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for Sustainable Development

Summary Report of the First Global Planning Meeting: UN Decade of Ocean Science for Sustainable Development

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The UN Decade of Ocean Science for Sustainable Development provides a once-in-a-lifetime opportunity to focus international efforts at the science-policy interface to reverse the cycle of decline in ocean health and to improve conditions for sustainable development of the ocean. The Decade will generate the scientific knowledge, underpinning infrastructures and partnerships needed to inform policies in support of all sustainable development goals of the 2030 Agenda.

Achieving the goals of the Decade will require a conscious adoption and promotion of a new ocean narrative that acknowledges that challenges are unprecedented and complex but not insurmountable, and that new science – carried out through new partnerships and taking advantage of advances in technology and innovation – will be able to address these challenges.

The Decade is not a UN research programme, but will provide an internationally-agreed framework of research priorities for sustainable development and encourage the scientific community, policy-makers, the private sector, and civil society to contribute to meeting ocean sustainable development goals. An important element of the Decade process will be to invite contributions from the science community to build the portfolio of activities in support of the Decade agenda.

The outputs of the first Global Planning Meeting for the Decade will inform the preparation phase of the Decade and the development of the implementation and resource mobilization plan. This paper summarizes the priority issues for programme development expressed by the participants, knowledge gaps in how to address the societal goals, and recommended activities for the way forward.

A list of acronyms used in this report is given in Annex I at the end of this document. A full report of the meeting is available at:

http://www.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=24807

Important Issues for Decade Development

Over the three days of meetings, working groups identified scientific knowledge gaps and research priorities for the 6 societal goals of the Decade. These are listed in the Working Group Report sections below. In working group and plenary sessions, other non-research issues were identified that provide global guidance about what will be most important for the success of the Decade:

It is critical to keep the central mission of the Decade in mind at all times: Ocean Science for Sustainable Development, not just ocean science.

Addressing sustainable development issues will require interdisciplinary and trans-disciplinary approaches with a broad range of stakeholders, with a critical need for the social sciences to be included in the early design of the programme and in every societal area.

If the Decade does not lead to significant capacity development, particularly for Small Island Developing States (SIDS) and Least Developed Countries (LDC), it will be a failure.

The Decade must make Ocean Literacy a priority, for youth, the general public, policy makers and business sectors. The Decade should create an “Ocean Generation” of informed citizens.

The Observing System is currently unsustainable. The success of the Decade and its legacy depend on making the observing system sustainable, both in infrastructure and financial support.

New technology and innovations are needed for every aspect of Decade science: data sharing and management, observing systems, measurement techniques, communication and visualisation, pollution mitigation, citizen science technologies, and capacity development.

The Decade must lead to a data sharing revolution. The Decade must develop guidelines for implementation, access, and sharing to make data FAIR – Findable, Accessible, Interoperable, and Reusable. The Decade should establish an ethical compact for data sharing to encourage timely data release and open sharing.

New partnerships with other stakeholders, particularly the Blue Economy sector and the Insurance sector, will be essential to meet the goals of the Decade, both in terms of developing the science needed for sustainable use of the ocean and its resources, and in terms of partnerships for augmenting observing systems and data sharing from private sector platforms (merchant ships, oil and gas platforms, fishing fleets, wind farms, submarine cables, aquaculture infrastructure, exploration platforms, etc.), and increasing data streams, financing, and outreach.

Young professionals, who represent the generation that will do the work of the Decade and carry on its legacy, must be involved in the design of the Decade.

Working Group 1. A Clean Ocean

Knowledge gaps and research priorities

There must be an emphasis on controlling sources of pollution rather than cleaning. Research priorities include: 1) identifying primary sources of pollution, 2) identifying pathways and fates of pollution, 3) determining ways of eliminating, reducing, or mitigating effects of pollution. The development of regional agreements and initiatives on sources, sinks, and types of wastes in all countries must be a priority.

What does ‘clean’ mean? What is ‘clean enough’? Recognizing that the ocean will never be pristine, the Group agreed that a ‘clean’ ocean is an ocean where inputs of all contaminants and pollutants are minimised and do not have adverse effects on physical, chemical and biological processes, ecosystem functions and ecosystem services. It is important to know the acceptable level of pollution, set threshold values, define ecological boundaries and tolerance levels for an ocean that is ‘clean enough.’ For setting threshold values, there is a lack of baselines and of measurable targets. Ecological boundaries need to be defined. The levels of pollutants that would limit optimal functioning of the ecosystems needs to be understood and defined. Understanding and calculating the half-life of pollutants in the marine environment and rates of ocean bio-degradation is needed.

Links between pollution, ecosystem impacts, and human health impacts. Research needs include: 1) accurate long-term impacts of pollutants on ecosystems, 2) effects of pollutants on seagrass / ecosystems, 3) cumulative impacts of contaminants (all types) on the biology, 4) quantifying impacts, 5) impacts of nano-plastics on the food chain, 6) effects and implications of underwater noise and its effects on reproduction and healthy ecosystems, 7) effects of deep-sea mining on the ocean health, 8) effects of plastic pollution on coastal communities globally, 9) overall population effects / mortality of marine fauna from plastic ingestion and entanglement, 10) effects of plastics through the ecosystem and impacts on health of communities, and 11) How cultural heritage is impacted by different forms of pollution.

