2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Vision 2030 White Paper

Challenge 8
Create a digital representation of the ocean

Zero Draft – January 2024

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Intergovernmental Oceanographic Commission

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VISION 2030 WHITE PAPER

ZERO DRAFT – JANUARY 2024

CHALLENGE 8: DEVELOPING A COMPREHENSIVE DIGITAL REPRESENTATION OF THE OCEAN

Through multi-stakeholder collaboration, develop a comprehensive digital representation of the ocean, including a dynamic ocean map, which provides free and open access for exploring, discovering and visualizing past, current and future ocean conditions in a manner relevant to diverse stakeholders

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Acknowledgements

To be included after the review process

Acronyms

AI	Artificial Intelligence
DCG	Decade Coordination Group
DCO	Decade Coordination Unit
DDAS	Data Discovery and Access Service
DSIG	Data Strategy Implementation Group
ECOP	Early Career Ocean Professional
FAO	Food and Agriculture Organization
GOOS	Global Ocean Observation System
ICAN	International Coastal Atlas Network
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IP	Implementation Plan
MSP	Marine Spatial Planning
UN	United Nations
UNESCO	UN Educational, Scientific and Cultural Organization

1. Executive summary

1.1. Overview of the Ocean Decade Challenge

Ocean Decade Challenge 8, of the United Nations Decade of Ocean Science for Sustainable Development 2021-2030 (the 'Ocean Decade') seeks to create an adaptive and dynamic digital representation of the ocean to enhance decision-making and support sustainable ocean management.

While creating a comprehensive digital representation of the Ocean is the ultimate objective of Decade Challenge 8, the focus in this White Paper is on delivering concrete outcomes and the transformational change needed to create the enabling environment and initial digital content, by 2030, that will enable us to fully deliver on the ambitions of Challenge 8 on the longer term.

An Action Plan for implementing the Ocean Decade's Data Strategy is currently under development by a Data Strategy Implementation Group (DSIG) to ensure the development of a distributed, robust, and collaborative 'digital ecosystem' of interoperating parts, that leverages open, scalable, easily implementable, and responsive digital management. This interoperable data sharing framework must be enabled to allow the realization of Challenge 8.

In developing the Strategic Ambition for Challenge 8, we consider the data and information needs and priorities identified by the other Decade Challenges and their working groups, as our primary users (and contributors), representing as they do the key sustainability challenges for the Decade, and encompassing all relevant stakeholders.

Guided by the Decade's ambition to 'leave no one behind' we recognize that this challenge must also deliver outputs that are relevant and useful for the global ocean science community, and in fact by extension the widest possible range of users and stakeholders, including the eight billion people on this planet, who should be able to access and use what is delivered by the Decade in ways adapted to their needs and capacities, if so desired.

By 2030, the Strategic Ambition for Ocean Decade Challenge 8 is to have in place the enabling environment for the creation of and access to an increasing number of digital representations and twin applications of the Ocean, delivering at minimum 10 societally relevant global base-layers (digital representations) accessible via a dynamic Digital Atlas, additionally contextualized by a minimum of 10 local use cases (prioritizing the global South) to stress test the inclusiveness of the interoperable sharing environment and address challenges along the marine knowledge value chain.

1.2. Key findings and recommendations

In delivering this Strategic Ambition **we identify the need for the following tools and services** to be developed and in place by 2030:

i)   A global Ocean Data Discovery and Access Service with a dynamic map viewer;

ii)   A global user-friendly Digital Atlas of the Ocean;

iii) An inclusive series of platforms, mechanisms and tools to share and exchange Marine Knowledge;

iv)   An Ocean Data Help Desk and Data Ingestion Service;

v)   Facilities and resources for Capacity Development and training to improve digital literacy;

vi)   A transparent process guiding the development of global consensus base layers.

We strongly recommend that any approach to meeting this challenge should include a roadmap and timeline to broadening digital representation of currently under-represented data sources and types. In convention with CARE principles, the roadmap should be developed with Indigenous groups who own and are represented by the data in question.

We call for:

−   The Decade Data Strategy Implementation Group (DCG-SIG) to delineate the specific tools and their technical infrastructure design and further development steps necessary to deliver the required global Ocean Data Discovery and Access Service.

−   ICAN and members of the global community of practice on digital coastal and marine atlases to further elaborate and define the functionality of the envisaged global Atlas, cost it and recommend it as Decade Programme to develop it, exploring also existing infrastructures developed by the private sector[1] that could be adapted.

−   The DCO for Ocean Data Sharing to coordinate with the global data management Community of Practice, and in particular with IODE, to develop and trial a blueprint for a permanent Data Help Desk service. This could be a shared service developed by the DCOs for Ocean Observing and Ocean Data Sharing with the potential to be integrated in a permanent DDAS service post-Decade in close collaboration with IODE.

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[1] Members pointed to two companies who are particularly active with Google Earth and Microsoft planetary computers. https://www.techforwildlife.com/blog/2022/10/10/google-earth-engine-vs-the-microsoft-planetary-computer, https://wildlabs.net/discussion/google-earth-engine-vs-microsofts-planetary-computer-which-do-i-use.

- Decade Capacity Building Facility, the Ocean Teacher Global Academy and network of experts of IODE, GOOS as well as the Decade Actions contributing in particular to Challenge 9 (i.e., Skills, knowledge and technology for all) to provide resources and training for increasing the data literacy of the Ocean Community to ensure meaningful contributions to the Decade Digital Ecosystem.

We identify the need for guiding principles to underpin the consensus-building process and call for maintaining an Expert Group beyond the delivery of this White Paper, as an independent expert group to:

- Oversee the identification and selection of the base-layers and local case studies.
- Act as custodians of the consensus-building process, overseeing the development and implementation of the guiding principles by the communities of practice developing the data-layers.
- Oversee the progress made overall to achieving the ambition targets of Challenge 8, using the set milestones and KPIs.

2. Introduction

2.1. Background and context of Challenge 8

Ocean Decade Challenge 8, of the United Nations Decade of Ocean Science for Sustainable Development 2021-2030 (the 'Ocean Decade') seeks to create an adaptive and dynamic digital representation of the ocean to enhance decision-making and support sustainable ocean management.

Challenge 8 was initially inspired by the need for a common digital atlas of ocean information to address the prevailing and future societal pressures on the ocean and enable its protection and sustainable management[2]. However, in elaborating Challenge 8 it was recognized that this digital atlas or map could only exist within the context of a more comprehensive 'digital representation' of the Ocean.

