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IOC/IODE-XXVII/6.5
Oostende, 2 March 2023
English only

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

Twenty-seventh Session of the IOC Committee on International Oceanographic Data and Information Exchange (IODE-XXVII)

UNESCO Headquarters, Paris, 22-24 March 2023

ODIS Current Status and future plans

1 INTRODUCTION

The world is undergoing continuous and expanding technological and digital revolutions, transforming global economies, societies, and the data and information landscape which underpins them. These revolutions are unfolding at different paces and with different impacts across Member States, which each have distinct needs, priorities, and challenges to address. The global digital transformation is also rapidly changing the relationship of the public to the ocean upon which we all depend.

Over its 60+ years of operation, the International Oceanographic Data and Information Exchange (IODE) has worked with Member States to enhance marine research, exploitation and development, by facilitating the exchange of, and by meeting the needs of, users for data and information products. As such, it supports Member States in meeting the Sustainable Development Goals, the Paris Agreement on Climate Change, and the Sendai Framework on Disaster Risk Reduction.

To continue to pursue its mission in an age of rapid and uneven digital transformations across nations, the IODE has initialised the Ocean Data and Information System (ODIS), and is demonstrating its value and utility through the Ocean InfoHub (OIH) Project. ODIS is rapidly transforming and modernising data and information exchange across its growing federation of partners, and is firmly rooted in the principles of multilateralism and collective interest in directing digital capacity to the wellbeing of the oceans and humanity.

Below, a briefing on the current state and future goals of ODIS is presented. The initiative's success – well beyond its original goals – has created new opportunities to support IODE's mission in the new realities of our digital age.

2 The Ocean InfoHub (OIH) and ODIS

IODE has documented over 3000 online repositories of ocean data and information, which shows the highly complex online environment, and challenge of finding the right information from the right source (ODISCat 2023-01; https://catalogue.odis.org). It is this challenge that ODIS – through the Ocean InfoHub Project – is addressing.

The Ocean InfoHub (OIH) Project, funded by the Government of Flanders, Kingdom of Belgium, and co-funded by NORAD, has supported the initial development of the Ocean Data and Information System (ODIS). Further, OIH builds upon the digital exchange and interoperability offered by ODIS, to create a global portal for all users to discover data, information, and other digital assets shared by ODIS partners. OIH focuses on three pilot regions (Africa, Latin America and the Caribbean region, and the Pacific Small Island Developing States), to facilitate a process of co-design for the ODIS-architecture, and to enable a diverse array of partners to test and ensure ODIS is fit for all. The project's first phase will end in June 2024.

ODIS is not a new portal or centralised system under the control of a single authority, but a partnership of distributed, independent systems voluntarily sharing (meta)data and information along co-developed and clear conventions in the pursuit of common goals. These conventions are formalised and operationalised in the ODIS Architecture (ODIS-Arch) to allow existing and emerging ocean data and information systems, from any stakeholder, to interoperate with one another. This enables and accelerates more effective development and dissemination of digital technology and sharing of ocean data, information, and knowledge. IODE's role is one of coordination and facilitation, ensuring that partners have equitable influence in the evolution of the system, and that it serves their interests and accommodates their concerns.

ODIS provides the technological capacity and coordination framework to allow these systems - including the global network of NODCs and ADUs – to sustainably interlink with one another, sharing content they wish to share in a manner under their control. In this manner, ODIS is a foundational ocean digital ecosystem, with high scalability and the potential to progressively deepen and broaden interoperability across diverse stakeholders. Products and services can be built on top of the ODIS ecosystem to meet numerous policy and management demands. This can significantly raise the profile of the IODE network on the global stage, while allowing IODE to share its capacities and experience with new partners.

The overarching goal of the Ocean Data and Information System (ODIS) is to provide a sustainable and responsive digital ecosystem where users can discover data, data products, data services, information, information products and services provided by IOC Member States, independent projects, and other partners associated with the UN Decade of Ocean Science for Sustainable Development.