Climate change impacts and cumulative stressors. Research needs include: 1) prediction of new forms of pollution as a consequence of sea-level rise; 2) how rising sea level and acidification will change ocean chemistry; 3) how climate change will impact the toxicity or degradation of pollutants.

Traditional and Local Knowledge. Identify complementary knowledge holders (local and indigenous) and local ocean users who can help advance research and develop solutions.

Recommendations for Activities in Support of the Decade

The Decade, working with UN Oceans, should promote the development of a global contaminants database containing information on essential ocean pollution elements including threshold values (particularly of use for SIDS) building on the experience and achievements of GOOS. This should be considered as a new Decade R&D priority area.

Encourage and enable scientists in pollution-related Decade programmes to spend 10% of their time committed to communication and outreach about pollution issues.

Provide information needed to increase the social and political willingness and ability to define pollution issues and respond, such as developing a cost-benefit analysis of reducing pollution. Provide guidance to local authorities and the private sector to improve waste and wastewater treatment facilities.

Demonstrate measurable impacts of pollution on ecosystem and human health.

Make legislation stronger for plastic producers; for example, advocate for 30% recycled plastic in new products, and make sure that new packaging materials can be recycled.

Carry out a horizon-scan for future pollution issues in collaboration with Blue Economy sectors. Also investigate impacts from legacy pollution (ship wrecks, etc.) and its effects on local ecosystem health.

Establish partnerships between local research institutions and citizen science programmes to develop protocols and use technology that permits citizens to make high-quality measurements and become valued partners in ocean observations.

The Decade should provide the scientific and technical support needed to develop cleaning solutions, including innovative ways to remove plastic pollution from the ocean and determining what levels of pollution are acceptably safe.

Working Group 2. A Healthy and Resilient Ocean

Knowledge gaps and research priorities

Defining ‘restoration’. There is no common understanding or definition of ‘ocean health’, ‘resilience’, or ‘ecological restoration’. Restoration gives a sense of turning back, but only systems and functions can be restored, and restoration to some past state may not be possible in the face of climate and other global environmental change. A scientific understanding of the future ocean we want is needed with clear definitions of what is possible and acceptable.

Structure and function of the ecosystem in the mesopelagic zone. Ocean health and resilience hinge on ecological knowledge, and basic baseline science is missing in many areas of the ocean, particularly ecosystem structure and function in the mesopelagic zone. What is the role of biodiversity in ecosystem function and services?

Interdependency between ecosystems. Research is needed to understand and model the interdependence among ecosystems, particularly the connecting role of mesopelagic zone, deep sea, and the open ocean.

There is also the issue of continuity in environments, where what happens upstream can be as important as what happens *in situ*, and land effects have impacts on ocean systems.

Ecosystem effects of Impacts. Ocean ecosystems will face increasing pressures from climate change (sea level rise, acidification, warming, eutrophication), the Blue Economy, and geoengineering. How will impacts such as fishing or mining impact ecosystem structure and function, particularly in the mesopelagic and deep sea? Transformative science is required to understand the new and cumulative impacts that could be associated with these emerging pressures. There is a need for a breakthrough in the science of ocean social-ecological complexity.

Essential Ocean Variables and sampling issues. Essential ocean variables that measure progress to ecosystem outcomes for societal outcomes must be identified. The goal is to be able to predict distributions and patterns, and research is needed to determine how to sample and map to achieve this. To predict changes, there are still many unanswered questions about the response value of perturbations and vulnerability.

Modelling abrupt changes and phase shifts. A major question is how to measure and model abrupt changes in ecosystem state, both systems and forcings.

Modeling the Impacts of Unknown Stresses on Ecosystems. There are many new pressures that ocean ecosystems will face, including several for which scientists have no experience or the full science required to address them, such as rapid global change, the Blue Economy and avoiding a “blue gold rush,” or geoengineering. Transformative science is required to understand the new and cumulative impacts that could be associated with these emerging pressures.

Recommendations for Activities in Support of the Decade

Monitor and evaluate policy actions by carrying out an assessment / evaluation of the effects of policy measures aimed at restoration and management. This should improve understanding of the ecological trade-offs associated with different policy actions and sustainable development pathways, the impact of poor decisions, and behaviour changes. Determine if Marine Protected Areas (MPA) and networks of MPAs are effective at doing what they were established to do. MPAs must have vertical as well as horizontal spatial integration so that migrating species are protected throughout their range.

Create more inter-disciplinary and trans-disciplinary interactions. Trans-disciplinary and multi-disciplinary interactions are needed to articulate questions, not just to inform existing research. Ocean science must include social sciences (plural), humanities, arts, and other disciplines, such as engineering. For the use of social science and wider knowledge, including local and traditional ecological knowledge, NGOs can help.

Barriers to scientific collaboration must be overcome. Scientific competition is a barrier. Preconceived ideas in all sectors must be avoided, including research. There are problems of engagement: how do people engage in science if they aren't scientists, or in policy if they aren't policymakers? And if there are too many overlapping entities that require engagement, it can push developing countries out because of financial and capacity constraints. Behavior change is a key area to understand.

Working Group 3. A Predicted Ocean

Knowledge gaps and research priorities

Scientific underpinning for prediction. ‘Prediction’ encompasses ‘understood’; it is not possible to provide prediction services and pathway-relevant advice without better scientific understanding of ocean

ecosystems. There are particular observation gaps in the Southern Hemisphere, Arctic, and for mid-and-deep water ecological processes, and there is a need for new technological innovations in sensor development.

