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IOC Strategic Plan for Oceanographic Data and Information Management (2017-2021)

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**IOC Strategic Plan for
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EXECUTIVE SUMMARY

The IOC Strategic Plan for Data and Information Management is for all data collected in IOC programmes. The **vision** is to achieve:

“A comprehensive and integrated ocean data and information system, serving the broad and diverse needs of IOC Member States, for both management and scientific use.”

The concept of delivering a data and information service for the “**global ocean commons**” (i.e. global public good) is central to this vision. The objectives of the Strategic Plan are to:

- Facilitate and promote the exchange of oceanographic data and information in compliance with the IOC Oceanographic Data Exchange Policy;
- Deliver a comprehensive distributed data system that can receive data collected by all IOC programmes and projects and deliver them in a uniform and transparent way to all users;
- Deliver a system that can collect bibliographic and factual information from all IOC programmes and projects and deliver them in a uniform and transparent way to all users; and
- Ensure alignment with, and contribution to, both the IOC’s Medium-Term Strategy for 2014-2021, and with the UN’s 2030 Agenda for sustainable development, in particular the dedicated sustainable development goal for the ocean (Conserve and sustainably use the oceans, seas and marine resources for sustainable development)

The IOC Data and Information Management System resulting from this strategy will deliver:

- Assembled, quality controlled and archived data on a diverse range of variables according to scientifically sound and well-documented standards and formats;
- Timely dissemination of data on a diverse range of variables (observations and model outputs) both on real-time and delayed modes depending on the needs of user groups and their technical capabilities (automatic dissemination as well as “on demand”); and
- Easy discovery and access to data and information on a diverse range of variables and derived products (including forecasts, alerts and warnings) by users who have a broad range of capabilities.

The IOC Data and Information System will provide seamless access to the real-time and delayed-mode oceanographic data and services **across all IOC and related programmes**, handling data from the point of collection, through processing and quality control, to archival and dissemination.

The IODE developed Ocean Data Portal (ODP), as well as other similar partner systems, will facilitate the exchange and dissemination of data and services and will be key components to deliver the objectives of the IOC Strategic Plan for Data and Information Management.

To ensure its success, the IOC Strategic Plan for Data and Information Management must achieve strong awareness, involvement, acceptance and recognition within and between IOC programmes, and with IOC partners. Efficient communication and outreach remain key elements of the Strategic Plan. Information about the Strategic Plan, its development, data

and information centres, standards, and implementation progress must be made available in an easy to understand form. By reaching out and serving user communities (scientists, policy makers, managers, educators, students, industries and businesses) will result in data and information, including derived products, being easily discoverable and accessible and can be used in the most efficient and user-friendly way.

The IOC Strategic Plan for Data and Information Management will contribute to the outputs and activities of the [IOC Capacity Development Strategy \(2015–2021\)](#). Capacity development for data and information management will incorporate the IODE OceanTeacher Learning Management System (LMS) and will promote regional collaboration through the OceanTeacher Global Academy network of Regional Training Centres. This will enable the sharing of training materials and translation into other languages and promote community building. The IODE capacity development strategy, implemented as Ocean Data and Information Networks or ODIN, also provides a cost-effective and sustainable model for capacity development at the regional level. ODINs develop networks for managing and exchanging oceanographic data and information within the regions including contributing to ocean sciences, operational oceanography development and integrated coastal management and disaster reduction programmes at the regional level. ODINs also contribute to improving the provision of oceanographic data and information products and services to different users by sharing of expertise, knowledge transfer and capacity building and aim to become useful platforms for other IOC programmes.

The major **elements** of the IOC Strategic Plan for Data and Information Management are:

- Adhere to the [IOC Oceanographic Data Exchange Policy](#);
- Ensure the long-term archival, management and services of oceanographic data and information;
- Recommended standards and best practice for management and exchange of oceanographic data;
- Acceptance and implementation of a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products;
- Discovery, access and retrieval of data from IOC programmes, as well as from programmes and organizations collaborating with IOC, through the Ocean Data Portal (ODP), OceanDocs and the Ocean Biogeographic Information System (OBIS);
- Utilize the ODIN model as the capacity building mechanism for the IOC Strategic Plan for Data and Information Management, supplementing and contributing to the IOC Capacity Development Strategy;
- Development of the IODE Quality Management Framework to ensure NODCs are able to provide quality data to meet the requirements of the IOC community;
- Provide the crucial link between data, information and the dissemination of knowledge through the management of marine information by marine librarians;
- Facilitate proper citation of datasets by providing all the required elements of a citation including a persistent identifier (an unambiguous, unchanging reference);
- Data publishing practices, access and intellectual property to publish and exchange datasets across IOC Member States, IOC sectors and other organizations; and
- Governance by an Advisory Group represented by experts nominated by the governing bodies of IOC programmes.

The activities undertaken by the IOC within the framework of oceanographic data and information management will result in a number of outputs that, through their use by Member States, should strengthen existing data and information systems to better manage the marine environment and serve user communities. A total of five expected outputs are identified that will be addressed on a long-term and sustained basis.

The greatest challenge to be faced in developing and implementing the IOC Strategic Plan for Data and Information Management is one of coordination and cooperation among Member States, partners and user communities. There are currently still major barriers to the efficient use and re-use of data, i.e. Open Data, and to overcome these, and make the best use of the new technologies available, a culture change is required. The information technology required to meet most of the requirements of the strategy, whilst challenging, can be developed from existing capabilities through relatively straightforward software engineering. But the strategy will only succeed if all participants actively use the data and metadata standards, communications protocols, software, and policies that will knit the parts into a fully integrated system.

1. OCEANOGRAPHIC DATA AND INFORMATION EXCHANGE IN THE IOC

The IOC Strategic Plan for Data and Information Management must take into account the IOC Medium-Term Strategy for 2014-2021¹, and its high-level objectives (to which IODE contributes). In addition, the United Nations 2030 Agenda for Sustainable Development², which includes a dedicated sustainable development goal for the oceans (Conserve and sustainably use the oceans, seas and marine resources for sustainable development), means that IOC needs to clearly integrate the 2030 Agenda into its core functions as defined in its Medium-Term Strategy, which in turn has implications for the data and information strategy. As part of this process, IOC is recognised by the UN as the custodian agency for two SDG 14 targets and related indicators, these relate to ocean acidification (Target 14.3) and marine scientific research (Target 14.a). Under this custodianship role, IOC will need to further develop the indicator methodology and underlying data standards for these 2 targets, before the indicators are operational and routinely measured by Member States for SDG reporting, using possibly IODE national mechanisms.

This Strategic Plan covers a wide diversity of data and information over a range of spatial and temporal scales, from operational data flows to the latest scientific research. It also covers a diverse array of Member States ranging from the highly technically developed to those that may have little infrastructure for collecting, managing and utilizing data, data products and information.

Within the context of IOC the following definitions for data and information are used:

- **Data:** consists of oceanographic observation data, derived data and gridded fields (*IOC Oceanographic Data Exchange Policy*)
- **Information:** includes factual (e.g. directories of experts) and textual (literature) information that may be the outcome or product of scientific research. (*IODE GEMIM*)

Over the history of the IOC, many ocean science and observation programmes and projects have been established. In 1961, the IOC established the IODE programme. Whereas the IODE, and especially its network of National Oceanographic Data Centres (NODCs) and (more recently) the Associated Data Units (ADUs), has assumed responsibility for the data management tasks of many national and international ocean science and observation programmes and projects, many programmes and projects have developed their own data and information management activities, often without linkages to the IODE network. In addition, other international organizations, programmes and projects have also developed data and information management programmes and activities with national, regional or global focus, often in isolation.