3 Key achievements of the Ocean InfoHub and ODIS

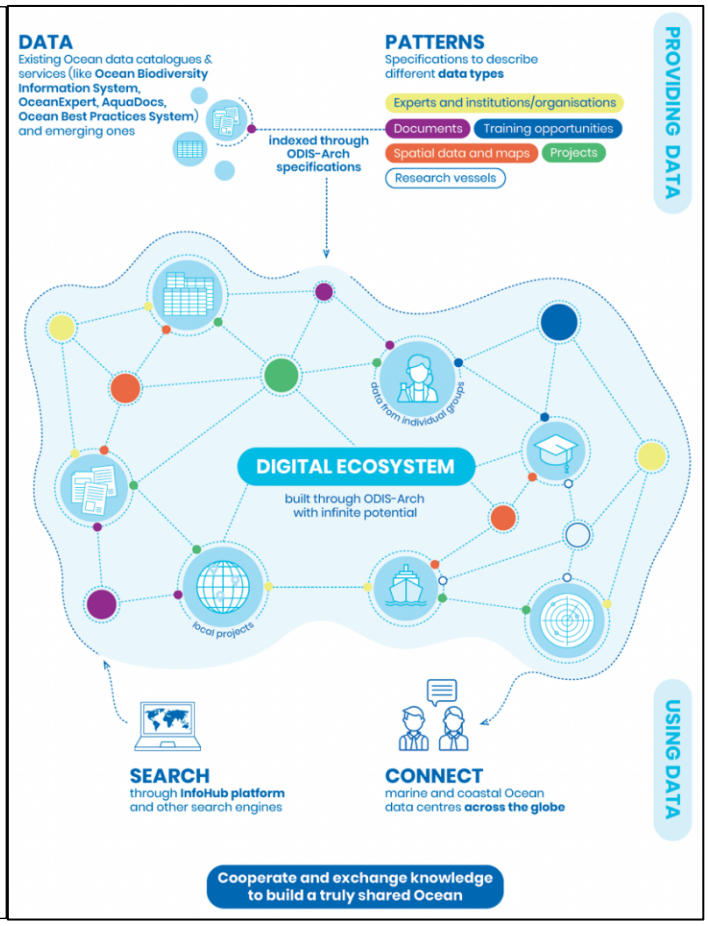
OIH has established the foundational technology and collaborative culture needed to build the IOC Ocean Data and Information System (ODIS). Since 2020, the ODIS technology has been implemented and tested with partners from across the globe, demonstrating that multiple data systems can interoperate with IOC systems and with each other across a range of information types through machine-to-machine interactions. This greatly facilitates the communication between the many (hundreds) of marine data and information systems, saving immense resources typically allocated to search and discovery of vital information across unlinked and isolated sources.

The rapidly growing ODIS federation relies on a co-developed, lightweight, decentralised, and extensible (meta)data exchange architecture (ODIS-Arch). ODIS-Arch leverages the globally adopted syntactic and semantic conventions put forth by the world's major search and discovery systems (e.g., Google, Bing, Yahoo, and Yandex) and co-maintained through working groups in the World Wide Web Consortium (W3C). Patterns have been created based on the focal areas of the IOC (e.g. experts and institutions, vessels, training opportunities) and requests from its community of users (e.g. for sensors and instrumentation, software applications, event series).

During the OIH project, our partners have made >500,000 digital records discoverable and accessible. Our 57 current partners are also actively extending ODIS-Arch, to ensure that conventions are in place for to help them exchange data and information about the issues relevant to them. In support of these developments, an expert technical working group has been convened with over 120 technical experts from partner projects and pilot regions. An active GitHub social software development space is in place and used on a daily basis to transparently advance both ODIS and OIH (https://github.com/iodepo/odis-arch). The documentation for ODIS-Arch is openly available online, for any stakeholder to interface with the system: https://book.oceaninfohub.org/index.html.