The deep ocean. There are many deep ocean knowledge gaps, including its role in climate, climate variation impacts on carbon cycling and organic matter fates, deep ocean responses to cumulative human impact, and ecosystem function and services, and adaptive capacity. The deep ocean is now used for extraction of resources, fish, energy, oil and gas, minerals, and genetic resources, and is a major repository of debris, contaminants, and carbon dioxide, and is considered in many geoengineering schemes. A major goal of the Decade should be to increase knowledge about the deep ocean sufficiently to address how the deep ocean is responding to climate change, how processes of the deep ocean are connected to surface and coastal processes, what lives there (biodiversity), and how deep ocean systems are responding to resource extraction.

Science to support management of high-seas areas beyond national jurisdiction. Nearly 50% of the planet is in areas beyond national jurisdiction. The negotiation process for management of the high-seas areas beyond national jurisdiction has begun, but agreements must be informed by science, not individual legal arguments of individual nations protecting their interests.

Observations for weather and climate forecasts. Increased use of ocean observations to extend time horizons of weather and climate forecasts will drive requirements for higher resolution observations in the upper ocean, better understanding of diurnal variability, air-sea fluxes, and atmosphere-thermocline feedbacks.

Connecting users to an ocean prediction system. Research is needed to design and develop a platform to identify and engage users and link them to the ocean knowledge and forecasts most important for them for sustainable development and operational applications.

Monitoring and evaluation of observation and data services. Develop methods to understand and identify how to measure 'success' (the Global Ocean Science Report provides one baseline) and foster partnerships in a joint way to ensure that data and forecasts can be used locally, as well as contribute to a global system, with a focus on increasing the capacity to monitor coastal waters for local benefit. Data needs of the Blue Economy or private sectors must be better understood, including, for example, data necessary to calculate risk and changes in ocean services due to climate change, or the extent to which climate change may impact resources, livelihoods, hunger, poverty, jobs, or equality.

Modelling. More research is needed on coupling models; e.g., wave, tide, circulation; coupling with the atmosphere; coupling physical and biological models. These should be seamless but with a focus on particular timescales, including short timescales for hazard warning and operational services, and seasonal to decadal-to-centennial.

Indicators for Societal Outcomes. Research is needed to develop indicators that go beyond the technical outputs of models to include measures of habitat loss, fisheries yields, and other societally-relevant indicators that inform policy. Developing scenarios could be a major effort that combines observations of physics, chemistry, biology and humans, models, and truly serves sustainable development challenges.

Recommendations for Activities in Support of the Decade

Design and develop a platform to build partnerships to ensure that the observing system is responsive and fit for purpose, is improving delivery, supporting technological innovation in observations, and observing human impacts.

Increase observations of ocean biology and ecosystem data sufficiently to evaluate the indicators of Sustainable Development Goals (SDG). For SDG-14 on oceans, only 2 of the 9 indicators have sufficient data to measure global progress, and 4 of 9 oceans indicators still have no agreed global methodology.

Establish partnerships with Blue Economy sectors to make use of private sector observing platforms for the observing system, particularly for bathymetric data and mapping activities.

Ensure that the deep ocean is mainstreamed into discussions across all of the societal benefit areas, not just A Predicted Ocean.

Develop indicators that include measures of habitat loss, fisheries yields, and other societally-relevant indicators. Developing scenarios that combine observations of physics, chemistry, biology and humans, models, and truly serves sustainable development challenges.

Encourage a large-scale ecosystem model intercomparison project to improve our predictive ability and the development of model ensembles.

Working Group 4. A Safe Ocean

Knowledge gaps and research priorities

The relationship between human health and ocean health. What polluting chemicals are in the ocean and what are the human health and environment implications? What are the toxicological implications of micro and nano plastics in seafood?

Impact-based forecasting. Impact-based forecasting – connecting hazards to impacts and forecasting impacts rather than ocean state – represents a major knowledge gap, especially with multiple stressors associated with the triple threat of warming, acidification, and loss of oxygen. These impacts affect not only marine life but also human well-being. Connecting hazards and impacts will require a multi-disciplinary approach, including social sciences, and including other stakeholders such as the insurance sector.

Harmful Algal Bloom (HAB) prediction and warning system. A global HAB observation and prediction system is needed, divided into regional systems, and making best use of coastal GOOS infrastructure. Development of automated *in situ* observing systems is needed (imaging systems, molecular tools, etc.) as well as remote sensing of ocean colour for detecting high biomass HAB. A HAB warning system for the public and aquaculture industry requires a combination of observations and modelling the advection of HABs.

Data availability. More data are needed to support accurate, real-time ocean hazard detection, forecast, warning and responses, including baseline data (scope and scaled to match hazard), real-time dynamic data, and data to improve models for tropical cyclones, hurricanes, and all extreme weather events. Enhanced machine computational abilities for Multi-Hazard Early Warning Systems (MHEWS) are also needed.

Focus on increasing hazards in Polar regions. Polar regions are areas of rapid change, where ice is melting and the ecosystem is changing. A better understanding of toxic food sources from heavy metal pollution and POPs is also needed for this region. Work with the Stockholm Convention to create an ocean focus for POPs. Research on changes, impacts, and adaptation strategies are needed for food security and impacts from Blue Economy sectors that may put increasing pressures on polar environments.