All programmes within IOC need a data and information management component, possibly developed within the programme but implemented in close collaboration and consultation with the IODE and its network of data and information centres, so the considerable expertise available in these national structures can be fully exploited. The IOC Strategic Plan for Data and Information Management provides the framework in which these plans can be developed, and recommends the use of standards as well as the data centres where the data can reside and be permanently archived.

¹ http://www.ioc-unesco.org/index.php?option=com_content&view=article&id=29&Itemid=81

² <https://sustainabledevelopment.un.org/post2015/transformingourworld>

The [Framework for Ocean Observing \(FOO\)](#), which has been developed as an outcome of OceanObs09, is a framework for planning an enhanced global sustained ocean observing system over the next decade, integrating new physical, biochemical, biological observations while sustaining present observations. The Framework identifies the requirements, priorities, implementation and costs for obtaining the highest-priority global ocean observations essential for both research and societal needs. The Framework encompasses a collection of processes that provide a roadmap of organization, communication, best practices, and systems engineering to foster improved interfaces and integration of ocean observing efforts into an optimal global system and endorses a concept of Essential Ocean Variables (EOVs). Data management across all IOC programmes incorporates activities discussed in the FOO and the IOC Strategic Plan for Data and Information Management will deliver an effective data management system to ensure the needs of the ocean observing community are addressed.

The task of building a global, distributed oceanographic data system is complex and requires a culture change leading to a greater level of international cooperation. Every participant will need to make changes in their present practices to conform to the larger view. But the payoff will be large and shared by all. The key to this process is **agreement on standard practices and protocols**. Starting afresh is not an option, and the current systems need to evolve into an interoperable system. New technologies and ideas will be exploited to handle and deliver data to a wide range of users or clients.

2. VISION AND OBJECTIVES

The **vision** of the IOC Strategic Plan for Data and Information Management (2017-2021) is to achieve:

“A comprehensive and integrated ocean data and information system, serving the broad and diverse needs of IOC Member States, for both management and scientific use”.

The Strategic Plan has been developed to support the IOC Vision and High-Level Objectives for 2014–2021 ([IOC Medium-Term Strategy](#)). The IOC High-Level Objectives are:

1. Healthy ocean ecosystems and sustained ecosystem services.

Developing indicators of ocean status, and locating their tipping points relative to marine ecosystem functioning, are important in the prediction or early detection of changes in ecosystem states, and in the evaluation of ecosystem resilience. Such knowledge and analytical tools will be very valuable in ocean management in general, and in placing management of single sectors into an ecosystem-based approach. The local and regional capacities, in terms of knowledge and tools, are also central for understanding how much an ecosystem can be stressed before it moves to other states from which recovery may be difficult. Current research on these topics is still piecemeal and needs coordination.

2. Effective early warning systems and preparedness for tsunamis and other ocean-related hazards.

The ultimate objective of this HLO is to reduce risk, by encouraging communities to implement effective mitigating measures and become aware of the hazards they face. As coastal development continues at a rapid pace, society is becoming increasingly vulnerable to coastal flooding and other extreme sea-level events such as tsunamis. Ensuring that nations have access to the necessary information for coastal adaptation planning and safe and secure operations in the marine environment, is dependent on continued progress in the implementation of tsunami and ocean observing systems, improvements of models of

the climate systems and ocean services and the development of local decision support tools.

3. Increased resiliency to climate change and variability and enhanced safety, efficiency and effectiveness of all ocean-based activities through scientifically-founded services, adaptation and mitigation strategies.

Climate variability and change impact many elements on which human well-being depends, modifying patterns of rainfall and drought, sea-level and coastal erosion, and through temperature changes and ocean acidification, adding stress to ecosystems and impacting on the goods and services they provide. Thus, human development goals including food security, access to water resources, and preparedness and resilience to disasters are threatened. It is known that the ocean plays a key role in climate; IOC will therefore assist its Member States in developing capacity so as to enable them to develop and improve climate impact mitigation and adaptation strategies that are based on growing scientific knowledge.

4. Enhanced knowledge of emerging ocean science issues.

A broad range of emerging environmental issues such as new contaminants, invasive species, marine renewable energies, the expansion and intensification of uses of marine resources, cumulative effects of human maritime activities, etc., jeopardize the conservation and sustainable use of marine spaces and ecosystems. It is important to improve our understanding of the opportunities and of the changes that are occurring within the Ocean, including the deep sea. The IOC's role is to encourage scientific research, technical analyses and syntheses of scientific information needed to effectively address these emerging issues, inform policy, and advance solutions in a timely and transparent manner.

The **conceptual framework of functions** required to implement IOC Medium-Term Strategy are:

- A. Foster ocean research to strengthen knowledge of ocean and coastal processes and human impacts upon them [Ocean research]
- B. Maintain, strengthen and integrate global ocean observing, data and information systems [Observing system / data management]
- C. Develop early warning systems and preparedness to mitigate the risks of tsunamis and ocean-related hazards [Early warning and services]
- D. Support assessment and information to improve the science-policy interface [Assessment and Information for policy]
- E. Enhance ocean governance through a shared knowledge base and improved regional cooperation [Sustainable management and governance]
- F. Develop the institutional capacity in all of the functions above, as a cross-cutting function [Capacity Development]

Data and information management play an important role in all these functions as illustrated in Figure 1.



Figure 1. The role of data and information management to the IOC Medium-Term Strategy

Data and information management is a crucial cross cutting and underpinning activity across a broad range of the environmental sciences. Mutual benefit is gained from cooperation and interaction across IOC programmes to ensure HLOs are met. Harmonization of this Strategy with other UN organizations and other non-IOC projects and activities is essential.

The **scope** of the IOC Strategic Plan for Data and Information Management is **comprehensive and covers all disciplines within the mandate of IOC**. All types of data and all time scales for data delivery (e.g. real-time versus delayed mode) are included. Different strategies might be employed to satisfy global, regional and local requirements, and to meet timeliness needs. We must move towards a coherent data management and information management communications strategy to enable us to integrate the wide variety of complex marine environmental measurements and observations across disciplines, institutions, and temporal and spatial scales.

The **aim** is to ensure the IOC oceanographic data and information management system is the system of choice for all ocean activities, particularly those of research programmes. It is essential that the system is built around already existing and operational national, regional, and international systems.

The **objectives** of the Strategic Plan are to:

- Facilitate and promote the exchange of oceanographic data and information in compliance with the IOC Oceanographic Data Exchange Policy;

- Deliver a comprehensive distributed data system that can receive data collected by all IOC programmes and projects and deliver them in a uniform and transparent way to all users;
- Deliver a system that can collect bibliographic and factual information from all IOC programmes and projects and deliver them in a uniform and transparent way to all users; and
- Ensure alignment with, and contribution to, both the IOC's Medium-Term Strategy for 2014-2021, and with the UN's 2030 Agenda for sustainable development, in particular the dedicated sustainable development goal for the ocean (Conserve and sustainably use the oceans, seas and marine resources for sustainable development)

The Strategic Plan addresses the requirements and needs identified within the scope of data and information management for all IOC programmes to:

- Ensure IOC Member States have the ability to comply with the terms of the IOC Oceanographic Data Exchange Policy;
- Meet the data and information needs to achieve the IOC High-Level Objectives as laid out in the IOC Medium-Term Strategy 2014-2021, and, where applicable, the UN's 2030 Agenda for Sustainable Development;
- Provide well described and accessible scientific data and information on ocean, coastal waters and ecosystems in support of integrated resource planning, management, conservation and sustainable use of marine resources;
- Support the data and information requirements for marine services, transportation, ocean forecasts, climate change and variability studies, scientific research and navigation;
- Establish and enhance cooperation within and between IOC programmes and IOC partners towards the creation of a unique data system;
- Ensure connectivity of, and encourage synergies between regional and global initiatives in data and information management; and
- Undertake marine assessments and routinely provide indices on the "health" of the marine environment;
- Support IOC's efforts related to its custodian responsibility for reporting SDG 14 indicators by providing internationally comparable data in the relevant statistical domains to the UN;
- Improve communication through coordination and cooperation among partners, user communities and other international bodies;