> ### *Challenge 8*
>
> *"Through multi-stakeholder collaboration, develop a comprehensive digital representation of the ocean, including a dynamic ocean map, which provides free and open access for exploring, discovering, and visualizing past, current, and future ocean conditions in a manner relevant to diverse stakeholders".*

Therefore, in outlining the Strategic Ambition for this Challenge by 2030, when we refer to creating a 'digital representation' of the ocean we do not mean the creation of a 'digital

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[2] https://www.frontiersin.org/articles/10.3389/fmars.2019.00470/full

replica' or Digital Twin of the Ocean *per se*, but rather to unlock the (findable, accessible, retrievable and, as far as possible, interoperable) collection of digital data and information about the past, current and future state of the Ocean as well as the complementary digital resources (e.g. socio-economic data/information on human activities), which allow us to generate a better understanding of the ocean, its use, and impacts of various dynamics at different scales. Therefore, in this context, 'digital representation' refers both to the ultimate end-products (maps, forecasts, time series models, digital twins, etc.) and more directly to the underlying system, tools and processes that underpin and facilitate the creation of these end-products.

While creating a comprehensive digital representation of the Ocean is the ultimate objective of Decade Challenge 8, **the focus in this White Paper is on delivering concrete outcomes and the transformational change needed to create the enabling environment and initial digital content, by 2030, that will enable us to fully deliver on the ambitions of Challenge 8 on the longer term.**

2.2. Overview of current work in the Ocean Decade

The Ocean Decade Implementation Plan (IP)[3] states that "*Digitizing, accessing, managing and, most importantly, using ocean-related data, information and knowledge will be cornerstones of the success of the Ocean Decade.*" The IP further highlights that no single data, information and knowledge management infrastructure system will be able to support the Ocean Decade's ambitions. Rather, the focus should be on "*the collective design and construction of a distributed, multi-component digital network capable of representing the entire ocean system, including its social and economic characteristics*".

To achieve these ambitions the Decade **Data Coordination Group (DCG)** was established to develop the **Ocean Decade Data and Information Strategy**[4] with the vision that by 2030, we will have: "*A trusted, inclusive, and interconnected ocean data and information ecosystem that is actively used for decision making to support sustainable ocean management.*"

Recognizing that many elements of such an ecosystem already exist, the Strategy aims to build on and leverage these components, infrastructures, systems and capacities while also allowing for new data sources, information networks and solutions, developed by Decade Actions and relevant stakeholders, to be integrated as the needs of the Ocean Decade evolve. An Action Plan for implementing the Data Strategy is currently under development by a **Data Strategy Implementation Group (DSIG)** to ensure the development of a distributed, robust, and collaborative '**digital ecosystem**' of

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[3] https://oceandecade.org/publications/ocean-decade-implementation-plan/

[4] https://unesdoc.unesco.org/ark:/48223/pf0000385542

interoperating parts, that leverages open, scalable, easily implementable, and responsive digital management. **This interoperable data sharing framework must be enabled to allow the realization of Challenge 8**.

Three key components are recognized as critical for any fit for purpose digital ocean ecosystem: observations and data collection, data management and sharing, and processing: analytics, modelling and predictions. These components must be well coordinated, interconnected and based on a common interoperable sharing framework. For that reason, three coordinating structures have been established to facilitate the development of the Decade's Digital Ecosystem, namely, the **Decade Coordination Offices for Ocean Data Sharing (DCO-ODS)[5] and Ocean Observing (DCO-OO)[6]**, and the **Decade Coordination Centre for Ocean Prediction (DCC-OP)[7]** (see figure 1).
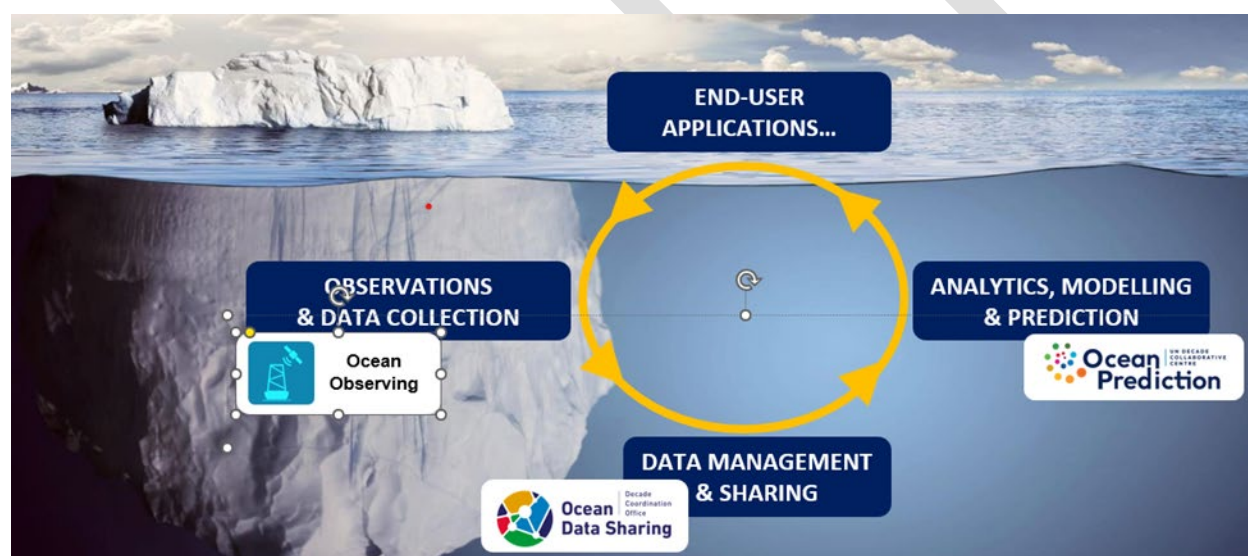
Figure 1. Main components of the ocean digital ecosystem and associated Ocean Decade coordination bodies

A **Corporate Data Group** has also been established to identify ways to unlock the enormous potential of private sector and industry data that is currently inaccessible to science. In addition to these entities and coordinating structures, there are also a large number of **Decade Actions that are identified as contributing to/addressing Challenge 8**.

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[5] https://www.iode.org/dcodatasharing

[6] https://oceandecade.org/actions/decade-coordination-office-for-ocean-observing/. Pertaining to the Ocean Observing part of the value chain, the recent GOOS Observation and Coordination Group Cross-Network Data Implementation Strategy should also be taken into account.