Recommendations for Activities in Support of the Decade

Develop partnerships with the private sector, non-governmental organizations (NGO), and industry to increase ocean observations and data sharing from industry platforms that can be used to support hazard identification and forecasting, particularly seismic data for tsunami warnings. The Decade can help to mobilize the deployment of instruments for the deep ocean and to make use of the fiber optic cables already in place that could be used for earthquake detection without new instrumentation. New partnerships with the private sector should be a priority.

Develop mechanisms to encourage investments and partnerships to support emergency warning system infrastructure and data provision. Create a data-pool of ship owners and insurance companies to develop 'safe ocean' guidelines (on-going). Engage funds such as the World Bank Pro Blue and the Green Climate Fund to develop programmes related to safety and adaptation.

The Decade, in partnership with UN Oceans, should encourage and support the revision of the international chemical standards framework. There is a continually-increasing number of Persistent Organic Pollutants (POP) being used that potentially harm the marine environment. Scientific and technical advice is needed to support international legislation in this area with a view to reversing the burden of proof to industry and also requiring industry to contribute resources towards monitoring.

Develop a global HAB observation and prediction system, divided into regional systems, and making best use of coastal GOOS infrastructure. Development of automated *in situ* observing systems is needed (imaging systems, molecular tools, etc.) as well as remote sensing of ocean colour for detecting high biomass HAB.

Working Group 5. A Sustainably Harvested Ocean

Knowledge gaps and research priorities

Links between ocean health and impacts on resources and blue economy sectors. Links must be established with biological, chemical, and solid pollutants such as plastics (see Working Group 4 issues), but there are also many questions about the impacts of ocean health on ocean resources, blue economy sectors, tourism, and human well-being.

Impacts of Blue Economy sector activities on fisheries. Fisheries science needs to go beyond traditional models that only consider impacts from fisheries activities to consider impacts from other Blue Economy sectors, such as offshore mining, energy generation, aquaculture, deep-sea minerals extraction and tourism. The complex interplay between science, policy, and socio-economic development must be better understood and used for sustainable development and social justice.

Climate change impacts on fisheries. Stock assessments currently lack basic information about impacts and multiple stressors from acidification, sea level rise, or warming. Life histories of many species are still unknown. Another important issue is how fishing influences the ecosystem structure and the ocean's ability to take up carbon.

Impacts on the seabed. How do impacts from activities such as mineral extraction, fisheries, etc., impact ecosystem health and sustainability?

Ecosystem function and sustainability at the ecosystem level. What is sustainable harvesting at the ecosystem level rather than at the species level? More research on trophic gaps is needed to better understand the inter-relationships between species. What proportion of fisheries in a given region are acceptably sustainable? How do we reverse declining trends?

Challenging biases. Current research has geographic biases (e.g., where data are collected, with gaps in the global south, for example), and taxonomic biases (e.g., Regional Fisheries Management Organizations that only conduct stock assessment for a limited number of species). There is also a need for a monitoring scheme across taxa.

Understanding the future of food production from the ocean. What is needed for food and nutrition? What is sustainable consumption? How to develop a needs-driven approach to food and nutrition: what are the needs in different regions, what are the sustainable pathways, how to integrate social and cultural considerations in pathways? Issues of human impacts, equity and social justice, improving affordable production of algae and oil as replacement for fish. Understanding issues of gender equity and indigenous fishers, informal rights and different impacts of harvesting on different communities.

Understanding trade-offs between different uses of the ocean and its resources. Where are the conflicts and synergies between ocean uses in near-shore? Comprehensive information for marine spatial planning is needed. Understanding impacts of tourism on the environment and impacts of adverse environmental impacts on tourism.

Recommendations for Activities in Support of the Decade

Develop compliance standards for fishing, with maximum sustainable yield being the threshold. Determine targets for what proportion of fisheries in a given region are acceptably sustainable.

Develop a global scale literature summary on how species distribution will change with climate change and the impact of this new distribution on fisheries activities.

Identify best-practice approaches and adopt these in access to data. Clarify what is needed in terms of data for pathways of sustainable use for each sector.

Develop an early warning system to manage risks to food sources. There are many food safety challenges, including pollution of food sources from plastics or sewage that has direct impacts on human health. The success of a warning system will also be dependent on education, cultural awareness, consumption patterns, and consumer choices.

Working Group 6: A Transparent Ocean

Knowledge gaps and research priorities

Need to clarify the science-policy interface at the national level. One of the biggest concerns is the policy disconnect and inability of nations to deal with ocean-related policy issues because of a lack of clarity. Few countries have a minister of oceans, and in many countries there are many ministries dealing with different ocean-related issues. This fragmentation is a systemic failure and policy failure in addressing ocean issues. The Decade may help with this by providing nations with a common scientific and technical programme around which various ocean-related agencies could communicate and coordinate their efforts.

Need to coordinate between United Nations (UN) agencies at the regional level. Could the Decade call on UN Oceans to coordinate efforts to compile ocean data and get all the regional centres set up as one coordinated entity? This would be a transformative change for regional actions that would eliminate duplication and make best use of financial and human resources.

The design of the Decade Data System. The data system mentioned in the Decade Roadmap still needs to be developed. It will probably be a distributed system but it should still be mentioned as a deliverable.