2.1 EXPECTED RESULTS

The Strategic Plan will deliver an IOC Data and Information System built around already existing and operational national, regional, and international systems which will be the system of choice for all ocean activities, particularly those of research programmes. The IOC Data and Information Management system will deliver:

- Support for IOC's commitment to its Member States and international organizations;
- Deliver timely access to assembled, quality controlled and archived data on a diverse range of variables according to scientifically sound and well-documented standards and formats;

- Facilitate easy and equitable discovery and access to data and information on a diverse range of variables and derived products;
- Integration of diverse datasets;
- Ensure long-term and reliable data preservation, archiving and accessibility;
- Collaboration with other organizations to ensure greater flexibility in timely and cost-effective access to data and information;
- Reliable long-term access to marine science literature representative of Member States and beyond;
- Advice and assistance in the development of information products and new information technologies;
- Promote marine science and oceanography research at the global level;
- Facilitate publishing of research findings by scientists (with special attention to scientists in developing countries); and
- More effective and enhanced communication and outreach to better serve user communities.

2.2 OUTPUTS

The activities undertaken by the IOC within the framework of oceanographic data and information management will result in a number of outputs that, through their use by Member States, should strengthen existing data and information systems to better manage the marine environment and serve user communities.

2.3 OVERVIEW OF OUTPUTS

A total of five expected outputs are identified that will be addressed on a long-term and sustained basis. In order to strengthen existing data and information systems the following requirements must be met:

- 1. Improved ability to integrate national, regional and global data systems.**
- 2. Improved capability and functionality of systems in the centres managing oceanographic data and information.**
- 3. Promote free and open access to oceanographic data and information and adherence to IOC Oceanographic Data Exchange policy.**
- 4. Address the needs of both the scientific users and society at large for the demand for access to quality data and information.**
- 5. Strengthened capacity to manage oceanographic data and information.**

These five outputs will be achieved through a number of targeted activities and related actions summarized in the table below:

Output	Activity	Action
<p>1. Improved ability to integrate regional and global data systems</p>	<p>1.1 Recommended standards and best practice for management and exchange of oceanographic data</p>	<p>1.1.1 IODE, jointly with JCOMM, to recommend standards and best practices for ocean data management and exchange. 1.1.2 Collaborate with other programmes and projects beyond IOC to develop, adapt, and adopt standards 1.1.3 Disseminate standards and best practices through the OceanBestPractices repository</p>
	<p>1.2 Use of interoperable metadata catalogues for data discovery.</p>	<p>1.2.1 Agreed common standards for metadata to facilitate data discovery and access</p>
	<p>1.3 Develop and maintain common lists of standardized terms relevant to the oceanographic community.</p>	<p>1.3.1 Utilize IODE SeaVox governance group for content management of controlled vocabularies 1.3.2 Collaborate closely with other programmes and projects developing common vocabularies</p>
	<p>1.4 Ensure delivery of quality oceanographic and related data, products and services.</p>	<p>1.4.1 Support organizational Quality Management System for the delivery of oceanographic and related data, products and services 1.4.2 Promote accreditation of IODE data centres according to agreed criteria 1.4.3 Facilitate the collection of data and metadata related to IOC SDG reporting responsibility, and subsequent delivery to global UN SDG reporting mechanism 1.4.4 Provide an interface between data providers and user communities for ocean data and information products related to climate, operational services and ocean health</p>
<p>2. Improved capability and functionality of systems in the centres managing oceanographic data and information</p>	<p>2.1 Strengthen the IODE network of National Oceanographic Data Centres (NODCs), Marine Science Libraries, Associate Data Unit (ADU), OBIS Regional Nodes</p>	<p>2.1.1 Promote the network of IODE NODCs as long-term repositories for data and metadata 2.1.2 Promote IODE marine information centres for reliable long-term access to marine science literature 2.1.3 Ensure long-term archival and preservation of ADU data by NODCs 2.1.4 Promote OBIS as the global database to support research as well as management of marine resources and ecosystems</p>
	<p>2.2 Strengthen cooperation with other data and information management programmes</p>	<p>2.2.1 Collaborate closely with JCOMM DMPA 2.2.2 Develop closer links with other JCOMM Programme Areas to provide advice and assistance to develop data systems 2.2.3 Work with other international organizations, programmes and projects to improve interoperability of data systems</p>

Output	Activity	Action
3. Promote free and open access to oceanographic data and information	3.1 Encourage Member States to provide timely, free and unrestricted access to relevant data and associated metadata	3.1.1 Ensure adherence to IOC Oceanographic Data Exchange policy 3.1.2 Ensure adherence to other relevant data policies that are compatible with the IOC policy, e.g. WMO Resolution 40, GEOSS Data Sharing Principles
	3.2 Encourage use of data licensing and publication	3.2.1 Promote a common approach to data licensing 3.2.2 Recommend a licensing system for data publishing
4. Address the needs of both the scientific users and society at large for the demand for access to quality data and information	4.1 Facilitate easy and equitable discovery and access to data and information on a diverse range of variables and derived products	4.1.1 Promote ODP for access to oceanographic data and information resources 4.1.2 Increase contributions to ODP from data management components of IOC programmes 4.1.3 Address the needs of the user community to achieve the IOC HLOs
	4.2 Effective and enhanced communication and outreach to better serve user communities	4.2.1 Endorse the IODE Communication & Outreach Strategy as the tool to communicate data and information management objectives 4.2.2 Facilitate publishing of research findings by scientists
5. Strengthened capacity to manage oceanographic data and information.	5.1 Use IODE OceanTeacher Learning Management System and the OceanTeacher Global Academy network of Regional Training Centres	5.1.1 Develop OceanTeacher content for all IOC programmes 5.1.2 Exploit OTGA RTCs for regional training programmes 5.1.3 Encourage continuous professional development using OceanTeacher platform
	5.2 Increase awareness amongst the ocean research and observation community of the importance of professional data management	5.2.1 Conduct training on importance of research data management 5.2.2 Collaborate with other institutions and organizations to develop awareness of professional data management
	5.3 Develop improved capacity building programmes in cooperation with IOC programmes and other international agencies	5.3.1 Deliver joint training courses with IOC programmes such as MPR, HAB, Tsunami, GOOS 5.3.2 Deliver joint training courses with international agencies such as JCOMM, POGO, IOI 5.3.3 Facilitate training related to SDG14 data reporting

3. IMPLEMENTING THE STRATEGY

The IOC Strategic Plan for Data and Information Management provides the mechanism for seamless interoperability of the dispersed oceanographic data management activities. The Strategic Plan recognizes a broad set of requirements of the IOC and as such will need careful guidance, both in terms of management and in terms of technical and scientific guidance. The future oceanographic data and information system is ambitious and will need access to expert advice.

As the Strategic Plan seeks to cover all data and information collected by IOC programmes it is crucial that there is input on the progress towards delivery of the strategic objectives from IOC Member States and IOC Programmes.

The IOC Strategic Plan for Data and Information Management Advisory Group has responsibility for overseeing the implementation of this Strategy. The Advisory Group will review and endorse the activities of data and information management components of all IOC programmes and will be responsible for both the development and execution of the Strategy. In order to be efficient, the Advisory Group will be a small representative group able to draw on additional expertise as required.

Membership of the Group will comprise representatives nominated by the governing bodies of each IOC programme (as well as JCOMM) and chaired by one of the IODE Co-chairs. Experts from the regional sub-commissions and regional committees are also encouraged to participate.

