

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 73/124 of 11 December 2018, entitled “Oceans and the law of the sea”, the information below represents the contribution of the Intergovernmental Oceanographic Commission of UNESCO to the report of the Secretary-General.

I Ocean Research

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

IOC has engaged actively in the review of the World Climate Research Programme (WCRP) and contributed to the development of the new WCRP Strategic Plan 2019–2028 (cf. IOC/INF-1375). Close cooperation has been established with the WCRP core project on Climate Variability, Predictability and Change (CLIVAR) in the area of Eastern Boundary Upwelling Systems (EBUS) in collaboration with the Scientific Committee on Oceanic Research (SCOR).

EBUS are the most productive marine ecosystems in the world in terms of their contribution to food security and may be undergoing change due to warming and alteration in stratification patterns, changes in upwelling regimes, and potentially changes in their biogeochemical features. Building on the longstanding IOC-Spain/AECID (Spanish Agency for International Development Cooperation) cooperation in the execution of the project “Enhancing oceanography capacities in the Canary Current Large Marine Ecosystem and the growing mobilization of countries from Western Africa, in partnership with the Instituto Español de Oceanografía (IEO), the Ocean Science Section of the IOC Secretariat has designed an ambitious work stream on EBUS, which would contribute directly to SDGs 14, 13 (Climate Change) and 2 (Food). This work stream foresees the following main steps: continuous implementation of the CCLME project, third phase (a workshop on The Effects of Climate Change on the Productivity in the CCLME was held in Santa Cruz de Tenerife, Spain on 18–20 September 2018, and a second workshop will be held in Cabo Verde in the fall of 2019. Both workshops involve experts from seven African countries and Spain; the co-sponsoring of the Summer School on EBUS: Assessing and Understanding their Changes and Predicting their Future, in collaboration with WCRP/CLIVAR, at the International Center for Theoretical Physics (ICTP) in Trieste, Italy from 15 to 21 July 2019; co-sponsoring of the Summer School on EBUS Variability and its Impact on Marine Life and Climate (Dakar, Senegal, 8–19 June 2020), jointly with the SCOR Working Group 155 on EBUS: Diversity, coupled dynamics and sensitivity to climate change; the organization of an international workshop on EBUS in Spain in 2020; and the organization of a first-ever Open Science Conference on EBUS in Lima, Peru in April 2021, jointly with SCOR and WCRP/CLIVAR. Moreover, the IOC Secretariat has held preliminary talks with the Food and Agriculture Organization of the United Nations (FAO) with the goal to design a joint project for consideration by the Global Environment Facility aimed at a comparative diagnosis and management actions relating to status and trends of the main four EBUS (Canary Current, Benguela Current, Humboldt Current and California Current LMEs) and related impacts on food security and sustainable ocean economies.

IOC is paving the ground with the WCRP core project on Climate and the Cryosphere (CliC) with regard to science requirements related to Polar Regions in the context of the UN Decade of Ocean Science.

IOC convened a major Symposium on the Effects of Climate Change on the World Ocean, the fourth of a series, together with ICES, PICES and FAO, and in collaboration with NOAA. The Symposium, organized by NOAA, was held in Washington D.C., USA from 4 to 8 June 2018, and benefited from the attendance of some 600 participants. The outputs of the Symposium will feed into the scoping process of the UN Decade of Ocean Science.

IOC continues to lead in the area of ocean acidification through its active participation in, and support to, the Global Ocean Acidification Observing Network (GOA-ON), as well as participation in other relevant international groups such as the international Ocean Acidification international Reference User Group (OAI-RUG). In the reporting period, the Commission hosted two expert group meetings to develop further the methodology for SDG indicator 14.3.1. This methodology is now openly available on the IOC website. The Inter-agency and Expert Group on SDG Indicators (SDG-IAEG) of the UN Statistical Commission agreed on the reclassification of SDG indicator 14.3.1 from Tier III to Tier II, which reflects that the indicator is considered conceptually clear, has an internationally established methodology and that standards are available, but that data are not yet regularly produced by countries. The IOC Ocean Science Section has embarked in the preparation of a manual for the application of the methodology related to SDG indicator 14.3.1 and of a related database hosted at IODE, which will facilitate the regular contribution to data collection and annual reporting to the UN; this activity will be supported financially by the Ocean Policy Research Institute of the Sasakawa Peace Foundation. IOC supported the annual GOA-ON Executive Council meeting in Sopot, Poland, from 28 to 30 May 2018; and co-organized the 4th GOA-ON International Workshop in Hangzhou, China 12–14 April 2019.

Thanks to the continuous fruitful collaboration between IOC and the Western Indian Ocean Marine Science Association (WIOMSA), six countries along the Eastern African Coast are now starting to measure ocean acidification on a systematic basis. A kick-off workshop for this activity was co-organized by IOC and WIOMSA in Mombasa, Kenya from 12 to 14 February 2019. During the reporting period, the Ocean Science Section continued to provide the function of the technical secretariat of the GOA-ON, together with the International Atomic Energy Agency (IAEA).

Two IOC expert activities organized in Santa Marta, Colombia supported the development of ocean acidification observation and research capacity in the Caribbean and Latin America: the OAI-RUG meeting, in partnership with Invermar and IAEA's Ocean Acidification International Coordination Centre on 19–21 March 2018, which resulted in the publication of the Regional Ocean Acidification Action Plan for Latin America and the Caribbean. A training "Latin American and Caribbean Regional Symposium on Ocean Acidification" focusing on the newly established methodology for SDG indicator 14.3.1 and related data and metadata requirement was held in Santa Marta, Colombia on 21–24 January 2019 at INVEMAR. The Symposium was organized by IOC, the Ocean Foundation with the support of the US Department of State, the Swedish International Development Agency, and in coordination with GOA-ON and the Latin America Ocean Acidification Network (LAOCA). The Symposium highlighted strategies for building low-cost ocean acidification monitoring systems, techniques for building resilient seafood supply chains (including through technological interventions), and policy frameworks for building economic and social resilience at regional and national scales. It also focused both on existing practices and future options for researching the impacts of ocean acidification on, and the development of adaptation plans for, coral reef ecosystems.

The IOC Working Group to Investigate Climate Change and Global Trends of Phytoplankton in the Oceans (TrendsPO) held its second workshop hosted by the Alfred Wegener Institute in Bremerhaven, Germany from 4 to 8 December 2017 and a third workshop hosted by the University of California Santa Cruz from 12 to 15 November 2018. Current work focuses on compiling and analyzing long-term time series of phytoplankton. A data plan has been developed in cooperation with IODE/OBIS to facilitate contribution of phytoplankton time series to OBIS and to develop analytical tools for TrendsPO.

In the area of coastal blue carbon ecosystems, the Blue Carbon Initiative (BCI), co-sponsored by IOC, the International Union for Conservation of Nature (IUCN) and Conservation International (CI) held its annual meetings in October 2017, in Ibiza, Spain, and in August 2018 in Weihai, China, stressing, in particular, the importance of seagrass ecosystems for the mitigation of climate change. The Commission supported several experts from developing countries in their attendance at these meetings. In addition, the Ocean Science Section co-organized and participated in several side events focusing on Blue Carbon ecosystems and their climate change mitigation potential at the 23rd and 24th sessions of the Conference of the Parties to the United Nations Framework Convention on Climate Change.

IOC is addressing the issue of marine geoengineering through the joint sponsorship with IMO and WHO of the GESAMP Working Group on Marine Geoengineering. In March 2019 the Group released its first report which comprehensively examines a wide range of marine geoengineering techniques to remove carbon dioxide from the atmosphere, boost the reflection of incoming solar radiation to space (albedo modification), or in some cases the application of both techniques. Further, the report recommends that a coordinated framework for proposing marine geoengineering activities, submitting supporting evidence and integrating independent expert assessment must be developed; and that a greater expertise on wider societal issues is sought with the aim to establish a knowledge base and provide a subsequent analysis of the major gaps in socio-economics and geopolitics. The sponsoring agencies are currently in the process of defining the future focus of GESAMP on geoengineering and IOC experts networks and Member States will be consulted in this respect.

The recently-formed IOC Working Group on Integrated Ocean Carbon Research (IOCR) has constituted a Scientific Steering Committee, made of experts designated by the Global Carbon Project (GCP), the International Ocean Carbon Coordinating Project (IOCCP), the Integrated Marine Biosphere Research project (IM-BeR), the Surface Ocean-Lower Surface Atmosphere Study (SOLAS), WCRP/CLIVAR and IOC. The IOCR SSC has initiated the scoping of a comprehensive expert workshop on integrated ocean carbon research, scheduled to take place at IOC headquarters in Paris, France, on 28–30 October 2019. IOC has been invited to contribute to the Research Dialogue of the UNFCCC, to be held in Bonn, Germany on 20 June 2019.