Some major issues to resolve include: Data control issues (nations serving their own data instead of through global systems), need to incorporate private sector data, need best practices (interoperability, QZ/QC, management plans, metadata, coding, archival and preservation, curation, best practices to be used for citizen science, etc.), computation needs (develop Platform as a Service), implications of new paradigms for data use: implications for developing nations, fostering partnerships for mutual data use, incorporating citizen science data (cultural challenges where the Decade can introduce the concept of “trusted data” and/or traceability of data and information).

Mechanisms to test and verify whether services meet societal needs. How will the Decade engage society? How do large efforts generating data ensure that they are addressing user needs? The ocean observing system was designed, the service was set up, and only then went looking for users. This needs to be reversed, but without transforming all science into application-driven science. Both data services and data products will be needed.

Ocean information as a public good. What if ocean information was understood as public good? This could be a transformative change. The observing system and ocean modeling systems are often discussed. Could there be an ocean information system that would increase engagement, sharing, visualization, and assessment of information against the societal agenda? In other fields of science, such as space programmes, there is shared access to a facility since few countries can put people into space. Particle accelerators are another example of shared facilities. What would be the equivalent for ocean observing and data platforms?

Data use, value, and access issues and knowledge gaps. By the end of the Decade a goal should be ‘no ocean datum left behind’. The research community cannot continue to spend resources and not fully use the data collected. Providing visibility is not sufficient. Data should be used, and it is necessary that all data collected through funding support are made available. The new data system should harness technology to enable new visualisations of data and models, like gaming technology, to break down barriers to access data, enable people to visualise data or move through it in new ways. It is difficult to communicate the value of data to policy makers. Environmental economics is starting to examine the value of ocean science, and this should be pursued further. The value of legacy activities and cultural values should be considered.

Support and promote the World Ocean Assessment to provide trusted advice. The scientific community should work through the UN World Ocean Assessment to provide the trusted information and advice that people will turn to as they do for the IPCC and the CBD. Some areas need more work for such assessments, such as plastics, where we don’t really know enough to produce a consensus report.

Recommendations for Activities in Support of the Decade

Develop the Decade Data System and a Code of Conduct on Data Sharing, Collection, and Management. This should be highlighted as a Decade deliverable. The ocean information system should increase engagement, data sharing, visualization, and assessment of information for societal needs. Ocean information should be viewed as a public good, and the ocean data system should be viewed as a shared international facility. Many knowledge gaps exist (see above) that must be addressed, including the development / improvement of the taxonomic data base. The Decade, working through UN Oceans, should develop a Code of Conduct on Data Sharing, Collection, and Management to encourage data sharing from both public and private sectors.

Develop a mechanism to test and verify that data products and services meet societal needs.

Harness technology to enable new visualisations of data and models, like gaming technology, to break down barriers to access data, enable people to visualise data or move through it in new ways.

The Observing System is expensive and it is important to state openly the cost of acquiring data; the value of the data need to be communicated to show the return on the investment. It is difficult to communicate the value of data to policy makers. Environmental economics is starting to examine the value of ocean science, and this should be pursued further. The value of legacy activities and cultural values should be considered.

There is a great need to better coordinate between agencies, particularly in developing countries, across NGOs, UN projects, etc. and to share data and support efficiency following the Code of Conduct on Data Sharing. The Decade should work to better connect these programmes on the regional level.

Providing access to information beyond the scientific community will mean working with communities more closely to understand their needs. It was suggested that NGOs could be a good partner as they work with many stakeholders. In addition, knowledge brokers can be important, working across disciplines, conducting participatory research, which also helps with capacity development. The Decade should help design partnership and knowledge needs, with a bottom up approach.

Cross-Cutting Actions

Capacity Development and Technology Transfer

The Decade should enhance the design and implementation of the clearing house mechanism for needs-based capacity development and technology transfer. The Intergovernmental Oceanographic Commission (IOC) is starting the development of a clearing house mechanism for the transfer of marine technology (CHM/TMT). Capacity development must be needs-driven, must acknowledge regional diversity, and the system must match offers with demands. The clearing house mechanism provides a valuable service in SIDS and LDCs, especially with programmes that work through regional nodes. However, the system needs improving and needs new tools to promote access for users to register their needs and offers. For GOOS, the clearing house mechanism is specifically needed to facilitate the brokering of technology transfer and capacity development for observations, particularly for coastal observations.

Regional level activities are particularly important for addressing pollution issues. The UN global bodies and programmes such as Food and Agriculture Organization (FAO), UNESCO/IOC, and United Nations Environment Programme (UNEP) have capacity development as an important part of their mandates. Best Practices for capacity development to address pollution issues should be developed by organizations to ensure the high quality of the training courses. Specific needs identified include: 1) training, education, scholarships, visiting programmes and supporting scientist mobility, 2) vessel and technology sharing and technology transfer, and 3) activities based on local needs and local pollution issues for capacity development by regions.

Human, infrastructural, and financial capacity is needed to increase geographic coverage in measuring 'Essential Ocean Variables' that measure progress to ecosystem outcomes for societal outcomes. The Decade should ensure that data and forecasts can be used locally, as well as contributing to a global system, with a focus on increasing the capacity to monitor coastal waters for local benefit.

For Multi-Hazard Emergency Warning Systems (MHEWS):

- Capacity development and knowledge transfer are needed at the institutional and individual level with a focus on developing public trust in emergency warnings. Ensure that hazard warnings are culturally relevant and include traditional as well as modern components in order to build trust and confidence.

