Assessment of Oceanographic Data and Scientific Research in the Western Indian Ocean Region

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A working document for the stocktaking segment of the Nairobi Convention Science to Policy Workshop
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SUMMARY

The project documents of the WIOSAP and SAPPHIRE projects that the Nairobi Convention is implementing prescribe the establishment of a Science to Policy Platform (SPP) as an interface between the knowledge generated through scientific activities and policy formulation and implementation related to the management of coastal and marine resources in the WIO region. The SPP is in line with decisions taken at various Conference of the Parties to the Nairobi Convention.

This working document for the Science to Policy workshop is intended to guide the member States in developing a roadmap for reviving the national data centres developed during the ASCLME project. Its focus is on oceanographic data collection and management and has been prepared from a rapid assessment of the current status of oceanographic data and scientific research in the Western Indian Ocean (WIO) region. The paper presents the basic framework and elements of an inventory of initiatives (projects, programmes, etc.) and institutions that generate oceanographic data, the available relevant global, regional and national datasets and management of the same as well as assessment of access to and sharing of the oceanographic data. Capacity development for data management and data centre managers is also considered.

The document provides elements for the discussion in the workshop on a framework to guide the countries to revive the national data centres for improved ocean governance and sustainable use of resources in the WIO region in line with the United Nations Sustainable Development Goal 14: “Conserve and sustainably use the oceans, seas and marine resources for sustainable development”. The participants of the workshop will be encouraged to add to the inventory and the results of the discussions will be included in the outputs of the Science to Policy workshop.

1. INTRODUCTION

This working document for the Nairobi Convention Science to Policy workshop is intended to guide the member countries in developing a roadmap for reviving the national data centres developed during the ASCLME project. The workshop is to enable contracting parties to the Nairobi Convention to take stock of research cruises/ocean-based monitoring and identify the gaps in data capturing and management.

The focus of the paper is on oceanographic data collection and management and covers:

- Inventory of initiatives (projects, programmes, etc.) and institutions that generate oceanographic data. If a basic inventory is found, then we will examine the best way for its expansion and make provision for quality and availability index.
- Inventory of the available relevant datasets and management of the same.
- An assessment of access to and sharing of the data.
- Experience with development of information from the datasets as input for policy, decision making and management related to ocean governance and sustainable use of resources in the WIO region.

It provides input for discussion on a framework to guide the countries to revive the national data centres including modalities/framework/protocols for ensuring data ownership, access and quality control. It also looks at modalities for sharing and archiving of national and regional oceanographic data and information for improved ocean governance and sustainable use of resources in the WIO region. The results of the discussions will be included in a report that will be one of the outputs of the Science to Policy workshop. We take a broader look at, and consider several aspects of ocean science which "includes disciplines related to the study of the ocean - physical, biological, chemical, geological, hydrographic, etc. and multidisciplinary research on the relationship between humans and the ocean" (IOC-UNESCO, 2017). It is recognised that ocean observation and marine data are relevant for all categories of ocean science. The paper looks at the collection, management, dissemination and use of marine data and information, ocean-related databases, data reporting and management.

2. BACKGROUND

The Nairobi Convention is currently executing two GEF Projects: '*Implementation of the Strategic Action Project for the protection of the Western Indian Ocean from land-based sources and activities*' (WIOSAP), and the *Western Indian Ocean Large Marine Ecosystem Strategic Action Programme Policy Harmonization and Institutional Reforms'* (WIO LME SAPPHIRE). The WIOSAP Project requires the establishment of a science-policy exchange platform while the SAPPHIRE Project has proposed the establishment of a scientific and technical advisory panel (STAP) to serve as key point (bridge) to science to policy interface for improved ocean governance, evidence-based decision making and adaptive management (Nairobi Convention, 2019). These suggestions are in line with decisions taken at various Conferences of the Parties (COPs) to the Nairobi Convention that have called for the strengthening of the links between science and policy formulation/implementation in the management of coastal and marine resources in the WIO region.

The Science to Policy workshop in Mauritius is to (i) discuss the need for regional ecosystem/indicator monitoring frameworks and a roadmap for its development; (ii) discuss topical emerging scientific findings with potential policy implications in the management of coastal and marine resources in the region; (iii) take stock of oceanographic research and data in the Western Indian Ocean (WIO) region; (iv) discuss the regional toolkits and guidelines being developed for the WIO region and (v) review the Terms of Reference for the Science to Policy Platform, its membership and modus operandi, among others.

The Nairobi Convention Secretariat commissioned this work with the following terms of reference:

- Conduct a rapid assessment of the current status of Oceanographic Data and Scientific Research and document lessons in the WIO region to inform the workshop participants, scientists and government representatives of the participating countries
- Draft guidelines to support countries in developing a roadmap for reviving the national data centres developed during the ASCLME project to ensure that the best available scientific data and local knowledge are shared and incorporated in planning and policy development at the national and regional level
- Modalities/framework/protocols for ensuring data ownership, access and quality control as well as sharing and archiving national and regional oceanographic data and information for improved ocean governance the sustainable use of resources in the WIO region.
- Guide (facilitate) the countries in developing a roadmap for reviving the national data centres developed during the ASCLME project to ensure that the best available scientific data and local knowledge are shared and incorporated in planning and policy development at the national and regional levels.

This paper has the SAPPHIRE project in focus. The overall objectives of the SAPPHIRE project are to achieve effective long-term ecosystem management in the WIO large marine ecosystems in line with the Strategic Action Programme as endorsed by the participating countries. The project is to support the collection of scientific and local information in the WIO region and ensure it is routinely archived in national data centres and regionally in the Nairobi Convention Clearinghouse Mechanism where it can be retrieved for long term environmental change studies.

3. INVENTORY OF INITIATIVES (PROJECTS, PROGRAMMES, ETC.) AND INSTITUTIONS THAT GENERATE OCEANOGRAPHIC DATA

The collection of oceanographic data in the Western Indian Ocean (WIO) area has been undertaken since the 1900s (SADCO, 2019) but collection methods have become more sophisticated over time. The expansion of technology has been accompanied by an increase in the number of institutions and initiatives collecting these data. For the purpose of this work, we look at datasets collected nationally, regionally and globally that are relevant to the WIO region.

There are a number of institutions that collect oceanographic data on a global scale. Two of these that hold a substantial amount of data for the WIO region are the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) both of the United States of America. These large institutes collect data mostly remotely through the use of

satellite technology or buoys either moored or drifting. The data collection is automated and continuous.