The Advisory Group will operate as an electronic discussion group and meet regularly by email or web conferencing, thus avoiding costly meetings. It is recommended the Advisory Group meets every six months to discuss specific programme issues related to data and information management.

Coordination and support for the implementation of the IOC Strategic Plan for Data and Information Management will be provided by the IOC Project Office for IODE. A staff member of the Project Office will be included in the Advisory Group to act as Secretary to the Group, to ensure smooth dissemination of Advisory Group meeting reports, information on progress in implementing the strategy, metrics, etc. In addition, taking into account the inherent linkages between IODE, GOOS and JCOMM, Secretariat members of these programmes/commission may also assist as a joint Secretariat of the advisory Group.

The Advisory Group may seek outside expert advice on technical issues relating to standards, interoperability, web services, transport protocols and formats, metadata, vocabularies and ontologies, quality control, etc.

A number of activities are already underway within the IODE programme to improve the efficiency and effectiveness of data management and IODE has project teams which can carry out specific tasks as required to contribute to the implementation of the IOC Strategic Plan for Data and Information Management.

ANNEX I. DETAILED DESCRIPTION OF OUTPUTS AND ACTIVITIES

Output 1. Improved ability to integrate regional and global data systems.

Oceanographic data are obtained by diverse means: nets are dragged, traps are set; instruments are lowered from ships, set adrift, or moored on cables and platforms, satellites scan the oceans from space, and laboratories are constructed on the seafloor. Measurements are made for a wide variety of purposes by individuals and sensors supported by many different kinds of institutions, including governments, commercial operations and non-governmental organizations. These data come in many different forms, from a single variable measured at a single point (e.g., a species name) to multivariate, four-dimensional collections of data that may be many terabytes in size. All these data need to be made available through integrated data systems and shared across scientific domains and international boundaries.

Activity 1.1 Recommended standards and best practice for management and exchange of oceanographic data.

The issue of standards is one of the most critical elements for the successful management and dissemination of oceanographic data. A recommended set of standards will benefit the IOC community as well as the broader oceanographic and marine meteorology data community. Interoperability between data centres can be achieved through the use of internationally endorsed standards and best practices to allow shared use of metadata, data and products and this is key to the successful implementation of the Strategy.

Action 1.1.1 IODE, jointly with JCOMM, to recommend standards and best practices for ocean data management and exchange.

The IODE, jointly with JCOMM has established the Ocean Data Standards and Best Practices Project (ODSBP)³ with the aim of achieving broad agreement and commitment to adopt a number of standards and best practices related to ocean data management and exchange. Three recommended standards have been published as IOC Manuals and Guides with further standards and best practices under consideration.

Action 1.1.2 Collaborate with other programmes and projects beyond IOC (e.g. RDA, ODIP) to develop, adapt, and adopt standards.

The Research Data Alliance (RDA)⁴ is an international initiative to build the social and technical bridges that enable open sharing of data. RDA has established a number of Interest and Working Groups comprised of experts from the international community engaged in creating deliverables that will directly enable data sharing, exchange, or interoperability. It will be especially valuable to contact the Marine Data Harmonization Interest Group⁵.

The Ocean Data Interoperability Project (ODIP)⁶ is a partnership of the major organizations engaged in ocean data management in EU, US, Australia and Canada. ODIP facilitates the dissemination of best practice and the transfer of technology to the broader international community. The ODIP work plan includes establishing standards

³ <http://www.oceandatastandards.org/>

⁴ <https://www.rd-alliance.org/>

⁵ <https://www.rd-alliance.org/groups/marine-data-harmonization-ig.html>

⁶ <http://odip.org/>

and best practices for data management, and development of interoperability solutions to facilitate sharing and dissemination of marine data.

IODE participates in the initiatives of RDA and is a partner in the ODIP project, ensuring that the IOC community is represented in the development and recommendation of international data standards and best practices.

Action 1.1.3 Disseminate standards and best practices through the OceanBestPractices repository.

IODE has established the OceanBestPractices (OBP)⁷ repository which contains a wide variety of “practices” such as manuals and guides related to oceanographic data and information management. It aims at enabling research groups that wish to start a new research project and want to prepare a data management plan to search and find existing methodologies and “best practices”, (a method or technique that has consistently shown results superior to those achieved with other means, and that is considered a benchmark). The service also enables you to submit your own documents that you wish to share with the community. In some cases, a “best practice” may become a “standard”.

Activity 1.2 Use of interoperable metadata catalogues for data discovery.

The importance of metadata attached to the observations in long-term datasets has been recognized for some time to enable efficient discovery and re-use of the data. Most observation programmes now provide for metadata that describe data collection methods, instruments, quality control procedures applied, analyses done, etc. Metadata must be stored with the data and included when the data are provided to users. Metadata catalogues provide easy discovery and access to oceanographic data and information on a diverse range of variables and derived products (including forecasts, alerts and warnings) by users who have a broad range of capabilities. The IOC Strategic Plan for Data and Information Management promotes standardization of discovery metadata and catalogues.

Action 1.2.1 Agreed common standards for metadata to facilitate data discovery and access.

Metadata standards enable discovery and interoperability both of which greatly enhance scientific research through the sharing of data. An agreed common standard is required to describe all IOC data as well as data from other programmes/projects. The IODE ODSBP project, in collaboration with JCOMM, ODIP and others should agree on a common standard.

Activity 1.3 Develop and maintain common lists of standardized terms relevant to the oceanographic community.

Controlled keywords (standardized topic names) and controlled vocabularies (standardized technical terminology) need to be adopted or developed. The breadth of scientific disciplines that are covered by the IOC Strategic Plan for Data and Information Management guarantees the existence of overlapping terminology, and therefore tools and techniques to perform translation among these controlled vocabularies are needed. The Strategy promotes the use of common standardized vocabularies and ontologies.

⁷ <http://www.oceanbestpractices.net/>

Action 1.3.1 Utilize IODE SeaVox governance group for content management of controlled vocabularies.

Vocabulary content governance is important in order to stay up-to-date and in synchronized with ongoing developments. The IODE Vocabulary Content Governance Group (SeaVoX)⁸ has been set up, is moderated by BODC and has provisions for broad community engagement. SeaVox operates by mailing list server and is open to anyone with a genuine interest in controlled vocabularies for the marine science domain. It has been operational for more than a decade and has an active membership of experts from IOC, JCOMM, ODIP and others.

Action 1.3.2 Collaborate closely with other programmes and projects developing common vocabularies.

Other international organizations and projects are also developing and maintaining vocabularies and code lists. ICES⁹ and ODIP partners are among the organizations developing controlled vocabularies to describe oceanographic variables. The RDA includes a vocabulary services group that is exploring best practices for services to support controlled vocabulary term lists and shared, community registries. The Strategy will collaborate with these initiatives to ensure a common terminology to describe ocean data.

Activity 1.4 Ensure delivery of quality oceanographic and related data, products and services.

Data centres are responsible the effective management and delivery of data, products and services. The provision of good management practices will enhance confidence in the quality of these data, products and services which by association will enhance the standing of the data centre among clients, users and stakeholders. Data collectors are more likely to contribute data to data centres in 'good standing' thereby increasing the quantity of data available from reputable data centres.

Action 1.4.1 Support organizational Quality Management System for the delivery of oceanographic and related data, products and services.

To ensure data centres are established and operate according to defined principles, including adherence to agreed standards and the requirements of the IOC Oceanographic Data Exchange Policy, the IODE has established a Quality Management Framework (IODE-QMF)¹⁰ to provide the overall strategy, advice and guidance to design and implement quality management systems for the successful delivery of oceanographic and related data, products and services.

Action 1.4.2 Promote accreditation of IODE data centres according to agreed criteria.

