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### **INTERNATIONAL DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT (2020-2030)**

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**INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION**  
(of UNESCO)

**INFORMATION DOCUMENT**

**INTERNATIONAL (UN) DECADE  
OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT**

**“TOWARDS THE OCEAN WE NEED FOR THE FUTURE WE WANT”**

Summary

The objectives of this document are to elaborate the idea of, and argue the case for, an international decade on ocean science for sustainable development.

The endorsement to pursue further elaboration of the idea followed its initial presentation and discussion at the IOC Executive Council in June 2016. The context is provided by the 2030 Agenda and related UN frameworks, namely the Sendai Framework for Risk Reduction 2015, the SAMOA Pathway for SIDS 2014, the UN FCCC Conferences of the Parties, COP-21 in Paris 2015 and COP-22 in Marrakech 2016, together with previous intergovernmental agreements. The bases include: (i) the conclusions of the First Global Integrated Marine Assessment, in particular that we are running out of time to effectively protect the world ocean from multiple interactive stressors; and (ii) the finding of the Scientific Advisory Board of the UN Secretary General that, of eight Grand Challenges the world community is facing, the most important one is improving ocean science and governance for the development of sustainable ocean knowledge-based economics. On these foundations, the document addresses a wide and diverse set of marine-related interests, including ocean science, sustained observations, marine environment problems and ocean (blue) economy.

A historical analysis of developments over the 50-year period since the International Decade of Ocean Exploration 1971-1980 suggests that governments need to engage and act in partnership with the many different ocean communities in order to achieve focus, cohesiveness, cooperation and coordination of efforts. An International Decade of Ocean Science for Sustainable Development, potentially under the UN auspices, emerges as the promising path towards “THE OCEAN WE NEED FOR THE FUTURE WE WANT.”



**FOREWORD**

The proposed "**International (UN) decade of ocean science for sustainable development - Towards the ocean we need for the future we want**" describes an initiative to develop a programme of work together with all interested parties in order to achieve major parts of the 2030 Sustainable Development agenda related to the ocean. The document is intended as starting point for further elaboration in discussion with Member States of IOC-UNESCO, other UN bodies and external collaborators.

The document provides a broad rationale and context, outlines possible goals and activities, themes and end results. It has been prepared as follow-up of a decision by the IOC Executive Council during its agenda item "Future of the IOC" in June 2016. The IOC Council encouraged the IOC Officers to pursue and develop such an initiative for an in-depth examination by the IOC Assembly in June 2017.

The initial idea for an IOC-led initiative in this direction was discussed at an IOC Officers meeting in January 2016. The discussion there and the further development has engaged all of us who have been involved, but it is fair to say that the process and the production of the written material has been skillfully facilitated by Gunnar Kullenberg, former IOC Executive Secretary. We owe him great thanks for his insight and effort.

Now we encourage an active and broad discussion of the directions the initiative should take, including potential contributions to execution of its major components.

Peter M. Haugan  
IOC Chair

Vladimir Ryabinin  
IOC Executive Secretary



## INTRODUCTION

The initial target audiences of this document include ocean and marine communities, associated private enterprises and sectors, national agencies in Member States of the IOC, and international partners of the IOC, inside and outside of the UN system. The objectives of the document are to elaborate the idea of, and argue the case for, an international decade on ocean science for sustainable development, to be aimed at “the ocean we need for the future we want”. The Ocean Decade would provide a framework and a focus for partnership and concerted action to implement the UN Sustainable Development 2030 Agenda with respect to the marine environment. It would also address the marine aspects of other related UN agreements. The main objectives would be: 1) to make a decisive step for turning the scientific knowledge and understanding of the ocean and sea floor processes and conditions about marine resources into effective actions supporting improved ocean governance, stewardship and sustainable development of the ocean (blue) economy; and 2) to identify and fill the significant remaining gaps in our knowledge.

An international decade on ocean science, referred to as the Ocean Decade in this document, preferably under the auspices of the United Nations, would bring out an increased understanding of the need to take urgent actions to maintain a life-supporting ocean and ensure adequate protection and adaptive management of the marine environment. This enhanced understanding, based on effective communication of scientific knowledge and the need to support oceanographic research and observations, is a prerequisite for generating commitments among governments and other stakeholders, and for creating a new level of awareness in the public about the state and future of the ocean. Science is indeed central for managing such a complex system as the ocean. The Ocean Decade would establish still missing or strengthen existing but weak links of science to marine applications of direct societal benefit, such as adaptation to climate change. This may include substantial technological developments and related transfer of marine technology, including modelling tools, through persistent cooperation over time, also stimulating capacity building.

It is hoped that this document would help to facilitate consultations and exchange of views on the concept of the Ocean Decade and stimulate its further elaboration. In order to give a reasonably complete and integrated overview and endeavour to reach out to the wide and diverse community of marine-related interests, the document touches upon ocean research, observations, marine environment problems, and economy. It also provides a historical perspective (detailed in a special Annex) and is centred on the ocean dimension of the 2030 Agenda and other international agreements.

### 1. SPIRIT AND OPPORTUNITY OF THE 2030 AGENDA

The celebration of the seventy years of the United Nations saw the endorsement of a set of 17 Sustainable Development Goals. The corresponding resolution “Transforming our world: the 2030 Agenda for Sustainable Development” was adopted by the UN General Assembly on 25 September 2015.

In the Preamble to the resolution, the UN Member States express the determination to protect the planet from degradation, end poverty and hunger, ensure that economic, social and technological progress occur in harmony with nature, and foster peaceful, just and inclusive societies free from fear and violence. Resolution [A/RES/70/1](#) sets out a “supremely ambitious and transformational vision” and envisages a world “*in which consumption and production patterns and use of all natural resources- from air to land, from rivers, lakes and aquifers to ocean and seas- are sustainable*”, under good governance and rule of law. It recognizes that climate change is one of the greatest challenges of our time and that increases in global temperature, sea-level rise, ocean acidification, and other impacts are seriously affecting coastal areas, especially in low-lying coastal countries, including many least developed countries (LDCs) and small island developing States (SIDS). The statement “*the survival of many societies, and of biological support systems of the planet, is at risk*” acknowledges the gravity of the continuing environmental deterioration of the ocean and depletion of its resources.

The resolution also notes, however, that this is a time of immense opportunity. Significant progress has been made in meeting many development challenges. The revolution in information and communication technologies generates a great potential to build active knowledge societies and achieve scientific and technological innovations across many diverse areas.

The new Development Agenda with its 17 Sustainable Development Goals represents a pledge by the world leaders for common action and endeavour across a broad and universal policy agenda never seen before. Through the 2030 Agenda *“we are setting out together on a path towards sustainable development, devoting ourselves collectively to the pursuit of global development and of “win-win” cooperation which can bring huge gains to all countries and all parts of the world. The Agenda will be “implemented for the full benefit of all, for the generation of today and for future generations, with commitment to international law”.*

The 2030 Agenda, as a *“plan of action for people, planet and prosperity”*, can be seen as specifying a unifying and integrating global adventure lasting for at least a decade. How can the ocean communities in partnership with all others best contribute to and help achieve involvement and support from governments so as to ensure its implementation? Can we achieve focus, cohesiveness, cooperation and coordination of our efforts through launching an International Decade of (Integrated?) Ocean Science for Sustainable Development, about 50 years after the (first) International Decade of Ocean Exploration 1971-1980 (IDOE)?

Sustainable development is inseparable from the health of the world ocean. Most countries have sea coasts and rely heavily on the ocean services. The ocean has played a leading role in the development of international cooperation. This has been manifested through the United Nations Convention on the Law of the Sea of 1982 (UNCLOS), which entered into force in November 1994, providing the rule of law for the ocean.