There are also initiatives that work on regional scales; key among these, in the context of ocean science, are the EAF-Nansen Programme and the Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER) of France. Both these initiatives include the use of research vessels in their data collection. The vessels are highly sophisticated and collect a multitude of data as they work in countries within the WIO. The EAF-Nansen Programme is a partnership between the Norwegian Agency for Development Cooperation (Norad), the Norwegian Institute of Marine Research (IMR) and the Food and Agriculture Organization of the United Nations (FAO). Other collaborative initiatives collect data for a specific period and/or area. These are mostly projects such as the Agulhas and Somali Currents Large Marine Ecosystem (ASCLME) project and the South West Indian Ocean Fisheries Project (SWIOFP). Both of these projects involved all the countries of the WIO and the data collected were on both regional and national scales.

In almost all countries of the WIO, there are national institutes that collect fisheries and oceanographic data in national waters. Notable among these are the Mauritius Oceanography Institute (MOI), the Seychelles Fishing Authority (SFA), the Kenya Marine and Fisheries Research Institute (KMFRI), the Tanzania Fisheries Research Institute (TAFIRI), the National Fisheries Research Institute (IIP) of Mozambique, and the Council for Scientific and Industrial Research as well as the Oceanographic Research Institute (ORI) in South Africa. There are also a number of university departments and schools in these countries, e.g. the Institut Halieutique et des Sciences Marines of the University of Toliara in Madagascar, that collect oceanographic, fisheries and marine information and data. Finally, some amount of oceanographic data is also collected for small areas as part of stand-alone projects or through consultancies.

The data collected and available in national, regional and international institutions cover the many facets of oceanography. These include physical ocean data such as temperature, salinity, density, currents, chlorophyll, fluorescence, etc. as well as chemical ocean data such as carbon, nitrogen, and phosphorus occurrence. Many of the institutes collecting oceanographic data collect other data along with the oceanographic data. These can include data on pollution (chemical contaminants, plastic, etc.) and biological ocean data (plankton distribution and biomass, marine species, etc.).

Appendix 1 provides an inventory of some of the initiatives and institutes that collect oceanographic data relevant to the WIO region. It also gives an indication of what data are collected and where and how they may be accessed. Modern datasets are mainly in electronic form but some older datasets may still be on hardcopy.

4. PLATFORMS FOR OCEAN DATA COLLECTION

Data collection platforms vary quite widely in their areas of operation, types of data collected and reporting mechanisms. A few of these are discussed here. Oceanographic data collection in the WIO is carried out on a diversity of platforms, including satellites and research vessels, and using instruments that range from ship board equipment through electronic sensors on automated vehicles, to Niskin and Nansen reversing bottles, Secchi disks and other basic tools and implements.

Some key Essential Ocean Variables (EOVs) to document ocean mean-state and variability as defined by the Global Ocean Observing System are *in situ* temperature, salinity, ocean currents, nutrients, dissolved inorganic and organic carbon, dissolved gases such as oxygen, plankton, etc. The various platforms are necessary to obtain the EOVs of relevance to the problems at hand.

4.1 Research vessels

Over time, many surveys have been conducted in the WIO by dedicated oceanographic and fisheries research vessels from many different nations around the world. While some of the vessels have conducted ad hoc surveys, others have been operating in the WIO for an extended period of time collecting data and information using standardised methods.

A well-known research vessel name in the WIO region is the RV *Dr Fridtjof Nansen*, owned by Norad and presently operating within the EAF-Nansen Programme of FAO (Groeneveld & Koranteng, 2017). To date, there have been three vessels of this name. The R/V *Dr Fridtjof Nansen* undertook its first survey in the WIO in 1975, and the three vessels have undertaken over 30 surveys in the area since then (Groeneveld & Koranteng, 2017). Beneficiaries of the surveys over the past four decades include the African mainland countries - Somalia, Kenya, Tanzania and Mozambique, and the island States – Seychelles, Comoros, Mauritius and Madagascar. The surveys are carried out with the participation of scientists and technicians from the region and have contributed immensely to the accumulated knowledge of the Western Indian Ocean, in diverse fields such as fisheries, biodiversity, ocean productivity, ecosystems and physical oceanography. According to Halo et al. (2017), the *Nansen* vessels have played an important role in describing the physical oceanographic processes of the WIO, often from the perspective of how they would affect fish distribution and abundance. Data from the R/V *Dr Fridtjof Nansen* surveys are maintained by the Institute of Marine Research in Bergen, Norway.

Similarly, the French vessels *Marion Dufresne* I and II worked in the WIO region over the same period of time. Information on these surveys is available on IFREMER's website (see Table 1). The R/V *Marion Dufresne* is capable of carrying out observations in all fields of ocean science - marine geosciences, marine biology, physical and chemical oceanography.

Regional projects and smaller projects wet lease commercial vessels and install scientific instrumentation on them for the duration of the project. The data from these surveys are not as readily available as those from the international operations.

While research vessels are dedicated to operating in specific areas at specific times, oceanographic data has also been collected by ships of opportunity. These commercial vessels collect data on dedicated instrumentation as they sail around the globe undertaking their normal activities. Some of these data can be found online (see Table 1). In some instances, summaries of the results of the surveys are available online but the data still need to be sourced from the host institutions.

Table 1: An exert from Appendix 1 of institutes that provide online searches for research vessel survey.

Institute/Initiative	**Vessels represented**	**Website**

IFREMER	French research vessels	https://campagnes.flotteoceanographique.fr/search
JCOMMOPS: Ship Observations Team	Voluntary observing ships and ships of opportunity operated through the Voluntary Observing Ship Scheme and Ship-of-Opportunity Implementation Panel	https://www.jcommops.org/board?t=sot
British Oceanographic Data Centre	British research vessels	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/search/
Southern African Data Centre for Oceanography	Vessels that operated in Southern African waters	http://sadcoinv.ocean.gov.za/sadco1/SadInv

4.2 Remote sensing

In this paper, remote sensing is considered as the acquisition of information about an object without making physical contact with the object. Platforms and equipment for collecting remote sensing data from the oceans include echo sounders, and Acoustic Doppler Current Profilers (ADCPs). The datasets from such sources include bathymetry (topography and substrate type). Many large oceanographic and fisheries research vessels have the necessary remote sensing equipment, e.g. echo-sounders, installed on-board while smaller vessels use towed equipment. Like echo sounders, ADCPs are installed on research vessels but they can also be moored. The ADCP measures water current velocities over various depth ranges.

