
REPORT OF THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

I. Introduction: The UN Decade of Ocean Science for Sustainable Development

In December 2017, the United Nations General Assembly proclaimed the United Nations Decade of Ocean Science for Sustainable Development from 2021 to 2030 (hereafter, the Decade), building on the efforts of IOC Member States and the IOC Secretariat. The Decade is a once in a life-time opportunity to deliver a step-change in ocean science and to influence how countries invest, utilize, and participate in science and innovation to embrace societal goals and align research investment to contribute to common goals. The period from 2018 to 2020 is focusing on the preparation of the Decade Implementation Plan that will be submitted to the UN General Assembly for its consideration in 2020. This work is led by IOC, in consultation with Member States and all relevant stakeholders.

The scientific community remained a focus of engagement efforts during this period. A request for submissions to inform the development of the scientific framework of the Decade was sent to partner organizations by the Executive Secretary of the IOC in September 2019. Over 55 detailed written submissions were received in response to this request. The results were used as a primary input to a meeting of the EPG task group on the scientific framework that was held in Washington DC in November 2019. The Decade was the subject of discussions during dedicated sessions, meetings, and side events at a number of ocean science meetings that took place in the period to March 2020 before travel restrictions became widespread due to the Covid-19 pandemic. Key international meetings included OceanObs' 19 September 2019, Honolulu, Hawaii; Our Ocean Conference, October 2019, Oslo, Norway; Oceans'19 MTS, October 2019, Washington, US; AGU Town Hall meeting, San Francisco, USA, December 2019, All-Atlantic Ocean Research Forum - Brussels, Belgium, February 2020; and Ocean Science Meeting 2020 - San Diego, USA, February 2020.

More than 1 900 experts – including numerous representatives of the scientific community - participated in 11 regional consultation workshops co-organized by IOC and institutional partners¹ hosted by the governments of France, Japan, Italy, Brazil, Canada, India, Kenya, Norway, United States of America, and Mexico. Starting in July 2019, the first three regional workshops focused on the Pacific Ocean, and were followed by workshops for the northern and western Indian Ocean, the North Atlantic, the Arctic, the South Atlantic, and the Southern Ocean. Due to the Covid-19 pandemic, a virtual Western Tropical Atlantic Workshop closed the series in April 2020, gathering more than 350 participants, and 4 200 viewers of the live streaming of the event. Organized around the Decade societal outcomes, the workshops allowed for regional interdisciplinary and multi-stakeholder discussions to assess the status of regional ocean research and to co-design mission-oriented research strategies in line with the regional policy requirements. They focused on regional needs and

¹ Pacific Community, the Permanent Commission for the South Pacific, Arctic Frontiers, European Commission, UNEP/MAP, Mediterranean Science Commission, the Secretariat of the Cartagena Convention, Universidad Nacional Autónoma de México, the Secretariat of the Nairobi Convention, SCOR, and WIOMSA.

priorities in data and capacity-development and reflected on the potential of transforming knowledge systems, accelerating transfer of technology, and enabling training and education. The regional consultations resulted in the production of a series of summary reports that have been posted online and will be published in the Decade report series.

An Informal Working Group (IWG) of Early Career Ocean Professionals (ECOP) was established in November 2019. The ECOP IWG coordinated a global survey of over 1000 ECOPs to ascertain interest in the Decade and generate suggestions for priority support needs and areas of engagement.

The Executive Planning Group continued to make significant contributions to the preparation phase of the Decade throughout this period. In its January 2020 meeting the EPG endorsed the proposed structure of the Implementation Plan. The resulting zero draft of the Implementation Plan was distributed for peer review between the 20 March and 24 April 2020. The document was distributed to IOC Member States, and shared with over 450 individuals representing scientific organizations, business and industry, philanthropic and corporate foundations, NGOs and civil society and ECOPs. Member States and peer reviewers were asked to submit feedback to the zero draft via an online survey. 228 responses were received to this process. The majority of responses were received from scientific community stakeholders, with responses also received from Member States, business and industry, philanthropic foundations, and NGOs. Most submissions were received from Europe, North America and Australia, with more limited input from Latin America and the Caribbean, South America and the Pacific regions.

A detailed analysis of the feedback received via the above processes was carried out by the IOC Secretariat. Reviewers of the plan provided detailed responses and the analysis revealed a set of clear and common messages to guide revision of the Plan. Overall, reviewers were supportive of the Plan in terms of content and structure, level of detail and length and ease of reading.

