decision-makers at national and regional levels to respond to challenges in coastal and marine environments. National representatives of Angola, Cameroon, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, the Republic of the Congo and São Tomé and Príncipe met in Libreville (Gabon) on 5–7 November 2019 to start mapping out a roadmap for adapting coastal zone management strategies and action plans at national and sub-regional levels. The longer-term objective: define scenarios for sub-regional and regional synergies to address transboundary coastal vulnerability challenges, with a focus on coastal adaptation.

IOC was actively enaged in the organisation of Marine Regions Forum that took place from 30 September to 2 October 2019 in Berlin, organised with the support of the German Government, the European Commission, IDDRI and IASS. The overarching theme of the conference was **"Achieving a healthy ocean – Regional ocean governance beyond 2020"**. IOC organised two sessions, respectively on: (i) the role of LMEs in advancing ecosystem-based management and SDG 14; and (ii) on the regional dimensions of the UN Decade. Both sessions came up with recommendations for strengthening regional ocean governance and science-policy interface in support of the 2030 Agenda for Sustainable Development and the UN Decade.

Work Programme of the IOC Regional Subsidiary Bodies

The **IOC Sub-Commission for the Western Pacific (WESTPAC)** continues to assist IOC Member States in the region to enhance their ocean governance by strengthening science-policy interface, and concerting the joint actions of research communities to address critical challenges for sustainable development. To deliver greater benefits of ocean operational services to wider stakeholders, the WESTPAC Training Workshop on "Delivering Ocean Forecasting Services for Coral Reef Conservation" (11–13 September 2019, Phuket, Thailand) wrapped up with the promise of further collaboration and data-sharing for advancing the SEAGOOS ocean forecasting system to develop early warning for coral reef bleaching. To assist IOC Member States to address plastic and microplastic pollution, the Sub-Commission enhanced Member States' capacity for research and monitoring of marine microplastics and plastics, with substantive progress presented at its 3rd Workshop on Distribution, Source, Fate and impact of marine microplastics (6–8 November 2019, Shanghai, China) including the first scientific finding published on microplastic in the Bay of Bengal. In November 2019, the Sub-Commission launched efforts to jointly research and monitor ocean deoxygenation, as reflected at its Inception

Workshop on Ocean Oxygen Network (20–22 November 2019, Manila, the Philippines) held jointly with PEMSEA and the University of the Philippines.

Co-designed with IOC Member States in the region, WESTPAC continues to develop a regional long-term network of training and research centres (RTRCs). Over the last year the Regional Training and Research Centre on Marine Biodiversity and Ecosystem Health in Indonesia on Assessment of Carbon Stock and Sequestration in Seagrass (4–12 November 2019, Bintan, Indonesia). Meanwhile, other three RTRCs, respectively on Reef Management and Restoration, Marine Toxin and Food Security, and Plastic Marine Debris and Microplastics are being set up. Operating in the field, the Sub-Commission demonstrated its unique value for IOC in addressing its Member States' specific needs directly. For instance, WESTPAC has been assisting Viet Nam to enhance its research capacity for ocean acidification and molecular techniques with a national training workshop conducted on 22–23 October 2019, Nha Trang, Viet Nam.

IOCAFRICA, in collaboration with the Western Indian Ocean Marine Science Association and the UN Environment Nairobi Convention secretariat organized the Regional Workshop on the UN Decade of Ocean Science for Sustainable Development (2021–2030) to identify knowledge gaps and regional ocean science priorities in Africa and the adjacent island States. The workshop was hosted by the Kenya Marine and Fisheries Research Institute (KMFRI) on 27–29 January 2020 in Nairobi, Kenya. The workshop emphasized the need to strengthen and build upon existing mechanisms such as the regional commissions and conventions, as well as frameworks and strategies and align with the African Union's initiatives. This includes the *Agenda 2063: The Africa We Want*, which recognizes the Blue Economy as a major contributor to continental transformation and growth, and the 2050 African Integrated Marine Strategic Plan of Action (AIMS2050), which provides a roadmap for increased wealth creation from Africa's oceans and seas by developing a sustainable thriving blue economy. Capacity development was identified as a key area of concern, especially the need to improve infrastructure and facilities for research, provision of training for scientific and technical staff, as well as translation of science to policy. This will enable the identification and bridging of major data and knowledge gaps. Other issues that were highlighted include the role of youth and job creation from the ocean economy, marine spatial planning, climate change impacts on the coastal zones, land-sea interactions and pollution, and innovative financing models for the ocean economy.