[7] https://www.mercator-ocean.eu/en/oceanprediction/

2.3. Importance and relevance of the Challenge for sustainable development

Creating a digital representation of the Ocean under Challenge 8 directly contributes to sustainable development by enhancing our understanding of the ocean, supporting informed decision-making, aiding in climate change mitigation, promoting sustainable economic activities, conserving biodiversity, and fostering global collaboration. This aligns with several of the United Nations Sustainable Development Goals, particularly those related to life below water (SDG 14), climate action (SDG 13), sustainable cities and communities (SDG 11), and partnerships for the goals (SDG 17). More specifically, achieving this challenge would lead to:

- **Enhanced Understanding of the Ocean**: A comprehensive digital representation of the ocean will greatly improve our understanding of ocean dynamics, processes and biodiversity. This knowledge is essential for managing ocean resources sustainably and for protecting marine ecosystems.
- **Informed Decision-Making**: Policymakers, businesses, and conservationists rely on accurate and timely information about the ocean to make informed decisions. A digital ocean provides the necessary data and insights to guide policies and actions that balance economic interests with environmental protection.
- **Improved Climate Change Research and Mitigation**: The ocean plays a critical role in regulating the Earth's climate. Understanding oceanic processes is vital for climate change research, including the study of carbon cycles, ocean acidification, and sea-level rise. This knowledge can inform strategies to mitigate and adapt to climate change.
- **Disaster Prevention and Response**: Real-time monitoring and forecasting of ocean conditions can enhance disaster preparedness and response, particularly in the context of tsunamis, hurricanes, and other ocean-related natural disasters.
- **A more Sustainable Blue Economy**: The blue economy encompasses a range of economic activities that rely on the marine environment, such as fisheries, tourism, and renewable energy. A digital representation of the ocean can support the sustainable development of these sectors by providing insights into resource availability, environmental impact, and sustainable practices.
- **Biodiversity Conservation**: Understanding the distribution and health of marine ecosystems and species is crucial for biodiversity conservation. Digital mapping and monitoring can help identify critical habitats, track species populations, and detect threats like overfishing and pollution.
- **Educational and Awareness Building**: A digital ocean can serve as a powerful educational tool, increasing public awareness and understanding of marine environments and the challenges they face. This can foster a stronger connection between society, the broader public and the ocean, encouraging conservation efforts and responsible behavior.

- **Global Collaboration and Data Sharing**: This challenge promotes international collaboration and data sharing. By pooling resources and expertise from around the world, initiatives that contribute to building a digital ocean can help overcome limitations of individual countries and create a more comprehensive and accessible global resource to the benefit of all.

2.4. Methodology for Strategic Ambition setting

This Strategic Ambition for Decade Challenge 8 was developed by a Working Group comprising a multidisciplinary group of experts, chosen for their diverse areas of expertise across the marine knowledge value chain and their regional representation. The process involved a series of brainstorming and drafting meetings and the iterative development of a background document from which this Strategic Ambition was extracted. Guidance and templates were provided by the Decade Coordination Unit of IOC.

In setting this Strategic Ambition, the Working Group built on and aligned with ongoing work in the Decade in the context of the implementation of its Data and Information Strategy and in close collaboration with those entities referenced above who are supporting this implementation (IODE, DCG, DSIG, DCO-ODS, DCO-OO, DCC-OP, …). Representatives from these entities participated to the expert group meetings as observers and acted also as interlocutors bringing the needs and priorities of Decade Actions (programmes and projects) active in this Challenge Area. Given also the crosscutting nature of this Challenge and thus its relevance to all Decade Challenges, the data and information needs identified by the other Working Groups were and will continue to be considered as critical in developing and realizing this Strategic Ambition.

Finally, the Strategic Ambition put forward in this document is guided by the following set of core principles:

– Creating the enabling environment to work towards ever more comprehensive sets of digital representations and Digital Twin applications of the Ocean.

– Building on what already exists, lifting up the core digital ecosystem components and interconnecting them, filling gaps if/where needed.

– Collecting data once and using it many times.

– Adopting FAIR and CARE data principles which should underpin all actions.

– Leaving no one behind – providing equitable access to all, both to use and contribute to the digital ecosystem including data, products, tools and services.

– Connecting the entire value chain, from observations and data collection to end-user applications, to develop a distributed digital ecosystem.

– Ensuring a multidisciplinary and multisectoral approach towards holistic solutions.

– Being transformative to evolve and strengthen the global ocean digital ecosystem.

3. Strategic ambition setting

3.1. Analysis of user needs and priorities

Challenge 8 requires the development of a comprehensive digital representation of the ocean, "*through **multistakeholder collaboration**… in a manner that is **relevant to diverse stakeholders**.*" This assumes and requires co-design and co-development with diverse stakeholders, to serve a wide range of users and contributors. Therefore, the term 'users' in this context does not only refer to those who may ultimately use the digital representations (as intermediate or end-users), but also to those communities who should contribute to developing both the digital representations (through shared data, information and knowledge) and the tools necessary to access and share these.

Given the breadth of this challenge area and its user-base, there is a need to categorize and prioritize its main user-groups to help define their needs and the actions required in developing this Strategic Ambition.

We consider that the **primary users** of Challenge 8 outputs **are the scientists, engineers and experts working** across Decade Actions and related Decade coordinating bodies **to address the other Decade Challenges**. These actors are diverse in their data and information needs, their ability to use these resources (access, combine, manipulate them) and their potential to contribute to the Decade's digital ecosystem. At the same time, the Decade seeks to **serve the wider ocean (science) community** and stakeholders who are not necessarily operating within the Decade's universe, these can be considered **secondary users**.

The Decade also has the ambition to **'leave no one behind'**, therefore this challenge must also **deliver outputs that are relevant and useful for the widest possible range of users and stakeholders**, that is the eight billion people on this planet who should be able to access and use what is delivered by the Decade if so desired (non-professional stakeholders and **wider public as tertiary users**).