The review process culminated in the preparation of the Version 1.0 of the draft Implementation Plan. In addition to questions of clarification and better articulation of key issues, the main changes that were made in the revised version include: the development of a new mission statement to better reflect the ambition of the Decade; the inclusion of a seventh outcome “An inspiring and engaging ocean” to reflect the importance of the cultural and educational values of the ocean; the introduction of ten Ocean Decade Challenges as the most immediate and pressing needs of the Decade that aim to galvanize stakeholders around common priorities; and reworking of the discussion on monitoring and evaluation of the Decade to highlight the process that will be followed to develop a monitoring and evaluation framework that will be endorsed by the Decade Board in 2021. A Summary Version of the Implementation Plan and a Regional Synthesis Report which analyses the outcomes of the regional planning meetings in more detail are also being prepared

The next six months represent a critical phase in the preparation of the Decade. Version 1.0 of the Implementation Plan is currently being reviewed by Member States and UN-Oceans prior to its finalization and presentation to the UNGA in September 2020. A first Call for Actions under the Decade is planned for later in 2020, and guidance on this Call will be disseminated widely in coming months. Looking forward, major events planned to celebrate the start of the Decade in 2021 include the First International Conference in Berlin in May 2020, and dedicated events during the UN Ocean Conference in Lisbon (date TBC).

II. Activities involving close cooperation and coordination between IOC and SCOR

Harmful Algal Blooms

The long-term focus of the IOC Harmful Algal Bloom (HAB) programme is on improved understanding of the factors controlling HAB events and thereby improving management and mitigation options. The scientific key questions have for more than a decade been addressed jointly with SCOR through research programmes. The current decadal IOC-SCOR research programme to meet societal needs in a changing world, entitled GlobalHAB, launched its science and implementation plan in 2017 (www.globalhab.info). GlobalHAB is reported on in detail directly by the GlobalHAB SSC.

The IOC is coordinating and developing its work on HAB through the IOC Intergovernmental Panel on HABs (IPHAB). A number of Task Teams, working groups and activities are operating and reporting to the IPHAB. A core activity is the development of a 'Global HAB Status Report' with the aims of compiling an overview of HAB events and their societal impacts; providing a worldwide appraisal of the occurrence of toxin-producing microalgae; and assessing the status and probability of change in HAB frequencies, intensities, and range resulting from environmental changes at the local and global scale. The development of this report is intimately linked with the systematic compilation of HAB data in OBIS and the IOC Harmful Algal Event Data base HAEDAT and is funded by Flanders and cosponsored by the IAEA.

Time Series

Since 2013 the establishment of an interdisciplinary IOC working group, the International Group for Marine Ecological Time Series (IGMETS), has offered the possibility to improve model projections and forecasts needed to understand open ocean and coastal changes. The collected information addresses new scientific questions and serves a well-established community of practice related to ship-based time series. The interdisciplinary character of IGMETS provides new scientific insights to improve model projections and forecasts needed to understand open ocean and coastal changes. IGMETS met on 7-9 November 2018 at IOC HQ to develop the scope its second report (read the first IGMETS report at <https://igmets.net/report>).

Since 2016 an IOC Group of Expert has worked specifically to investigate Climate Change and Global Trends of Phytoplankton in the ocean, in particular the coastal ocean (TrendsPO). The Group continues the comparative analysis and synthesis of long time series data sets compiled by SCOR WG137, and expands the focus not only to the continental shelf and open oceans, but also to estuarine and upstream freshwater ecosystems where perturbations from terrestrial, atmospheric, oceanic sources and human activities converge to cause changes that ramify across local and global scales. TrendsPO is working on a plan for a Phyto-GOOS with BIO-ECO GOOS members. The Phyto-GOOS implementation is foreseen to at least cover all the Large Marine Ecosystems over a ten-year period.

De-oxygenation

De-oxygenation is a global problem in coastal and open regions of the ocean, which has led to expanding areas of oxygen minimum zones and coastal hypoxia. In the coastal ocean, the number of reported dead zones has increased exponentially since the 1960s, with more than 600 systems catalogued now. The recent expansion of hypoxia in coastal ecosystems has been primarily attributed to global warming and enhanced nutrient input from land and atmosphere. The global extent and threat of ocean deoxygenation to human health and marine ecosystem services are just beginning to be appreciated; the related social and economic consequences have yet to be determined but are likely to be significant.