Downloads of global bathymetry data are available from the National Oceanic and Atmospheric Administration (NOAA). There are data available from other programmes such as the EAF-Nansen Programme. These data are also available either online or on request depending on the host institute.

Other remote sensing data are from RADAR and LIDAR (Light Detection and Ranging) as well as aerial photographs and satellite imagery. Aerial photographs, RADAR and LIDAR datasets appear to be available mostly from the commercial sector at cost. There is, however, LIDAR data available for download without cost for Madagascar from the GEOSUD[1] website. Satellite imagery is widely available and depending on the resolution, may be freely available or have a cost associated with it. Probably the most well-known dataset is from the National Aeronautics and Space Administration (NASA) Landsat Program which has been running since 1972. All the Landsat data are available free

[1] The GEOSUD *remote sensing data and services infrastructure* project aims to develop the use of satellite imagery within the scientific community and public actors involved in environmental management and territorial development.

of charge. NASA also provides ocean biology data at no cost through its Ocean Color Web. Data include chlorophyll, sea surface temperature and fluorescence, among others, collected from the MODIS platform. The MODIS instruments image the entire Earth every 1 to 2 days and are designed to provide measurements in large-scale global dynamics including changes in Earth's cloud cover, radiation budget and processes occurring in the oceans, on land, and in the lower atmosphere. MODIS data are available from 2002 to the present. There are other satellite data available from other sources and cost depends on the resolution of the data requested. Table 2 gives the institutions that provide online searches for remotely-sensed data.

Table 2: An exert from Appendix 1 of institutes that provide online searches for remotely sensed data.

Institute/Initiative	**Data type**	**Website**
National Oceanic and Atmospheric Administration	Sonar – Bathymetry, bottom mapping	https://maps.ngdc.noaa.gov/viewers/bathymetry/
GEOSUD	LIDAR - Madagascar	http://ids.equipex-geosud.fr/web/guest/madagascar
National Aeronautics and Space Administration: Landsat Program	Satellite	https://landsatlook.usgs.gov/viewer.html
National Aeronautics and Space Administration: Ocean Colour	Satellite	https://oceancolor.gsfc.nasa.gov/l3/

4.3 Deep sea observation techniques (moorings, drifters, ROVs and AUVs, etc.)

Satellites and research vessels are expensive operations and they are not always in the area of interest or there are issues with data collection such as cloud cover, etc. A relatively affordable method of ocean data collection is through moorings and drifting buoys. A number of varieties of buoys have been deployed and their data are available online. NOAA's Environmental Research Division's Data Access Program (ERDDAP) has 32 datasets available for download. These datasets are from buoys such as the generic and Argo drifting buoys, the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) moored buoys and sea gliders. The datasets cover various atmospheric and oceanographic parameters. Some other autonomous underwater vehicle (AUV) data is available for download from the University of Washington's Seaglider® Project. Data collected by sea gliders are determined by which instruments are fitted to the gliders so not every glider collects the same types of data. Data collected may include variables such as temperature, salinity, density, current strength, etc. Recent Seaglider® deployments have, however, been limited to South Africa. AUV and remotely operated underwater vehicle (ROV) data are generally project based and the data are not immediately available for general use outside of the project. After a specified exclusion time, raw data can be requested directly from the archiving institute. Argo buoy data (currents, temperature and salinity profiles) can also be accessed through

the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) website. While this is a global dataset, specific areas can be selected. JCOMM also provides sites of moored and other generic drifting buoys. Table 3 shows some of the institutes that provide online searches for buoy and autonomous underwater vehicle data.

Table 3: An exert from Appendix 1 of institutes that provide online searches for buoy and autonomous underwater vehicle data.

Institute/Initiative	**Platforms**	**Website**
National Oceanic and Atmospheric Administration: Environmental Research Division's Data Access Program (ERDDAP)	Drifting and moored buoys, sea gliders	http://osmc.noaa.gov/erddap/index.html
University of Washington: Seaglider® Project	Sea gliders	http://iop.apl.washington.edu/seaglider/index.php
Joint Technical Commission for Oceanography and Marine Meteorology: Argo	Argo and generic drifting buoys, moored buoys	https://www.jcommops.org/board?t=jcommops

5. REGIONAL AND NATIONAL DATA CENTRES

Data Centres are very important facilities that are essentially networks of connected servers, primary objectives of which are to secure, store and disseminate data. They are to ensure that the best available scientific data and local knowledge are shared and incorporated in planning and policy development at the national and regional level. This is particularly important for large datasets. These data centres are also expected to improve accessibility to data thus allowing the data to be used for scientific research and management of various ecosystems.

For oceanographic data, a key player is the International Oceanographic Data and Information Exchange (IODE) programme of the Intergovernmental Oceanographic Commission (IOC) of UNESCO. Its purpose is "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 (GOSR, 2018). According to Garcia et al. (2018) the data centres have a mandate to manage all ocean-related data variables including physical oceanography, chemical, biological, etc. The IODE established a network of National Oceanographic Data Centres (NODC) throughout the world and all WIO countries are represented with the exception of Yemen and Somalia. Certain organisations have been designated by the governments of the WIO Member States as the official oceanographic data centres for each country (Table 4). Also designated are personnel to manage the centres. The number of scientific personnel in the fields of oceanography and related disciplines in each country is also given through the related site https://www.oceanexpert.net. Through the IODE network substantial amounts of ocean data

and observations, have been collected, archived and made available to Member States. Thus, the IODE Programme ensures accessibility to oceanographic data, metadata and information.

The IOC of UNESCO's Ocean Data and Information Network for Africa (ODINAFRICA) project brought together marine related institutions from African Member States with the aim of enabling them to get access to data available in other data centres, develop skills for manipulation of data and preparation of data and information products. It also looked at development of infrastructure for archival, analysis and dissemination of the data and information products, develop data and information products required for integrated management of the coastal areas of Africa(www.odinafrica.org). Each of the participating institutions developed a suite of data and information products that have been quality controlled, merged and availed through project website. Examples are Directories of marine and freshwater professionals, Catalogues of marine related data sets, Marine Species data bases, catalogue of marine related publications from/about Africa.