These broad user-groups will have different needs, both in terms of digital and thematic content, but also, in terms of their ability and capacity to access, use - and contribute to - the envisaged digital representation, and so can be categorized also according to their data literacy, as follows:

i)   professional[8] **with** hands-on data-handling experience [Group 1]

ii)   professional **without** hands-on data-handling experience [Group 2]

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[8] In this instance, professional refers to professional in the marine/ocean management/science/business domain

iii)   non-professional, non-expert, i.e. broader public[9]. [Group 3]

For the professional users (group 1 and 2), there will be different levels of engagement and interaction both in the development and use of the Challenge 8 outputs, depending on their unique roles, user rights, and other factors which should be considered, as follows:

- **Those who are operating within the Ocean Decade** - i.e. the Actions (Programmes, Projects and Contractions including Implementing Partners), coordinating entities and Communities of Practice as well as other UN organisations and/or bodies – **versus those who are operating outside/beyond the Ocean Decade formal framework**; all of whom can and should be leveraged to co-design and co-deliver the Challenge 8 Strategic Ambition[10]
- **Different functions along the marine knowledge value chain**: from ocean observers/data-collectors (including from indigenous communities) to data management / technical experts, data analysts and modelers, Artificial Intelligence (AI) experts, and ultimately to diverse end-users (scientists and knowledge generators, policy advisors, decision-makers, Digital Twin developers, coastal communities, maritime operators, etc.)
- **Location and digital capacity**: Users from different regions with different levels of access to digital capacities, infrastructure, …

Because we cannot pre-consider every possible use of the digital ecosystem envisaged, in developing the Strategic Ambition for Challenge 8, therefore, we consider the data and information needs and priorities identified by the other Decade Challenges[11], and their working groups, as the primary users **(**and contributors), representing as they do the key sustainability challenges for the Decade, and encompassing stakeholders from all the groups mentioned above.

We consider and define these user needs as follows:

i)   **Tools and services need**: The enabling environment facilitating the creation of the envisaged digital representation(s) *via multi-stakeholder collaboration*, ensuring also that the digital representations are developed in a way that can be used by and are *relevant to diverse stakeholders*, bearing in mind the various categories of stakeholders, their needs and abilities.

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[9] By the broader public, we recognize that this is not a monolithic group but a community of sub-groups of varying degrees of education and capacity.

[10] Annex X contains a list of entities who can help deliver the Challenge 8 strategic ambition (it was suggested to develop a preliminary list of those established/governed thematic communities of practice which Challenge 8 can leverage). Throughout this White Paper, where possible, we will name the user/stakeholder group and the role that they will play in delivering the Strategic Ambition.

[11] https://oceandecade.org/challenges/

ii) **Digital content needs**: The envisaged digital representations including the underlying data and data-products (harmonized data layers, maps, time-series, models) facilitating also the development of overlying features, including Digital Twins.

3.2. Definition of the Strategic Ambition for the Challenge

By 2030, the Strategic Ambition for Ocean Decade Challenge 8 is to have in place the enabling environment (data, products, tools and services) for the creation of and access to an increasing number of digital representations and twin applications of the Ocean, delivering at minimum 10 societally relevant global base-layers (digital representations) accessible via a dynamic Digital Atlas, additionally contextualized by a minimum of 10 local use cases (prioritizing the global South) to stress test the inclusiveness of the interoperable sharing environment and address challenges along the marine knowledge value chain.

In delivering this Strategic Ambition we identify the need for the following **tools and services** to be developed and in place by 2030:

i) A global **Ocean Data Discovery and Access Servi**ce with a dynamic map viewer [for Group 1 above, i.e. professionals **with** hands-on data-handling experience].

ii) A global user-friendly **Digital Atlas of the Ocean** [for Group 2 and 3 above, i.e. professionals **without** hands-on data-handling experience and the broader public].

iii) An inclusive series of platforms, mechanisms and tools to share and exchange Marine Knowledge.

iv) An Ocean **Data Help Desk and Data Ingestion Service**.

v) Facilities and resources for **Capacity Development and Training** to improve digital literacy.

vi) A transparent process guiding the selection, validation and development of global consensus base layers.

These envisaged tools and services either do not yet exist yet, exist only partly as prototype/concepts, are not yet operational, or do not operate at the scale and level needed. Each of these needs is further elaborated in the sections below.

We note also that the architecture of the data and information-sharing platforms/tools/services that will be created (or further developed based on existing concepts/tools), should be compatible with the architecture of other core service and/or decision support tools and applications proposed or currently under development, such as for example, the Ocean Forecasting System architecture being developed by the DCC-OceanPrediction; the Digital Twin application architecture as being developed by the

Digital Twins of the Oceans Programme DITTO[12] and its associated endorsed Action TURTLE[13], among others.

Challenge 8 Strategic Ambition Setting
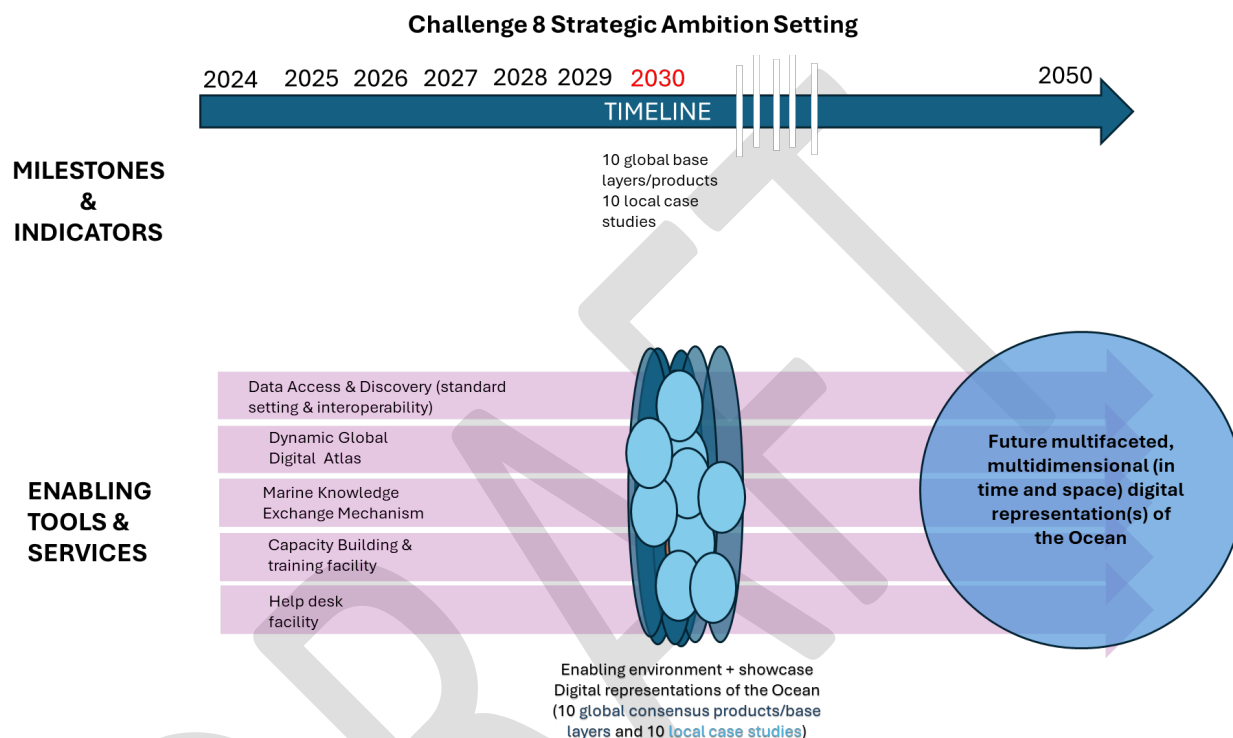
Figure 2. Graphical representation of the Challenge 8 Strategic Ambition setting (NOT FINAL- TO BE DEVELOPED)