The IOC Secretariat together with the SCOR Working Group 149 on Changing Ocean Biological Systems: How will biota respond to a changing ocean? developed a policy brief on multiple ocean stressors (cf. IOC/INF-1367) aimed at scoping further joint work of IOC and SCOR in this area.

In the area of de-oxygenation, annual meetings of the IOC Global Ocean Oxygen Network expert group (GO2NE) were held in Kiel, Germany from 31 August to 1 September 2018 and at IOC headquarters in Paris, France on 13–14 June 2019. Recent achievements related to de-oxygenation include a comprehensive IOC summary for policy-makers on de-oxygenation in the ocean (cf. IOC/2018/TS/137); a review article in *Science*, which has benefited from significant media coverage; and the organization of a major conference on de-oxygenation held at GEOMAR in Kiel, Germany in September 2018. In addition, an Ocean Oxygen Summer School will take place in Xiamen, China, on 2–7 September 2019.

IOC has continued to co-lead with UN Environment the GESAMP Working Group 40 on Sources, Fate and Effects of Plastics and Microplastics in the Marine Environment. The second part of the Global Assessment on Plastics has been completed and published as GESAMP Report no. 93 on Sources, Fate and Effects of Microplastics in the Marine Environment: Part 2 of a Global Assessment. The Working Group is now in the third phase of its work, which aims to develop guidelines covering terminology and methodologies for the sampling and analysis of marine macroplastics and microplastics, to be published in early 2019; and to assess the significance of plastics and microplastics as a vector for indigenous and non-indigenous organisms, and make research and policy-relevant recommendations.

The IOC International Group on Marine Ecological Time Series (IGMETS) produced a first time ever review of quality controlled ecological time series and held a first meeting in November 2018 at IOC headquarters in Paris, France in order to undertake the scoping of a second assessment, to be published in 2020. This activity is instrumental in developing a multidisciplinary, integrated view at trends in ocean changes.

In the area of science capacity, IOC has embarked into the production of the second edition of the Global Ocean Science Report (GOSR) (cf. IOC/INF-1366). GOSR acts as the main means to monitor progress towards the achievement of SDG Target 14.A on ocean science capacity. A renewed Editorial Board for GOSR has been formed and a GOSR Data Portal is being designed in collaboration with IODE, pursuant to the request of the IOC Assembly at its 29th session. IOC Member States were invited to submit national data relevant for the GOSR-II via a web-based GOSR-II questionnaire. The IOC Secretariat together with the GOSR-II Editorial Board and authors of the report are currently processing and analyzing the information received through the questionnaire. A bibliometrics study on science production will also inform the data underpinning GOSR-II. Two meetings of the Editorial Board took place, in the spring of 2018 at IOC headquarters and in May 2019 in Zanzibar, Tanzania, hosted by WIOMSA and benefiting from financial support from the Flanders Marine Institute (VLIZ) and WIOMSA. The Board agreed on detailed intended content and structure of the report, the production timeline and a dedicated communication strategy. The GOSR-II is envisaged to be published in 2020, thus providing the baseline information for the UN Decade of Ocean Science for Sustainable Development. The report will be launched at the second UN Oceans Conference in the second quarter of 2020.

II Observing System/Data Management

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

The main elements of this function focus 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, the observing programme area of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), 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 are the basic infra-

structure 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 *Framework for Ocean Observing* (IOC/INF-1284) remains a guiding document for GOOS and the full value chain of observing and data management activities. It emphasizes a systems approach, responding to user requirements, coordinating observations, ensuring data flow to users, regular cycles of evaluation, and improving readiness and capacity to observe.

Following feedback from the IOC Executive Council in June 2018, and an open comment period for stakeholders (April–June 2018) and Member States (August–October 2018), GOOS developed and submitted a *Global Ocean Observing System 2030 Strategy* to the IOC Assembly in 2019 which approved it (cf. IOC-XXX/2 Annex 7). It has an ambitious vision for a broad ocean observing community in all Member States, and a mission more focused on what the programme can deliver, consistent with the processes in the *Framework for Ocean Observing* and a clearer expression of the value chain from observations, through data management systems, into scientific assessments and ocean forecast systems, to service and information delivery, and finally into the hands of end-users that can use the information for individual or collective societal benefit. The Strategic Objectives identified have shaped a developing implementation plan and partnership strategy. GOOS innovation actions, both for the observations themselves and in the partnership to improve delivery, are expected to be highlighted in the UN Decade of Ocean Science for Sustainable Development.

Developments in this area will be marked significantly by the creation of a new Joint WMO-IOC Collaborative Board, and GOOS taking on a number of observing and forecast system activities of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology after its disbanding in 2020 after a proposed transition period as endorsed by the IOC Assembly and WMO Congress in June 2019. As the major function engaged in cooperation with the World Meteorological Organization (WMO), IOC has worked through a Joint Consultation Group on the Future of JCOMM, co-chaired by IOC vice-chairperson Ariel Troisi, to ensure that these changes, precipitated by a governance reform at WMO, create opportunities for IOC Member States and defend their interests.

Identifying observing and data requirements

Climate

Work through the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), which coordinates a system of observing systems focused on climate requirements, remains the primary way the ocean observing and data system identifies and tracks the needed actions for climate. The IOC gave an invited statement at the opening of the UNFCCC Subsidiary Body for Scientific and Technological advice at COP-23 (Bonn, hosted by the government of Fiji, 6–17 November 2017) on the status of the ocean observing system for climate. The GOOS contribution to GCOS continued with clearer specification of product requirements, and engagement in a Pacific Islands regional workshop focused on needed climate observations (9–12 October 2017, Nadi, Fiji). GCOS and GOOS have worked over this period to develop an operational partnership that highlights ocean observing contributions for climate research, mitigation policy and adaptation, including shared ownership of the Ocean Observations Panel for Climate and Physics (OOPC), and engagement with the Intergovernmental Panel for Climate Change and the UN Framework Convention for Climate Change.

Operational services

Operational information and services developed from sustained ocean observations include ocean forecasting system output, longer-term weather and climate predictions, and tsunami and other ocean-related hazard early warnings. The GOOS Physics Panel (OOPC) and the JCOMM Observations Coordination Group both actively participated in updating the WMO rolling review of requirements (largely focused on meteorological applications), and examining how requirements could be implemented in observing networks. The pending creation of a Joint WMO-IOC Advisory Board and closer links from GOOS to its co-sponsor WMO will evolve the link in the value chain from ocean observing activities to operational service delivery related to coastal hazards, long-term weather forecasting, and climate services.

Marine ecosystem health

Authors from the GOOS Biology and Ecosystems Panel published a highly-cited peer-reviewed paper in *Global Change Biology* summarizing the requirements for monitoring biological and ecosystems Essential Ocean Variables (EOVs) to help effectively mitigate or manage the detrimental effects we may be having on the world ocean. The analysis (open access through <https://doi.org/10.1111/gcb.14108>) reports on work analyzing the impact of monitoring on the stated needs in more than 30 global and regional conventions that touch on ocean ecosystem or biodiversity monitoring, as well as the feasibility from a survey of over 100 global and regional networks observing biological and ecosystems variables. The Panel is shifting from a mode primarily focused

on defining requirements to one supporting the development of sustained observing networks for the biological and ecosystems EOVs, focused on capacity development, coordination, and sharing of best practice. While requirements have been expressed in EOVs, it is in fact a structure of requirements that can be identified against information needed to deliver applications and services, key phenomena of the ocean to capture, EOVs, and the capacity of observing platforms and networks to respond, that are the core of improving the integration of GOOS. The three panels of GOOS have been working on harmonization of this, in connection also to regional reviews of observing systems.

Coordinating observing networks

The JCOMM Observations Coordination Group (OCG) maintained an active workplan focused on delivery against user requirements, delivery of metadata to oceanographic and meteorological data systems, monitoring progress of the system, engaging GOOS Regional Alliances and satellite observing systems, incorporating new technologies, identifying and promoting standards and best practice, and ensuring data flow. Supported in large part from the IOC side as a joint WMO-IOC activity, the OCG meets on an annual basis (14–18 May 2018; 8–11 April 2019), and has engaged new networks such as OceanGliders, HF Radar, and animal tracking networks. The OCG, building on ongoing monitoring of key performance indicators, published a two annual JCOMM Report Cards on the status of the observing system, as well as individual network specification sheets.