The same sentiments transcend the presentation of international ocean science, observation, data and information exchange and training programmes in the book *Troubled Waters: Ocean Science and Governance* (Holland and Pugh, 2010), prepared for the fiftieth anniversary of the Intergovernmental Oceanographic Commission of UNESCO. Its overall message is “that governments need to work together with greater urgency, to address the many natural and man-made issues concerning the ocean; they need understand better the role that ocean science can play and they need to develop much stronger ocean governance mechanisms to profit from the knowledge obtained.” This harmonizes well with the message and aim of the 2030 Agenda, both as regards the urgency of actions and emerging opportunities.

## **2. CARING FOR THE OCEAN - AN URGENT NEED AND DUTY**

The deep ocean is the last frontier of the planet. The ocean and its seas are shared by nations, exploited by them but are still least explored. The resources in the ocean, on and in the seabed, represent a very large treasure for humankind. If so, why are they far from being completely mapped and why are their inventories so incomplete? The ocean bathymetry and tectonic conditions are also poorly known and incompletely mapped despite processes there have considerable influence on the planet and people. This situation is reflected in Sustainable Development Goal 14 (SDG 14) of the 2030 Agenda “Conserve and sustainably use the oceans, seas and marine resources for sustainable development.” SDG 14 specifies several targets to be achieved during the coming decade and a half. They direct the attention to the ocean management and use. In addition to these targets, several other SDGs include targets and actions which are of high relevance for the ocean and coastal conditions. In particular, the climate change issue, covered by SDG 13 and the Paris Agreement, is of great concern for the ocean conditions which also feedback to climate due to the role of the ocean in the climate system.

Society now depends on the ocean more than at any time before. Covering 71 % of the Earth surface, the Ocean is the origin of life on our planet, the home for the largest shared, heavily exploited but still very poorly known ecosystem of the planet, and a source of critical resources for our survival.

The ocean provides about half of the oxygen we breathe. It is a vital source of nourishment, for instance high-grade animal protein, supporting directly the livelihood of about 500 million people, especially in the poorest nations, and, indirectly, the global population. Food from the ocean is vital to human health and brain development. Recent economic assessments assign to the Gross Marine Product an annual value of about 2.5 trillion USD, of the order 3 -5 % of global GDP, not including much of the coastal areas. Marine and coastal resources and industries represent over 5 % of global GDP. For many nations, the ocean-related economic activities such as tourism and artisanal fisheries are major contributors to the national economy and development, supporting up to 30 % of the national economy. Over 90 % of the world trade is carried by the sea, currently at a value of about 13 trillion USD, having increased from about 7 trillion in early 1990s. Ocean economies are among the most rapidly growing and promising in the world, providing benefits to many sectors of great economic value, including through fisheries, energy production, tourism and transport, climate change regulation and carbon sequestration, the conservation and use of habitat and biodiversity, as well as through positive influence on human health and well-being. Additionally, the ocean biological systems offer exciting opportunities for the development of new drugs to treat many human ailments, such as asthma, tuberculosis and cancer. Marine biotechnology is a rapidly rising industry. Financial benefits from worldwide sales of marine biotechnology-related products are estimated to represent at least a multi-billion dollar market. Economic losses can be also very substantial due to coastal erosion, degradation of coastal seas, removal of discarded material and marine litter or debris, disturbances or failure of aquaculture and fisheries, contaminated marine food, beaches and swimming areas by both dissolved substances and particulate, suspended matter such as microplastics. In addition large losses of human life and infrastructure are common due to natural hazards associated with the ocean.

### 3. CHALLENGES AND OPPORTUNITIES OF THE OCEAN

The major issues concerning the marine environment include: pollution, waste and contamination; overfishing; warming; and acidification. There is also great concern, including among the public, for changes of the ocean currents, from local to basin-wide scales, sea-ice melt, sea-level rise, coastal flooding, extreme weather events and changes in their frequency and intensity, environmental impacts of aquaculture, effects of marine invasive species, losses of biodiversity and habitat destruction and coastal erosion. Public perceptions also show strong connections to marine and coastal environments affected by aesthetics, identity, practical considerations of access, livelihoods, assessment of impacts on marine wildlife, and clean energy production. International evaluations of human impacts on the marine environment do not assess the public awareness and perceptions, concerns and priorities (Gelcich et al., 2014). Public attitude and understanding are key to successful implementation of changes, and public perceptions need be taken into account in specifying national programmes, management decisions and interventions.

The scientific community has identified the leading 20 marine research questions as follows (from Rudd, 2014):

Cumulative stressors;	Climate change mitigation and manipulation;	Coral reef management strategies;
Ocean productivity;	Global biodiversity and ecological function;	Cross-disciplinary ocean science and Management;
Ocean acidification;	Benthopelagic coupling;	Energy development.
Monitoring cumulative effects;	Science communication;	
Oceanographic data;	Contaminants;	
Biodiversity contributions to ecosystem function;	Top predator decline;	
Greenhouse gas flux;	Climate change-induced species dispersal;	
	Ecosystem structure to service linkages;	
	Thermohaline circulation;	



This set of research questions is the outcome of a broad survey of scientists covering 94 countries. Five of the top 10 research priorities were shared by respondents globally. Seven of the top 10 priority questions were shared by physical and ecological scientists. They are (with the global ranking in parenthesis): cumulative stressors (1); ocean productivity (2); ocean acidification (3); monitoring cumulative effects (4); oceanographic data (5); greenhouse gas flux (7); and climate change mitigation and manipulation (8). However, only the cumulative stressors question was among the top 10 priorities for social scientists. Many of the high-priority questions for social scientists were low in the ranking order for natural scientists. Many social scientists top-ranked science communication (1), risk assessment for governance (2), and ocean literacy messages (4), all of which point at the interest in the purpose of environmental management and normative aspects of our relationship with the environment and of interpreting, integrating and advocating science by engaging in the policy process.

There were also differences in the rankings between regions. Furthermore, the rankings do not reflect the research priorities of society as a whole or of government policy makers. It would be valuable to systematically compile and compare existing ocean research priorities among governments and other bodies, which could be a task of the Ocean Decade.

Reports from the World Bank and the European Commission, according to Rudd (2014), point to an increasingly held view of the ocean as the driver of economic and social wellbeing as well as the importance of safety and security, all influenced by the ocean conditions. Realization of that role requires the health of the ocean to be restored and maintained (Rudd, 2014). The European Environment Agency (2014, cited by Rudd) states: *“Our seas are rapidly changing while our dependence on them is growing. We do not fully understand the complex interactions of natural and human-driven changes. But we do know that we are not yet on the path to achieving healthy, clean and productive seas”*. Rudd (2014) concludes that his results *“provide insights as to how research scanning results can be synthesized and used to target ocean research on questions that, if answered, would be central to achieving ocean sustainability”*.

It should be noted that the role of the ocean as the driver of socio-economic development and wellbeing during this century was brought out earlier by the founder of the International Ocean Institute (Elisabeth Mann Borgese, 1996, 1998, 2000). Her analysis was based on the application of the Law of the Sea and in particular the possibilities stemming from the use of the principle of the Common Heritage together with the economic potential of ocean-dependent and ocean-related goods and services.