3.2.1. Priority datasets

Challenge 8 aspires to enable creation of digital representations of the ocean that are built on broad, inclusive and equitable foundations, drawing on a variety of data that reflect environmental and human variables while convening with FAIR[14] and CARE[15] principles.

Ocean data varies across characteristics including (but not limited to) geographic scale and resolution, temporal scale and resolution, findability, interoperability, digitization and the adherence to FAIR and CARE[16] principles. The relationships between these categories are likely predictable. For instance, data that are easily findable, broad scale and digitized (e.g., commercial fisheries data, census data) are less likely to meet CARE

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[12] https://ditto-oceandecade.org/

[13] https://ditto-oceandecade.org/affiliated-projects/interoperability-architecture-for-a-digital-ocean-turtle/

[14] Findable, Accessible, Interoperable, and Reusable

[15] Collective Benefit, Authority to Control, Responsibility, Ethics

[16] In considering FAIR and CARE aspects, we note and build on the significant ongoing work on interoperability to develop common standards, ontologies, best practices, etc., by Decade entities implementing the Decade's Data and Information Strategy.

criteria, while data that do meet such criteria (e.g., Indigenous knowledge or co-produced human use, socio-economic, and environmental data) are likely hyper-local in scope and may not yet be available in digital formats. As a result, easily ingested 'big' data will be biased towards certain types of sources. Reliance on such data alone will erase the activities, values, and knowledge of sectors of society (e.g., Small Island Developing States, stateless peoples, Indigenous fishers) that are poorly represented in the most accessible datasets, thereby perpetuating and worsening inequity, while violating CARE principles.

We strongly recommend that any approach to meeting this challenge should include a roadmap and timeline to broadening digital representation of currently under-represented data sources and types. In convention with CARE principles, the roadmap should be developed with Indigenous groups who own and are represented by the data in question.

We also note that the data needs and priorities identified by the other Working Groups of the Vision 2030 process are also subject to some of the challenges already outlined above, in particular those concerned with human activities, co-creation, capacity sharing, and/or Indigenous partners.

Global base layers and local case studies

Rather than starting by targeting priority datasets, we propose to work the other way around and focus on prioritizing and making available a series of <u>societally relevant global consensus base layers</u> (flagship data-products per challenge area) that deliver solutions to address the other (thematic) challenges areas and which will act as drivers to identify and address underlying data gaps and interoperability issues. While the complexity of this is not to be underestimated, regional experience[17] has shown that the potential of a common, desired data-product/layer creates the incentive for actors to reach agreements on standards, overcome challenges and develop a common approach, building on and expanding existing communities of practice.

Furthermore, these global/flagship data products should be complemented with a selection of <u>local case studies</u> (prioritizing the global south) focusing on providing marine and coastal data and data products at a higher resolution to highlight concrete bottlenecks in the marine knowledge value chain, stress test the ability of various communities to access the Decade's digital ecosystem and address potential equity ramifications of reliance only on digitalized, quantitative data inputs.

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[17] GEBCO https://www.gebco.net/, EMODnet (https://emodnet.ec.europa.eu/en/bathymetry#bathymetry-approach, https://emodnet.ec.europa.eu/en/euseamap-2021-emodnet-broad-scale-seabed-habitat-map-europe)

We identify the need to distinguish between two processes as follows:

Process 1: Identification and selection of the priority societally-relevant base layers and local case-studies:

Our ambition by 2030 is to have delivered at least one societally-relevant global consensus base layer (flagship data-product) per Decade Challenge area and one local case study. We recommend that the process of collecting suggestions and prioritization should draw on thematic Communities of Practice, Decade Actions and Working Groups focusing on addressing the other Challenges and that the selection process follows a series of developed criteria.

We identify the need for an independent Expert Group to oversee the consultation process with the various actors working to resolve the various decade challenges as part of the first-tier selection process of the base layers and identify the priority base layers and local case studies according to a set of to-be-developed criteria. The criteria should include, amongst others the following:

i) *For Consensus Base Layers*

- Societal relevance: in the context of the sustainable development goals and ambitions of the relevant challenge area as identified in the respective White Papers.
- Readiness level: what is already being developed at regional level and can be built on.
- Technical criteria: Potential of the layer to meet FAIR and CARE principles.
- Potential to be used by the global community to make business cases to preserve and improve the ocean showing both an actual and a desired state, so the gap between the layers can serve to generate preservation or restoration Actions.
- Potential for long-term sustained funding to ensure that the base layer does not remain static, but is developed in an iterative, validated and transparent process.
- Existence of an owner/custodian or community of practice working on developing the sought-after base layer via consensus. Where one does not exist, but the need for the base layer is identified as a priority based on other criteria, then a call for an Action bringing together a consortium of data providers, implementers and target users to co-develop it could be issued.
- Potential of the layer to leverage innovative and cost-effective observation technologies to address important data gaps.
- Recognition of best practice in current approaches at more local/regional level.
- The development and co-creation process will be crucial, and must be transparent, both in terms of the methodology and the underlying data, this invites and allows others to build on, improve and create new or better products.