IOC has a long history of working with Member States and the Argo profiling float programme to manage the float of drifters into waters under national jurisdiction. In 2018, after a period of consultation with Member States, the IOC Executive Council at its 51st session approved Decision EC-LI/4.8 on the "Evolving Capabilities of the Argo Global Array of Profiling Floats," approving the global implementation of six new biogeochemical parameters for Argo floats, through continued use of IOC's EEZ drift notification guidelines, and an approval framework for additional new parameters for Argo, which allows for a pilot period for a limited period allowing for the scientific evaluation of the results, before bringing the results to an IOC governing body for approval for global implementation. In February 2019, the World Meteorological Organization held a technical workshop on "Enhancing ocean observations and research, and the free exchange of data, to foster services for the safety of life and property" (Geneva, Switzerland, 5–6 February 2019). The workshop resulted in two draft resolutions for consideration by the Eighteenth World Meteorological Congress (to be held 3–14 June 2019), which emphasize: (i) the critical importance and continuing legality of the Voluntary Observing Ship Scheme and operational surface marine meteorological observing platforms for ensuring the provision on a routine basis of adequate marine meteorological observations and data coverage; and (ii) noting the growing importance of sustained global data streams of subsurface ocean observations to improve the skill of operational weather and climate forecasts, decides that WMO work closely with the IOC in order to explore mechanisms that make the highest-impact subsurface ocean data freely available.

The Second International Indian Ocean Expedition (IIOE-2) continued to build its ocean (and coupled climate) research portfolio, aligning strongly with and receiving input from the alliances of IORP, SIBER, IOGOOS and IRF1. Strong linkages have been established with IOC regional subsidiary bodies IOCAFRICA, WESTPAC, IOCINDIO and UNESCO Category-2 Centres based in Iran and India. Progress has responded well to the IIOE-2 Science Plan. Communications on IIOE-2 science continued via the IIOE-2 website (hosted by the IIOE-2 Indian Joint Project Office), involving monthly newsletters and 6-monthly editions of the Indian Ocean Bubble-2. The Data and Information management Plan for IIOE-2 was finalized with the support of IODE Co-Chair Cyndy Chandler, underpinned by a formative workshop at the 2nd IIOE-2 Steering Committee (March 2018, leading to a draft Plan that was then finalized). In March 2019 the IIOE-2's full Steering Committee had its third annual meeting in Port Elizabeth, South Africa (co-hosted by the IIOE-2 JPO and Nelson Mandela University). That meeting highlighted about 30 major research projects 'endorsed' under IIOE-2. The IIOE-2 community has agreed to advocate for a continuance of IIOE-2 into the next decade, in light of: the IIOE-2's strength of operation and achievements; its clear relevancy for the mutual interests of its three principal sponsors (IOC, SCOR and IOGOOS) and wider stakeholder constituency; more planned prospective research initiatives (into the next decade); and the contribution that an extended IIOE-2 would make to the UN Decade of Ocean Science for Sustainable Development.

Data management

IODE published the IOC Strategic Plan for Data and Information Management (2017–2021) and the IOC Communication and Outreach Strategy for Data and Information Management, IOC Manuals and Guides, 77 & 79. The World Ocean Database (WOD), maintained by the NOAA National Centers for Environmental Information (NCEI), is the world's largest collection of ocean data available internationally without restriction. WOD was

first released in 1994 but established as an IODE project in 2000. A mirror copy has been established in January 2018 at the IOC Project Office for IODE in Ostend, Belgium.

In order to enhance the role of marine information management IODE 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 end of February 2019 three marine libraries have joined the IODE network as AIU.

A new Memorandum of Understanding (MoU) has been signed between UNESCO/IOC and the Flanders Marine Institute (VLIZ) for the period 2017–31/12/2021, securing continued support to the IOC Project Office for IODE, Ostend, Belgium, by the Government of Flanders (Kingdom of Belgium).

IODE is continuing and further developing its collaboration with, and support of, other IOC programmes and activities, including the GOSR, HAB, and SDG 14.3.1; as well as more broadly the implementation of the IOC Capacity Development Strategy through its OceanTeacher Global Academy project.

The First Session of the Intersessional Working Group to Develop a Concept Paper for an Ocean Data and Information System (ODIS, 5–8 March 2018, Ostend, Belgium) decided to pursue a federated approach leveraging connections between existing systems, to improve semantic and technical interoperability between systems, and to connect data providers having limited capacity to established repositories for securing and making data accessible. The initial output will be a register of known marine data and information sources, including discovery and technical level metadata that will support federated access across these systems in the future. Over time additional sources will be added that are aligned with the FAIR Data Principles, a set of guiding principles to make data Findable, Accessible, Interoperable, and Re-usable (FAIR).

Since May 2017 (until 9 April 2018), the Ocean Biogeographic Information System (OBIS) grew with 269 new datasets, adding 7,700 new species and 3.1 million observations resulting in a total of 50.9 million records of 118,000 marine species. Two new national OBIS nodes were established, one in Colombia (hosted by INVE-MAR) and one in the UK (hosted by the MBA). The OBIS secretariat is supporting the implementation of the OBIS-ENV-DATA standard through the development of new QC tools, available as webservices and as an R package (<https://github.com/iobis/obistools>).

OBIS is undergoing a major reengineering of its platform (OBIS2.0) which is urgently needed to drive new innovations in science and technology, and to meet the increasing demands for services from global drivers (such as GOOS, GEO BON, CBD, ISA, WOA and IPBES), as well as support the regional focus of several OBIS Nodes (e.g. USA/OBIS, Europe/EMODnet).

IODE launched the Ocean Data and Information System Catalogue of Sources (ODISCat) (available through <http://catalogue.odis.org>). The ODIS "Catalogue of Sources" aims to be an online browsable and searchable catalogue of existing ocean related web-based sources/systems of data and information as well as products and services. It will also provide information on products and visualize the landscape (entities and their connections) of ocean data and information sources. It currently welcomes 16 different types of resources. By end of February 2019, 345 online sources have been described in the catalogue. ODISCat is the first product developed within the context of ODIS and will facilitate the further deployment of the system based on existing data and information.

The 25th Session of the IODE Committee was held in Tokyo, Japan on 20–22 February 2019 (cf. IOC/IODE-XXV/3s). The session was preceded by a two-day scientific conference which welcomed 150 participants from 40 countries. The 35 presentations (which were recorded and available online at http://www.iode.org/iode25_sciconf) focused on (i) the UN Decade, (ii) how IODE is collaborating in ongoing major initiatives and activities that may contribute to the UN Decade, as well as (iii) regional developments, (iv) capacity development, (v) emerging opportunities for the future of IODE, including (vi) cooperation with partners. In order to maximize accessibility to the Conference all sessions were live-streamed.

The conference concluded with the recommendation that it is critical for IODE to be further strengthened and expanded for it is to play an essential role in supporting the flow from data to information to knowledge. The oceanographic community needs to build a global ocean forecasting system delivering society relevant services, by focusing on managing the data streams of essential ocean variables, both in the climate, operational services and ocean health space. To realize this, IODE and GOOS will need to continue their strong partnership and engage with regional bodies and stakeholders including the private sector. Important steps have been taken by the development of a prototype global Ocean Data and Information System. Future efforts will be in further improving the harmonization of data and metadata standards, developing common vocabularies and promoting and providing training in best practices. The international community is looking to IODE to facilitate and coordinate this process under its intergovernmental mandate. Two special highlights of the conference were (i) the keynote talk by Professor Toshio Yamagata, professor emeritus of the University of Tokyo on the

exceptional history of contributions to the field of oceanography by Japan, and (ii) the very first lecture in the Fred Grassle Memorial Lecture Series presented by Dr Yoshihisa Shirayama of JAMSTEC.

The IODE Committee Session, as did the scientific conference, specifically addressed the way IODE will be able to contribute to the UN Decade. The IODE Committee recommended to the IOC to include, as part of preparatory process, the formulation of common guidelines/principles on flow, discovery, access, and re/use of data collected during the decade. The IODE Committee adopted a recommendation on the “Establishment of an inter-sessional working group to propose a strategy on ocean data and information stewardship for the UN ocean Decade (IWG-SODIS)” in this regard. The Committee also recommended the IOC Assembly to request the IOC Secretariat to explore through UN-Oceans the interest of relevant UN entities to develop a joint data and information system under the Decade and to start assessing respective data and information policies and identify relevant data and information repositories that may contribute to such system. IODE-XXV also established the IODE/GOOS Ocean Best Practices System project (OBPS) which long-term objective is to provide the ocean research, observing and application communities with a mechanism to discover, review, agree upon, adopt and support the widest possible dissemination of ocean best practices.