There are, also, other data centres that are not part of IODE list that also store and distribute WIO ocean-related data. These include the Southern African Data Centre for Oceanography (SADCO), the Partnership for Observation of the Global Oceans (POGO) and the Indian National Centre for Ocean Information Services (INCOS) which is a unit of the Earth System Science Organization (ESSO). ESSO-INCOIS is mandated to provide the best possible ocean information and advisory services to society, industry, government agencies and the scientific community through sustained ocean observations and constant improvements through systematic and focused research.

There have been other data centres created as part of projects but their current functionality is questionable. One of these is African Coastal and Marine Atlas developed by ODINAFRICA III, in collaboration with the African Coelacanth Ecosystem Programme (ACEP) and the United Nations Environment Programme (UNEP). It does not work across all browsers (layers do not display in Chrome and Explorer) and the Open metadata and Download data options do not work at all. The search functionality also appears to be compromised. When looking forward to re-establishing a data portal for the region, this atlas would be an ideal candidate for resurrection. Another option that is already established is the Nairobi Convention Clearinghouse Mechanism (NCCM) which currently includes only 12 records. The ASCLME Project incorporated in its data policy that an inventory of new data would be lodged with the NCCM and data would be archived at the SADCO and the World Data Centre for Oceanography (now named World Ocean Database). The NCCM does not hold the ASCLME data inventory, SADCO has summaries from three RV *Dr Fridtjof Nansen* surveys co-sponsored by the ASCLME project, and the World Ocean Database (WOD) has no record of project data for the ASCLME project. This does not, however, exclude the possibility that the data were included as they could have been included without a project name.

A data centre was set up at the Kenya Marine and Fisheries Research Institute (KMFRI) for all the data collected during the South West Indian Ocean Fisheries Project (SWIOFP). Unfortunately, this digital library, as it was termed, is now only available to users who access the server from the KMFRI premises in Mombasa, Kenya. These and additional data centres and portals are listed in Appendix 1.

6. THE AVAILABLE RELEVANT DATASETS AND THEIR MANAGEMENT

There are many relevant datasets available to researchers in the WIO region (see Appendix 1). They differ in their scale, the collection platforms, the sensors that were used and the amount of post-collection processing that has been done. The datasets are generally large and complex necessitating capital investment in their storage and distribution. The large institutes and multinational commissions that are well-funded tend to have the most accessible data. Examples are from IFREMER, NASA and NOAA. This does not, however, mean that all data for a particular country are stored on one server in one locality. Many online data storage access points are portals that direct users to the appropriate server rather than using only one source.

National datasets are not always readily available online and are generally scattered over more than one national institute. This makes it more challenging for users to access all the relevant data required. Unless specific institutional/project data policies are in place, data are not made easily discoverable. These data may be stored on local servers or desktop computers. This is particularly the case with smaller projects that may have collected valuable data but not registered it on a meta-database or an archiving portal.

Appendix 1 provides details of some institutes and initiatives that have collected data and it provides some indication of the accessibility of the data as well as hurdles that need to be overcome to gain access.

As mentioned previously, the storage of the large datasets that accumulate from oceanographic sampling require a substantial capital investment in servers and personnel to set up and maintain the data servers and portals. Often there is an investment in these activities during projects but when they projects are concluded the servers and portals are no longer maintained. It seems, therefore, a better option to incorporate data storage on servers and portals that have proven track records when it comes to longevity.

Table 4: International Oceanographic Data and Information Exchange (IODE) list of Western Indian Ocean National Data Centres, National Coordinators and their contact details (https://www.iode.org/index.php?option=com_content&view=article&id=61&Itemid=100057)

Country	Contact	Institute / Person	Email	Website
Comoros	Data Centre host	Centre National de Documentation et de Recherches Scientifiques	cndrs@comorestelecom.km	http://www.cndrs-comores.org/
	National Coordinator	Ahmed ABDOULKARIM	a_abdoulkarim@yahoo.fr cdo.cndrs@comorestelecom.km	
Kenya	Data Centre host	Kenya Marine and Freshwater Fisheries	director@kmfri.co.ke	http://www.kmfri.co.ke
	National Coordinator	Mr. Harrison ONGANDA	honganda@kmfri.co.ke	
	IODE NC for information management	Mr Elijah MOKAYA	emokaya@kmfri.co.ke emokaya2001@yahoo.com	
Madagascar	Data centre host:	Institut Halieutique et des Sciences Marines	contact@ihsm.mg	http://ihsm.mg
	National Coordinator	Mr. John BEMIASA	j.bemiasa@ihsm.mg	
	IODE NC for information management	Dr. Tsarahevitra JARISOA	jers_jarisoa@hotmail.com jarisoa@assocout.org	

Country	Contact	Institute / Person	Email	Website
Mauritius	Data Centre host:	Mauritius Meteorological Services	meteo@intnet.mu	http://metservice.intnet.mu
	National Coordinator	Mr. Krisna BUCHA	krisnabucha@gmail.com	
Mozambique	Data Centre host	Insituto Nacional de Hidrografia e Navegaco	inahina@inahina.uem.mz	http://www.inahina.gov.mz
	National Coordinator	Ms. Clousa MAUEUA	clousam@yahoo.com.br clousamaueua@gmail.com	
Seychelles	Data Centre host:	Seychelles Fishing Authority	management@sfa.sc	http://www.sfa.sc
	National Coordinator	Mr. Calvin GERRY	cgerry@sfa.sc calvingerry@gmail.com	
	IODE NC for information management	Ms. Denise MATHIOT	dmathiot@sfa.sc denise.mathiot@gmail.com	
South Africa	Data Centre host:	Department of Environmental Affairs		
	Council for Scientific and Industrial Research, Stellenbosch (African OBIS node)	Council for Scientific and Industrial Research, Stellenbosch		http://www.csir.co.za

Country	Contact	Institute / Person	Email	Website
Tanzania (United Republic of)	Data Centre host:	University of Dar es Salaam, Institute of Marine Sciences	director@ims.udsm.ac.tz	https://ims.udsm.ac.tz
	National Coordinator	Prof. Desiderius MASALU	masalu@ims.udsm.ac.tz d.masalu@odinafrica.net	
	IODE NC for information management	Ms. Fatma UKI	ukifatma@gmail.com	

7. AN ASSESSMENT OF ACCESS TO, AND SHARING OF THE DATA.

7.1 National and regional approaches for oceanographic data and information exchange

According to IOC, "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". IOC Oceanographic Data Exchange Policy stipulates that Member States shall provide timely, free and unrestricted access to all data, associated metadata and products generated under the auspices of IOC programmes. Member States are also "encouraged to provide timely, free and unrestricted access to relevant data and associated metadata from non-IOC programmes that are essential for application to the preservation of life, beneficial public use and protection of the ocean environment, the forecasting of weather, the operational forecasting of the marine environment, the monitoring and modelling of climate and sustainable development in the marine environment".