In order to raise increase the scientific capacity globally the IOC Global Ocean Oxygen Network (GO2NE) working group organized the first international GO2NE Summer School, held from September 2 to 8, 2019 in China at Xiamen University Xiang'an Campus, which hosts the State Key Laboratory of Marine Environmental Science. SCOR supported the participation of two young researchers. The summer school was attended by 37 students from 19 countries. The IOC Secretariat further coordinated the input to the WMO Climate Change bulletin (published in March 2020) addressing deoxygenation in the ocean in 2019; it also contributed to the production and launching at the UNFCCC COP25 of a major book on ocean deoxygenation coordinated by IUCN.

Multiple Stressors

In 2019 the IOC established an international Group of Experts which aims at identifying main ocean stressors and their interaction, with a view to elucidating possible actions related to ecosystem-based management (EBM).

The Working Group is composed of approximately 20 experts, the majority of whom are co-chairs of relevant IOC working groups (GOA-ON, GO2NE, HABs, TrendsPO, BCI, GESAMP WG 40 and nutrients), with the addition of expertise, including EBM, with a geographic and gender balanced representation. The group met for online workshop in March 2020 and used this opportunity to further develop and draft the publication 'Ocean under Stress: Managing a Changing Ocean at All Locations', which will be published during the second half of 2020.

Enhancing oceanography capacities in CCLME Western Africa countries (Eastern Boundary Upwelling Systems – EBUS)

Since 2013, the IOC has worked in the implementation of the project *Enhancing oceanography capacities in the CCLME Western Africa countries*. The overall goal of its third phase was to improve the existing knowledge on the possible effects of climate change on the Canary Current Eastern Boundary Upwelling System (EBUS) and to continue building regional science capacity in such knowledge.

Since a technical workshop held in 2018, coordination efforts have focused mainly on the implementation of the work packages included in the Research and Capacity Development Agendas for phase III of the project. With regards to the Research Agenda and based on the desktop research carried out, a data archive comprising 327 primary production *in situ* data points from 20 studies for the different EBUS was produced. A new layer will be made available in the CCLME Eco-GIS Viewer (<http://www.ideo-cclme.ieo.es>). A case study was elaborated as a first attempt to calibrate available satellite-based primary production estimates with *in situ* measurements in the Canary region near the NW-African coastal upwelling (from IEO surveys).

In what refers to the Capacity Development Agenda, significant progress was made in the inventory of capacity development programmes in the region. The list of training programmes now contains a total of 49 programmes, including University degrees, Master programmes and PhD programmes in 5 countries, as well as 9 international exchange programmes.

A Training Workshop on "The Canary Current Eastern Boundary Upwelling System" was held at the Ocean Science Centre Mindelo on 10-12 March 2020. The training was addressed to young researchers (post-graduate students and post-docs) from the countries in the region (Cabo Verde, Gambia, Guinea, Mauritania, Morocco, Senegal and Spain) whose research focuses on the Canary Current EBUS dynamics, biogeochemical processes or ecological processes. The meeting was attended by a total of 20 participants from 13 organizations in 8 countries (Cabo Verde, France, Gambia, Guinea, Mauritania, Morocco, Senegal and Spain). Trainers included one expert from SCOR WG155 on "EBUS: Diversity, coupled dynamics and sensitivity to climate change". 14 trainees benefited from the training, with equal participation of men and women.

A project meeting was organized back to back, on 13 March 2020. Its main aim was to provide

room for discussions on the work carried out within the third phase of the project and on future regional and interregional cooperation on EBUS. A total of 16 participants attended the meeting, including 3 members of SCOR WG 155.

The Spanish Agency of International Development Cooperation (AECID) accepted a concept note for a phase IV of the project, which will allow, among other outcomes, a full implementation of the Research and Capacity Development Agendas proposed within project's phase III, specific action on gender issues and to strengthen IOC collaborations with similar efforts on capacity development on EBUS, like the WCRP CLIVAR "Research Focus EBUS" and SCOR WG 155. This new project will frame IOC's contribution to the SCOR Summer School on EBUS (dates to be determined) and to the organization of the Conference on Open Science in EBUS, to be held in Lima (Peru) in 2021.

III. Other activities of actual or potential interest to SCOR

Ocean acidification

In view of the growing urgency and recognition of ocean acidification as one of the major stressors for the marine environment, improved observation and research are needed to help scientists and governments in implementing related mitigation and adaptation measures.