IODE continues to operate mainly through extra-budgetary support (staff and operational budget). For several of these these projects and staff funding will end by December 2019. Mobilizing funds for the continued operation of the IODE Secretariat beyond 2019, especially taking into account the additional expectations from the UN Decade, will be a priority.

Engaging with users of observations and developing information products

The sustained observing and data management systems are user-driven, and engagement with representative user communities, such as ocean forecasting systems, is an important part of evaluation and advocacy. GOOS has re-engaged with the GODAE OceanView ocean forecasting system development activity through its Physics Panel and directly in a partnership development process.

GOOS, JCOMM, and OBIS are operating at present with a distributed and majority extrabudgetary-funded staff to support all three GOOS Panels, the technical coordination and metadata activity of the global observing networks at JCOMMOPS, and the development and maintenance of the OBIS platform. For many of these extrabudgetary staff members, project funding expires in 2019. These have been identified as priorities for fundraising, focusing on the outputs of the projects.

III Early Warning and Services

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

This function centres around four main programmatic components: (i) the global Tsunami Warning System; (ii) the Global Sea Level Observing System (GLOSS); (iii) Operational Ocean Forecast Systems services under JCOMM; and (iv) the Harmful Algal Bloom programme.

Tsunami Warning Systems

The main elements of the Tsunami Programme focus on: (i) secretariat support to the four Intergovernmental Coordination Groups (ICG) and respective technical working groups and task teams under the four regional Tsunami Warning and Mitigation Systems in the Caribbean (CARIBE-EWS), Indian Ocean (IOTWMS), Pacific (PTWS) and North-East Atlantic, Mediterranean and connected seas (NEAMTWS) as well as the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG) which address inter-ICG and cross-cutting coordination and harmonization; (ii) preparedness and awareness courses and workshops; and (iii) enabling research and policy development.

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. The ICG/CARIBE EWS held two regular ICG meetings, on April 24–27, 2018 (Willemstad, Curaçao) and 8–11 April 2019 (Punta Leona, Costa Rica), and one Officers Meeting on 13–14 November 2017 (Santo Domingo, Dominican Republic). In the IOTWMS, two integrated meetings were organised on 4–17 September 2017 hosted by Indonesia at BMKG, Jakarta and 26 June–14 July 2018 hosted by India at INCOIS, Hyderabad. Integrated meetings have proven to be highly effective in pursuing intersessional workplans of the ICG and ensuring wider engagement of Member States in the working group/task team activities and trainings/workshops, as well as optimising resources. ICG/IOTWMS-XII took place in Kish Island, Iran, 9–12 March 2019. ICG/NEAMTWS held two ICG meetings (Lisbon, 21–23 November 2017 and Paris 26–28 November 2018). PTWS

held one Steering Committee and back-to-back Working Group/Task Teams meetings on 4–8 June 2018 (Honolulu, USA) and one regular biannual meeting on 2–6 April 2019 near Managua, Nicaragua.

National and sub-regional system developments

The active investments of nations and/or their concerted actions contribute substantially to the development of the Tsunami Warning Systems. The Portuguese National Tsunami Warning Centre was formally inaugurated on 25 November 2017 following the ICG/NEAMTWS meeting. The Centre started to act as a candidate Tsunami Service Provider in January 2018. In February 2019 the Centre requested to be accredited as a NEAM Tsunami Service Provider. The South China Sea Tsunami Advisory Centre (SCSTAC) hosted by China was formally inaugurated on 8 May 2018. The Seventh Meeting of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (WG-SCS) took place in March 2018, in Hanoi, Vietnam. The meeting produced a draft Recommendation for the ICG/PTWS-XXVIII concerning transition to full operation of the SCSTAC. The Eighth Meeting of the WG-SCS was held on 4–6 March 2019 in Jakarta, Indonesia hosted by BMKG. The Fifth ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation for Pacific Island Countries and Territories (PICTs) and PTWS Working Group 2 Task Team on Seismic Data Sharing in South West Pacific, was organized in August 2017 in Honiara, Solomon Islands. The Sixth WG-PICTs took place on 8 March 2019 in Noumea, New Caledonia – France. A meeting of the ICG/IOTWMS sub-regional working group for the North West Indian Ocean region was held on 9 July 2018 in Hyderabad, India. Further, an expert consultation of scientific tsunami hazard assessment of the Makran Subduction Zone (MSZ) was organised on 8 March 2019 back to back with the ICG/IOTWMS-XII session in Iran. The Expert Consultation was successful in identifying current status, gaps and future priorities in the MSZ. Based on recommendations of the Expert Consultation, the ICG/IOTWMS-XII established two new Task Teams on “Tsunami Preparedness for a near-field Tsunami Hazard” and “Scientific Tsunami Hazard Assessment of the Makran Subduction Zone”, whose activities will be closely aligned to an upcoming project on “Strengthening Tsunami Early Warning in the North West Indian Ocean” being funded through the ESCAP multi-donor trust fund for tsunami, disaster and climate preparedness. Planned activities will enhance collective understanding of the Makran tsunami hazard, and assist Member States to assess their tsunami risk, strengthen national warning systems, enhance warning chains, develop evacuation plans, build emergency response capacity and raise community awareness, preparedness and resilience with specific emphasis on a near-field tsunami threat. As part of the Tuvalu National Adaptation Programme of Action (NAPA), UNDP funded installation of portable Iridium satellite terminals (so called Chatty Beetle) on 8 Tuvalu islands. The terminals allow for text-based alerts and messaging in remote locations, where communication options are limited. Tuvalu NTC and NDMO tested the terminals during the PacWave18 exercise. In 2018, Fiji installed a 13-siren network within the capital city and the Suva Peninsula.

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. Tsunami exercise were organized in the Caribbean region (15 March 2018 and 14 March 2019), Indian Ocean region (4–5 September 2018), NE Atlantic and Mediterranean (31 October–3 November 2017), and in the Pacific (1 September–30 November 2018). With support from the Caribbean Tsunami Information Center and the US hosted Caribbean Tsunami Warning Programme (CTWP), the CaribeWave 2018 Exercise mobilized ~0.5 million of participants that contributed once again to increase awareness and preparedness for tsunamis in the Caribbean. CaribeWave 2019 took place on 14 March 2019, with the Exercise Handbook finalised in November 2018 and the trilingual webinars convened in January–February 2019. Two scenarios have been prepared and for the first time a volcano scenario is used which presents an opportunity to evaluate the type of products PTWC could issue for such an event as well as the corresponding national and local standard operation procedures for such an event. NeamWave 2017 was the third exercise for the region. Twenty countries and the European Union Civil Protection Mechanism (ERCC) participated in the exercise and the evaluation report has been published with recommendations for future exercises. The PacWave18 exercise was conducted in 27 countries under ICG/PTWS from 13 October–20 December 2018. Twenty-five countries have fully submitted their online evaluation. Israel carried out an earthquake and tsunami exercise on 12 March 2019 focusing on schools along Israel's Mediterranean coast with about 10,000 students participating.

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 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—a

UNESCO-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 Center (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. 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 the US NOAA Caribbean Tsunami Warning Program (CTWP) and Member States in the implementation of ICG/CARIBE-EWS Community Based Tsunami Performance Pilot Programme (Tsunami Ready) which resulted in the recognition of the pilot communities of St. Patrick, Grenada and Fort Liberte, Haiti being recognised in September 2018. Some twelve (12) additional pilots are currently being supported as part of various UNESCO/IOC and CTWP implementation initiatives. 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 Tsunami Evacuation Maps, Plans and Procedures (TEMPP), etc. Following the 28 September 2018 Palu tsunami, the IOTIC coordinated International post-Tsunami Survey Teams (ITST) by 7 teams comprising 87 scientists from 18 countries and Indonesia. IOTIC was also part of a rapid assessment team that surveyed the tsunami impacted areas in Palu and the Anak Krakatau tsunami due to volcanic eruption of 23 December 2018.

World Tsunami Awareness Day

On 16 October 2018, UNISDR and IOC convened a high-level panel event on Reducing Human and Economic Impacts from Tsunamis at UNESCO as a contribution to the 3rd edition of World Tsunami Awareness Day (commemorated on 5 November 2018). The meeting exemplified real impacts of tsunamis for SIDS and their coastal tourism sector, and underscored the need for continued community preparedness to avoid complacency.