The results by Rudd are corroborated by the Nordic Study (W. Boonstra, Marine Policy; cited by Catherine Jex, 2016). According to that study marine scientists identified overfishing as a top concern, followed by elevated temperature, contamination and waste, and ocean acidification. Differences depended upon the scientific background of the respondent. Natural scientists stress the symptoms of global change driven by human impacts, whereas social scientists tend to focus on human causes of the threats. The review by Williamson et al., 2016 highlights the main science issues raised by the G7 Science Ministers, namely plastic pollution, deep-sea mining and its ecosystem impacts, ocean acidification, de-oxygenation, ocean warming, biodiversity loss and marine ecosystem degradation, as the areas of scientific efforts for finding proper and economically valid solutions. This leads to identification of actions, which could be taken by the G7 countries through a concerted, coordinated action platform. The analysis brings out the need for a transdisciplinary approach, for strengthened scientific observations of the state of the ocean and its seas, improving and integrating the worldwide gathering of information on the on-going changes in ocean physics, chemistry and biology, including by means of new technology. The review calls for joint research initiatives involving researchers, industry and government bodies building on existing networks and frameworks of international collaboration. It also calls for greater international coordination of research by industry and scientific institutes, e.g. in deep-sea mining. The review concludes that in order to improve our understanding of processes controlling global ocean warming, additional full-depth monitoring of such variables as oxygen and pH is required. Marine protected areas can help maintain biodiversity and, besides improving coordination of marine biodiversity

research, the G7 countries suggest promoting global networking of marine protected areas, linking developed and developing countries and sharing lessons learned and best practices. Marine ecosystem degradation has greatly accelerated during the last five decades and international policy actions are needed to reduce the drivers of marine degradation, improve marine literacy and develop a global approach to marine conservation. Actions could include improved assessments of the state of marine ecosystems based on observing strategies that consider biodiversity and ecosystem functioning as well as physical and chemical conditions.

The silent services of the ocean in the context of global and climate change include (Stocker, 2015): the ocean uptake of over 90 % of the excess energy in the climate system, confirmed by observed ocean waters warming on a worldwide scale to depths over 2,000 m; the ocean acting as a receiver and global distributor of the excess water from melting glaciers and ice sheets of Greenland and Antarctica, with this melt and the warming driving the sea-level rise; the ocean absorption of up to 30 % of the carbon dioxide emitted by society and about 28 % of the cumulative anthropogenic carbon dioxide emissions from 1750 to 2011, now stored in the ocean, being roughly equivalent to the amount of carbon taken up by the land biosphere. The price for the ocean uptake is ocean acidification, which has reached great depths. The implications include gradual calcium carbonate under-saturation, the critical threshold of which can be predicted, probably with the smallest uncertainty among all projections of future change related to the climate issue. Model simulations suggest this threshold will first be crossed in the Arctic. The specific Sustainable Development Goal target 14.3 calls for minimizing and addressing impacts of ocean acidification, including through enhanced scientific cooperation at all levels.

The Scientific Advisory Board to the United Nations Secretary General (UNESCO, 2016) stressed eight grand challenges, which were categorized as serious problems of the entire world community. Number one of these concerns “improving ocean science and governance for the development of sustainable ocean knowledge-based economies”, and number five concerns “averting human disasters through prediction of extreme environmental events”. The Board recommends that to “*address these grand challenges the United Nations should press for greater collaboration among international science networks, including professional societies and academies, and indigenous and local knowledge holders*”.

This brief overview, mostly focussed on SDG 14, brings out the multitude of uses and related impacts on the ocean from our society. The multiple, cumulative stressors constitute a priority research area. The First World Ocean Assessment confirmed this in concluding that we are running out of time to effectively protect the world ocean from multiple interactive stressors. This in itself provides ample justification for a consolidated global effort. The problems and priorities are known and documented. Hence now we need to orient ourselves towards providing science-based solutions. It should be noted that the evaluation of the seriousness of the problems largely depends upon science. Finding solutions will also depend upon science and technology, involving several science disciplines and engineering, thus providing a justification for an Ocean Science - focussed Decade.

#### **4. PROPOSAL FOR AN OCEAN DECADE**

The supremely ambitious and transforming vision of the 2030 Agenda provides a great opportunity and a rationale for another “historic and unprecedented adventure” in form of an International (UN) Decade of Ocean Science for Sustainable Development, with the overall goal to support achievement of the SDG 14 and the vision of securing the life-supporting ocean, “the ocean we need for the future we want”. Hence the emphasis is on science and integration as well as on communication and international cooperation. The science-drive is motivated by the issues and problems recalled here, the gaps in required information and by the fact that the ocean is far from fully explored or mapped, although observations of the ocean under the Global Ocean Observing System are now more of regular and sustained nature than of exploratory character, in analogy with the weather observations. Since the creation of the Intergovernmental Oceanographic Commission of UNESCO in 1960, the science and marine technology and related capacities have developed so

that the overall goal can now be achieved through concerted, cooperative and well coordinated support and action.

### ***Purpose of the Ocean Decade***

The First World Ocean Assessment concludes that “*many parts of the ocean have been seriously degraded*”, and that “*the general threat to the ocean comes from a failure to deal quickly with the manifold problems described in the assessment*”, as well as with problems identified independently by the scientific community. The reason for the failure is related to, or even is due to, lack of integration of scientific results into management. If the problems are not addressed, there is a major risk that, combined, they will drive a destructive cycle of degradation of the ocean life-support system through which it will no longer provide many of the benefits that our society currently derives from it. This would seriously limit our means of achieving the visionary goal of sustainable development.

The main purpose of the International Decade of Ocean Science for Sustainable Development would be therefore to seek and communicate scientific solutions to the problems. In particular the aim could be to address the cumulative impacts of multi-stressors, and endeavour to fill the related information gaps by means of observations, mapping the ocean space and its sub-soil in three dimensions as far as possible, with newly developed technologies combined with experiments and modelling.

The Ocean Decade would provide a framework for partnership developments with respect to ocean science and observations in support of implementation of ocean-related aspects of the United Nations Sustainable Development 2030 Agenda. The Ocean Decade efforts should also address the parts coupled to the marine environment of other relevant international agreements and frameworks, e.g. the Sendai Framework for Risk Reduction (2015), the SAMOA Pathway (2014), and the Outcome Document of the Sustainable Development Conference 2012. Through coordination with the on-going negotiations concerning a new international legally binding instrument on conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction, the Ocean Decade programme may help to address the associated requirements of marine science, technology transfer and capacity development.

Specific goals or objectives of the Ocean Decade could include:

- Elucidating impacts of cumulative stressors on the ocean, its seas, ecosystems and resources, and related processes, obtaining more complete information to fill identified gaps, also with respect to seriously degraded parts of the life-supporting ocean system; seeking to clarify and investigate related processes and specify actions, which can improve the situation and reverse the degradation;
- Supplementing and completing the science base for an adaptive management approach towards good ocean stewardship and an ocean economy for sustainable development, with the transdisciplinary oriented approach in the research and in objectives, including co-design together with stakeholders involving people or groups affected by the research and its results;
- Revisiting selected programmes of the first IDOE 1971-1980 to elucidate changes of the ocean, and obtaining a more complete inventory and better quantitative knowledge of the state of the ocean, its bathymetry and subsoil, and an inventory of marine resources and opportunities to exploit the resources in a sustainable manner;
- Enhanced participation in, use of, and support to sustained ocean observations within GOOS, strengthened science base and networking of marine protected areas;
- Addressing other major ocean issues indicated herein, including development and strengthening of interdisciplinary ocean research;

- Implementation of capacity development through transfer of marine technology, modelling tools and training through research leading to significantly enhanced economic benefits for SIDS and LDCs from marine resources and technology;
- Enhanced trust, cooperation, coordination, exchange of information and communication between various institutions and bodies dealing with or responsible for marine affairs and related policy, including ocean research and observations, with faster and more effective delivery of new and existing knowledge to policy and decision-makers.

Other objectives are to be specified in the course of the further development of the Ocean Decade programmes.