These notwithstanding, several national datasets are not always readily available online and are generally scattered over more than one national institute. These data may be stored on local servers or desktop computers. Such datasets are not easily discoverable nor made readily available.

The main objectives of the IODE Programme are to: (i) facilitate and promote the discovery, exchange of, and access to, marine data and information, including metadata, products and information, through the use of international standards, and in compliance with the IOC Oceanographic Data Exchange Policy for the ocean research and observation community and other stakeholders; (ii) encourage the long-term archival, preservation, documentation, management and services of all marine data, data products, and information; (iii) develop or use existing best practices for the discovery, management, exchange of, and access to marine data and information, including international standards, quality control and appropriate information technology; (iv) assist Member States to acquire the necessary capacity to manage marine research and observation data and information and become partners in the IODE network; and (v) support international scientific and operational marine programmes, including the Framework for Ocean Observing for the benefit of a wide range of users.

7.2 Institutional/National/Regional Data Policies

With the exception of the IOC Oceanographic Data Exchange Policy and others for the EAF-Nansen Programme and the ASCLME project, we did not come across any modalities/framework/protocols for ensuring data ownership, access and quality control of national and regional oceanographic data and information.

Policy on the access and use of data collected in the R/V Dr Fridtjof Nansen surveys (Nansen Data Policy)

The Nansen Data Policy (EAF-Nansen Project, 2015) is intended primarily to guide and regulate access to the data collected during the R/V *Dr Fridtjof Nansen* surveys, their distribution, especially to third parties, and the use of such data for the good of the beneficiary countries and regions. The Policy also looks at management of the data, especially from cooperative surveys carried out with partner institutions. The Nansen Data Policy is intended to facilitate and encourage extensive use of the data collected in the surveys as well as producing accurate information from the data for management purposes and for scientific publications. It also encourages the establishment of strong linkages between the use of the data and capacity development of scientists and technicians from developing countries where the surveys were conducted.

Under the EAF-Nansen Programme, all data collected through the surveys within national EEZs are owned by the respective countries. Each country receiving the services of the R/V *Dr Fridtjof Nansen* is expected to specify which institution will be the main partner in carrying out the survey, have the responsibility for receiving the data collected, and represent the country as "data owner". Data collected in international waters are owned by the Regional Fisheries Management Organization (RFMO) or Regional Fisheries Body (RFB) that manages or oversees the resources in the particular region, and the countries that are members of the RFMO of RFB. Data obtained from surveys that are co-funded by partner projects (like the LME projects that act on behalf of the countries participating in the project) must also be supplied to the partner projects. The subsequent distribution and use of data and all publications that use the data are also to be guided by the data policies of the partners. No data and information obtained from the R/V *Dr Fridtjof Nansen* surveys may be traded or used for commercial gain.

Unless restrictions are stipulated by the data owner, environmental data (temperature, salinity, oxygen, plankton) can be made publicly available immediately after the survey. Fish abundance data older than 5 years, from the date of collection, are to become publicly available, unless restrictions are specified by the data owner for reasons of confidentiality.

Data management agreement for cruises undertaken under the ASCLME Project

The ASCLME Data Management Agreement (ASCLME, 2008) outlines the principles and guidelines for ASCLME data and information management so that it facilitates the effective collection, use and dissemination of information in support of TDA/SAP development in the short term and the ecosystem approach in the long term. The Agreement was intended to govern the collection, storage and access to data on the ASCLME 2008 Cruises and to clarify and protect the interests of all scientists and countries. National Data and Information

coordinators in particular, have a responsibility for developing mechanisms for reliable long-term storage and use of information collected under the ASCLME Project.

There is understanding in the agreement that data collected was to be shared freely between the ASCLME project and the SWIOFP bearing in mind that access to new data, associated metadata, information collection activities and resulting products funded by the ASCLME Project would be free and unrestricted. The primary custodians of data sets would be the ASCLME Project and the member-countries of the ASCLME Project. The primary contact points and archive locations for ASCLME-generated data would be at nationally appointed data centres as well as through the ASCLME Project Coordination Unit. The intellectual property of new data, associated metadata, information collection activities and resulting products funded by the ASCLME Project resided with the principal investigator (in the case of a scientific investigation), the institution to which the scientist belongs, the participating country and the ASCLME Project.

8. CAPACITY DEVELOPMENT FOR DATA CENTRES MANAGERS AND DATA MANAGEMENT

Data management includes a wide range of activities related to assembling of data, the assessment of the quality and completeness of the data, archiving, and the dissemination of archived data to users (Austin *et al.*, 2016). Member States of IOC are encouraged to enhance the capacity in developing countries to obtain and manage oceanographic data and information and assist them to benefit fully from the exchange of oceanographic data, associated metadata and products.

The IOC Training Education and Mutual Assistance (TEMA) programme and other relevant IOC programmes are designated channels for the capacity development initiative. The IODE Programme has developed an active training programme to address the problem of non-existent formal education related to oceanographic data management. IODE operates its OceanTeacher Global Academy programme (OTGA) that provides continuous professional development for staff of the data centres associated with the IODE network. The OTGA is “a global network of Regional Training Centres (RTC) delivering customised ocean training for ocean experts and practitioners, contributing to the IOC mandate”. In Africa, there are Regional Centres in Kenya (Kenya Marine & Fisheries Research Institute, Mombasa), Mozambique (School of Coastal & Marine Sciences, Eduardo Mondlane University, Quelimane), Senegal (Institut Senegalais de Recherches Agricoles/Centre de Recherches Oceanographiques de Dakar-Thiaroye (CRODT) and South Africa (AfriCOG/Rhodes University, Grahamstown).