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 SOP and TEMPP trainings, with a total of 7 trainings/workshops conducted in the inter-sessional period. SOP trainings covered 21 countries and TEMPP trainings covered 22 countries. These trainings directly benefited Member States by improving in-country procedures for end-to-end tsunami warning, participation in IOWave18 and enhancing community preparedness through the piloting of the Indian Ocean Tsunami Ready programme. An online survey on the capacity Assessment of Tsunami Preparedness of the IOTWMS Member States was undertaken leading to the development of IOTWMS Status Report. The IOTWMS continues to conduct biannual communications tests in June and December each year and the participation rate is generally about 85–90% of 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 November 2017 in Guatemala, Nicaragua, Honduras and El Salvador 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. A second phase for this project, also supporting Costa Rica and Panama, is ongoing (2018–2019) and is targeting the Tsunami Ready pilot recognition for 10 Central America communities. UNESCO/IOC has been successful in securing funding from ECHO to implement the “Strengthening capacities of early warning and response for tsunamis and other coastal hazards in the Caribbean” Project from July 2018. This 18-month initiative seeks to develop a sub-regional tsunami response coordination plan for CDEMA Participating States focusing on the CDEMA-led Regional Response Mechanism (RRM). Under this project initiative each pilot state will also benefit from a national tsunami response protocol and SOPs with non-pilot States benefiting from a generic protocol which would facilitate adaptation to the country-specific situation. Five (5) new TR communities are also expected to be recognized through this initiative. The 2018 annual ITP-ITIC-IOC training course (1–10 August) was for the first time organised outside Hawaii. The course was hosted by the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) in Chile, and with attendance of students and experts from the Caribbean, Pacific and Europe. The training covered earthquake seismology and tsunami hazard assessment for planning and warning decision making through emergency response chain all the way to the public. IOC has organized

information meetings on NEAMTWS in: (i) Tunis in collaboration with the Arab League Educational Cultural and Scientific Organization (ALESCO) and Institut National de la Météorologie (13–14 September 2017); (ii) in Madrid in collaboration with Instituto Español de Oceanografía and the Protección Civil y Emergencias (26–27 September 2017); and in Rabat in collaboration with the Islamic Education, Scientific, and Cultural Organization (ISESCO), the UNESCO Rabat Office and the UNESCO Science Sector (12–13 November 2018).

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 CARIBE-EWS convened the inaugural meeting of the Group of Experts on Coastal Hazards in November 2018. This meeting leveraged an approach by regional and national stakeholders towards the formal integration of other coastal hazards within the ICG/CARIBE-EWS. Key outputs include a characterization of coastal threats, a list of priority coastal threats, a status of the coastal hazards EWS for the Caribbean and Adjacent Regions and a draft outline of the strategic plan and timetable including the development of the implementation plan to guide the integration of other coastal hazards within the ICG/CARIBE-EWS. A Chairperson and Vice-Chairperson have also been selected to guide the work of the Group.

Global Sea Level Observing System (GLOSS)

Sea-level observations provide information on a wide spectrum of oceanographic processes. Field observations of sea level also are needed to monitor and understand global sea level rise, as well as interannual to decadal sea-level variations, which provide insight into ocean circulation changes on climate time scales. In addition, sea-level observations are used to examine extreme events associated with tsunamis, storm surges, and other factors leading to short-term coastal inundation. 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. GLOSS Group of Experts meetings have been organized on 11–13 April 2019 (Busan, Republic of Korea). The GLOSS GE coordinates and reviews observation network and programmatic and strategic activities. The GLOSS observation network and four GLOSS data centres rely on observation contributions from a very large number of countries (>70). A conservative estimate is that the four GLOSS data centres underpin at least 200 papers in 2017. Aside from the publications other products are generated based on the data availability. As an example, the IOC Sea Level Station Monitoring Facility tracks some 858 active sea-level stations from more than 150 institutions, and the web-site had 2 billion web-hits in 2018 and during Tsunami events usage increases by 400%. IOCINDIO organized a scientific, technical and institutional innovations workshop in order to assist Member States in the region to build their national and regional Framework and Guidelines for Coastal Vulnerability Assessment in the context of Sea-level rise and Storm Surges, with the kind support of the newly established International Training Centre for operational oceanography under the auspices of UNESCO (Category 2) at the Indian National Centre for Ocean Information Services (INCOIS) in Hyderabad, (27–31 May 2019).

JCOMM Services

The JCOMM Expert Team on Operational Ocean Forecast Systems was reconstituted following JCOMM-5 (November 2017), and is preparing a workplan focused on supporting best practices in forecasting systems and the services they enable, including a focus on supporting capacity development. In advice from the JCOMM Management Committee which met in November 2018, it is foreseen that under the reorganization of ongoing work after the reform of WMO structures, that GOOS be a focus of ocean forecast system activity.

Harmful Algal Bloom programme

Impacts of harmful algae on aquaculture, food safety, fisheries, tourism and other ecosystem services are permanent and widespread and intensify as the exploitation of the coastal seas intensifies. Routine monitoring and appropriate management plans can to a large degree prevent or minimize impacts. IOC priorities and actions on Harmful Algal Blooms are since 1992 set by the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB) and the work programme is implemented through number of global and regional initiatives. The research component under IPHAB, GlobalHAB, which is jointly sponsored with SCOR, has based on its Science and Implementation Plan a number of initiatives under development. One initiative is on HAB event modelling with a strong training component including development of an online textbook on HAB modelling. A special issue of the journal Harmful Algae (Impact Factor 4.138) is in preparation on HABs and climate Change and an IOC-SCOR Scientific Summary for Policy Makers on HABs and Climate Change is being developed

based on the main messages in the papers of the special issue. The draft is to be presented at 14th intergovernmental session of IPHAB in Paris, on 24–26 April 2019. 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. Draft chapters are due by May 2019. An international GlobalHAB workshop on evaluating, reducing and mitigating the cost of harmful algal blooms is being 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 is receiving additional co-sponsorship from NOWPAP, ISSHA and US NOAA. It has for several years been on the priority list of both IPHAB and GlobalHAB to focus specifically on Fish Killing HABs. An international workshop is planned for Puerto Varas in the South of Chile for June 2019 and is co-funded by the Chilean Centre for Studies of Harmful Algae (CREAN). HAB related fish kills are a very important issue for salmon culture. There is rapid technological development in different types of observation systems and GlobalHAB is jointly with SMHI/Sweden organizing an international workshop to test, inter-compare and train participants in various automated and non-automated observation technologies. Collaboration between GlobalHAB and GO2NE has been initiated and a joint expert meeting on HABs and Deoxygenation is planned for 11–12 June 2019 in Paris. GlobalHAB is even covering brackish and freshwater HABs through the development of a mitigation manual as well as a global mapping of HAB events caused by cyanobacteria/bluegreen algae. The comprehensive undertaking to develop the first Global HAB Status Report 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 IOC-IAEA-FAO-WHO Inter-agency Joint Strategy on Ciguatera Fish Poisoning is being further developed and implemented through joint workshops and alignment of agency workplans and a draft Memorandum of Understanding is being processed for signature early 2019. Through the IOC Science and Communication Centre on Harmful Algae the longstanding opportunities for capacity enhancement in monitoring of HABs continues with several annual courses with examination giving the trainees certification in identification of HAB causative species. The IOC Centre in collaboration with the Marine Institute (Ireland) also operate the International Phytoplankton Inter-calibration (IPI) which in 2018 involved 99 analysts from 47 laboratories. Accreditation of the IPI under ISO17043 is expected for 2019. HAB-ANCA organized the "Workshop for the Development of National Protocol Models for Risk Management of Harmful Algal Blooms in Marine Coastal Waters in the IOCARIBE Region" on 12–14 November 2018 in Panama. Its goal is to reduce the vulnerability existing in the Caribbean in case of threat of toxic and harmful events produced by microalgae generating risk management protocol models that can be adapted to the specific conditions in the IOCARIBE region. There were 40 participants from eight countries.

IV Assessment and Information for Policy

Support assessment and information to improve the science-policy interface

World Ocean Assessment (WOA)

IOC continues to provide scientific and technical support to the World Ocean Assessment process established under the UNGA. A second cycle of assessment (2017–2020) was initiated under the UN Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects. In 2019, a Multi-stakeholder dialogue and capacity-building partnership event was held on 24–25 January at United Nations Headquarters in New York. The event aimed to increase awareness of the importance of the Regular Process and more generally the science-policy interface at all levels. It also sought to highlight the importance of capacity-building in support of the Regular Process, including regarding the preparation of integrated assessments which are important to inform decision-making by policy-makers and other relevant stakeholders. In-depth multi-stakeholder dialogues on current opportunities, gaps and needs in capacity took place. IOC through its Vice-chairperson Ariel Troisi delivered a keynote on the contribution of ocean science in global policy processes. The contribution of IOC in supporting capacity development through its dedicated CD strategy as well as its work on ocean literacy were recognized by several Member States.