In the Rio+20 Outcome Document “The Future we want”, Heads of States and government recognize the importance of building capacity of developing countries to benefit from the conservation and sustainable use of oceans and seas and their resources. The Outcome Document emphasises the need for transfer of technology taking into account IOC [Criteria and Guidelines on the transfer of marine technology](#). The proposed Ocean Decade should also support education and enhance awareness about the Sustainable Development, the contributions of research, technology and observations together with the need to care about the ocean and marine resources. The Ocean Decade should endeavour to make ocean science and ocean policy-making work together, for the common good of society as well as the ocean itself (see e.g. Holland and Pugh, 2010). The Ocean Decade should inspire cooperation and exchange of human experiences and marine technology, in support of and in conformity with UNCLOS. The spirit of the Ocean Decade could include, following the overall goal of the UN Decade of Education for Sustainable Development (UNESCO, 2005), the integration of principles, values and practices of sustainable development into ocean governance and related education, into use and management of marine resources and the ocean as a whole, in conformity with the Law of the Sea. This should include involvement of local coastal communities, practitioners and holders of traditional knowledge.

### **Activities of the Ocean Decade**

The Ocean Decade may include activities to:

- Facilitate networking, linkages, exchanges and interaction among individuals and groups in ocean research, marine technology, ocean economy and ocean policy making, so as to stimulate achievement of the Sustainable Development Goals of the 2030 Agenda;
- Support countries, especially those least developed in ocean research and ocean economy, to utilize marine technology and develop marine resources to achieve the Sustainable Development Goals with related relevant indicators;
- Stimulate countries to utilize new marine technology in support of observations, data retrievals, interpretations and applications for the sustainable development of marine resources and environment with economic benefits for the people; and
- Stimulate the national and regional links and development of sustained ocean observations as national contributions in the framework of the Global Ocean Observing System.

Programmes and actions of the Ocean Decade should also enhance access to ocean and marine education, research and technology; increase public understanding and awareness about the need for sustainable development and rational use of the marine environment; provide training through research and support implementation of capacity development.

Enhancing understanding of and addressing the global issues of sustainability with respect to the ocean that impact nations, people and communities will be central to the Ocean Decade efforts. All the issues emerge from the three spheres of sustainable development: environment, society and economy. Economic issues include poverty reduction, health protection and job creation,

responsibility and accountability. In short, it should be a decadal effort for the Ocean and Society, a shared responsibility for a shared resource, the ocean.

A major task in context of the development of the ocean economy is documenting the potential impacts from environmental changes on the established and emerging maritime industries and their ability to generate growth, especially for LDCs and SIDS. This concerns capture fisheries and mariculture, tourism, adaptation of and in coastal urbanizations, port and infrastructure services, development of pharmaceuticals and genetic resources, chemicals and marine biotechnical industry, coastal developments, sea-bed mining, oil and gas extraction, marine renewable energy, desalination, habitat protection and restoration, nutrients and recycling, transportation and communication. Climate change impacts on the ocean will have profound implications for all human societies and most of our activities. This is of particular concern with respect to potential impacts on coastal megacities. In view of this insight there is a need also to bring in knowledge and understanding from other science disciplines in addition to natural sciences and economics in assessments of oceanic and coastal changes, such as maritime history, ethnographies of coastal cultures, and political geography of oceans (Allison and Basett, 2015).

The efforts of the Ocean Decade will support free flow of data, of scientific and technological information and exchanges by means of modern communication technologies. The programmes will enhance knowledge about international law, in particular the UNCLOS, and the need to abide by it. This requirement is as important for geopolitical stability as for sustainable development of the ocean (blue) economy. Pollution of the ocean as well as shelf seas, including spreading of plastic and other types of debris, continued overfishing, with complete depletion of some stocks, including through illegal, unregulated and unreported fisheries and the uncertain status of the High Seas are critical problems. The concern for overfishing is also exacerbated by the uncertainties of the global fisheries statistics, which tend to underestimate the total catch, often missing the artisanal fisheries.

The interactions between processes in the ocean, coastal seas, atmosphere and the land have created multiple imbalances and impacts. One example is a change in the harmful algal bloom occurrence, affecting the health of marine life, fisheries, aquaculture, coral reefs and human health. In order to address the corresponding threats to society, there is an increasing need for coastal protection and development, marine spatial planning, hazard assessment, with related preparedness, adaptation, mitigation, and comprehensive education and information. Community resilience and adaptive capacities, with related education and awareness raising as regards the use of observations and data, are needed to reduce impacts of changes and improve the efficiency of early warning systems for natural and man-made hazards. The actions can create jobs and improve livelihoods and wellbeing. In order to achieve the sustainability goals, one priority should be obtaining a more complete mapping and inventory of the marine resources.

## **5. HARMONY WITH AND CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT GOALS**

The SDG 14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development” in its crosscutting target 14.a specifies the need for increasing scientific knowledge, for developing research capacity and transfer of marine technology in order to improve ocean health and to enhance the contribution of marine biodiversity to the wellbeing of developing countries, in particular SIDS and LDCs. The target 14.b aims to provide access for small-scale artisanal fishers to marine resources and markets. The target 14.c strives to enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources.

In addition to these overall objectives and needs, SDG 14 also specifies seven specific targets, namely:

- Reduction of marine pollution of all kinds by 2025;

- Sustainable management and protection of marine and coastal ecosystems to avoid significant adverse impacts, strengthening the ecosystem resilience and taking actions for their restoration in order to achieve healthy and productive oceans, all by 2020;
- Minimizing and addressing the impacts of ocean acidification, including through enhanced scientific cooperation at all levels;
- Effective regulation by 2020 of harvesting and end to overfishing, illegal and unregulated fishing and destructive fishing practices and with implementation of science-based management plans;
- Conservation by 2020 of at least 10 per cent of coastal and marine areas;
- End, by 2020, detrimental forms of fisheries subsidies; and
- By 2030, increase the economic benefit to small island States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism.

The scientific and social rationale and tentative framework of an international decade of (integrated) ocean science harmonizes well with these goals and targets for concerted actions. A unifying, focusing global concept and the aim of encouraging participation in commonly agreed programmes addressing the agreed priorities will greatly support the implementation. Being global and long-term, the Ocean Decade can address concerns of global to local nature and provide feedback and benefits to all participants, which can help achieving the overall goals of the 2030 Agenda. The overview given here and in the Annex identifies the need for research and data, including on natural and man-made changes and their interactions, science communication and dialogue between sciences, as well as between scientists and policymakers, as well as the need for improved governance and management. Furthermore, international coordination of research and monitoring efforts, regard for differences between regions and capacities, together with the socio-economic importance of a life-supporting ocean, provide additional motivation for an Ocean Decade, with major challenges and opportunities.

## **6. CONCEPTUAL MODEL OF DECADAL PROGRAMME: CHARACTERISTICS, STRUCTURE AND RESPONSIBILITY**

The 2030 Agenda is a “*plan of action for people, planet and prosperity*”, to be implemented by all countries and all stakeholders acting in collaborative partnership. Likewise, the proposed international decade of integrated ocean science for sustainable development should have the character of a plan of action for the people, the planet ocean and the common prosperity, specifically addressing the ocean and seas component of the whole, with responsibilities for all. With the broad overall goal to achieve and maintain a healthy life-supporting ocean, with sustainable consumption, production and utilization patterns of the natural resources of the ocean and seas and the whole marine environment under good governance and rule of law, the programme of the Ocean Decade should achieve a comprehensive mapping of the ocean properties and distributions thereof, a significantly improved inventory of ocean resources, enhanced scientific basis for forecasting of conditions in ocean and seas, and the impacts thereon by human actions and utilization, and related consequences for life on the planet. A central spirit of the Ocean Decade should be underpinning good governance and stewardship under rule of law, for the sake of the ocean and human society as a whole, and thus a responsibility for all. This aspect highlights the need for sciences and policy making working together.