9. GUIDELINE TO SUPPORT COUNTRIES IN DEVELOPING A ROADMAP FOR REVIVING THE NATIONAL DATA CENTRES DEVELOPED DURING THE ASCLME PROJECT

9.1 Guidelines for developing a roadmap for reviving the national data centres (developed during the ASCLME project)

The ASCLME project recognized that the countries have institutions that have mandates for collection and management of certain marine related data. Consequently, member countries of the Project were identified as the primary custodians of datasets hence the primary contact points and archive locations for ASCLME-generated data. Selected institutions in the countries were designated as National Data Centres and data and information coordinators were appointed from each country (Table 5). The ASCLME Project offered to provide appropriate support and training to the Data Centres to enable them to function as required.

The Centres were expected to use internationally accepted standards and best-practices for data collection and management and the ASCLME Project offered to support the coordination of effort across the region for the promotion of access to coastal and marine-related information in appropriate forms, to underpin informed ecosystem management decisions[2].

To have data centres function under the Sapphire Project it may be a good idea to use the same institutions and revive the data centres supported by the ASCLME project. The first step in reviving the data centres would be to contact the institutions and coordinators to establish their willingness to continue as the data and information coordinators for the SAPPHIRE Project. The steps detailed below are suggested to see to the functioning of the data centres under SAPPHIRE.

Assess the current status of the data center and the facilities. In each country, it will be necessary to carry out a quick assessment of the current status of the ASCLME/National ocean-related Data Centre, including the facilities, hardware and software. In this process, it is important to think about the type of Data Centre that will serve the needs of the project and the country effectively as well as how much technology is available and the objectives for the Centre. It is necessary also to understand the current IT environment and how this will evolve over time.

Categorise data needs and take stock of the required data for each category. The inventory provided in Appendix 1 is a start to this process. Data categories need to be defined and available data should be appended to each category.

Identify sources of data (nationally, regionally, and internationally). Once again Appendix 1 is a start to this process but there are many other sources of data available and members should add to the appendix where possible.

Select a metadata format and prepare metadata of the data and information. The metadata format needs to incorporate geographic data as almost all oceanographic data has spatial

[2] (www. ASCLME.org)

context. There are a few options: ISO/TC 211 currently used by the FAO GeoNetwork metadatabase, the International Organization for Standardization's ISO 19115-1:2014 or the Content Standard for Digital Geospatial Metadata (GSDGM) maintained by the Federal Geographic Data Committee (FGDC). Once a format has been selected the metadata for each dataset should be prepared.

Selection of Data portals. A data portal is "*a list of datasets with pointers to how those datasets can be accessed".* Once there are more than a handful of datasets then it is necessary to help users discover the datasets that are of interest to them and provide the facility to search and browse through the list[3]. There are issues to consider in the selection of a suitable data portal (e.g. co-location solutions, managed services, managed hosting) and it is essential to resolve this at the onset.

Prepare data sharing protocols (with national, regional and international institutions). Data sharing of existing data is dependent on the limitations/restrictions placed on the data by the data originators. It therefore necessitates that protocols need to be developed with those institutions that would contribute to the data centre. This contribution might only be a metadata entry with a link to their own data portal or it may involve the storage of their data at the regional/national data centre. These conditions will be captured in the metadatabase. Any data collected under the SAPPHIRE Project must be subject to the data sharing policies of the project, something that needs to be discussed and finalised with the partner countries and others. Typically, these policies allow for data sharing among project members during the project lifespan as well as for a limited period after the project (e.g. 3 – 5 years) after which the data become more accessible to the wider community.

The IOC of UNESCO encourages Member States to use data centres linked to IODE's National Oceanographic Data Centres (NODCs) and World Data Centre (WDC) networks as long-term repositories for oceanographic data and associated metadata with established data sharing protocols. IODE Ocean Data Portal (ODP)[4] provides an approach to oceanographic data held by the IODE global network of NODCs, as well as to resources from other participating systems.

Assess and implement training of data centre managers. Training of Data Centre managers is necessary to ensure that staff there are capable of providing the necessary services to the oceanographic community. Part of the data management team must be composed of computer experts, who maintain the data processing systems and write the necessary software for processing. To design and build a good data management system, it is crucial to have a combination of computer expertise and subject-matter expertise, working together.

Prepare clear Data Policy (define ownership, access, patent, etc.). A data policy needs to be formulated sooner rather than later to provide absolute clarity to all the users of the data

[3] (https://blog.ldodds.com/2015/10/13)

[4] (http://www.oceandataportal.org)

centres on how the data may be used and accessed without contravening any restrictions that have been placed on the data. It also provides data originators with confidence to share their data without fear of it being abused.

Prepare communication and data sharing procedures. Well thought out procedures encourage the use of data centres and contribute to their relevance and longevity. They provide clear-cut instructions on how data may be added to the data centre with minimal effort which goes a long way to encourage use of the data centre. Similarly, procedures that detail how data may be accessed encourage other users to frequent the data centre for their data requirements. All electronic traffic through the data centre is a measure of the relevance and success of the centre. Regular communication about the data centre keeps the centre in the forefront of data users' minds encouraging them to use the centre for data dissemination, storage, archiving and retrieval.

The Data Centre should have access to high-quality and stable electrical energy and internet connectivity, be away from flood-prone areas, have suitable operating temperature for the machines and the location should allow for future growth. Safety and security have to be considered as the servers need to be protected against unauthorized access.

Mainstream management of the data centre within national/institutional workplan and budget. Setting up data centres is a costly activity that requires the purchase of hardware, software and internet resources, as well as the allocation/hiring and training of staff. It is important that data centres designated or developed under SAPPHIRE will have the means to survive longer than the project. Mechanisms should be put in place to ensure the longevity of the metadata base and data portals. Many data portal initiatives have been set up during the lifespan of individual projects but as soon as the projects end so too does the availability of the data. Examples are the Ocean Data Collections and Catalogues developed under ODINAFRICA and the data portal for the South West Indian Ocean Fisheries Project held at Kenya Marine and Fisheries Research Institute. The lack of continued funding results in these systems receiving no maintenance or attention and they become relics that are of little use to the wider oceanographic community.

Thus, activities associated with the dissemination, storage and archiving of data should be incorporated in staff duties and not seen as an ad hoc activity. Operation of the Data Centre should be mainstreamed in national/institutional work plan and budget.