Sustainable Development Goals (SDGs)

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. The Commission is supporting the development of a global SDG indicator framework for specific targets, primarily Targets 14.3 (ocean acidification) and 14.a (scientific knowledge and ocean research capacity) where IOC is identified as the UN custodian agency by the Inter-agency and Expert Group on SDG Indicators (IAEG-SDGs). Several activities were undertaken to advance the methodology of 14.3 and 14.a, as well as in relation to target 14.1 on marine pollution (Nutrients). These are reported under Function I.

General Bathymetric Chart of the Oceans (GEBCO)

The Nippon Foundation-GEBCO Seabed 2030 project, aimed at facilitating the complete mapping of the ocean floor by the year 2030 was officially launched on 20th February 2018 in Tokyo. The Nippon Foundation is planning to contribute US\$ 18.5 million for the first ten years of the project. The aspiration is for Seabed 2030 to compile all available and newly collected bathymetric data into a high quality, high resolution digital model of the ocean floor and to promote international efforts to collect new data. Four Regional Data Assembly and Coordination Centres (RDACCs) and a Global Data Assembly and Coordination Centre (GDACC) based at the British Oceanographic Data Centre have been established to facilitate the collection of bathymetric data. Seabed 2030 operates under the guidance of the GEBCO Guiding Committee. In addition, IHO, IOC and the Nippon Foundation have established a sponsors committee to review the progress of the project on a regular basis (meets twice a year). In the future, it will be important to identify how Seabed 2030 can support the needs of IOC programmes through the regular work of the IOC User Requirements for GEBCO Working Group. At the regional level, national hydrographic services in the IOCARIBE region are working in the development and publishing of the International Bathymetric Chart of the Caribbean and the Gulf of Mexico (IBCCA). These have established partnerships within the IHO MesoAmerican and Caribbean Sea Hydrographic Commission – MACHC and are working to coordinate analysis of regional data gaps and catalyze contributions for the completion of the Chart, as well as planning new bathymetric surveys to be developed as part of new GEBCO-Nippon Foundation SEABED 2030 Project.

Ocean and coastal Atlases

The Atlas was launched on the Oceans World Day (8th June 2018) including the demonstration of the Atlas platform in three countries. Special attention is paid to coastal hazards, climate change and biodiversity, as well as habitats, fisheries and pollution - the three main transboundary problems identified in the Large Marine Ecosystems in the Wider Caribbean region—mainly Caribbean and North Brazil Shelf Large Marine Ecosystems (the CLME+ Region). CMA brings together 25 countries, 7 of which are actively providing the integrated coastal zone management (ICZM) national information and data for regional indicators. CMA currently holds more than 800 GIS layers. The Atlas is addressed to professionals in charge of planning and development, ministries and national and regional authorities, decision- and policy-makers. The CMA2 project, funded under the UNESCO/Flanders Fund-in-Trust has now started its final year. In terms of dissemination, CMA2 have been promoting the use of its platform at several scientific and technical events including CoastGIS 2018 - International Coastal Atlas Network ICAN Mini-workshop, 28 September 2018, Isafjördur, Iceland; the Regional Experts Workshop on Harmonised Marine Litter Monitoring Programmes, 18–19 October 2018, Miami, Florida; the Gulf Caribbean Fisheries Institute 71st Conference, 5–9 November 2018; the RAMSAR Convention, 13th meeting of the Convention of the Parties COP13 Duba, 21–29 October 2018; and the 9th Conference of the Meso-American & Caribbean Sea Hydrographic Commission MACHC, 30 November 2018, at the Regional Training Center for Latin America and Caribbean—OTGA. CMA2 is being introduced during training courses as a tool for spatial information for Integrated coastal zone management.

The long-term strategic goal of the International Coastal Atlas Network (ICAN), under IODE, is to encourage and help facilitate the development of digital atlases of the global coast based on the principle of distributed, high-quality data and information. These atlases can be local, regional, national and international in scale. The ICAN is an IODE project since 2013.

V Sustainable Management and Governance

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

Biodiversity in Areas beyond National Jurisdiction (BBNJ)

The UN General Assembly decided in December 2017 through Resolution 72/249 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 legally-binding instrument 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). Negotiations would address topics identified in the package agreed in 2011, namely environmental impact assessments and area-based management tools, including the establishment of marine protected areas in areas beyond national jurisdiction. It will also provide a governance mechanism that regulates access to and benefit sharing derived from marine genetic resources. Capacity development and transfer of marine technology are also being considered to serve all its future Parties including developing countries. The Conference touches on areas of IOC's competency, particularly the use of the best available scientific information as the basis for management decisions and conservation policies, the application of IOC

Criteria and Guidelines for the Transfer of Marine Technology as a guiding principle as well as the potential contribution of the Ocean Biogeographic Information System (OBIS) as an effective global platform for the sharing of research data and information. IOC took active part in the first and second meeting of the Inter-governmental Conference, held in September 2018 and April 2019. In total, five side events have been co-organised by IOC to showcase the contribution of science to the BBNJ process. In June 2019, the IOC Assembly request the IOC Group of Expert on Capacity Development to advance the concept and feasibility of a TMT Clearing House Mechanism under the IOC, by developing a cost assessment, taking into account future requirements under the BBNJ international legally-binding instrument.

Global Conference on Sustainable Blue Economy, 26–28 November 2018, Nairobi, Kenya

IOC participated actively in the Global Conference on the Sustainable Blue Economy hosted jointly by Kenya, Canada and Japan, and organized three side events with partners on the following topics: (i) Marine Spatial Planning and ecosystem-based approaches to support national and transboundary Sustainable Blue Economy; (ii) Towards a knowledge-based sustainable ocean economy: The contribution of ocean science, observation, and marine technologies towards sustainable blue economy; and (iii) Large marine ecosystems approach: an essential management and partnership tool for realizing blue economy opportunities. IOC also organized an exhibition show casing its activities and made key contributions during the Signature thematic sessions, the Science and research symposium and the Leaders circle and closing ceremony.

Joint Roadmap on Marine/Maritime Spatial Planning (MSP)

IOC and the European Commission continue the implementation of the Joint Roadmap to accelerate marine spatial planning processes worldwide (#SDG OceanAction15346). The European Commission invited IOC to apply for an ad hoc grant to develop internationally accepted guidelines for marine spatial planning, including transboundary projects in the Western Mediterranean and the Southeast Pacific and communication activities to support the Joint Roadmap. The MSP global project proposal was funded by the European Commission and started its work in November 2018. Over the course of three years, the MSP global initiative will contribute to improving cross-border and transboundary cooperation where it already exists and promoting MSP processes in areas where it is yet to be put in place, with the objective to triple the marine area benefiting from MSP effectively implemented by 2030. More specifically, it aims to: i) Develop **guidance on international cross-border planning**; ii) Perform a **pilot regional project in the West Mediterranean**: Algeria, France, Italy, Malta, Morocco, Spain and Tunisia (other WestMED countries can also participate in training activities); iii) Perform a **pilot regional project in the Southeast Pacific** with a specific cross-border exercise at the historical Bay of Guayaquil (Ecuador/Peru) and training activities benefiting Chile, Colombia, Ecuador, Panama and Peru. Since June 2018, IOC has increased the number of capacity development initiatives dedicated to MSP, integrated coastal area management, sustainable blue growth and large marine ecosystems. Organised in partnership with IOC Sub-commissions (IOCARIBE, IOCAFRICA), OceanTeacher Global Academy, as well as other regional organisations (CPPS, Regional Seas), these were respectively held in Brest (FR), Panama City (PA), Santa Marta (CO), Guayaquil (EC), Mahe (SEY), Cape Town (ZA), Tokyo (JP), Sevilla (ES), Azores (PT), Brussels (BE), Mindelo (CV), Antananarivo (MG) and Cali (CO), and were conducted either in English, French, Spanish or Portuguese. These are reported on the new IOC MSP website (<http://msp.ioc-unesco.org>). IOC and the European Commission jointly organized the second and third International Forum of Marine Spatial Planning in March 2019 (La Reunion, France) and May 2019 (Vigo, Spain) bringing together MSP practitioners from all ocean basins. A new collaboration framework to support IOC's role in marine spatial planning and sustainable blue economy has agreed by the Government of Sweden.