- Improve public awareness of forecasts and improve capacity to deliver forecasts for National Meteorological and Hydrological Services (NMHS) at the national level.
- Evaluate lessons learned on Disaster Risk Reduction (how to do it well).
- Develop an alert system for Harmful Algal Blooms and capacity building, technology transfer, and education modules necessary to make monitoring and hazard warnings possible.
- Adapt infrastructure and strengthening national capacity and resilience in response to sea level rise.
- Technology transfer and training (software and instruments) are specifically needed for alert systems for evacuation in SIDS.
- Need a new focus on loss of life from non-extreme events at sea: statistics for Pacific Island Countries and Territories (PICT) show that more lives are lost at sea in maritime weather events that are not extreme, compared to extreme weather events and/or lives lost due to coastal hazards.

Traditional knowledge and local indigenous communities have much to offer the Decade. These communities have been addressing local environmental problems and sustainable living as part of their culture for centuries. At the same time, many ways of life in SIDS and LDCs are destructive and unsustainable, and global agendas and priorities are often not applicable to their problems. The Decade must develop a needs-based approach to capacity development, listening to local needs and priorities, and noting the local / traditional environmental knowledge and solutions that these cultures have to offer to address SDGs that could be valuable for everyone.

Developing capacity in young scientists. The role of scientists in society is evolving. Oceanographers need to be able to seek out unconventional partnerships and communicate with other scientists in other disciplines and non-scientific partners. The Decade should: (i) provide training in how to engage policy and decision makers, (ii) get more young people involved in the Decade so they can see how the strategy is developed, (iii) set up mentorship programmes for young scientists to make them better equipped for the Decade to come, and (iv) establish an early career researcher programme.

Establish a Young Professionals Programme for the Decade. It is the young professionals of today that will be embarking on international collaborations and projects, and these new partnerships need to begin as soon as possible since it will take time for young professionals from different sectors to learn each other's professional languages in fields as diverse as policy, business, science, advocacy, communication, and many other areas. A Young Professionals Programme should 1) include young professionals in the Executive Planning Group (EPG) to provide continuity and mentoring, 2) include, when possible, young professionals in meetings, with senior EPG members serving as mentors, so that the young professionals get a first-hand experience in how these processes work, and 3) build a platform to reach other young professionals and establish networks to take the Decade forward.

In partnership with UNESCO, science organizations, international and national scientific unions, and journal editors, the Decade should develop a mechanism to assist developing country scientists to get their research results published in a way that will mainstream their visibility and encourage partnerships.

Partnerships and Financing

The Global Ocean Observing System is unsustainable in its funding, infrastructure, and lack of global participation. A sustainable business model must be developed and implemented during the Decade so that a sustainable Observing System is a legacy of the Decade.

Working with the business community, the Decade should find a way to turn 'healing the ocean' into an investable proposition. The economics and the benefits of investment must be considered, which requires an ocean equity and debt proposition. Businesses will increasingly be focused on corporate responsibility and visible actions for sustainable development, and ocean science is required to provide a framework for

this accountability and to help investors make the right financial decisions, including consideration of the impacts on the global ecosystem and the human domain. The Decade should also consider the business opportunities that may exist in the major ocean sustainable development challenges, including pollution remediation and renewable energy. The UN General Assembly will be launching a set of ocean principles for the business community in September, where businesses will report on their impacts on the oceans through existing reporting regimes. Businesses recognize that investors will not support a company that harms the oceans. The successful engagement of civil society in the Decade will lead to informed citizens who put pressure on companies and industries to comply with responsible sustainable development practices. The Decade should establish a natural capital financing committee, where all projects must follow the framework of science-based ocean sustainability.

Develop a partnership with Blue Economy sectors to 1) contribute observations and data, and 2) instrument platforms to measure essential ocean variables from the vast array of non-research infrastructure (e.g., 90,000 merchant ships, 3-4 million fishing boats, 9000 operating oil and gas platforms, 1 million kilometres of submarine cables, and numerous wind farms and aquaculture farms, all representing infrastructure that can be used to gather data.) Particular emphasis should be placed on increasing observation platforms for seismic data and tsunami warnings.

Recognizing the challenges faced by traditional funding models, the Decade should engage the development, finance, and insurance communities and make the link between a safe ocean and poverty reduction or reduced risk. In particular, the insurance industry should be a valuable partner to finance studies on coastal damage and loss of life from erosion and extreme events. The Decade should liaise with the Green Climate Fund on climate change adaptation strategies.

Partnerships and improved coordination are needed among various national agencies and activities that deal with ocean sustainable development issues. All relevant agencies and programmes should work together to identify a national ocean science plan encompassing research, observations, and modelling.

The Decade will need access to information beyond the scientific community, and will need to work closely with local communities to understand their needs. NGOs should be sought as valuable partners for this engagement since they work with many stakeholders at this level, work across disciplines, conduct participatory citizen-science research, and implement capacity development activities.

The Decade should develop an education and outreach programme that would expose ocean science students to scientists and non-scientists from relevant fields working in ocean sustainable development. Learning the languages of other disciplines and how they work will be critical for young scientists implementing the Decade in new partnerships and with diverse stakeholders.