18 project partners are fully operational "nodes" in ODIS, and are contributing openly discoverable content to the Ocean InfoHub knowledge graph:

- Ocean Best Practices System
- Ocean Biodiversity Information System
- AquaDocs
- Marine Training EU
- EDMERP SeaDataNet
- EDMO SeaDataNet
- OceanExpert UNESCO/IOC Project Office for IODE
- INVEMAR
- EurOcean
- MASPAWIO: Marine Spatial Atlas for the Western Indian Ocean
- Indonesia National Oceanic Data Center
- Benguela Current Convention (BCC) GeoData Portal
- Caribbean Marine Atlas catalogue
- Oceanscape project
- CIOOS
- Secretariat of the Pacific Regional Environment Programme catalogue
- Pacific Data Hub
- Flanders Marine Institute catalogue



Thanks to its diverse partnership and ease of implementation, ODIS is quickly gaining ground as an interoperability solution across regional infrastructures, projects, and initiatives in the UN Decade of Ocean Science for Sustainable Development (UN Ocean Decade). Further, an **Ocean InfoHub Global Search portal** has been established (https://search.oceaninfohub.org/) and will be further developed over the duration of the OIH project, to improve and refine services offered.

The three regional communities of practice are an important focus. Many other data-sharing initiatives work primarily in Europe or North America, but the Ocean InfoHub and ODIS is demonstrating interoperability between highly diverse themes, regions, and capacities across the globe. The low barriers to joining enable the inclusion of very simple, to highly complex systems. The project has supported early career scientists and initiatives that contribute to UNESCO's global priority on gender equality, complemented by measures to reduce disparity, inequity, and underrepresentation along other axes of diversity.

A new portal for Africa Marine Training as an OIH node, has been established and populated with the support of co-financing from NORAD, and may be found at: https://africa.marinetraining.org/ and is discoverable through ODIS. It currently hosts details of 278 courses from 18 countries.

Interest in and the desire to interoperate with ODIS has gone beyond the IOC and the Oceans community. Other UN agencies, global data systems, and initiatives in other domains and sectors have expressed an interest in adopting the ODIS technology. In addition, OIH/ODIS is supporting additional communities of practice such as those focused on Marine Protected

Areas, the GOOS Essential Ocean Variables, and Areas Beyond National Jurisdication. Interoperability and strategic alignment deliberations are underway with organisations including the Group on Earth Observations Biodiversity Observation Network (GEO BON), the Helmholtz Metadata Collaboration (HMC), the Earth Science Information Partners (ESIP), and the Polar Data Discovery Enhancement Research (POLDER) project).

Further - in collaboration with the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research – OIH/ODIS is a case study in the ongoing WorldFAIR project – a global cooperation on FAIR data policy and practice - funded by the European Commission within the Horizon Europe Framework Programme (grant agreement 101058393) and coordinated by the International Science Council's Committee on Data (CODATA). Representing the ocean domain in a constellation of 11 case studies, the initiative is contributing to the development of a cross-domain interoperability framework (CDIF) that will help domains from cultural heritage to nanomaterials discover and exchange data, information, and other digital assets with ever increasing interoperability.

4 Immediate priorities

1. The Ocean InfoHub Project and ODIS will develop (as requested by IOC Regional Subsidiary Bodies and other groupings of member states or partner organizations/programmes) **additional regional data and information nodes** to meet the needs of their users.
2. The project will provide **technical and procedural guidance documentation as well as related training** to assist data/information providers as well as diverse user communities with the necessary capacity to actively and equitably participate in ODIS.
3. The Ocean InfoHub Project and ODIS will develop **additional functionality to support end-users**.
4. The Ocean InfoHub and ODIS will create a co-development model to bridge ocean data to other domains and secure sustainability and community-driven growth of the ODIS Architecture.

5 The Future of ODIS (2025-2030)

ODIS has demonstrated that a well-coordinated network of distributed and independent systems can interoperate and more effectively exchange ocean data and information for the benefit of all. As such, it has laid a foundation for a sustainable, co-developed, and open interoperability solution at the heart of a thriving digital ocean ecosystem. To achieve this future, the coordination and convention-building role of IODE is key: its ability to balance needs and capacities to ensure effective partnership will be central to the extension of ODIS into new frontiers.

During this process, ODIS has the potential to revolutionise, enhance, and streamline the **operations of the IODE** in pursuit of its mission**.** ODIS allows real-time monitoring of data and information exchange across its partners, a model which can be extended across IODE's core stakeholders to match the new demands of the digital revolution. Its current form has concretely demonstrated the feasibility of lightweight, but interoperable, data exchange and encourages further development and extension to new data, information, and other digital assets including software, modelling capacities, and digital twin components. These capacities also allow the identification of new opportunities, gaps, and new challenges in global ocean data sharing.