ii) *For Local Case Studies*

- Priority is given to case studies located in SIDS and in coastal Least Developed Countries, as LDCs are expected to have less institutional capacity to identify, collect, digitize and share ocean data.
- Outreach establishes the opportunity and willingness of multiple stakeholders or their representatives to participate in co-creation of the case study. Special emphasis must be given to identifying and enabling the participation and empowerment of groups, especially marine resource-reliant groups, likely to have less voice at the national/regional level (e.g., Indigenous groups, small-scale fishers, stateless peoples, coastal populations living in poverty, women). This approach will ground cases in local expertise and concerns. It will furthermore ensure that those who are less likely to have input into/access to/control over data and information that represents and affects them are empowered and included in case processes.
- A significant subset of the case study include participation by stakeholders who have long-standing connections to and knowledge of marine and coastal resources that is grounded in ways of knowing other than Western science (i.e., Indigenous, local and traditional knowledge). These types of knowledge are likely to be more difficult to include into digital representations of the ocean, and participation by knowledge-holders is key to identifying gaps, barriers, and ways forward that are in line with CARE principles.
- A significant subset of the case study include participation by stakeholders who hold relevant qualitative data grounded in Western scientific approaches. Although likely based in similar ontologies to quantitative data, qualitative data are anticipated to be more difficult to include in digital representations of the ocean and to cover different topics of interest, especially social phenomena.
- The suite of case studies strives to represent a variety of ecosystems, as well as uses of, pressures on, and benefits derived from oceans and coasts, to best reflect the diversity of environments and experiences included under the umbrella of a global representation of the ocean.
- The suite of case studies strives to represent a variety of conditions and challenges regarding existing data availability, to best reflect extant diversity in this area.

Process 2 - Building consensus: co-design/co-development of the selected base layers

Building consensus-base layers implies a group or consortium co-developing the layers. This consensus process is as important as the final product, to ensure transparency and agreement on what constitutes the best approach/methodology, what data (and sources) are incorporated, and to mitigate strategic and vested interests in the data and data-products. In some cases, a Decade Action bringing together a group of actors might

already be working on developing the base layer (e.g. seafloor map as key deliverable of the Seabed 2030 initiative), while in other cases, data providers, developers and users in need of a data product might still need to be brought together. This process of identifying target data products by 2030 may provide an incentive and clear objective to bring these actors together.

For both processes, we identify the need for guiding principles to underpin the consensus-building process and call for maintaining an Expert Group beyond the delivery of this White Paper, as an independent expert group to:

i) Oversee the identification and selection of the base-layers and local case studies.

ii) Act as custodians of the consensus building process, overseeing the development and implementation of the guiding principles by the communities of practice developing the data-layers.

iii) Oversee the progress made overall to achieving the ambition targets of Challenge 8, using the set milestones and KPIs.

A few suggested potential base-layers and local case-studies proposed by expert working group members are provided in Annex 1, based on priority data gaps and needs identified in the (nascent) strategic ambitions of the other challenges.

Finally, it is important to clarify that, while there is a clear target to generate and provide priority base layers, which will by necessity identify, unlock, and promote harmonization of, underlying datasets, the strategic ambition for Challenge 8 put forward by the Working Group does not ignore the needs expressed by so many decade actors who are struggling to find out what marine data and data products exist already that could be accessed and used, as highlighted in the Decade's Data and Information Strategy. **Unlocking as much existing ocean observations, data and data products as possible by making them discoverable and accessible is one the key objectives** of the Ocean Data and Information System (ODIS) which' whose development and further deployment is at the core of the Decade's Ocean Data 2030 Programme, **aligned with this Vision Paper's ambition for Challenge 8** to put in place by 2030 an operational Data Discovery and Access Service (DDAS).

3.2.2. Marine Knowledge generation and sharing

Decade Actions are generating a wealth of marine knowledge outputs, delivering observations, data, processed information and solutions relevant to their particular challenge area. These include methodologies, best-practices, technological innovations, as well as observations data themselves, derived data-products, maps, times-series, models, forecasts, Digital Twins and use cases. Facilitating sharing of and access to these marine knowledge resources in a way that is visible to and accessible by the global

community is the first step in enabling co-design and development of solutions that can be implemented by decision makers.

In the following sections, we elaborate the specific infrastructure, tools and services, identified by this Strategic Ambition as necessary to enable this knowledge generation and sharing, including but not limited to the knowledge products to be developed in delivering this Strategic Ambition.

3.2.3. Services, tools and infrastructures' requirements

In identifying the infrastructures, tools and related services needed to enable the development and accessibility of the digital representation for all contributors and users, **we call for the development of the following:**

3.2.3.1. Global Ocean Data Discovery and Access Service

In line with the Decade's Data and Information Strategy's vision of a functional, inclusive globally distributed data and information service that provides timely access to data and information about the past, current and future state of the ocean, we support the urgent need for an **operational global Ocean Data Discovery and Access Service** for professional experts with hands on expertise in data-handling, allowing discovering, retrieving, viewing and downloading data (and information).

This Service should:

- Be a support service for Decade Actors and wider stakeholders to support their data access, sharing and management needs.
- Be compatible with the envisaged Digital Atlas (below) and allow users to easily discover, access and download the data underlying the base layers and local case studies, as well as the data-products themselves.
- Have an architecture that is compatible with the architecture of other core service and/or decision support tools/applications e.g. the Ocean forecasting system being developed by the DCC-OceanPrediction; the Digital Twin application architecture as being developed by DITTO/TURTLE etc.
- Be developed to allow interfaces adapted to the needs of users with different digital capabilities and allow to include atypical sources of data (socio-economic data, new types of data, data from indigenous knowledge, …)
- Be built upon existing platforms, infrastructures, programmes.

In considering what exists, and what could be further developed, the Decade's Ocean Data 2030 Programme, has ambitions to further develop, populate and expand the scope of the Global Ocean Data and Information System (ODIS) and we call for the Ocean

Infohub[18] project follow-up in 2024 and onwards. Other relevant Actions providing critical data infrastructures include the World Ocean Database Programme and a range of regional data services which already provide a wealth of resources and services.

We call on the Decade Data Strategy Implementation Group (DCG-SIG) to delineate the specific tools and their technical infrastructure design and further development steps.

3.2.3.2. Global Digital Atlas of the Ocean

We identify the need for an online user-friendly Digital Atlas of the Ocean for both professional users, without hands-on data-handing expertise and wider communities of non-professional users.