To confirm IODE data centres are able to provide quality data to meet the requirements of a broad and varied community of users, an accreditation process has been implemented which requires compliance with a set of requirements that can be translated into quantitative indicators to set up standard metrics. Data centres will be encouraged to establish quality management systems and to seek accreditation.

⁸ <https://www.bodc.ac.uk/resources/vocabularies/seavox/>

⁹ <http://vocab.ices.dk/>

¹⁰ <http://www.iode.org/qmf>

Action 1.4.3 Facilitate the collection of data and metadata related to IOC SDG reporting responsibility, and subsequent delivery to global UN SDG reporting mechanism.

Submit data and metadata to reflect the latest information provided by IOC in preparation for the annual report on "Progress towards the Sustainable Development Goals".

Action 1.4.4 Provide an interface between data providers and user communities for ocean data and information products related to climate, operational services and ocean health.

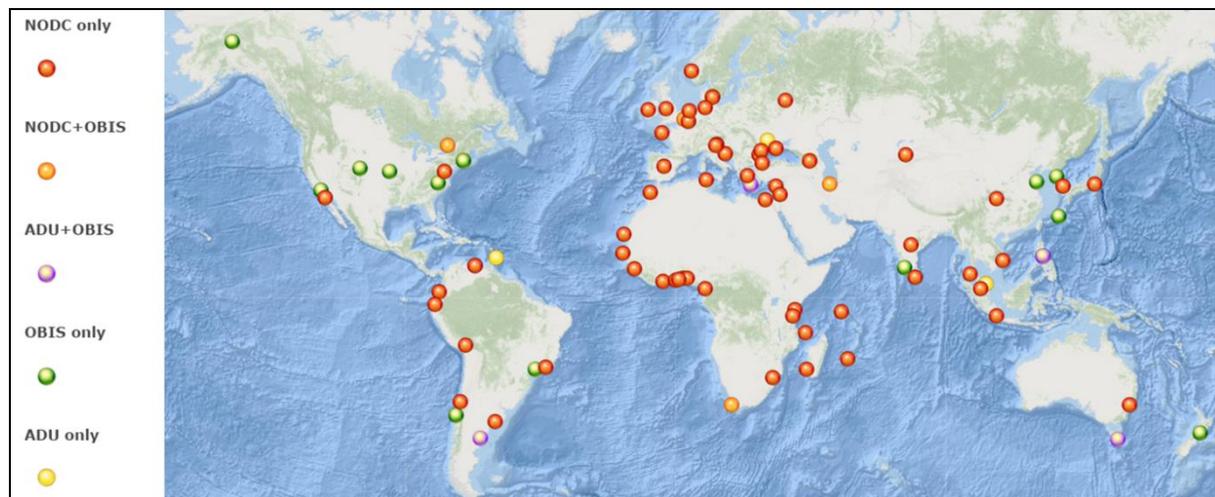
Ensure the data management activities of the observing networks under the JCOMM OCG, the GOOS Regional Alliances, and the developing networks under the GOOS Biology and Ecosystems Panel, are connected to IODE programmes, projects and data centres.

Output 2. Improved capability and functionality of systems in the centres managing oceanographic data and information.

The IOC International Oceanographic Data and Information Exchange (IODE) was established in 1961 to “*enhance marine research, exploitation and development by facilitating the exchange of oceanographic data and information between participating Member States and by meeting the needs of users for data and information products*”. The IODE network has been successful in collecting, controlling the quality of, and archiving millions of ocean observations, and making these available to Member States. The IODE programme gives attention to all ocean related data including physical oceanography, chemical, biological, etc. IODE closely collaborates with, and services the needs of the other IOC and related programmes. Another major and long-term commitment of the IODE programme is the long-term accessibility and archival of oceanographic data, metadata and information to safeguard present and future holdings against loss or degradation.

Activity 2.1 Strengthen the IODE network of National Oceanographic Data Centres (NODCs), Marine Science Libraries, Associate Data Unit (ADU), OBIS Regional Nodes.

The IODE system forms a worldwide service oriented network of National Oceanographic Data Centres (NODCs), Marine Science Libraries and Information Centres, Associate Data Unit (ADU), OBIS Regional Nodes (as shown below).



The IODE network (2017)

Action 2.1.1 Promote the network of IODE NODCs as long-term repositories for data and metadata.

National Oceanographic Data Centres (NODCs) form the backbone of the IODE system, and act as the national focal points for archiving, stewardship and dissemination of oceanographic data. The NODC system has contributed greatly to the management of oceanographic data. NODCs can be either centralized or distributed facilities. Although they operate to a set of common principles, the NODCs have widely varying national remits and vary in size and expertise. Accreditation of NODC, as recommended by the IODE Quality Management Framework, will ensure quality data and products will be available to meet the requirements of a broad community of users.

Action 2.1.2 Promote IODE marine information centres for reliable long-term access to marine science literature.

The OpenScienceDirectory¹¹ is a service that provides access to scientific literature to developing countries at no charge and provides a comprehensive search tool for all open access and special programme journal titles. The Open Science Directory has been developed by EBSCO Information Services and the Hasselt University Library (Belgium) based upon a request by marine information management experts collaborating within the framework of the IODE programme.

OceanDocs¹² is an IODE project to make marine science publications/outputs more easily and freely accessible primarily to the ocean (and coastal) research and management community and to enhance scientific cooperation communication at the regional level. OceanDocs enables researchers to deposit the full text of their works: articles, conference papers, technical reports, working papers, theses and more. The information managers and librarians of the participating institutes will help the researchers with the submission of their publications. Researchers can publish in a scientific journal and at the same time submit their publication.

Action 2.1.3 Ensure long-term archival and preservation of ADU data by NODCs.

The decision by IODE-XXII (2013) to establish Associated Data Units (ADU) has further expanded the network of data centres to include ocean research and observation programmes and projects. As the list of ocean data sensor types expands, the domain-specific expertise developed at ADUs will be a valuable addition to the IODE network. ADUs share their data and information on their data collection (metadata) through their respective NODC (in the case of national projects, programmes, institutions or organizations) or, in the case of biogeographic data, through OBIS. There are currently 22 established ADUs.

Action 2.1.4 Promote OBIS as the global database to support research as well as management of marine resources and ecosystems.

The Ocean Biogeographic Information System (OBIS) is a global network of marine biodiversity scientists collaborating to mobilise, integrate and publish primary data about life in the oceans. OBIS provides datasets that are integrated and searchable by species name, higher taxonomic level, geographic area, depth, and time. In 2009 the IOC at its 25th session agreed to accept OBIS within the IODE Programme and to integrate the

¹¹ <http://www.opensciencedirectory.net/>

¹² <http://www.oceandocs.org/>

functions of OBIS into IOC. OBIS comprises a global system of data providers that work to meet regional and thematic needs within a global data architecture. OBIS data are taxonomically and geographically resolved and are checked for errors and inconsistencies before being incorporated into the data holdings. OBIS seeks to absorb, integrate, and assess isolated datasets into a larger, more comprehensive picture of life in our oceans and offers quality control for biogeographic data and through creation of standardized metadata, facilitates data discovery and access.

Activity 2.2 Strengthen cooperation with other data and information management programmes.

Many other organizations and programmes collect and manage oceanographic data. It is essential that the IOC Strategic Plan for Data and Information Management acknowledges these sources of data and information and works together to ensure that there is no duplication of effort and synergies are developed by sharing experience and knowledge.

Action 2.2.1 Collaborate closely with JCOMM DMPA.

The objective of the JCOMM Data Management Programme Area (DMPA) is to implement and maintain a fully integrated end-to-end data management system across the marine meteorology and oceanographic community and to offer its expertise to assist other groups to specify and implement their own data management requirements, with the overall goal of integrating their data management into the overall end-to-end data management system. JCOMM has published its Data Management Plan¹³ which covers elements in common with the IOC Data and Information Management Strategic Plan, for example, data and information exchange, data processing and data access.