Table 5: National Data and Information Coordinators for the ASCLME Project (www.asclme.org)

Country	Institution	Official Representative	Alternate	Contact Details
Comoros	Ministry of Agriculture, Fisheries and the Environment (MAPE)	Mr. Farid Anasse	Yahaya Ibrahim	farid_anasse@yahoo.fr; yahayaim@yahoo.fr
Kenya	Kenya Marine and Fisheries Research Institute (KMFRI)	Mr. Harrison Onganda		honganda@kmfri.co.ke
Madagascar	Office National pour l'Environnement (ONE)	Mr. Jean-Roger Rakotoarijaona		jroger@pnae.mg; jr.rakotoarijaona@gmail.com
Mauritius	Mauritius Meteorological Services (MMS)	Mr. Mohamudally Beebeejaun	Renganaden Virasami	m.bbjohn@odinafrica.net; vganessen@yahoo.com
Mozambique	Instituto Nacional de Hidrografia e Navegação (INAHINA)	Ms. Clousa Maueua	Obadias Cossa	clousam@yahoo.com.br
Seychelles	Policy Planning and Services Division, Ministry of Environment, Natural Resources and Transport	Mr. Justin Prosper	Michelle Etienne	j.prosper@pps.gov.sc; justinpros@hotmail.com; m.etienne@scmrt-mpa.sc
South Africa	South African Environmental Observation Network (SAEON)	Dr. Juliet Hermes		juliet@saeon.ac.za
Somalia	Ministry of Fisheries	Mr. Ali Sabriye		ali.sabriye@gmail.com
Tanzania	Institute of Marine Sciences	Dr. Desiderius Masalu	Dr. M. Kyewalyanga	masalu@ims.udsm.ac.tz
France (Observer)	IRD-EME	Dr. Jean-Francois Ternon		Jean.Francois.Ternon@ifremer.fr
PCU	ASCLME Project Office	Ms. Lucy Scott		Contact

9.2 Modalities/frameworks/protocol for ensuring data ownership, access and quality control

The main objective of data management is to ensure safe and long-term storage of data and metadata so that present and future users are able to use all of the data that have been collected over time. Delivery of data and metadata is, therefore, a vital step.

An archive must be able to respond, in a timely way, to requests for the data and information it holds, and to deliver these to a user in a way that is suitable for their purposes. The user community of an archive is not solely the same people who provide data; rather, the users may include a diverse range of other actors from public (e.g. policy-makers) and private sectors. It is important that data managers also include information about how the data were collected, the instruments used, including the precision of the instrumentation, the collection procedures, and when the data were collected. The inclusion of this metadata in data management procedures is crucial.

Modalities, frameworks and/or protocols need to be developed to ensure that the storage and archiving of data are done in such a way as to provide the most benefit to the oceanographic data user community while at the same time ensuring that the original stipulations for use and dissemination of the data are honoured. Since the data are of a geographic nature it would be best to record the metadata for each dataset in one of the recognized geographic metadata standards These standards allow for the recording of aspects such as ownership of the data, the access and use constraints as well as geographic positions, data collection dates, etc. The metadatabase would provide a portal to either the data servers if the data are publicly accessible or to the contact person should there be restrictions placed on the access and use of the data.

Data centres need to meet the following six characteristics to ensure that data are of good quality (KCP, 2010):

- Accuracy - data should be sufficiently accurate for their intended purpose and where there are limitations, this should be made clear to the users
- Validity – data should be collected in accordance with standardized methodologies
- Reliability – data should reflect stable and consistent data collection processes
- Timeliness – data should be made available as quickly as possible after collection within reasonable time periods, or periods stipulated by the data collector
- Relevance – the data should be relevant to the field of oceanography
- Completeness – data should reflect the entire collection without any omissions

KCP (2010) also outlines principles that would be beneficial to include in the protocols for the national and regional data centres. These fall under three larger headings of Awareness, Collecting and recording, and Evaluating. The below have been adapted from the original document:

- AWARENESS
  - Responsibility for data quality is clearly assigned and everyone understands their role.
  - Members at all levels recognise why data quality is important and it is seen as part of the work.
  - Third parties which provide data are made aware of the value placed on data quality and set high standards.
- COLLECTING AND RECORDING
  - Indicator definitions and associated guidance are readily available and well understood.

- Systems and processes are fit for purpose and operate efficiently.
- Procedure notes, guidelines and training are used to ensure members/staff have the skills and knowledge to correctly collect, store and archive data.
- Data is held securely and used and shared in compliance with all requirements as stipulated by the data originator/owner.

- EVALUATING
  - Data are subject to proportionate verification to check accuracy, validity, relevance and completeness.
  - Arrangements for providing data are evaluated proactively and any deficiencies reported and remedied.
  - There is a region-wide approach to data quality which is reviewed regularly

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Appendix 1: Inventory of some of the initiatives and institutes that collect oceanographic data relevant to the WIO region

Responsible Institute	Country	Initiative	Platform/Data type	URL	Dataset	Period	Coverage	Access
Consortium	KEN, TAN, MOZ, RSA, SEY, MAU, MAD, COM	South West Indian Ocean Fisheries Project	Fisheries, oceanography	Currently not available	Various surveys, rapid assessments and data collation exercises	2009-2013	KEN, TAN, MOZ, RSA, SEY, MAU, MAD, COM	Data are stored on servers at KMFRI, need to clarify access rights
Department of Environmental Affairs: Oceans and Coasts (DEA:OC)	RSA	Southern African Data Centre for Oceanography	Multi-disciplinary marine information	http://sadco.ocean.gov.za/	Various	1920 - 2019	KEN, TAN, MOZ, RSA, SEY, MAU, MAD, COM	Public
ESSO - Indian National Centre for Ocean Information Services	IND		Location, temperature, salinity, density from Argo Buoys	https://incois.gov.in/argo/ADV.jsp	18 databases and one nc file	2001 - 2017	IO	Public
Food and Agriculture Organization of the United Nations	ITA	GeoNetwork	Applied Ecology, Base Maps, Remote Sensing, Biological and Ecological Resources, Climate, Fisheries and Aquaculture, Hydrology	http://www.fao.org/geonetwork/srv/en/main.home	Only 15 files available for download from the WIO, not very useful	1978 - 2009	WIO	Public
Remote Sensing Centre (AgroParisTech, CIRAD, IRD and Irstea)	FRA	GEOSUD	LIDAR data	http://ids.equipex-geosud.fr/web/guest/madagascar	1 zip file with sharefiles, text and jpeg files	???	MAD	Public