The Ocean Decade should be international and include interdisciplinary research addressing the elements of sustainable development. This includes interactions and interdependencies of the environmental conditions and processes, the use of resources and the economy. In order to support its implementation, the Ocean Decade programme should seek to promote marine scientific research under UNCLOS.

The ocean waters reach everywhere and the processes cover all scales. Hence the Ocean Decade programme should offer to network all communities, from local, national, regional to global. Cooperation stimulates implementation, develops understanding through the exchanges as well as enables uses of results and promotes education and awareness.

The overall themes of the Ocean Decade should aim to address the ocean challenges identified above, relate to ocean issues identified in the Sustainable Development Goals, and strengthen the capacity of the States, in particular SIDS and LDCs, in marine scientific research and in developing and using the related technologies according to the provisions of UNCLOS. This overall direction may lead to some themes, as follows:

- (i) Theme aiming at increasing scientific knowledge: this may include research to elucidate impacts of multiple, cumulative interacting stressors, to support reduction and minimizing impacts of various changes (risk reduction), and help clarify interactions between natural and man-induced changes; developing research and observation capacities and supporting transfer of marine technology, e.g. with focus on changes and impacts of warming, carbon dioxide uptake and acidification, processes at the ocean floor, active geological and tectonic zones and degassing, natural and man-made habitat destruction, changes and losses of biodiversity and ecosystem or ecological functions; achieving cross-disciplinary research, including on cumulative stressors and cumulative effects, and management actions. Introduction and use of new technologies could be a breakthrough for economy, sustainable development, risk reduction and breaking poverty. This may include use of satellites, intercontinental cables as well as local sea level stations, all feeding into the agreed existing international ocean data and information systems and GOOS.
- (ii) Theme aiming to enhance conservation and sustainable use of ocean and marine resources: this may include for economic development and benefit, in support of implementation of UNCLOS with focus e.g. on: the inventory and distribution of ocean resources and productivity and management of aquaculture; mapping of level of wastes, including debris and plastics, other contaminants and the effects of the pollution; understanding and quantifying role of marine protected areas and biogeographical zones in ecosystem, biodiversity and possibly economic terms, for protection, conservation, restoration and output.
- (iii) Theme on interpretation and use of knowledge about the ocean conditions: this may include data management, data gathering and information systems, modelling, forecasting and utilization of forecasts, public perceptions, including in context of adaptation and risk reduction, capacity development and technology transfer, and focus, e.g. on forecasting ocean conditions, ocean food productivity, capture fisheries and aquaculture, evaluating its capacity to meet growing demands, taking into account biogeographical zones and biodiversity with focus on areas beyond national jurisdiction, markets and distribution patterns and public perceptions; evaluations of significance of knowledge about the ocean for social development, protection and economy, e.g. as regards outputs, costs, infrastructure and organization of production and distribution, tourism and transportation; adaptation to changes and up-scaling of science-based management approaches and interventions.
- (iv) Theme on development of ocean economy: this may include analyses and evaluations of economic and social benefits from sustainable use of marine resources, use of traditional knowledge, and focus, e.g. on science-based management of fisheries, aquaculture, reduction of waste and pollution, coastal conditions, including role and up-scaling of integrated coastal area management and marine spatial planning, economy of tourism and recreation; on evaluation of legal, economic and social aspects of sustained use of the ocean and the marine resources and products; on approaches and techniques to reduce overfishing and deal with illegal, unreported and unregulated fisheries; on



mapping, making inventories on mining and other extractions of marine non-living resources, including renewable energy and freshwater through desalination.

- (v) Theme on sustainable management and protection of coastal ecosystems: this may include improvements of baselines on environmental conditions and public perceptions, and focus, e.g. on ecosystem resilience, avoidance of adverse impacts and economic losses, various uses and developments as harbours and other infrastructures, potential impacts of possible increase of sea-level and extreme weather events, flooding and erosion.

Possible overall structural outcomes of the Ocean Decade may be the strengthening of interaction, coordination, cooperation and exchange of information between institutions and agencies at national and international level. A similar perspective can develop between scientific disciplines, technology, and associated private enterprises. An increase of trust between the different parties, from local, to national, regional or sub-regional and global, can lead to more coherence and less fragmentation in ocean governance and management. The Ocean Decade efforts may also help address at least some of the points of the conclusion of the [Blueprint](#) (IOC/UNESCO, IMO, FAO, UNDP, 2011) that a major reason for the slow progress in the implementation of the international agreements is “*due to alternative political priorities, insufficient institutional capacity or inappropriate institutions, market distortions, incomplete science, lack of financing and, or, willingness to participate.*”

## 7. CONCLUSIONS: SPECIAL FEATURES AND CHARACTERISTICS OF THE OCEAN DECADE

The overall aim is a functioning life-supporting ocean, for the sake of the ocean and society, and its sustainability, *the ocean we need for the future we want*. The purpose of the Ocean Decade brings out the need for having an integrated, possibly interdisciplinary and not only multi-disciplinary but also trans-disciplinary research. The role of different disciplines implies a need for linkages and interaction between natural sciences and engineering, social sciences, ecology and economy, human health, medicine and pharmacology, legal aspects, and policy making. This fits with the aim to achieve a more complete mapping and description of the ocean, including connections and interdependencies of processes and conditions; improved inventories of the living and non-living resources; more complete baselines and boundary conditions for use in identifying trends and changes; more complete description and understanding of the changes and processes over time scales of decades, in particular for modelling and management purposes. Such an emphasis can provide results and outputs of the Ocean Decade to achieve better governance and stewardship of the ocean and its resources as part of our social duty, on basis of science, technology and sustained ocean observations.

Projects should be international, involve cooperation and require facilities of several groups, and be of long-term and continuing nature. International cooperation in ocean research is of long standing as a necessity but the Ocean Decade projects should aim to involve interdisciplinary cooperation, covering also economy, science communication and communication technology, e.g. the role of ocean cabling, looking for solutions to legal problems with potential use of science diplomacy. The Ocean Decade should be a period of enhanced and more complete collaborative planning, intensified development of national capabilities and implementation of both national and international programmes. Networking should be pursued including also local communities, practitioners and traditional knowledge. This can be achieved using modern communication technology, transparency and trust building. Criteria will have to be developed and agreed for identifying and defining Ocean Decade projects.

The regional perspectives should receive strong attention and regional cooperation could be emphasized, using existing mechanisms as the IOC Regional and Technical Subsidiary bodies, UNEP Regional Seas, the European Union, ICES, PICES, SOPAC, PEMSEA, and involve other regional conventions such as HELCOM, ASEAN, OSPARCOM, and Barcelona Convention. Integration of proposed, preferred national projects into a comprehensive international programme



should be organized through the appropriate international bodies. These should also facilitate coordination and cooperation and international networking and exchanges. However, governmental support, involvement and ownership are all absolutely necessary, just as in the case of the 2030 Agenda. For the Ocean Decade to be successful, a definite set of themes and programmes will need be determined, on basis of agreed criteria and indicators of progress, possibly similar or same as those being developed for the targets of SDG in the Agenda 2030 so as to ensure links and responses to the Sustainable Development Goals overall and Goals 14 and 14a in particular.