IODE collaborates with JCOMM through the JCOMM DMPA and the joint JCOMM/IODE Expert Team on Data Management Practices (ETDMP). The activities of ETDMP include development, recommendation and implementation principles and practices for an end-to-end data management system for JCOMM; recommendation of best data management practices for adoption by JCOMM and other related/dependent activities; and review and assessment of the effectiveness of data management practices, including integration and consideration of new techniques and approaches.

Action 2.2.2 Develop closer links with other JCOMM Programme Areas to provide advice and assistance to develop data systems.

Close links with other JCOMM Programme Areas which have a data management component will ensure these activities are well coordinated and managed. The Observations Programme Area (OPA), for example, is primarily responsible for the development, coordination and maintenance of moored buoy, drifting buoy, ship-based and space-based observational networks and related telecommunications facilities. OPA is also responsible for a number of other observational programmes that report through JCOMM.

The establishment of the Marine Climate Data System (MCDS) and its network of WMO-IOC Centres for Marine-meteorological and Oceanographic Climate data (CMOCs) as joint activities of marine meteorology and oceanographic services will develop synergies

¹³ <http://www.jcomm.info>

between IODE and JCOMM by sharing experience and knowledge to optimize data management between marine meteorology and oceanographic communities

Action 2.2.3 Work with other international organizations, programmes and projects to improve interoperability of data systems.

Other international organizations, programmes and projects have also developed data and information management programmes and activities with national, regional or global foci. The success of the IOC Data and Information System depends on the acceptance and implementation of a set of interoperability arrangements, including technical specifications for collecting, processing, storing, and disseminating shared data, metadata and products. Interoperability should be based on non-proprietary standards, with preference given to formal international standards.

Output 3. Promote free and open access to oceanographic data and information.

The function of data collection, through the IOC networks of ocean observations, is fundamental and underpins current research efforts on climate and the development of ocean services. Consistent with its international public service mission, all data collected by Member States as part of IOC Programmes and activities are subject to free and open exchange under the current IOC Data Exchange Policy. Other programme, project, national and organizational data exchange policies also exist to provide free and open access to data, with some programmes providing free and open access to data collected in real-time within 24 hours after collection.

Activity 3.1 Encourage Member States to provide timely, free and unrestricted access to relevant data and associated metadata.

The timely, free and unrestricted international exchange of oceanographic data is the cornerstone of the IOC Oceanographic Data Exchange Policy. Open access to oceanographic data and information should be easy, timely, user-friendly and preferably Internet-based. Unrestricted access benefits the whole community by encouraging collaboration between multiple research disciplines and institutions, verification of previous results, encouraging new research and new types of research, and allowing exploration of topics not envisioned by the initial investigators.

Action 3.1.1 Ensure adherence to IOC Oceanographic Data Exchange policy.

The IOC strategic Plan for Data and Information Management builds on the IOC Oceanographic Data Exchange Policy¹⁴ which promotes the free and open access to data, metadata and products.

“The timely, free and unrestricted international exchange of oceanographic data is essential for the efficient acquisition, integration and use of ocean observations gathered by the countries of the world for a wide variety of purposes including the prediction of weather and climate, the operational forecasting of the marine environment, the preservation of life, the mitigation of human-induced changes in the marine and coastal environment, as well as for the advancement of scientific understanding that makes this possible.”

¹⁴ <http://www.iode.org/policy>

The IODE Ocean Data Portal makes data and services available freely and without restriction in a timely and user-friendly way through a single-entry point and supports the data sharing principles of the IOC.

Action 3.1.2 Ensure adherence to other relevant data policies that are compatible with the IOC policy, e.g. WMO Resolution 40, ICSU WDS Data Sharing Principles, GEOSS Data Sharing Principles.

The IOC Oceanographic Data Exchange Policy is compatible with other relevant international data exchange policies which promote free and open access to data. WMO Resolutions 40¹⁵ and 60¹⁶ which provides for the free and unrestricted sharing of meteorological and climate data and products, the ICSU WDS Data Sharing Principles¹⁷ and the GEOSS Data Sharing Principles¹⁸.

A variety of other programme, project, national and organizational data exchange policies also exist and as far as possible they should be encouraged to provide free and open access to data.

Activity 3.2 Encourage use of data licensing and publication.

It is important to ensure intellectual property rights are not compromised in the data and in scientific papers produced by those responsible for the data collection. It is also important to give proper credit to the data creators and data must be properly referenced or cited.

Action 3.2.1 Promote a common approach to data licensing.

Policies, procedures and guidelines related data management often ignore the issue of data licensing. Attaching a licence or reuse notice to data is an important element of data management and is dependent upon clarifying the provenance, ownership, and custodianship of the organization's data assets. A simple data licensing regime allows simplified data integration. Licences provide a clear and standardized guide for other people about how they can use data, including the option to reuse, remix and share the content.

Action 3.2.2 Recommend a licensing system for data publishing.

The IODE promotes the publishing of datasets within repositories as unique objects with data citations to improve data flow and has published the *Ocean Data Publication Cookbook*¹⁹ which describes the assigning a permanent identifier to a dataset for the purposes of publishing the dataset online and for the citation of that dataset within the scientific literature.

Output 4. Address the needs of both the scientific users and society at large for the demand for access to quality data and information.

Timely access to quality data is essential for the understanding of marine processes and the full and open sharing of datasets is fundamental to ensure the rapid dissemination of data and

¹⁵ WMO Resolution 40 (Cg-XII, 1995)

¹⁶ WMO Resolution 60 (Cg-17, 2015)

¹⁷ <https://www.icsu-wds.org/services/data-sharing-principles>

¹⁸ https://www.earthobservations.org/geoss_dsp.shtml

¹⁹ IOC M&G 64. http://www.iode.org/index.php?option=com_oa&task=viewDocumentRecord&docID=10574

information is available to researchers. This can be achieved by providing online, unified access to oceanographic datasets of distributed data centres through a data portal.

Activity 4.1 Facilitate easy and equitable discovery and access to data and information on a diverse range of variables and derived products.

The IOC Data and Information system will provide seamless access to the real-time and delayed-mode oceanographic data and services across all IOC and related programmes, handling data from the point of collection, through processing and quality control, to archival and dissemination. This can be achieved by facilitating the discovery and access of marine data through the development, implementation, population and operation of national, regional and international distributed data management infrastructures.

Action 4.1.1 Promote ODP for access to oceanographic data and information resources.

The IODE has developed the Ocean Data Portal (ODP) to facilitate and promote the exchange and dissemination of oceanographic data and services for both management and scientific use on global, regional and national levels. **The ODP is a key component to delivery of the objectives of the IOC Strategic Plan Data and Information** and serves as a multipurpose and multidisciplinary standards-based, extensible infrastructure for interconnection and seamless access to the real-time and delayed-mode oceanographic data and services across many IOC and related programmes.

The objective of the ODP is to facilitate and promote the exchange and dissemination of marine data and services through the provision of seamless access to collections and inventories of marine data from the NODCs in the IODE network and to allow for discovery, evaluation and access to data via web services. This is achieved through a standards-based infrastructure that provides the integration of marine data and information from the network of distributed IODE NODCs as well as the resources from other participating systems. The ODP has been developed, and is managed by, IOC member states through the IODE NODC network with contributions from the data management components of IOC programmes, as well as from programmes and organizations collaborating with IOC. The ODP contributes oceanographic data and services to the WMO Information System (WIS) and will function as a WIS Data Collection or Production Centre (DCPC).

Action 4.1.2 Increase contributions to ODP from data management components of IOC programmes.