The Atlas would function at the interface between **Ocean Literacy and Data Management/Sharing** and links the ambitions of the Decade's Data and Information Strategy to wider society, acting as a 'community square' for sharing data-products developed by Decade actors and beyond, allowing a diversity of users to be able to browse and interact with the products that are being created around the globe, including the consensus base layers and local case studies developed as part of this Strategic Ambition. The envisaged Atlas should:

- Facilitate multi-lingual access.
- Be needs driven and dynamic, going beyond static map layers.
- Reach the widest possible user group with an API for smartphone access.
- Provide access to the consensus global base layers with functionality to store at least some of these for offline use in land and sea areas where internet is not available.
- Support interrogation and interaction with the data-products and underlying data-resources. from global layers to local products/data resources, allowing users to zoom into their specific area of interest and spotlight a local area.
- Be governed centrally, with specific communities responsible for maintaining their layers, layers that are not maintained are removed.

The creation and development of the Atlas could build on expertise in the International Coastal Atlas Network (ICAN)[19] ICAN network and regional examples such as the

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[18] Ocean Infohub is the operational development pilot project for ODIS which aims to connect local national and regional data systems across the world via agreed standards.

[19] ICAN is a project of UNESCO IOC´s IODE Programme, and ICAN members seek to play a leadership role in forging international collaborations of value to the participating nations, thereby optimizing regional governance in coastal zone management and marine spatial planning. https://ican.iode.org/

European Atlas of the Seas[20] and Japan's Digital Marine Atlas' (https://www.msil.go.jp/msil/htm/main.html?Lang=1) whose technology could be repurposed thereby reducing the costs considerably.

We call for ICAN and members of the global community of practice on digital coastal and marine atlases to further elaborate and define the functionality of the Atlas, cost it and recommend it as Decade Programme to develop it, exploring also existing infrastructures developed by the private sector[21] that could be adapted.

3.2.3.3. Marine Knowledge Exchange Mechanism

In addition to infrastructure facilitating sharing and use of ocean observations, data and data-products, we identify the need for a suite of tools, platforms and/or mechanisms enabling the sharing of other forms of ocean knowledge. These would include methodologies, best-practices, peer-reviewed publications, grey literature, videos, and other forms of non-typical knowledge outputs.

This mechanism/infrastructure should:

- Facilitate different levels of access, reflecting the different users, from the wider public to professionals in the field.
- Facilitate multi-lingual access and input.
- Ensure curation, implement versioning and control of what constitutes a 'best-practice' is.

Examples of existing platforms, tools and systems that could be further developed and promoted include, the Ocean Best Practices System[22] which provides access to 'technological advances and community approaches for all ocean methods', and AquaDocs[23], a joint open access repository of diverse knowledge products covering marine, coastal, estuarine and freshwater environments.

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[20] The European Atlas of the Seas provides information about Europe's marine environment, covering topics such as nature, tourism, security, energy, passenger transport, sea bottom, sea level rise, fish consumption, and much more.https://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas

[21] Members pointed to two companies who are particularly active with Google Earth and Microsoft planetary computers. https://www.techforwildlife.com/blog/2022/10/10/google-earth-engine-vs-the-microsoft-planetary-computer , https://wildlabs.net/discussion/google-earth-engine-vs-microsofts-planetary-computer-which-do-i-use.

[22] OceanPractices is a Decade programme to support all ocean stakeholders in securing, equitable sharing, and collectively advancing methods to manage our oceans sustainably. https://www.oceanbestpractices.org/

[23] AquaDocs is the joint open access repository of the UNESCO/IOC International Oceanographic Data and Information Exchange (IODE) and the International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC) with support from the FAO Aquatic Sciences and Fisheries Abstracts. https://aquadocs.org/

3.2.3.4. An Ocean Data Help Desk

Decade Actors have identified the urgent need for support and guidance with data management and sharing, with a growing request that there should be a permanent data-sharing help-desk service (virtual/distributed). The help desk should:

- **Provide an online point of access where stakeholders can submit questions/requests for support,** connected to a team of data managers and experts to receive guidance on all ocean data related aspects from collecting data, making a data management plan, metadata, etc.
- Provide support and facilitate access to distributed **Data Ingestion Service(s) to enable** diverse stakeholders share their data according to FAIR and CARE principles.
- Facilitate multi-lingual querying.
- Consider both contributors and users of the digital representation at varying levels of ability and capacity access), to maximize sharing and use of Decade data resources.
- Provide access to an online, interactive Ocean Data Toolkit including and linking to resources, including template for Data Management Plans, community best practices and standards, data policies and principles and distributed ingestion services.

We call for the DCO for Ocean Data Sharing to coordinate with the global data management Community of Practice, and in particular with IODE, to develop and trial a blueprint for a permanent Data Help Desk service. This could be a shared service developed by the DCOs for Ocean Observing and Ocean Data Sharing with the potential to be integrated in a permanent DDAS service post-Decade in close collaboration with IODE

3.2.3.5. Capacity Development and Exchange Facilities

To maximize engagement with the digital representation (both contribution to, and use of), we identify the need for facilities and resources for Capacity Development and training. These facilities and opportunities should:

- Take account of language barriers.
- Provide a space to learn how to use the digital representation resources but also how to contribute to it, as well as to new uses of it.
- Be a two-way mechanism, to also collate user feedback on the digital representation(s) products and services, for owners/custodians to incorporate and improve future iterations of base-layers, data-products, services.
- Possible tools could include:

- Education and Advanced discovery modes[24]: educational version can be a series of preset themes with layers configure to a certain topic, while advance opens more choices;
- Case study page where users can either browse or submit analysis performed with the developed digital representation of the ocean;
- Blog/Social Media;
- Moderated forum;
- User guide and how-to videos;
- Teacher page: study materials and worksheets for teachers;[25]
- Virtual Research Environments / Virtual Labs such as available in BlueCloud from the D4Science infrastructure[26]. These can also be set-up for hands-on training on scientific tools and algorithms;
- Well accredited courses on MOOCS[27] platforms such as Udemy[28], of Coursera[29], UDACITY[30], edx[31];
- Citizen Science apps for data collection. (e.g. from indigenous fishermen[32]).

The Ocean Teach Global Academy (https://www.oceanteacher.org/) could assist with capacity development and training. IOC is also launching an internship programme to build capacity in data-sharing.

We call for the Decade Capacity Building Facility, the Ocean Teacher Global Academy and network of experts of IODE, GOOS as well as the Decade Actions contributing in particular to Challenge 9 (i.e. Skills, knowledge and technology for all) to provide resources and training for increasing the data literacy of the Ocean Community to ensure meaningful contributions to the Decade Digital Ecosystem.