IOC-UNESCO actively provided technical support to Member States to report towards the Sustainable Development Goal indicator 14.3.1, focusing on ocean acidification in the framework of sustainable development. The Commission provides the methodology guiding scientists and countries in terms of how to carry out measurements following the best practices established by the ocean acidification community. In this way, IOC and its networks, including the Global Ocean Acidification Observing Network (GOA-ON), directly contribute to the achievement of SDG Target 14.3. The Commission, together with its ocean acidification expert working group, is developing an IOC manual focusing on the 14.3.1 methodology, to be published in the third quarter of 2020, ahead of the second call for data submissions towards the SDG 14.3.1 Indicator.

The first call to Member States and researchers for the collection of data towards the SDG 14.3.1 Indicator was launched in late 2019. Data was submitted mainly through the 14.3.1 Data Portal, an online tool to facilitate the collection and quality control of ocean acidification data, developed by IOC and IODE. The Commission gave an account of the data collected towards the SDG 14.3.1 in its annual contribution to the UN SDG Report.

The IOC further contributed on ocean acidification to the WMO annual Statement on the State of the Global Climate. This is only the second year that ocean acidification is included in the Statement as one of the seven Global Climate Indicators. The IOC Secretariat also contributed to a Community White Paper for the OceanObs'19 conference, highlighting the 14.3.1 methodology. IOC co-organized the annual GOA-ON Executive Council meetings in 2019 (Hangzhou, China), and further actively supported and participated in the 4th international GOA-ON Workshop (14-17 April 2019, Hangzhou, China). IOC supported several side events at the UNFCCC COP25 highlighting ocean acidification together with members of the GOA-ON Executive Council and regional hubs. IOC will further support the 5th International Symposium on the Ocean in a High CO₂ World, and the GOA-ON Executive Council Meeting in September 2021 in Lima, Peru.

GOA-ON has now more than 730 members from 100 countries (in 2015 there were 150 scientists from 31 countries) and is constantly growing; currently 23 SIDS and 23 African countries are represented in GOA-ON. This is also thanks to IOC engagement and involvement in Ocean Acidification projects in the Caribbean, the Middle East and East Africa. The network supports a scientific mentoring programme, Pier2Peer, and an online Explorer showcasing ocean acidification observing platforms. GOA-ON is planning a webinar series on ocean acidification beginning in September 2020 and invites expression of interest for presentations.

Nutrient's coastal Impacts research

Nutrient over-enrichment of coastal ecosystems is a major environmental problem globally, contributing to problems such as harmful algal blooms, dead zone formation, and fishery decline. Yet, quantitative relationships between nutrient loading and ecosystem effects are not well defined. The IOC Nutrients and Coastal Impacts Research Programme (N-CIRP) is focusing on integrated coastal research and coastal eutrophication and linking nutrient sources to coastal ecosystem effects and management in particular. As part of the implementation strategy for N-CIRP, IOC actively participates in a UN Environment led 'Global Partnership on Nutrient Management' (GPNM) with intergovernmental organizations, non-governmental organizations and governments. GPNM has an online information portal to enable GPNM partners to monitor progress on implementing activities related to the sustainable use of nutrients. IOC-UNESCO supports the development of the indicators for SDG 14.1, for which UN Environment is the custodian agency. A task force, which includes experts from IOC-UNESCO and GESAMP, the UN Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, supported by the Group on Earth Observation (GEO) Blue Planet, was established to provide the technical expertise during the course of the development of the methodology for the indicator. The core focus of IOC-UNESCO is to contribute to the development of the Index of Coastal Eutrophication (ICEP). Currently, IOC UNESCO together with UN Environment is soliciting for funding to finalize the Silica component of the model and for testing it.

Microplastics

Plastics form a large proportion of marine litter, and the widespread occurrence of macroscopic plastic debris and the direct impact this can have both on marine fauna and legitimate uses of the environment, sometimes remote from industrial or urban sources, has grown rapidly. Lately the existence of micro-plastics and their potential impact has received increasing attention. The extent of the impact of plastic litter in the oceans is uncertain, despite the considerable scientific effort that has been expended in recent years.

GESAMP Working Group 40 on 'Sources, Fate and Effects of plastics and micro-plastics in the marine environment', led by IOC and UNEP, was initiated in 2012. The Working Group has published guidelines on how to monitor plastics in the ocean, This set of publicly-available guidelines for monitoring plastics and microplastics in the oceans will help harmonize how scientists and others assess the scale of the marine plastic litter problem (read more at <http://www.gesamp.org/publications/guidelines-for-the-monitoring-and-assessment-of-plastic-litter-in-the-ocean>). The focus for 2020–2021 is on an overview of risks associated with marine plastic litter; environmental risk from nano- and microplastics; and human health risks associated with nano- and microplastics.