The **IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE)** Member States are implementing the Recommendations of their fifteenth session. In particular those initiatives for Disaster Risk Reduction and Ecosystem-based management, including: (i) IOCARIBE-GOOS establishment of a pilot project on Improvement of Hurricane Observing Forecasting Capacity; (ii) development of an operational region-wide information and forecasting system for sargassum and oil spills; and (iii) development of a guide on best management practices for sargassum events in the coastal environment. IOCARIBE Member States, expert networks, and education and research institutions are focusing on their contribution to the UN Decade, and to the SDG 14 implementation progress and challenges. A virtual UN Decade Regional Workshop for the Western Tropical Atlantic (28–29 April 2020) provided a major contribution to the plans of the UN Decade and identified IOCARIBE countries and territories needs and priorities in terms of transforming knowledge systems; accelerating transfer of technology; enabling training and education; fostering science-policy dialogues, and enabling scientific solutions to the region's socio-economic challenges

The **IOC Regional Committee for the Central Indian Ocean (IOCINDIO)** continued its efforts and mobilized additional Member States and partners to implement the IOCINDIO-VII work plans and recommendations. This was done through issuance of calls for contributions and coordinated actions enabling a reinforced IOCINDIO governance and leadership. IOCINDIO was engaged in a number of successful actions for the preparatory phase of the Decade notably, the IOCINDIO Leadership Workshop on Developing a Regional Framework for Coastal Vulnerability (6–7 January 2020) that was held back to back with the Northern & Central Indian Ocean Regional Planning Workshop for the Decade in Chennai, India (8–10 January 2020). These activities attracted participants from countries including Australia, Bangladesh, India, Kuwait, Maldives, Saudi Arabia, United Kingdom, USA together with partner countries and institutions such as the South Asian Cooperative Environment Programme and South Asian Seas Programme (SACEP/SASP) and for the first time, representatives from the IOC Sub Commission for Africa and Adjacent Islands. As a result of the meetings the Indian Ocean Youth

Leadership Network and the Indian Ocean Leadership Mentoring Network of Ocean, Climate and Atmospheric Sciences were established to support ocean and climate governance in the region.

IOCINDIO and the Second International Indian Ocean Expedition (IIOE-2) have developed a strong collaboration and partnership based on a co-design approach with a mutual participation in respective activities. Thus, IOCINDIO had planned a side session at the International Indian Ocean Science Conference 2020 scheduled in Goa, India, on 21–26 March 2020 (now postponed due to the Covid-19 situation). This session would have addressed: (i) the IOCINDIO Coastal Vulnerability Framework implementation at national level; (ii) the UN Decade Regional Planning Recommendations; (iii) status of the preparations of the joint IOCINDIO Coastal Vulnerability and Ocean Literacy Workshop scheduled on 26–30 August 2020 in Bangladesh. A joint Summit was also planned for the Indian Ocean Youth Leadership Network and Leadership Mentoring Network of Ocean, Climate and Atmospheric Sciences during the Conference.

VII. CAPACITY DEVELOPMENT

Develop the institutional capacity in all of the functions above, as a cross-cutting function

IOC Capacity Development Strategy

Through IOC Circular Letter 2793 (27 January 2020), Member States were invited to designate national IOC focal points for capacity development. This resulted in 23 additional focal points (March 2020) bringing the total to 31.

IODE's Ocean Teacher Global Academy

Between 2015 and 2019 the IODE Ocean Teacher Global Academy Project has established a global network of Regional Training Centres (RTCs) to deliver customized training for ocean experts and practitioners and to increase national and regional capacity in coastal and marine knowledge and management. OTGA currently has six designated RTCs (in Belgium, Colombia, Kenya, Mozambique, India and Malaysia) and two candidate RTCs (China and Iran). The RTC in Senegal was not active during this reporting period. During the past intersessional period, OTGA organized 12 face-to-face training courses at the 8 RTCs, involving 345 participants. Courses focused on a range of topics related to IOC programmes, contributing to the sustainable management of oceans and coastal areas worldwide, and relevant to Member States in the regions. Four different languages (English, Spanish, French and Portuguese) were used during the different training courses and workshops depending on venue, and all training resources were hosted by the Ocean Teacher e-Learning Platform (www.oceanteacher.org). By April 2020, over 6,600 users had registered on the e-Learning Platform.

Additionally, during the reporting period, Ocean Teacher supported the organization of another five training courses, involving close to 250 participants (International training course on "Instrumenting our ocean for better observation: a training course on a suite of biogeochemical sensors"; 2nd SeaDataCloud Training Course; IOC/HAB International Phytoplankton Intercomparison (IPI): IOC/HAB Training Course: Certification on Identification of Harmful Marine Algae; NF-POGO Centre of Excellence: Ocean Data Management; Marine biodiversity in rocky shores: Biological Essential Ocean Variables (EOVs) for the analysis of marine biodiversity patterns in rocky shores).

The second phase of the Ocean Teacher Global Academy commenced in April 2020 funded by FUST. The Ocean Teacher Global Academy's ISO 29990 certification as a Learning Services Provider for non-formal education and training was renewed in 2020.