Responsible Institute	Country	Initiative	Platform/Data type	URL	Dataset	Period	Coverage	Access
IFREMER	FRA	Marine Data Portal	Oceanography, Fisheries	http://data.ifremer.fr/			FRA, ATF, WIO	Public
Institute of Marine Research/Food and Agriculture Organization of the United Nations	NOR / ITA	EAF-Nansen Programme	Oceanography, Fisheries, Pollution	http://www.fao.org/in-action/eaf-nansen/en/	RV Dr Fridtjof Nansen	1975 – 2018 (not continuous)	KEN, TAN, MOZ, RSA, SEY, MAU, MAD, COM	Country permission required for data more recent than 5 years
Joint Technical Commission for Oceanography and Marine Meteorology	FRA	Ocean Data Portal	Physical and chemical oceanography – mostly metadata Argo, drifting and moored buoys	http://www.oceandataportal.net/portal https://www.jcommops.org/board?t=jcommops,	351 datasets	1889 – 2019	Global	Public
Joint Technical Commission for Oceanography and Marine Meteorology	FRA	Voluntary observing ships and ships of opportunity operated through the Voluntary Observing Ship Scheme and Ship-of-Opportunity Implementation Panel	Surface meteorological observations, plus sub-sets for upper air meteorological and upper ocean physical data	https://www.jcommops.org/board?t=sot	88 cruises in Indian Ocean	1987 – 2019	Global	Public
Kenya Marine and Fisheries Research Institute	KEN	Surveys on R/V *Mtafiti*	Oceanography, macrobenthos, sediments				KEN	???

Responsible Institute	Country	Initiative	Platform/Data type	URL	Dataset	Period	Coverage	Access
Mauritius Oceanography Institute	MAU	Oceanographic Data Mapping	Oceanography, Genetics, Biology, Aquaculture	http://moi.govmu.org/online-databases			MAU	On request
Nairobi Convention		Nairobi Convention Clearinghouse mechanism	Sustainable 'data shop', providing accurate and relevant data and information for improved management and protection of the coastal and marine environment in the in the Western Indian Ocean region	http://staging1.unep.org/emunyao/ncchm/discover-data	12 records	2001 - 2017	WIO	Public
National Aeronautics and Space Administration	USA	LANDSAT	Satellite	https://landsat.gsfc.nasa.gov/data/where-to-get-data/	Raster images	1972 - 2109	Global	Public
National Aeronautics and Space Administration	USA	OceanColor Web	Satellite	https://oceancolor.gsfc.nasa.gov/data/overview/	Raster images	2002 - 2019	Global	Public
National Oceanic and Atmospheric Administration	USA	Bathymetry Data Viewer	Single beam sonar	https://maps.ngdc.noaa.gov/viewers/bathymetry/	233 cruises	1956 - 2016	Global	Public

Responsible Institute	Country	Initiative	Platform/Data type	URL	Dataset	Period	Coverage	Access
National Oceanic and Atmospheric Administration	USA	ERDDAP	Oceanographic data from satellites and buoys	http://osmc.noaa.gov/erddap/index.html	31 datasets	1970 - 2019	Global	Public
National Oceanic and Atmospheric Administration	USA	Global Ocean Heat and Salt Content	Temperature, sea level and salinity	https://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/	Distribution figures	1960 - 2019	Global	Public
National Oceanic and Atmospheric Administration	USA	TAO Project - Global Tropical Moored Buoy Array	Position and sea surface temperature data along with other meteorological data	https://www.pmel.noaa.gov/tao/drupal/disdel/	Data from 4 moored buoys in the WIO off the east coast of Madagascar	2000 - 2019	Global	Public
National Oceanic and Atmospheric Administration	USA	Temperature, Nutrients, Plankton, Salinity, Oxygen, Coral Reef, Ocean Currents, Chlorophyll, Sea Level, Waves, pH	All data products available	https://www.nodc.noaa.gov/archivesearch/catalog/search/browse/browse.page	netCDF files	1800 - 2019	Global	Public
National Oceanic and Atmospheric Administration	USA	World Ocean Database	Oceanography	https://www.nodc.noaa.gov/OC5/WOD/pr_wod.html https://www.nodc.noaa.gov/OC5/SELECT/dbsearch/dbsearch.html	Large set of data that can be refined on locality, datatype and date	1800 - 2018	Global	Public

Responsible Institute	Country	Initiative	Platform/Data type	URL	Dataset	Period	Coverage	Access
National Oceanography Centre	U.K.	British Oceanographic Data Centre	Research vessels	https://www.bodc.ac.uk/resources/inventories/cruise_inventory/search/	6 cruises	1975 - 2006	MOZ Channel	Public
ODINAFRICA	Online	Ocean Data Collections and Catalogues	Metadata for ocean station data, satellite analyses, ocean climatology, weather climatology, geology, base mapping, ecology, fisheries.	http://geonetwork.iode.org/geonetworkAMA/srv/en/main.home	A catalogue of datasets but the search page does not work.	1989 - 2014	WIO	Public
ODINAFRICA III, in collaboration with the African Coelacanth Ecosystem Programme (ACEP) and the United Nations Environment Programme (UNEP)	Online	African Coastal and Marine Atlas	Phytoplankton, Chlorophyll/pigments Zooplankton, Etc.	http://www.africanmarineatlas.org/	Over 800 downloadable spatial data products	Various	MAD, MAU, MOZ, SEY, TAN	Public

Responsible Institute	Country	Initiative	Platform/Data type	URL	Dataset	Period	Coverage	Access
SeaDataNet: National Oceanographic Data Centres (NODCs) from 35 countries	USA	Partnership for Observation of the Global Oceans (POGO)	Physical and chemical oceanography, Contamination, Biology and Fisheries, Meteorology, Geology and geophysics	http://seadata.bsh.de/csr/retrieve/pogo_index.html	284 cruise summaries from the Indian Ocean	1978 - 2019	Global	Public
University of Washington	USA	Seaglider Project	Autonomous underwater vehicles - gliders	http://www.apl.washington.edu/project/project.php?id=seaglider http://iop.apl.washington.edu/seaglider/index.php	Variable	2017 - 2019	Various, most recently RSA	Public
South African Environmental Observation Network	RSA	SAEON Data Portal	Oceanography.	http://www.saeon.ac.za/data-portal-ac	Not of relevance to the WIO. It is a good example of a functioning metadatabase from which data can be downloaded	1950 - 2019	RSA	Public