Blue Carbon

The Blue Carbon Initiative, established in 2011 by the IOC, the International Union for the Conservation of Nature (IUCN) and Conservation International (CI), works to synthesize, scientific and technical knowledge, including policy mechanisms, for ensuring the conservation, restoration and sustainable use of coastal blue carbon ecosystems. The IOC is highly involved in the Blue Carbon Scientific Working Group, which provides the scientific foundation for the Blue Carbon Initiative by synthesizing current and emerging science on blue carbon assessment, conservation and management. Priority research activities coordinated by the Scientific Working Group are conducted in close partnership with the Initiative's Policy Working Group. IOC is further a coordinating member of the International Blue Carbon Partnership, a body that brings together governments, NGOs, IGOs and UN-Agencies.

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.

Integrated Ocean Carbon Research

In 2018, the IOC Executive Council considered a note prepared by the IOC Secretariat on recent developments related to ocean carbon research and the landscape of ocean carbon research activities. Scientific considerations included the need for generating new knowledge on the role of ocean carbon in climate regulation and on the effects of climate change on ocean carbon, including carbon biology, thus responding to growing needs for such knowledge from relevant initiatives and processes, namely the IPCC (also taking into account the findings and knowledge gaps in the IPCC Special Report on Ocean and the Cryosphere, in due course) and scientific and technical work related to requests formulated by the UNFCCC and its Subsidiary Body on Scientific and Technical Advice (SBSTA).

The global ocean carbon research community is constituted by several initiatives carried out in the context of: the International Ocean Carbon Coordination Project (IOCCP); the Surface-Ocean Lower Atmosphere Study (SOLAS), the Integrated Marine Biosphere Research (IMBeR); the Global Carbon Project (GCP); WCRP's core project on Climate and Ocean Variability, Predictability and Change (CLIVAR), and numerous other relevant activities of IOC itself. Relevant national efforts on carbon research, as exemplified by the Ocean Carbon and Biogeochemistry programme under the US Carbon Cycle Science Program, contribute directly to such global efforts on ocean carbon research.

Historically IOC played a central role in federating the global ocean carbon research community through the SOCOVV workshop held in April 2007 at IOC's headquarters and follow-up meetings. IOC had supported the creation of IOCCP in the early 2000s, building on joint efforts of IOC during the previous two decades with SCOR and ICSU, including the CO₂ Advisory Panel of the Committee on Climate Change and the Ocean and the subsequent Joint SCOR-JGOFS-CCCO Advisory Panel on Ocean CO₂. IOCCP was hosted at, and its secretariat supported by, IOC until 2012. IOCCP is co-sponsored by IOC and SCOR.

The IOC Executive Council concluded that these developments indicated the need to strengthen the IOC Ocean Science portfolio's focus related to ocean carbon, responding to the demand for such coordinating role by the scientific community. The IOC Executive Council noted that while IOCCP tends to focus on ocean carbon observations, assisting in the development of new needed technology, and developing relevant capacity, there is a continuous need for an integrative platform on ocean carbon research, and a clear role for IOC therein.

The discontinuation in 2017 of the IMBeR and SOLAS carbon working groups that, based on the Joint SOLAS/IMBeR Carbon Implementation Plan, were charged with coordination and synthesis of ocean carbon research related to both ocean surface and ocean interior, had created the need for such a new federating initiative on ocean carbon research. This would contribute to inter alia better-coordinated ocean carbon cycle simulations in the context of CMIP6 and of the Global Carbon Project's efforts to establish annual global carbon budgets with reduced uncertainty for each iteration.

The executive Council therefore decided to establish the IOC Working Group on Integrated Ocean Carbon Research, which will operate in in cooperation with IOCCP, IMBeR, SOLAS, WCRP/CLIVAR and GCP.

Some 30 experts designated by the above-mentioned organizations and programmes met at a workshop organized by IOC in Paris from 28 to 30 October 2019. As a result, a synthesis report on ocean carbon: current knowledge, gaps, and related research and observation requirements was prepared and is currently being finalized for consideration by the IOC governing bodies later in the year. This document will also be presented to the attention of the UNFCCC SBSTA and the Research Dialogue and the Ocean and Climate Dialogue convene under the auspices of the

Subsidiary Body.

IV. Potential future IOC and SCOR cooperation

The IOC and SCOR have long successfully cooperated and thereby strengthened research and scientific programmes.

The IOC Secretariat looks forward to sharing with SCOR its views on those proposals for new and to-be-renewed SCOR Working Groups that more closely reflect the current priorities of IOC in the area of ocean science.