Ocean literacy

The voluntary commitment "Ocean Literacy for All" coordinated by the IOC was announced at the first UN Ocean Conference (New York, June 2017). The implementation of the voluntary commitment started in August 2017, and was completed in December 2019 thanks to the support of the Swedish Government. In 2019, two main activities were implemented: one related to the development of a proposal for an Ocean Literacy Strategy for the UN Decade of Ocean Science; and the second one to development a pilot ocean literacy professional development workshop for the private sector. The

process has involved a series of stakeholder consultations, including an open questionnaire with over 300 respondents from across the world, a participatory multi-stakeholder workshop as well as bibliographical review. The workshop held in Venice in December 2019, was attended by 37 people from 34 countries. As a result of the workshop a set of recommendations to further develop the strategy were put forward. The ocean literacy professional development workshop was held in Venice on 16–17 December 2019 was attended by 15 people coming from 12 countries. The course included an expert panel with representatives of media, finance, science and NGOs. It presented some good practices of businesses that have transformed their activities towards ocean sustainability and the implementation of the Sustainable Development Goals.

Global Ocean Science Report

The work on the second edition of GOSR ("GOSR2020") has progressed well. As GOSR2020 was originally intended to be launched at the second UN Ocean Conference in Lisbon in June 2020, which has been postponed, the Secretariat is exploring options for an adequate high-level opportunity to launch of the Report. The specific modalities of the launch may also depend on the evolution of the Covid-19 pandemic and, therefore, the possibility of a virtual launch of the report is not excluded. In addition to primary data from IOC Member States and other governments, GOSR2020 benefits from bibliometrics analysis related to scientific production globally (already reflected in the first edition of the GOSR) as well as of a technometrics analysis of patents in ocean science, also at the global level. Such a comprehensive analysis of patents in ocean science constitutes a precedent in the area of ocean R&D and should be of particular use in assessing the contribution of ocean science to sustainable blue economies.

It is worth recollecting that the *Global Ocean Science Report* provides information on status and trends of ocean science worldwide in terms of infrastructure, human resources (using sex-disaggregated data), and level of investments (the latter calculated as the ocean science proportion of the R&D expenditures in the national envelope). GOSR is, therefore, envisioned to guide strategic investments in ocean science in support of national sustainable development agendas. The report is also the main mechanism to report on progress on SDG Indicator 14.a.1, for which IOC is custodian agency (cf. Function D). *GOSR2020* will also provide a baseline in relation to ocean science capacity for the UN Decade of Ocean Science for Sustainable Development (2021–2030).

The Editorial Board of *GOSR2020*, composed of 12 members with adequate discipline, geographic and gender balance, has provided the oversight function needed to ensure the scoping of the report, quality assurance and control over its development and finalization, and continuity and renewal between the first and second editions. *GOSR2020* includes eight chapters, as follows: 1. Introduction; 2. Definitions, data collection and analyses; 3. Ocean science funding; 4. Research capacity and infrastructure; 5. Data and information; 6. Research productivity and science impact; 7. Implications and applications of ocean science for sustainable development; 8. Conclusions and recommendations.

Particular attention was given to the peer-review of *GOSR2020*, which has seen the contribution of many scholars and expert practitioners in all regions of the world, and has followed a rigorous procedure in terms of confidentiality; provision of structured comments related to the structure of the report and the comprehensiveness of the findings in individual chapters and of the report as a whole as well as of the related analysis; overlaps, inconsistencies and gaps in the assessment within or across different chapters; proposed revisions, providing supporting evidence from the literature; relevant additional scientific articles; suggestions on improving the presentation of material graphically or through tables.

GOSR2020 will be published online as well as in a limited number of printed copies and will be complemented by the *GOSR2020* portal. The portal will allow for open access to all data underpinning *GOSR2020* and will also publish the comments received following individual reviews, in an IPCC style.

The *Global Ocean Science Report* measures, in a systematic manner, investments in ocean science (human resources, infrastructure such as research vessels and laboratories) as a proportion of national R&D envelopes. Trends in scientific production, including through international scientific collaborations, and in the transfer of research findings to the application sectors (via patents and their licensing) are also measured by the GOSR. It is important to assess the impacts of the Covid-19 pandemic on such strategic investments in relation to the 2030 Agenda. For this purpose, and in the context of the

UNESCO-wide response to the Covid-19 pandemic, the IOC Secretariat will lead a complementary study to *GOSR2020* to assess how the Covid-19 crisis may have led to the shifting of funding and support more in general from ocean science towards other branches of science/economic sectors e.g. health. The study will also allow to foresee the related impact on the achievement of SDG Target 14.a on ocean science capacity and the transfer of marine technology, and will suggest options to mitigate risks related to undershooting efforts supporting the realization of the target, and to maximize the contribution of ocean science to the 2030 Sustainable Development Agenda, including through the production of research findings for developing applications for health (SDG 3), and also in relation to food security (SDG 2). The study will contain a communication element demonstrating the relevance of ocean science and, specifically, the work coordinated by IOC, to the knowledge base for health applications.