ODP fully depends on the data contributions from IOC Member states and related projects, programmes and initiatives. Presently ODP has established global, regional and specialized nodes in Russia, China, Kenya and Argentina that provide access to more than 200 national, regional and global datasets and products. Data centres and systems are encouraged to contribute to ODP which requires the implementation of a set of agreed interoperability arrangements including the technical specifications and web services for the integration and shared use of the metadata, data and services.

Action 4.1.3 Address the needs of the user community to achieve the IOC HLOs.

IODE, jointly with other IOC programmes and relevant external programmes, to engage with community, organized by IOC HLOs. For climate, with WCRP, GCOS, IPCC and GFCS; for operational systems, by reinforcing the linkages between IODE, through JCOMM, to the Services and Forecast Systems Programme Area, and with the IOC Tsunami Unit; for ocean

health, engagement with assessment processes, CBD, BBNJ, and the International Sea Bed Authority.

Activity 4.2 *Effective and enhanced communication and outreach to better serve user communities.*

IOC must work with Member States, governments, partner organizations, academia and industry, to articulate the global benefits to society and required funding to build and sustain the ocean observing data and information system. The number of international marine science related organizations is growing and there is often a perception that they have similar or overlapping objectives. It is therefore increasingly important to state clearly IOC's unique role, how it differs from other organizations, who its stakeholders are and how to prioritise and optimise its communication methods with all potential partner organizations.

Action 4.2.1 *Endorse the IODE Communication & Outreach Strategy as the tool to communicate data and information management objectives.*

The IODE Programme has acknowledged the need for greater communication and outreach activities to its target audiences by publishing the IODE Communication and Outreach Strategy for Data and Information Management.

The IODE Communication Strategy identifies the major stakeholder, identifies key messages and suitable communication channels, and proposes specific communication and stakeholder participation activities to be implemented as part of the overarching IODE activities. Most importantly, it calls for an IODE Communication Team to be built.

Action 4.2.2 *Facilitate publishing of research findings by scientists.*

Scientific publications of research findings are increasingly produced and freely disseminated electronically by research institutions or specialized research groups. This creates challenges for the business models of commercial publishers of peer reviewed journals as there is an increasing demand for free open access to on-line publications. However this changed publishing model also offers considerable opportunities to scientists and research organizations. The advances in technology now make it possible to search among thousands of e-repositories and to retrieve full-text documents and linked data instantaneously.

Output 5. *Strengthened capacity to manage oceanographic data and information.*

Capacity building and sustainability are important aspects of the IOC Strategic Plan for Data and Information and will contribute to the outputs and activities of the IOC Capacity Development Strategy (2015–2021). The IODE Programme has a long and respected track record in capacity building, including the building of Ocean Data and Information Networks (ODIN) in various regions. Through the use of low-cost, mass-market technology for linking components (with an emphasis on "main-stream" rather than "special purpose" or "cutting edge research") the IODE can leverage technology to assure the cost-effectiveness and sustainability of project implementations via the ODIN system. ODINs provide a valuable mechanism for assessing the current and potential state of development of national data centres and creating the means for mutual capacity building in a region.

Activity 5.1 Use IODE OceanTeacher Learning Management System and the OceanTeacher Global Academy network of Regional Training Centres.

Fundamental to the IODE capacity building activities is OceanTeacher²⁰ which provides training mostly on ocean data and information management, including marine biodiversity data management. OceanTeacher evolved from a single (international) training centre²¹ located at the IOC Project Office for IODE in Ostend, Belgium, to a distributed network of Regional Training Centres (RTCs)²². Currently the OceanTeacher Global Academy has RTC's in all regions²³. It is expected that approximately 10 regional training centres will be operational by 2017. The OTGA model recognizes and enables the benefits of local training sites (e.g. eliminating the need for costly travel to remote sites, removing the difficulty of recovering from jet-lag, and supporting the development of local infrastructure, both in terms of physical capabilities and increase in local knowledge capacity).

Action 5.1.1 Develop OceanTeacher content for all IOC programmes.

The OceanTeacher learning management system provides a platform where learners can find training resources in several languages (English, French, Spanish and Portuguese) as well as videos on main/specific topics. The OceanTeacher e-Learning Platform is used during IODE traditional face-to-face training courses but can also be used for self-training and continuous professional development. OceanTeacher training resources are freely and openly available and licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License²⁴.

Action 5.1.2 Exploit OTGA RTCs for regional training programmes.

RTCs organize training courses focusing on regional training needs, and using the local/regional language(s). The use of the OceanTeacher e-Learning Platform promotes the exchange of training resources amongst RTCs and ensures the quality of the training resources. Additionally, the exchange of lecturers and experts is promoted, namely by using videoconferencing technology, and enabling interaction amongst the participants in different classrooms/RTCs.

Action 5.1.3 Encourage continuous professional development using OceanTeacher platform.

The OceanTeacher e-Learning Platform can be used during traditional face-to-face training courses but can also be used for self-training and continuous professional development. Opportunities to expand the use of OceanTeacher for distance learning and blended learning should be investigated.

Activity 5.2 Increase awareness amongst the ocean research and observation community of the importance of professional data management.

The management of data, particularly large-scale data, has many challenges, and the roles of researchers, facilities that manage marine data, repositories and libraries are coming together to provide access, preservation and archive of this data and the scholarly products associated

²⁰ <http://www.oceanteacher.org>

²¹ OceanTeacher Academy (OTA) project, 2009-2013 (FUST funding).

²² OceanTeacher Global Academy (OTGA) project, 2014-2018 (FUST funding).

²³ For a detailed and up to date list of RTCs see <http://www.oceanteacher.org>.

²⁴ <https://creativecommons.org/licenses/by-nc-sa/4.0/>

with it. Researchers need to recognize the importance of good research data management practice and to understand of the roles of data managers and information managers in the management of research data.

Action 5.2.1 Conduct training on importance of research data management.

Regular training for marine researchers and postgraduate students on managing research data throughout its lifecycle including preparing data management plans and publishing research data.

Action 5.2.2 Collaborate with other institutions and organizations to develop awareness of professional data management.

IOC should collaborate with other organizations, including universities, to develop training and awareness materials to highlight the importance of research data management.

Activity 5.3 Develop improved capacity building programmes in cooperation with IOC programmes and other international agencies.

Capacity building is a crucial component of this Strategic Plan. Improved cooperation across all IOC programmes and with other agencies is essential to deliver an effective data management system to meet the needs of the ocean observing community This Strategic Plan aims to create more partnerships and embed training courses in partner training programmes that focus on data and information management. As well as meeting the training requirements of all IOC programme areas, there is a need to link to other relevant ocean and coastal management activities.

Action 5.3.1 Deliver joint training courses with IOC programmes such as MPR, HAB, Tsunami, GOOS.

The OceanTeacher e-Learning Platform supports all IOC programmes in their capacity development activities, namely hosting training resources on topics such as marine spatial planning, harmful algal blooms and tsunami awareness. The current collection of training courses including MPR (including marine spatial planning in English and Spanish), HAB (including BHAB Identification Training Course, International Phytoplankton Intercalibration, IOC advanced HAB Course), Tsunami (including tsunami standard operating procedures, tsunami modelling, evacuation mapping). Close collaboration across all IOC programmes will result in improved capacity development in the data and information management domain.

Action 5.3.2 Deliver joint training courses with international agencies such as JCOMM, POGO, IOI.

OTGA works in partnership with a number of international and global ocean-related initiatives promoting the use and awareness of oceanographic data and information management for different audiences and communities. IODE has collaborated with JCOMM to develop and deliver training material for marine meteorological and oceanographic data management. New training material is needed to cover operational ocean modelling and this can be achieved by developing connections with the meteorological modelling community.