Climate Change Mitigation & Adaptation

Since COP21, new elements of knowledge have emerged, thus enhancing scientific understanding of the interactions between ocean, climate and biodiversity. The well-being of marine ecosystems is recognized as central to address climate change, hence sustaining ocean science and observation is key to understanding these interactions, monitor ocean changes and inform adaptation strategies. In view of the launching of the United Nations Decade of Ocean Science for Sustainable Development (2021–2030), the Ocean and Climate Platform and IOC organized the High Level Scientific Conference on 10–11 September 2018, at UNESCO Headquarters in Paris. The conference aimed at synthesizing recent scientific progress on ocean and climate interplays; evaluating the latest ocean-climate trends within the context of increased ocean action; and reflecting on ways to move “from science to action”. The event brought together 500 experts from the research community, civil society, businesses, decision-makers and UN entities, to share their expertise on ocean and

climate related issues. The key messages of the Conference were subsequently presented at the Global Climate Action Summit 2018 (13–14 September, San Francisco, USA) and Ocean Day at UNFCCC COP 24 (Katowice, Poland).

Large Marine Ecosystem (LME) programme

In 2018, the LME:LEARN project continued to be implemented in line with objectives and the previously approved workplan. Regarding networking, the project continued its efforts to strengthen the global governance of large marine ecosystems and their coasts. The second round of regional network meetings commenced alongside the launch of an introductory virtual training course on governance and MSP, followed by face-to-face training at the regional network meetings. Organized respectively with IOCAFRICA, and IOCARIBE, the regional network meetings took place in Dakar for the Africa region, with 30 participants from 14 countries, and the second one in Panama City for the LAC region, with 46 participants. Those were coupled with training sessions on Transboundary Marine Spatial Planning, Sustainable Blue Economy and Ocean Governance, and Economic Valuation. Both meetings also included private sector engagement sessions with 3-4 companies each in partnership with World Ocean Council, as well as science-to-management sessions. In February 2019, Viet Nam hosted the second regional network meeting for South East Asia, which was also coupled with a training course on MSP. The project conducted its first two Inter-Project Collaboration Opportunities, supporting CERMES and Caribbean States on Governance performance, CLME+ and PEMSEA on business community engagement. Finally, the LME20 took place in Marrakech in November 2019 with around 100 participants attending. In addition to being the global forum for GEF-funded and other marine and coastal practitioners, leaders and institutions, Regional Seas organizations and Fisheries Bodies, the meeting gave further impetus to the Cape Town process on regional Ocean governance. Finally, the participants attended the training sessions on MSP and marine toolkits. With regard to Knowledge Sharing, the project finalized the layout/design of six of the seven guidance toolkits (Environmental Economics, Governance, Marine Spatial Planning, Stakeholder Engagement, LME Strategic Approach, LME Scorecard). All toolkits are available in PDF and online formats and a dedicated part of the website was established. In terms of data and information management, progress was made in terms of a LME spatial metadata catalogue as well as a proposed data and information management plan for the LME portfolio. The project participated in two global dialogue events, namely the GEF Assembly, organizing a side event on regional ocean governance. A similar event was organized at the Sustainable Blue Economy Conference in Nairobi with over 200 people in attendance. Finally, the project supported four LME projects (South China Sea, Indonesian Seas, Bay of Bengal and Yellow Sea) to the East Asian Seas Congress where it supported two events in the course of the Congress to showcase project results and build partnerships. In terms of Communications and Outreach, partner IUCN executed numerous enhancements to the overall design and layout of the Large Marine Ecosystem Hub. They added global data layers for LME boundaries (including layers highlighting active LME's and those with featured content on the Hub), LME Ocean Health Index, National EEZ Boundaries, Protected Areas, Marine Protected Areas, FAO Fishing Areas, Marine World Heritage Sites, Continental Shelf, Coral Reefs, Mangroves, Seagrass, Seamounts, Ocean Pollution and Commercial Activity/Impact. Finally, in terms of project management the project concluded its mid-term evaluation process and the associated mid-term management response. A condensed project steering committee meeting took place at IWC9 in Marrakech to discuss this and the steering committee planned in May 2019 focused on the sustainability of the project.

The United Nations Decade of Ocean Science for Sustainable Development (the Decade)

At its seventy-second session, the United Nations General Assembly proclaimed (Part XI of the Omnibus Resolution for Oceans and the law of the sea) the United Nations Decade of Ocean Science for Sustainable Development and mandated the Intergovernmental Oceanographic Commission of UNESCO (IOC) to prepare an Implementation Plan in consultation with Member States, UN partners and other relevant stakeholders.

The IOC drafted a Roadmap that provides an initial guide for the steps and processes needed to develop this Implementation Plan. It also contains the Decade strategy, the governance arrangements for the preparatory phase of the Decade and an outline of what is required to achieve this plan by the first quarter of 2020 (key milestones and consultations that will be part of the preparation of the Plan). This Roadmap was reviewed by the IOC Member States and benefited from inputs by UN-Oceans. Communication activities have been initiated to inform Member States, potential partners and other stakeholders of the preparatory phase underway, with the aim of inviting contributions, as well as to communicate the purpose and expected results of the Decade.

In July 2018, the IOC Executive Council at its 51st session approved the Decade “Roadmap” document intended to guide the preparation process in terms of preliminary objectives, societal outcomes, governance and engagement processes. The Council decided to establish an Executive Planning Group (EPG) consisting of high-level experts and a Stakeholder Forum, open to a broad range of communities. IOC convened the first meeting of the EPG from 17 to 19 December 2018 to brainstorm on scientific, governance, communications, and engagement elements of the Decade ahead of a first Global Planning Meeting and a series of regional

consultations foreseen in 2019. Experts also sought to lay out the basis for an effective strategy to communicate the objectives of the Decade, engage stakeholders, and ultimately influence behaviours and perceptions of scientists, decision-makers and the public.

Regional activities

The **SPINCAM** Atlas updated in February 2019 the agreed 15 regional indicators with data compiled from national sources in 2018, new indicators dedicated to sustainable blue economy are currently under development using a common methodology for the five countries of the Southeast Pacific. The atlas contains more than 500 spatial datasets in May 2019 and national authorities continue the improvement and development of decision support tools in order to increase the synergies to implement both integrated coastal area management plans and the pre-planning phase of their national marine spatial plans.

IOC concluded the implementation of the project **AQUACROSS** (www.aquacross.eu) funded by the European Commission's Horizon 2020 Programme in November 2018. IOC-UNESCO delivered in April 2018 the final version of the AQUACROSS Data Management Plan (DMP) and in June 2018 the final version of the AQUACROSS Information Platform. Furthermore, IOC delivered an analysis of transboundary water ecosystems and green/blue infrastructures in the Intercontinental Biosphere Reserve of the Mediterranean of Andalusia (Spain) and Morocco and organized workshops for local socio-economic stakeholders of the two countries in Facinas / Tarifa – Cádiz (Spain) and with national stakeholders in Tangier (Morocco) in February 2018. The results of IOC's work in the context of AQUACROSS were presented at the 9th International Water Conference in Marrakesh in November 2018 with the support of the Government of Morocco and the Government of Andalusia (Spain). A multilingual storytelling tool available in Spanish, Arabic, French and English was launched during the conference in Marrakesh and it is fully operative at the Environmental Information Network of Andalusia (REDIAM) and the Regional Observatory of Environment and Sustainable Development Tanger-Tetouan-Al Hoceima (OREDD).

In IOC Regional Committee for the Central Indian Ocean (IOCINDIO), officers and the IOC Secretariat continued their efforts and mobilized additional Member States and partners to implement the IOCINDIO-VI workplans and recommendations. This was done through issuance of calls for contribution, coordinated actions in the context of the Second International Indian Ocean Expedition (**IIOE-2**), such as the organization of an IOC-INDIO side session at the International Indian Ocean Science Conference 2018 and 2019, respectively in Jakarta, Indonesia, 18–23 March 2018 and in South Africa at the Nelson Mandela University in Port Elizabeth, 11–15 March 2019. These workshops helped to gain the engagement of additional Member States for a reinforced revitalisation of IOCINDIO while also reinforcing cooperation with IIOE-2. They increased the level of ownership and appropriation of Member States, as demonstrated by offers from India and Kuwait to provide in-kind contribution to the IOCINDIO kick-off workshop on coastal vulnerability assessment for sea-level rise and storm surges at the new Category-2 International training centre on operational oceanography in India.