***Possible end results of the Ocean Decade could be:***

- Scientific processes resulting from actions and support and taken up by governments in response to the condition of the ocean as the main life-supporting system on planet, with products used by them, by the private sector, civil society and the broad public, including in support of new legal elements;
- Consolidation of the ocean science communities through communication, dialogue, trust and regular exchanges between governments and their agencies and other users of the marine environment and its resources, the public and the different science communities, e.g. natural, social, economy, human health, legal;
- A new generation of observing technologies for the ocean and its seas emanating from efforts of technologically developed (e.g., G7) and developing countries introduced into GOOS for sustained observations, expanded to include more biochemical, biological, biodiversity and ecosystem related parameters, in support of ecosystem-based management;
- Use of the new generation of inter-compared coupled modelling tools for prediction of ocean conditions, including biological and biochemical parameters such as oxygen and pH, going beyond the existing abilities to describe the physical state of the ocean;
- Complete, or at least significantly more complete than in 2015, mapping of the ocean conditions, the bathymetry and subduction zones, and a regular or at least on-going updating of the Census of Marine life, more comprehensive information and understanding of subduction zones and hot vents, functions and roles of biodiversity in areas beyond national jurisdiction;
- More transdisciplinary and integrating oceanographic research, with prospects for much improved delivery of the science and technological results and data, with knowledge which is applicable for achieving sustainable development and supporting related adaptive management;
- Strengthened and directed capacity building linked to technology transfer, including new technologies, and sustained observations with related training through research;
- An information portal of IOC responding to the new role of science in communication and use of scientific results, regularly providing and updating information on the state of the ocean to all stakeholders, through available new communication and data assimilation technologies;
- Higher profile and more visibility of the IOC and trust in its role and ability to deliver, with National Oceanographic Committees highlighted, with strengthened and more extensive links to user sectors, including economy, human health, private industries and the public through appropriate mechanisms representing ocean and coastal area related communities;
- Ocean literacy consolidation, training and education about the ocean and its seas, possibly in schools, including on the ocean information system, IOC portal, with its improved and streamlined approach for delivery of controlled data and scientific results;
- An alliance of likeminded institutions, agencies, national and international, with strong cooperation, coordination and trust; both in the UN system for the leading Agencies

associated with the ocean and seas, including ISA and legal authorities, and with partners outside the UN, including IHO, ICSU, SCOR, IAPSO, and regional bodies.

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## ANNEX

**From the International Decade of Ocean Exploration 1971-1980  
to the Decade of Ocean Science for Sustainable development**

**TOWARDS THE OCEAN WE NEED FOR THE FUTURE WE WANT”**

**AN HISTORICAL BACKGROUND**

The ocean dynamics require that ocean research is international and cooperative. A significant manifestation of this fact is the generation and successful completion of the International Decade of Ocean Exploration 1971-1980 (IDOE). The idea of an ocean decade was announced in March 1968 by the President of the United States as *“an historic and unprecedented adventure”*, with the underlying position stated by the same President in 1966 that *“Under no circumstances must we ever allow the prospects of rich harvest and mineral wealth to create a new form of colonial competition among the maritime nations. We must be careful to avoid a race to grab and hold the lands under the high seas. We must ensure that the deep seas and the ocean bottom are, and remains the legacy of all human beings”*. This constituted a foundation and position for the Law of the Sea, as well as for sustainable development: all elements of sustainable development are included in the Law of the Sea, which also includes the idea of peace and security. The concept of the Common Heritage of Mankind was first discussed by the General Assembly in 1967 following an introduction on ocean development by the Ambassador of Malta, in context of the opportunity of preservation of the sea-bed and ocean floor exclusively for peaceful purposes. In 1970, the General Assembly adopted a Declaration of Principles, on basis of negotiations in the Committee on the Peaceful Uses of the Sea-bed and ocean Floor beyond the limits of National Jurisdiction. The Declaration stated that *“The Sea-bed and ocean floor, and the subsoil thereof, beyond the limits of national jurisdiction... as well as the resources of the area, are the Common Heritage of Mankind”*, and shall not be subject to appropriation by any means by States or persons, and *“the area shall be open to use exclusively for peaceful purposes by all States...., without discrimination.”* These clauses reflect the declaration of the President of the United States leading to the International Decade of Ocean Exploration.

Systematic oceanographic research was initiated only in the second half of the 19th century. The global research cruise of *HMS Challenger* starting 1873 provides a landmark for development and support of ocean research. Almost hundred years later, the International Decade of Ocean Exploration was conceived by the US National Council of Marine Resources and Engineering, chaired by the US Vice President, in 1966. The Council argued the case for such a collaborative global effort on the basis of *“food for the world population, maritime threats to world order, waterfront deterioration in coastal cities, increased pollution of the shoreline, expanding requirements for sea-bed oil, gas and minerals, and expanding ocean shipping.”* The concept was officially announced in March 1968 by the US President in his conservation message proposing *“an historic and unprecedented adventure-an International Decade of Ocean Exploration for the 1970s.”* The Marine Council then sought international support for the Decade. Following consultations, the IOC in June 1968 recommended support for the IDOE. In December the same year the UN General Assembly endorsed *“the concept of an IDOE to be undertaken within the framework of a long-term programme of research and exploration designed to assist in a better understanding of the marine environment through science.”* The Decade, initiated a century after the *Challenger* expedition, marked a major turning point in ocean exploration and changed the science of oceanography (Report by NSF on IDOE, in *The discovery of Hydrothermal Vents, 25 Anniversary*, WHOI, 2002).

Role of the IOC for development of the Decade

Through a group of experts IOC had prepared a General Framework for the Study of the World Ocean (GSF) published in 1965 with a final version in *Perspectives in Oceanography* published in 1968 (IOC Technical Series, 6). The approach was purely scientific and discipline oriented. The broader perspectives of ocean studies for understanding and use of the ocean were specified in a

*Comprehensive outline of the scope of the Long-term and Expanded Programme of Ocean Exploration and Research (LEPOR) published in 1970 ([IOC Technical Series, 7](#)). This was based on the study *Global Ocean Research* (the PONZA Report) of 1969. Subsequently the Group of Experts on Long-term Scientific Policy and Planning included specifications of a set of scientific exercises and multi-national experiments, with corresponding oceanographic services and a strong component of Training, Education and Mutual Assistance in the Marine Sciences (TEMA). The purpose of LEPOR was “to increase knowledge of the ocean, its contents and the contents of its subsoil, and its interfaces with the land, the atmosphere and the ocean floor, and to improve understanding of processes operating in or affecting the marine environment, with the goal of enhanced utilization of the ocean and its resources for the benefit of Mankind” (e.g. IOC-XIII/8 Annex 3, 1985).*

The IOC decided to begin the implementation of LEPOR through an initial ten-year programme to accelerate the acquisition of scientific knowledge of the ocean and improve the capacity of all Member States to participate in oceanographic research through the IDOE scheduled for 1971-1980. Member States were encouraged to participate in the IDOE and to move from individual, uncoordinated efforts to probe the ocean to new levels of scientific enterprise based on systematic planning and multidisciplinary approaches to the whole system. Several criteria were specified for the potential projects of the IDOE. These included “*Does the research require increased emphasis because of economic potential of the resources or ocean use, or the urgency of human need to which it relates?*” The individual programmes or projects were proposed by Member States or groups thereof, taking into account the criteria. In order to stimulate and facilitate active participation, the IOC organized a series of regional workshops. On the basis of the proposals, the IDOE programme came to focus on four main areas: environmental forecasting and major physical processes; environmental quality including baseline studies of several contaminants such as DDT, PCB, heavy metals; sea-bed assessment addressing plate tectonics, continental margins and non-living resources; living resources, assessments and ecology, e.g. of coastal upwelling systems. A coherent approach was emphasized. The programme structure was supposed to be discipline-oriented including, e.g. geology-geophysics, physics, biology, and geochemistry. It would include representative projects of scientific and engineering interest, with consideration of major uses of the ocean and the benefit from the proposed investigations.