Furthermore, ODIS is a means to enhance and **unlock more value** from the >100 National Oceanographic Data Centres (NODCs), Associate Data Units (ADUs) and Associate Information Units (AIUs). These centres manage and make available millions of ocean observations that contribute to ocean data products and services developed and used by other IOC programmes. The technology that has been developed is easy to adopt, open and portable to new applications. ODIS offers a **long-term solution for NODCs, ADUs and new partners** to keep ownership and complete control over their data holdings, while choosing which (meta)data to share with a growing global ocean digital ecosystem. It is expected that in the coming years, **the further involvement of NODCs and ADUs** with direct technical support where needed, will facilitate their adoption of ODIS-Arch and thus benefit from their involvement in the ODIS global data ecosystem.

It is noted that the "ocean digital ecosystem" concept promoted and developed through OIH/ODIS is adopted also by the **UN Decade of Ocean Science for Sustainable Development** and is referred to in the "Data & Information Strategy for the UN Ocean Decade". It will furthermore be promoted by the Decade Coordination Office (DCO) for Data Sharing, that has been approved for establishment by the IOC Executive Council (2022) and will be hosted by the IOC Project Office for IODE, Oostende, Belgium. It is therefore clear that Ocean InfoHub (and the underpinning ODIS architecture) is a "trailblazer" for the UN decade's ocean digital ecosystem. Many of ODIS core principles are also being integrated into the Cross-domain Interoperability Framework (CDIF) being formulated under the coordination of CODATA (see above).

The OIH project's development of a proof-of-concept architecture for distributed and interoperable data sharing is vital to supporting **data exchange across basin-scale observing systems** noted in (ii) "comprehensive ocean observing system for all major basins". Further, the Ocean InfoHub will substantially contribute to outcomes (iv), "data and information portal" and (vi), "capacity building and accelerated technology transfer, training and education, Ocean literacy" by empowering local, national, regional and global actors to distribute capacity and information through harmonized portals, integrated into other solutions.

A Programme called **An Ocean Data and Information System supporting the UN Decade of Ocean Science for Sustainable Development (OceanData-2030)** has been registered with the UN Decade for Ocean Science for Sustainable Development. The programme will play a central role in supporting the Ocean Decade mission to catalyse transformative ocean science solutions for sustainable development, connecting people and the ocean. In order to achieve the Ocean Decade vision of 'the science we need for the ocean we want'.

"The solution proposed by the OceanInfoHub project directly supports several key objectives of the Ocean Decade's data and information strategy. This strategy aims to transform the way we discover, access and use ocean data and information within the Ocean Decade and beyond, thus unleashing its power for the benefit of science and sustainable development solutions."

Louis Demargne
Data & Knowledge Management Officer
Ocean Decade Coordination Unit
Intergovernmental Oceanographic Commission of UNESCO

ODIS-Arch and the ODIS partnership have a high potential for sustainability. The project's open-source philosophy ensures its software and extensive documentation is available online, promoting reuse and adaptation by any institution, whether or not they are an OIH project partner. Further, ODIS nodes do not depend on OIH to interoperate, and can freely create new, multi-party interfaces through their co-implementation of the ODIS-Arch.

This is an incentive for all partners to maintain the ODIS Network with or without OIH running as an active project. Furthermore, implementation of the ODIS-Architecture also allows the major search providers (Google, Microsoft, Yandex, etc) to index content shared by ODIS nodes, adding greater incentive to maintain interconnection through ODIS. This will build resilience and sustainability of ODIS as it becomes adopted and implemented by more partners beyond the life of the OIH Project.

The Ocean InfoHub Project and ODIS have already succeeded in creating a self-sustaining network of partners, but there remains much work to do to widen the collaboration to other regions and nations, build capacity and digital equity in regions with low resourcing, and continually upgrade the capabilities of the network.

Support is also needed to maintain the collaborations outside of the ocean domain and to support the next wave of co-development of new products and services based on ODIS interoperability with regional, national, subnational, and thematic partners. IOC/IODE has a neutral convening role to help global alignment of these developments, for the benefit of the Oceans community and beyond.