Access to Data, Information, and Knowledge

A new paradigm on data sharing is urgently needed and the Decade should develop a Code of Conduct on Data Sharing, Collection, and Management. It must advocate for non-disclosure agreements or licenses with time limits, so that data are eventually made available. It must encourage data collection and sharing from Blue Economy sectors (especially fisheries data) and from non-traditional sources such as citizen science projects. The Code of Conduct should address the ethical use of data (e.g., appropriate attribution, digital colonialism, etc.) and ensure that data are FAIR: Findable, Accessible, Interoperable, and Reusable.

The Decade, working through UN Oceans, should encourage and support the development of an internationally-agreed ocean data policy modelled on the data policy for meteorological data of WMO, where nations agree to free and unrestricted exchange of data and information, products and services on matters relating to safety and security of society, economic welfare and the protection of the environment.

One of the R&D priority areas for the Decade is the development of a Digital Atlas of the ocean. Developing such an Atlas will require finding and gaining access to a large amount of existing data not currently shared, coordinating regional mapping initiatives to eliminate duplication of effort, and making use of the many vessels working in the oceans that have the capability of making bathymetric measurements but are not doing so (e.g., while the ship is in transit between stations.) The vision for the Digital Atlas should be augmented to cover more than bathymetry and physical data. It should also map habitats and species, on the bottom and in the water column, and all the key physical, chemical, biological, geological, archaeological, and human impact variables. Basic mapping should support development of more complex products: mapping of risks, of habitat loss, of hotspots, of scenarios. While much emphasis has been put on mapping the bottom of the deep ocean, it is in the coastal zone that humans have the greatest use of and impact on the ocean. The ambition of the Decade should not be to create simply a Digital Atlas of bathymetry but rather a Digital Aquarium that allows anyone to dive and explore the ocean virtually for a better understanding and application of science.

Develop a database of ongoing activities, including a synthesis and systematic review of existing information, and curation of information, navigable data and literature, and information about the results of scientific experiments, like a medical register of drug trials. The database should include visual, geographic information of activities in the ocean.

Develop a data discovery activity, targeting the full range of data relating to human impacts on the ocean (e.g., plastics, pollution, etc.) and including data from industry and NGOs. Excellent science is being done outside traditional academic structures, notably in NGOs, and these data are often over long time series, often integrate traditional or local knowledge, and are usually user focused to drive solutions to observed problems. Such data are often not published or diffused, lack status or prestige, and are thus unavailable to a wide audience.

Give careful thought to the design of the Decade Data System. The 'portal' concept is a thing of the past and is being replaced by machine-to-machine interaction.

Encourage scientists to work with data managers in their meetings and conferences to provide the necessary information to develop ontologies to aid the semantic part of data interoperability. Use the ontology base actively to discover places where people are using terms inappropriately or inaccurately.

Foster synthesis working groups that bring science, business, policy, and civil society together in creative problem-solving spaces to address specific SDG targets and societal goals. Promote investment in synthesis centres that have the methodology and infrastructure working to support these ventures.

Citizen science has the potential to be a major paradigm shift in ocean observing during the Decade, partially solving the basic issue of unresolved time and space scales in the ocean ecosystem. Design of citizen science projects should include data management concepts from the start. For data sharing, it will be important to improve the simplicity of ways to submit and access data, and to improve global standardisation of methods of collection and data submission.

An expanded understanding of data and information must include traditional ecological knowledge, citizen science and other forms of knowledge generation. Cultural data needs to be taken into account including the use of data on historical ecological and human conditions; for example, there is millennia of historical data on how people have caused and adapted to ocean change.

In partnership with UNESCO and science journal editors, a Decade goal should be to make data from published research articles available, using approved data management standards.

Communicating the Decade

It was noted that, despite efforts made by the meeting organizers to ensure the participation of women and scientists from the southern hemisphere, the Panels were still dominated by older, white men from the global north. The Decade should redefine how high-level panels are composed; otherwise, exclusion is exacerbated in a programme whose success will depend on new global voices and partnerships. Similarly, the Decade needs to invest in working and communicating in different languages from the start of information sharing processes, including workshops and conferences. While translation is expensive, it is worth the investment in the early design stages of the Decade, especially for spoken interactions, like conference presentations.

Communicating to other audiences outside of the traditional science channels with a concrete message and shorter timelines should be a priority. The Decade should bring together scientists from other disciplines and other non-science stakeholders to look at societal goals and targets from various viewpoints and learn how to communicate between sectors and specialities, and to understand different concerns, priorities, and vocabularies.

Artists can play an important role in the Decade. Human faces have to communicate the new ocean narrative. Individual scientists and their passion can make a difference in that communication. It is also important to know who the target public is for this message and how to effectively share it. Building on existing activities such as the Artists at Sea programme, the Decade should facilitate the creation of art that makes science approachable. Artists should be included as stakeholders and communicators in the design and implementation of the Decade.

Aquariums have more than 700 million visitors per year all over the world, and, according to a recent European survey, constitute the most credible source of information on ocean for the public. The Decade should establish a long-term partnership with the aquariums of the world to communicate ocean science with the public. Decade meeting planners should invite aquarium representatives to regional and thematic planning meetings. The Decade needs to inspire a blue revolution and the aquariums of the world can help.