The regional cooperative studies previously initiated by Member States and IOC continued but were not seen as part of the IDOE programme. However, there is no doubt that they stimulated participation in the IDOE and helped elucidate the linkages between the regional and global processes and conditions. Several regional subsidiary bodies of the IOC were launched during the 1971-80 decade. The IDOE was used at national level also to develop and raise support for sub-regional cooperative studies involving several Member States. These studies were thought to continue over several years and stimulate further cooperation and data exchange between scientists and institutions together with national coordination. The development of sustained ocean observations was gradually initiated with the Integrated Global Ocean Services System (IGOSS) in cooperation between IOC and several agencies, in particular members of the Inter-secretariat Committee on Scientific Programmes Relating to Oceanography (ICSPRO).

### Some results of the IDOE

The efforts, spirit and opportunities of the IDOE raised considerable support from governments for ocean research and observations, stimulated much interest in the ocean and the marine environment, the marine resources and their use and management. One of the major discoveries was that of the deep sea hydrothermal vents with their exceptional ecosystems. The example demonstrated the limits of our mapping and knowledge about the ocean floor. Although somewhat improved and extended, our quantification of processes at the water-sediment interface and the mapping of the ocean floor are not satisfactory and far from complete, even now, at the beginning of the Third Millennium. The large role of the ocean for the human environment and health was furthermore brought out at the UN Conference on the Human Environment, Stockholm 1972. During the IDOE the negotiations for the law of the sea were initiated and almost completed with signature

in 1982. The research during the IDOE also triggered and stimulated support for several large scale global ocean research programmes becoming parts of the World Climate Research Programme and International Geosphere-Biosphere Programme, as well as studies of marine pollution including biological effects, interaction between physical, chemical and biological processes. Sustained observations, monitoring and warning systems attracted increasing attention, including for seawater and sea food contamination, and algal blooms. The international reviews of the health of the ocean by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) were initiated, with the first one completed in 1982. At the end of the Decade in June 1981 the IOC requested its advisory bodies to make a study of “expected major trends in ocean research up to the year 2000” (UNESCO, 1984).

### Subsequent related developments

The last two decades of the Century saw the development of the Sustainable Development paradigm, the UN Conference on Environment and Development, Rio 1992, resulting in the Rio Declaration, Agenda 21, and conventions on climate change and biological diversity, and several follow-up meetings, including on intergovernmental programmes regarding Small Island Developing States, control of land-based sources of marine pollution and addressing risk reduction. The Law of the Sea entered into force in November 1994. Chapter 17 of Agenda 21 specifies the programme for conservation and management of resources for development with respect to “*protection of the oceans, all kinds of seas and coastal areas and the protection, rational use and development of their living resources.*” This inherently extends the Law of the Sea to coastal seas and semi-enclosed seas. Thus the notion of treating the ocean as a whole specified in the Law of the Sea is met. The interest for ocean development was noted by the end of the century through the work and release of the report of the Independent World Commission on the Oceans, chaired by Mário Soares, and the International Year of the Ocean 1998. The results of the third assessment of ocean sciences conducted jointly by IOC, SCOR and SCOPE (of ICSU), with the purpose of identifying opportunities provided by new knowledge and technologies as well as identifying gaps, were released with the title *Oceans 2020: Science, Trends and the Challenge of Sustainability* (Field et al, 2002). The Law of the Sea does not cover the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction. The development of a legally binding agreement under UNCLOS to meet this need has been initiated during 2015-2016.

In the new Millennium, the global framework of international agreements was further developed in 2012 through the Outcome Document of the Sustainable Development Conference Rio+20; the Small Island Developing States SAMOA Pathway of 2014; the Sendai Pathway for Risk Reduction of the 3rd UN Risk Reduction Conference in 2015; the results of the UNFCCC-COP 21 in Paris 2015, in addition to the new Sustainable Development Goals and the 2030 Agenda.

### Current economic and social significance

The implementation of all these international legal instruments and agreements requires large efforts at national level with coordinated and cohesive programmes responding to the specific national needs, as well as to the regional and global requirements. There is therefore a strong need to strengthen the dialogue, interaction, cooperation and coordination between institutions and sectors at national and international level, as well as between scientific disciplines, ocean observations and services. This aspect is particularly important for the ocean. Although some frameworks have been agreed, for instance with respect to sustained ocean observations, data and information exchange and capacity building and development, more needs to be done, including in economic terms. The growing pressure on the planet seems to further motivate coherent, consistent and cooperative efforts towards more complete understanding, knowledge and mapping of conditions and inventories of the ocean, including the sea floor and interactions between the subsoil and the ocean. The pressure and concerns furthermore emphasize the need for scientists and policy makers to work together.

The ocean is a key compartment of our common heritage and an important part of many cultures. Coastal States around the world, in particular Small Island Developing States, are striving to protect and valorise their marine resources. The development of science-based and integrated management frameworks such as Marine Spatial Planning, Integrated Coastal Area (Zone) Management, Marine Protected Areas and Large Marine Ecosystems become a prerequisite to ensure sustainable economic activities, and help ensuring long-term protection of ocean ecosystems. The globalization requires safe international communication systems, very much depending upon cables on the ocean floor linking the continents together. Dimensions of a blue economy need ensure a fair and sustainable development of marine resources, including development of blue carbon markets, protection and restoration of ocean ecosystems, more use of renewable energy and deep sea resources from the ocean, recycling of pollutants to prevent them reaching the ocean, provision of uncontaminated water for desalination, improving current fisheries and aquaculture management regimes. However, although the linkages and interactions are recognized, and that the ocean should be treated as a whole, the ocean governance and management are still very fragmented.

Investments in sustained ocean observations, ocean services and marine science provide major returns through early warning systems for extreme events and tsunamis, through development of marine technology, infrastructure and associated protection measures, sustainable use of marine living resources and support of aquaculture, offshore mineral and fossil fuel extraction, development of renewable energy sources, tourism and recreation, marine transportation, and improved basis for marine conservation and ecosystem protection; the healthier and more resilient the ocean is, the more positive is its contribution to the environmental, social and economic dimensions of sustainable development. All nations therefore have an interest in a healthy and resilient ocean and preserving its capacity to deliver food, income, support transportation and many other elements of sustainable development, including support of human development and survival.

#### Multiple stressors and goals: reflections on progress of implementation

The issues and impacts are interlinked which underlines the necessity of considering not only the maximum global warming but several combined targets as set out in the SDGs, and adopt a holistic approach in evaluating the life-support system and mitigation of changes of the whole system. This reflects the realization in UNCLOS of the need to consider the ocean as a whole. The approach is reflected in the chapters of the Law of the Sea. Besides specifying the delimitations of different zones, the Law includes rules regarding the conservation and management of the living resources of the high seas, concerning protection and preservation of the marine environment, with respect to conduct of marine scientific research, development and transfer of marine technology, including the option of establishing regional marine scientific and technical research centres, and settlements of disputes.

In 1992, a matching approach is adopted in Agenda 21, chapter 17, which provides *“the international basis on which to pursue the protection and sustainable development of the marine and coastal environment and its resources, requiring approaches that are integrated in content and are precautionary and anticipating in ambit”*, specified in the seven programmes as follows: marine environmental protection; sustainable use and conservation of marine living resources in the high seas; sustainable use and conservation of marine living resources under national jurisdiction; addressing critical uncertainties for management of the marine environment and climate change; strengthening international, including regional, cooperation and coordination; sustainable development of small islands. The Chapter highlights the programme areas in form of basis for actions, objectives, activities together with data, information, scientific and technical needs, human resource developments and capacity building.