VI Capacity Development

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

IOC Capacity Development Strategy

The IOC Assembly adopted the IOC Capacity Development Strategy, 2014–2021 through Resolution XXVIII-2 and agreed that the IOC global and regional programmes needed to develop programmatic and regionally relevant capacity development workplans based on this strategy and related needs assessments conducted in a consistent manner, building on ongoing activities and making use of existing training and education facilities. This resulted in document (IOC-XXIX/2 Annex 17: IOC Capacity Development Strategy, 2015–2021 and its Implementation Plan: Status Report) submitted to the Assembly at its 29th session. That session established the "IOC Group of Experts on Capacity Development". IOC Circular Letter 2680 was issued on 11 July 2017 inviting IOC Member States as well as Scientific, Technical and Regional subsidiary bodies to nominate members of the IOC Group of Experts on Capacity Development (IOC GE-CD). The First Session of the Group was held at UNESCO Headquarters on 21–23 March 2018. The Group continued its discussions with the objective of reporting to the 30th Session of the IOC Assembly, June/July 2019. At the first session of the Group of Experts it was decided to establish two task teams: one on CD requirements of Member States (with special attention to SIDS), and one on the implementation of a Transfer of Marine Technology/Clearing House Mechanism "portal". The task teams decided to develop a joint online survey to collect the necessary information and IOC Circular Letter 2738 was issued on 5 October 2018. The circular letter also invited Member

States to designate an IOC National Focal Point in Capacity Development to enable more effective communication with the IOC on CD and CHM issues and to assist with the future implementation of the IOC CD Strategy by Member States. A total of 49 responses was received. The survey results were reviewed and analyzed during a meeting of both Task Teams, held at UNESCO Headquarters on 13-14 March 2019.

Regarding CD needs the survey results demonstrated some differences between the regions. Regarding the development of a Clearing-House Mechanism for the Transfer of Marine Technology all regions reported that such a mechanism would be instrumental to the further development of ocean science capacity in countries. Regarding the functional format, all regions expressed preference for an online central portal integrating the data and information harvested from regional/sectoral CHM portals (need for interoperability). As such the respondents identified the need for a series of nodes rather than one global central node but using technology that allows interoperability between the nodes. A “regional TMT/CHM portal prototype for Latin America project” was started by INVEMAR (Colombia). In the context of priority areas of research and development for the UN Decade of Ocean Science for Sustainable Development (2021–2030), all respondents across all regions identified “Capacity development and accelerated technology transfer, training and education, ocean literacy” as the top priority. In June 2019, the IOC Assembly request the IOC Group of Expert on Capacity Development to advance the concept and feasibility of the TMT/CHM under the IOC, by developing a cost assessment, taking into account future requirements under the BBNJ international legally-binding instrument.

IODE’s OceanTeacher Global Academy (OTGA)

The IODE established the OceanTeacher Global Academy Project to implement 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 seven active RTCs (Belgium, Colombia, Senegal, Kenya, Mozambique, India and Malaysia) and two candidate RTCs (China and Iran). During the past intersessional period, OTGA organized 16 face-to-face training courses at the 7 RTCs, involving 376 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 OceanTeacher e-Learning Platform (www.oceanteacher.org). Currently, over 4,200 users are registered on the Platform.

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 thanks to the support of the Swedish Government. In December 2017, the IOC organized the first Ocean Literacy conference (Venice, Italy). This event was the first of its kind and aimed at gathering the most prominent international actors from a wide variety of backgrounds, including Ms Gesine Meissner, Member of the European Parliament, Mr Peter Thomson, UN Special Envoy for the Ocean, Ms Francesca von Habsburg, Thyssen-Bornemisza Art, Contemporary and the Executive Secretary, together with over one hundred participants, representing governmental and intergovernmental bodies, public administrations, private foundations, universities, media and NGOs from 30 countries covering all regions (Europe, Africa, North and South America and Asia). During the conference the Ocean Literacy for All – A toolkit was launched. The toolkit is meant to provide educators and learners with innovative tools, methods and resources to understand ocean processes and functions, to alert them on the most urgent ocean issues and to provide ready to use activities to be implemented in formal and non-formal educational contexts. Currently the toolkit is being tested in schools of 36 countries belonging to the UNESCO Network of Associated Schools (ASPNet). The IOC Ocean Literacy Portal was launched in July 2018 with the aim of in being a repository for quality education and information tools, resources, good practices and local or international success stories. In 2018 a partnership was established with the Ocean Frontier Institute, the Dalhousie University and the National Film Board of Canada to develop a feasibility study for the internationalization of the Ocean School Programme. Ocean School is an ocean science educational programme, which uses storytelling techniques, immersive technologies and interactive media to promulgate ocean literacy. An Ocean School Teacher Training Workshop was organized in San José, Costa Rica (3–4 December 2018), in collaboration with the UNESCO Office, to test the possibility of adapting the Ocean School programme and technology to different educational systems and geographical and cultural contexts. In November 2018 the First Ocean Literacy for multi-stakeholder processes in Ocean

Governance workshop was organized in Paris at UNESCO HQ. Ocean Literacy experts, journalists, researchers, foundations, MSP practitioners, educators, representatives of NGOs and public authorities participated in the workshop with the aim of discussing the most effective ways to communicate ocean knowledge to different audiences, and to share best practices and innovative views on the challenges of transforming knowledge into action, using Ocean Literacy tools. The event represented a bridge between the “Ocean Literacy for All” and the “MSP Global”.

IOC Regional Subsidiary Bodies

IOC Sub-Commission for Africa and the Adjacent Island States (IOCAFRICA)

The Fifth session of the IOC Sub Commission for Africa and the Adjacent Island States (IOCAFRICA) was held at the United Nations Office at Nairobi, Kenya from 25-27 March 2019. The session was attended by more than 45 participants representing 22 member states and other partners, including the Food and Agriculture Organization of the United Nations (FAO), the Secretariats of the UN Environment Abidjan and Nairobi Conventions, and the Western Indian Ocean Marine Sciences Association (WIOMSA). IOC AFRICA endorsed the proposal to organize a Pan African Conference on Ocean Science for Sustainable Development, in 2020 to be hosted by Egypt. The Sub Commission stressed that the conference must be different from previous conferences and should be used to take ocean sciences in Africa to another level, by bringing new actors to the table, such as the regional economic communities, regional development banks and the private sector. IOCAFRICA established the IOCAFRICA Strategic Planning Group to guide the planning for the conference and develop ideas for the regional implementation of the UN Decade for Ocean Science for Sustainable Development (2021–2030) as well as the IOCAFRICA Strategic Plan for 2022–2029;

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

IOC/WESTPAC continues to lead of marine science development and cooperation in the region, translating IOC global objectives into concrete actions at regional and national scale. Effective coordination and efficient communication have been maintained, which resulted in a wide support of Member States to WESTPAC activities contributing to ocean process and climate change, marine biodiversity and healthy ecosystem, and emerging issues for ocean knowledge. It is worth mentioning that the 12th WESTPAC Intergovernmental Session took place on 2-5 April 2019, Manila, the Philippines. The 12th Session was hosted by the Government of the Philippines, with the participation of close to 100 delegates from 16 countries and representatives from international programmes/organizations within and outside the region. The 12th Session serves as a timely starting point for the Sub-Commission to prepare for the UN Decade of Ocean Science. In addition to reviewing all WESTPAC programmes, the Sub-Commission adopted a total of six recommendation, covering the engagement of WESTPAC into the UN Decade of Ocean Science, the conduct of a feasibility study on the 2nd Cooperative Study on Kuroshio and its adjacent regions, the IOC Regional Network of Training and Research Centers on Marine Science in the Western Pacific, the 12th WESTPAC International Marine Science Conference 2020, the 13th WESTPAC Intergovernmental Session 2021, and its Programme and Budget for the next intersessional period which will serve mainly as guidance on the activities that Member States would like to jointly promote and seek funding from various sources in support of their implementation.

IOC Regional Committee for the Central Indian Ocean (IOCINDIO)

During the reporting period, IOCINDIO Officers and the IOC Secretariat vigorously pursued the mobilization and support of additional Member States and partners for implementing specific capacity development activities: (i) IOCINDIO networking research infrastructures, facilities and human resources with dedicated questionnaire for inventory of existing oceanographic infrastructures, facilities and manpower; (ii) IOCINDIO Scientific, technical and innovations workshop on coastal vulnerability assessment for sea level rise and storm surges at the newly established UNESCO Category-2 International training centre on operational oceanography at the Indian National Centre for Ocean Information Services (INCOIS) (27–31 May 2019).

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