Archaeologists working in North and South America, Africa, Europe, Asia and Oceania attended the Copenhagen meeting, providing the core for an Ocean Decade Heritage Network that will grow in coming years to help support planning and implementation of the Decade. Cultural heritage will be at the forefront of developing the new narratives that are necessary to deliver the ocean we want.

Communications, ocean literacy, education, and outreach are needed to shift global perceptions about what it means to be “green” or concerned about the environment. By the end of the Decade, being green should be considered something that is just normal and it should be accepted that humanity is on a journey towards sustainable development as a natural part of societal evolution. Some of the most popular topics in the media are food and travel. These need a light touch, and they do not try to be persuasive because they already assume that the world is changing. The new ocean science narrative should avoid being preachy, but should instead entertain with stories linked to ocean sustainable development to shift perceptions.

Partnerships with Yacht Racing offer a unique opportunity for communication of the Decade’s goals and ocean literacy. The America’s Cup can build a stage to amplify the message of the Decade and to engage citizens and the private sector in actions that support the work of the Decade. While yacht racing is a niche sport, it is one with a strong connection to the ocean and one that can leverage business partnerships. Quoting Nelson Mandela, “Sport has the power to change the world and it speaks to youth in a language they can understand.” The next America’s Cup Race will be in Auckland in 2021, but that there will also be many preliminary regattas around the world. The yacht racing community can serve as ambassadors for ocean science and the work of the Decade.

Because communication is such an important component of the Decade, it should use professional science communicators to work with scientists to help them develop better communication and presentation skills, and the Decade should also partner early with social scientists to assist in communicating key messages and generating public trust in emergency warnings and safety advice. Communications strategies and guidelines must be developed for different audiences, especially communicating effects and pathways to politicians.

The Decade should establish a communications network built on the communications and outreach programmes of participating institutions and NGOs. NGOs such as World Wildlife Fund (WWF) could be valuable partners for communication since they have great efficiency in disseminating information to wide audiences.

In collaboration with professional communicators and social scientists, support NGOs that will develop guidelines for citizens to take when making decisions about sustainable consumption of not only food but ocean resources.

Communication with other partners and stakeholders is important, but it is also important to establish joint messages and campaigns within the Decade with regular communications with all participating programmes.

The meeting highlighted the importance of a broad Ocean Literacy campaign that will be critical to the success of the Decade. Ocean Literacy will be needed, *inter alia*, to:

- Communicate the message that protecting the oceans is good for business, particularly to Blue Economy sectors and the general public. Public health, fisheries, tourism, businesses and their global brands, and all stakeholders will benefit from cleaner oceans and the visible actions of users of the ocean to support sustainable development.
- Promote the use of science in ocean conservation and management and to facilitate the use of science in decision making. Evidence-based approaches are critical to improve understanding and to make communications more effective.
- Communicate the benefits of ocean observations and listen to the needs of different stakeholders. Messages should be developed for politicians that emphasize the economic benefit from services, and scenarios of risk and loss, and messages should be developed for businesses focused on managing risk and the added value to them of ocean and climate data.
- Spark fascination about the ocean by supporting educational programs and supplying teachers with materials, in many languages, for many age groups, with attention to empowering girls and young women. A specific Decade programme in Ocean Literacy should be developed for different target groups.

Conclusions and Way Forward

This first Global Planning Meeting was held to reach agreement among different stakeholders about what can be collectively achieved through the Decade and to better define the actions to be taken to develop the implementation plan for the Decade. A number of meetings and regional workshops will be held soon, starting with the first Decade regional workshop being held in the Pacific from 23-25 July and focusing on SIDS (organized by EPG member Jens Kruger). A second regional workshop will be held in the North Pacific at the end of July in Tokyo. The secretariat is still working to develop regional workshops for the Mediterranean, the South Atlantic, the North Atlantic, the Caribbean, the Southeast Pacific, and the Indian

Ocean and arrange consultations for the polar regions and marginal seas. While there is a great deal of effort going into the planning of these meetings, it is not always possible for all relevant actors to attend meetings, and it is therefore important to allow people to self-organize and get their ideas into the planning process. The Decade needs to cultivate parallel tracks, where different stakeholder communities organize their own meetings about the Decade. The Decade designers need to follow this up through partnership with the private sector and philanthropic organizations. The Decade also needs more direct engagement by the science community. The UN agencies need to communicate and coordinate better about the Decade programme, and this process will begin in the coming months and in partnership with regional seas organizations.

Finally, the design and coordination of the Decade requires staff and leadership, and the IOC must carefully plan how to meet this challenge without over-burdening the small secretariat. Stakeholders in the Decade and in ocean sustainable development are asked to recognize the importance of this early coordination, which requires financial support.

Annex 1. List of Acronyms used in this Report

CBD	Convention on Biological Diversity
CHM / TMT	Clearing house mechanism for the transfer of marine technology
EPG	Executive Planning Group
FAIR	Findable, Accessible, Interoperable, and Reusable
FAO	Food and Agriculture Organization
GOOS	Global Ocean Observing System
HAB	Harmful Algal Bloom
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
MHEWS	Multi-Hazard Early Warning Systems
MPA	Marine Protected Areas
MSY	Maximum sustainable yield
NGO	Non-governmental organization
NMHS	National Meteorological and Hydrological Services
POP	Persistent Organic Pollutants
SDG	Sustainable Development Goals
SIDS	Small Island Developing States
UNEP	United Nations Environment Programme
WWF	World Wildlife Fund