The inter-agency analysis *Blueprint for Ocean and Coastal Sustainability* (IOC/UNESCO, IMO, FAO, UNDP, 2011) provided a context for *“Rio+20 discussions through analysis of current challenges in ocean and coastal management around the world, assessment of how well the multiple goals and objectives of previous international efforts have been met”*. The analysis of the importance

of the ocean for global sustainability, the contribution of ocean sectors to the green economy and the status of the international oceans commitments from Rio 1992 and Johannesburg 2002 with progress and gaps defined a way forward towards sustainability of ocean societies. Four overall objectives were specified with actions aiming at: reduction of stressors and maintaining or restoring the structure and function of marine ecosystems for equitable and sustainable use of marine resources and ecosystems; supporting the Green Economy concept leading to alleviation of poverty and promotion of sustainable ocean sectors and livelihoods; policy, legal and institutional reforms for effective ocean governance; supporting marine research, monitoring and evaluation, technology and capacity transfer to improve knowledge, address emerging issues, develop capacities for sustainable use of the ocean.

The “Blueprint” noted several areas of progress, for instance as regards development of sustained global ocean observations; establishment of ecosystem based, integrated ocean and coastal management approaches through the Large Marine Ecosystem programmes; global agreement on the integrated coastal management concept and implementation of several such programmes with up-scaling towards regional level; other progress concerns certain aspects of fisheries management, of dealing with invasive species, of implementing ecosystem approach to fisheries and aquaculture; and obtaining a global assessment of the state of the marine environment. A number of gaps were also identified such as: the insufficient commitment to maintain or restore depleted fish stocks to levels that can produce maximum sustainable yield; the very limited progress towards implementation of an ecosystem approach; the marine pollution from land-based sources remaining a serious problem, reflected in continued growth of hypoxia; as well as commitments on biodiversity and Marine Protected Areas that are far from being reached. Emerging issues which hamper progress include: a failure to build the open ocean component of global ocean observations; increasing nutrient over-enrichment and eutrophication; continuing threats to coral reefs, from ocean acidification, warming, pollution, habitat loss and invasive species; marine debris effecting human health, biodiversity and shipping; need for greater protection of marine biodiversity; and lack of systematic environmental data exchange across nations and the international community. The *Blueprint* concludes that overall progress in implementation of the international agreements has been slow. Much of this is considered to be “*due to alternative political priorities, insufficient institutional capacity or inappropriate institutions, market distortions, incomplete science, lack of financing, and/or willingness to participate*”. Since the analysis in the *Blueprint*, further progress has been made in relation to the global assessment of the marine environment and of the transboundary waters assessment. This provides a more complete global evaluation of the state of the changing conditions of the water systems, to a great extent on basis of the results from the Large Marine Ecosystem programme.

One way to overcome some of the barriers to implementation of agreements and to achieve the objectives of sustainability may be to focus on a regional programme which includes priorities of all the rim States and their governments. This can stimulate interest and help ensure benefits to all participants. Since its beginning in 1961, the IOC has, in cooperation with SCOR, built and supported implementation of regional research and exchange programmes which have stimulated actions at national and local level, as well as radiated into global programmes and networks. The programmes have also motivated the governments to establish regional bodies - subsidiaries to the IOC global governance. The initial regional programme was the International Indian Ocean Expedition (IIOE) 1965-1970. The most recent one is a renewal of this, IIOE-2 (2015-2020), the development of which may provide basis for the further conceptualization of an international decade for the world ocean. The mission of the Second Indian Ocean exercise is “*to advance the understanding of the Indian Ocean to enable informed decisions in support of sustainable development and well-being of humankind*”. Six over-arching science themes have been specified: human impacts; boundary current dynamics, upwelling variability and ecosystem impacts; monsoon variability and ecosystem response; circulation, climate variability and change; extreme events and their impacts on ecosystems and human populations; unique geological, physical, biogeochemical and ecological features of the Indian Ocean (IPC, 2015). These themes put focus on obtaining a more complete understanding of the Indian Ocean, as stated in the mission, but also emphasize integrating the role of the ecosystem.



### Achieving sustainable ocean development

The challenges associated with sustainable development, protection and proper government and management of the ocean in accordance with the Law of the Sea, UNCED Agenda 21, and other related agreements are well recognized also in the Sustainable Development Goals. From the Stockholm Conference 1972 onwards an understanding has emerged that the ocean is finite, with finite resources which we are depleting, and that we are influencing its conditions and ecosystem, while, at the same time, sustainable development, human health, livelihoods and well-being, including brain development depending upon marine food, all require a healthy and life-supporting ocean.

Shipping and goods transport across the ocean are necessary parts of the society, as is well known, and so is the international communication system. It is perhaps not so well known that the internet communication system is highly dependent upon submarine cables, a very important peaceful use of the ocean floor, the cabling industries and the security of the cables. Many of these cables are and can likely be used more for ocean observations. Another peaceful use of the ocean water is the increasing desalination production of fresh water.

Climate change impacts on the ocean will have profound implications for all human societies and most of our activities. In view of this insight, social sciences have a large role to play through research and observations, not only of the ocean and its resources, but also of the human development. The research, technologies, sustained observations and dynamic modelling capabilities as well as the capacities to utilize these elements at national, regional and global level have been sufficiently developed to make an effort in form of an International Decade as a unifying approach to support the implementation of the 2030 Agenda, both feasible and rewarding. The First Global Integrated Marine Assessment (the World Ocean Assessment), was completed in 2015. It cannot be summarized here but it is essential to note that it stressed the need for urgent action, including addressing the problem of multiple cumulative stressors impacting the ocean conditions.

### An International Decade of Ocean Science for Sustainable Development and the role of IOC

Ocean research and observation activities are covering a wide range of interests, sectors, users and uses, disciplines, transfer of technology, skills and technology development, industrial developments and now - biotechnology of potentially very large significance. All of these activities are of great socio-economic importance, and the goal to ensure that benefits are shared in a fair way is one of the foundations of UNCLOS. Observations of the ocean and coastal seas so far largely rest on the scientific communities involving several disciplines and institutions. Nevertheless, a gradual shift in the methods of observing the ocean is underway from exploration to a more sustained nature with the aim to provide ocean services, possibly eventually matching the meteorological weather services.

The statutory role of the IOC is to promote coordination and cooperation in ocean research, services and capacity building. Since 1960 the number of institutions and other organizations having the marine environment or parts thereof in their sphere of interest has increased at least by an order of magnitude, probably by two. This is reflected in the number of marine scientists, research and education institutions and significant infrastructure investments for ocean observations. These show the move of ocean sciences from exploration by means of research vessels to permanent establishments of large distributed facilities, as noted in (Field et al., 2002). The situation confirms the large current interest in the ocean and its resources as well as the need for the IOC, also highlighted in the increase of Membership from 40 in 1960 to 148 in 2016, representing respectively 45 % and 75 % of all independent States, but still not including all signatories to UNCLOS. The diversity of interests including the fast growing development of ocean economy, the fragmented, essentially sector-oriented management despite UNCLOS, and the Sustainable Development Goals of the 2030 Agenda call for a unifying proposal for mobilizing over a time period new government and industrial resources in support of marine science, its applications and links to policy making, sustained observations and services with related capacity development and technology transfer in

order to meet the goal of sustainable ocean development. The experiences from the International Decade for Ocean Exploration 1971-1980, and the International Year of the Ocean 1998 show that they stimulated much support for ocean-related activities at local, national and global level, in governments, the public, civil society and scientific communities. The national governments were willing to provide additional resources for research and infrastructure, while local governments supported local awareness creating actions.

In view of such experiences together with the present issues concerning the ocean conditions, an international decade of ocean science for sustainable development is proposed for maintaining the ocean we need for the future we want. The concept and the plan for the decade, to be launched around 2020-2021, preferably under the auspices of the United Nations, need to be developed and resourced for its planning and implementation. The IOC as the intergovernmental ocean science body is committed to lead the initial efforts to pursue the idea further.

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