The Nippon Foundation-POGO Centre of Excellence (CofE)²⁵ in Observational Oceanography provides world class education and training courses in the field of observational oceanography which includes a module on data management. Continued cooperation between IOC and CofE should continue and POGO members should be encouraged to contribute content and lecturers to the OT Global Academy

Traditional IODE technical courses on data management can be expanded to address *data management for society* in collaboration with International Ocean Institute (IOI)²⁶ Ocean Policy module in the MA degree in Ocean Governance.

Action 5.3.3 Facilitate training related to SDG14 data reporting.

Use the OceanTeacher e-Learning Platform to support training related to SDG14 data reporting.

²⁵ <http://www.ocean-partners.org/centre-of-excellence>

²⁶ <https://www.ioinst.org/>

ANNEX II. ACRONYMS

ADU	Associate Data Unit - a structural element of IODE
BBNJ	Biodiversity Beyond National Jurisdiction (UN)
BHAB	Benthic Harmful Algae Bloom
BODC	British Oceanographic Data Centre
CBD	Convention on Biological Diversity
CMOC	Centres for Marine-meteorological and Oceanographic Climate data (JCOMM)
CofE	POGO Centre of Excellence
DMPA	Data Management Programme Area (JCOMM)
EOV	Essential Ocean Variables
ETDMP	Joint JCOMM/IODE Expert Team on Data Management Practices
FOO	Framework for Ocean Observing
GCOS	Global Climate Observing System (WMO)
GEMIM	IODE Group of Experts on Marine Information Management
GEOSS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Services
GOOS	Global Ocean Observing System
HAB	Harmful Algal Blooms programme
HLO	High-Level Objectives (IOC)
ICAM	Integrated Coastal Area Management
ICES	International Council for the Exploration of the Sea
ICSU	International Council for Science
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IODE	International Oceanographic Data and Information Exchange
IOI	International Ocean Institute
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
LMS	Learning Management System
MCDS	Marine Climate Data System (JCOMM)
MPR	Marine Policy and Regional Coordination Section of IOC
NODC	National Oceanographic Data Centre (IODE)
OBIS	Ocean Biogeographic Information System
OCG	Observations Coordination Group (JCOMM)
OBP	OceanBestPractices

ODIN	Ocean Data and Information Network
ODP	Ocean Data Portal (IODE)
ODIP	Ocean Data Interoperability Project
ODSBP	Ocean Data Standards and Best Practices Project (IODE/JCOMM)
OPA	Observations Programme Area (JCOMM)
OT	OceanTeacher
OTGA	OceanTeacher Global Academy
POGO	Partnership for Observation of the Global Oceans
QMF	Quality Management Framework
RDA	Research Data Alliance
RTC	Regional Training Centre (IODE)
SCOR	Scientific Committee on Oceanic Research (ICSU)
SDG	Sustainable Development Goals
UNESCO	United National Educational, Scientific and Cultural Organization
WCRP	World Climate Research Programme
WDS	World Data System (ICSU)
WIS	WMO Information System
WMO	World Meteorological Organization

IOC Manuals and Guides

No.	Title
1 rev. 2	Guide to IGOSS Data Archives and Exchange (BATHY and TESAC). 1993. 27 pp. (English, French, Spanish, Russian)
2	International Catalogue of Ocean Data Station. 1976. (<i>Out of stock</i>)
3 rev. 3	Guide to Operational Procedures for the Collection and Exchange of JCOMM Oceanographic Data. Third Revised Edition, 1999. 38 pp. (English, French, Spanish, Russian)
4	Guide to Oceanographic and Marine Meteorological Instruments and Observing Practices. 1975. 54 pp. (English)
5 rev. 2	Guide for Establishing a National Oceanographic Data Centre. Second Revised Edition, 2008. 27 pp. (English) (<i>Electronic only</i>)
6 rev.	Wave Reporting Procedures for Tide Observers in the Tsunami Warning System. 1968. 30 pp. (English)
7	Guide to Operational Procedures for the IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring. 1976. 50 pp. (French, Spanish)
8	(<i>Superseded by IOC Manuals and Guides No. 16</i>)
9 rev.	Manual on International Oceanographic Data Exchange. (Fifth Edition). 1991. 82 pp. (French, Spanish, Russian)
9 Annex I	(<i>Superseded by IOC Manuals and Guides No. 17</i>)
9 Annex II	Guide for Responsible National Oceanographic Data Centres. 1982. 29 pp. (English, French, Spanish, Russian)
10	(<i>Superseded by IOC Manuals and Guides No. 16</i>)
11	The Determination of Petroleum Hydrocarbons in Sediments. 1982. 38 pp. (French, Spanish, Russian)
12	Chemical Methods for Use in Marine Environment Monitoring. 1983. 53 pp. (English)
13	Manual for Monitoring Oil and Dissolved/Dispersed Petroleum Hydrocarbons in Marine Waters and on Beaches. 1984. 35 pp. (English, French, Spanish, Russian)
14	Manual on Sea-Level Measurements and Interpretation. (English, French, Spanish, Russian) Vol. I: Basic Procedure. 1985. 83 pp. (English) Vol. II: Emerging Technologies. 1994. 72 pp. (English) Vol. III: Reappraisals and Recommendations as of the year 2000. 2002. 55 pp. (English) Vol. IV: An Update to 2006. 2006. 78 pp. (English) Vol. V: Radar Gauges. 2016. 100 pp. and Supplement: Practical Experiences. 100 pp. (English, French, Spanish)
15	Operational Procedures for Sampling the Sea-Surface Microlayer. 1985. 15 pp. (English)
16	Marine Environmental Data Information Referral Catalogue. Third Edition. 1993. 157 pp. (Composite English/French/Spanish/Russian)
17	GF3: A General Formatting System for Geo-referenced Data Vol. 1: Introductory Guide to the GF3 Formatting System. 1993. 35 pp. (English, French, Spanish, Russian) Vol. 2: Technical Description of the GF3 Format and Code Tables. 1987. 111 pp. (English, French, Spanish, Russian) Vol. 3: Standard Subsets of GF3. 1996. 67 pp. (English) Vol. 4: User Guide to the GF3-Proc Software. 1989. 23 pp. (English, French, Spanish, Russian)

No.	Title
	Vol. 5: Reference Manual for the GF3-Proc Software. 1992. 67 pp. (English, French, Spanish, Russian)
	Vol. 6: Quick Reference Sheets for GF3 and GF3-Proc. 1989. 22 pp. (English, French, Spanish, Russian)
18	User Guide for the Exchange of Measured Wave Data. 1987. 81 pp. (English, French, Spanish, Russian)
19	Guide to IGOSS Specialized Oceanographic Centres (SOCs). 1988. 17 pp. (English, French, Spanish, Russian)
20	Guide to Drifting Data Buoys. 1988. 71 pp. (English, French, Spanish, Russian)
21	<i>(Superseded by IOC Manuals and Guides No. 25)</i>
22 rev.	GTSP Real-time Quality Control Manual, First revised edition. 2010. 145 pp. (English)
23	Marine Information Centre Development: An Introductory Manual. 1991. 32 pp. (English, French, Spanish, Russian)
24	Guide to Satellite Remote Sensing of the Marine Environment. 1992. 178 pp. (English)
25	Standard and Reference Materials for Marine Science. Revised Edition. 1993. 577 pp. (English)
26	Manual of Quality Control Procedures for Validation of Oceanographic Data. 1993. 436 pp. (English)
27	Chlorinated Biphenyls in Open Ocean Waters: Sampling, Extraction, Clean-up and Instrumental Determination. 1993. 36 pp. (English)
28	Nutrient Analysis in Tropical Marine Waters. 1993. 24 pp. (English)
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65	Tsunami Preparedness Civil Protection: Good Practices Guide. 2013. 57 pp. (English)
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