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[24] Example of recommended training site : https://www.sentinel-hub.com/explore/

[25] Example of initiative: https://www.worldwildlife.org/teaching-resources/toolkits

[26] https://blue-cloud.d4science.org/

[27] https://www.mooc.org/

[28] https://www.udemy.com/

[29] https://www.coursera.org/

[30] https://www.udacity.com/

[31] https://www.udemy.com/

[32] An example of an App developed by an ECOP to collect data from indigenous fishermen in Ghana was provided (Ruivo Demo project, Peter Busumprah)

3.2.4. Partnerships and resources

As far as possible in outlining this Strategic Ambition we have name-checked relevant partnerships who should be mobilized or engaged with to create or further develop the elements identified.

For each of the identified requirements and vision targets (be it required services, infrastructures, tools and content) we propose the development of a Value Proposition[33], defining the challenge for the end user and the solution offered by the data, data product and/or service as well as an estimate of what efforts and resources are required to deliver it, be it, for example, a consensus map layer or the Digital Atlas.

Where examples of applications or platforms exist in the private sector, that could be adapted through collaboration or investment we have referenced these and encourage exploration of these opportunities, avoiding becoming locked in and maintaining freedom of use and neutrality.

Crucial also to this Strategic Ambition are the Decade entities, supporting the implementation of the Data and Information Strategy and those Actions contributing to the digital representation.

3.2.5. Capacity development and exchange

We have identified this as a core need and proposed Actions as part of the Strategic Ambition setting for this Challenge (see above: Capacity Development and Exchange Facilities). This needs to be tightly linked to the ambitions of, and efforts to address, Decade Challenges 9 and 10. This aspect was also highlighted as an important strategic objective (#5) in the Decade Data and Information Strategy (i.e. to Expand, empower, and mobilize global communities to advance and maintain the ocean digital ecosystem).

3.2.6. Technology and innovation solutions

The Decade calls for transformation. Technology and innovation are enablers if the Strategic Ambitions set forth in this white paper. Among others by developing and deploying cost-effective sensors, drone technology, the internet of things, cloud computing, Artificial Intelligence and Digital Twins, technology and innovations will allow for ever more comprehensive, inclusive, and useful digital representations of the ocean supporting sustainable ocean management.

Data Lakes

While we call for the need for an operational Ocean Data Discovery and Access Service, we note also that from a commercial company perspective (and increasingly amongst the

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[33] We acknowledge the DCO for Ocean Observation for inspiring the application of this concept

scientific community), the approach to 'discover, access and download' is becoming less relevant, with even modern webservices not sufficient for big data analysis. While the academic and governance communities tend to have their own IT infrastructure, for companies the trend to move to commercial clouds has taken over. Therefore, we recommend considering also the potential flow of data towards the commercial cloud companies where companies are renting their IT services. Sending synced copies of major subsets of data to a data lake in such major cloud computing facilities would be very beneficial. This would reduce the internet-burden on the government services and allow commercial companies to do big data analysis on the data. For this reason, the concept of using data lakes for big data analysis, instead of webservices, has gained traction with a growing number of commercial user communities. Data lakes are also ideal for maximizing the unique value of Digital Twins. Big cloud companies are eager to ingest data, and may even do this for free, meaning that the data lake will be shared (read-only), and other companies have only to rent a server next to the data lake. In addition to commercial companies, researchers are also moving in this direction, paying for a bucket of data in a commercial company. We propose to consider an Ocean Decade alternative to this, with the Decade remaining strictly neutral, the commercial cloud companies should come and offer their alternatives to support and contribute to the UN Ocean Decade.

In highlighting the transformative potential of data lakes, we recognize also the concerns of the community regarding creating copies of data and propose that these discussions are advanced in the context of Decade's Data Strategy Implementation Group and the Corporate Data Group towards a way forward.

Artificial Intelligence and Digital Representations

Artificial Intelligence is extensively utilized to process data and generate knowledge. It is used in taxonomic identification in images and satellite image classification, e.g. for cage or ponds aquaculture, in species distribution forecasts, etc., and is therefore already implicit in many pipelines along the marine knowledge value chain. Recent advancements such as Large Language Models (LLMs) are accelerating the pace and also lowering the bar to analyze data. Together, these technologies could present new opportunities in the context of this challenge, including the following:

- Unlock unstructured geospatial data from publications and grey literature to provide improved observational datasets.
- New insights from structured and unstructured data together with cheap storage and computing power, improved earth observations, seabed knowledge (though still poor) and climate models, enable more accurate predictive modelling with higher temporal, spatial and thematic resolution.
- Data sharing, such as source data behind publications, from science, industry and governments is improved with affordable cloud infrastructure and new policy and

regulations. Open-source libraries including powerful AI tools have potential to accelerate the extraction of meaningful information from these data sources, for example extracting new information from large amounts of underwater videos, or sonar data.

- AI assistance has the potential to lower language and know-how barriers empowering more people to generate and visualize knowledge and ultimately take more informed decisions in the blue economy.

- AI could potentially be used to capture traditional knowledge that cannot easily be put into databases. An important caveat is that if AI were to be used to interpret traditional knowledge, the training steps would be biased towards certain ways of using knowledge and language and this may be flawed given inherently different world views. Pilots in specific regions could be used to see how the training would work.

- While Artificial Intelligence has raised a lot of expectations. Effective AI models only exist by the grace of large, unified collections of data offered in a form that can be ingested as a whole as input for AI models. The Common crawl (https://commoncrawl.org/) and WebImageText (https://github.com/google-research-datasets/wit) are examples. To allow AI to contribute to Ocean Understanding the UN Ocean Decade should strive towards an OceanCrawl: one big chunk (of set of chunks) of all measured data ready to be bulk downloaded and ingested into any AI training.

Digital representations and Digital Twins of the Ocean provide the ultimate tool enabling decision-makers to address 'what if scenarios' and empowering all ocean stakeholders to explore our ocean resources. As noted above (see Section 3.1), the characteristics of the data required to create a digital representation of the ocean will vary widely across and within the physical, ecological and human domains. Within the socioeconomic realm, in particular, while large commercial uses (e.g., industrial fishing, offshore wind) may create streams of real-time data suitable for input into a Digital Twin, data on many human activities and socioeconomic conditions are likely both less available and less suitable for input as they currently stand (e.g., non-quantitative, limited volume, heterogenous, patchy in space and time). In particular, socioeconomic data available as input into AI-driven models data are likely to focus on more organized, higher economic-value activities. Furthermore, although work on how AI can reproduce social biases from input data is well-developed (e.g., racial and gender bias and machine learning algorithms, Zou & Schiebinger, 2018), and work on how social inequity intersects with ocean governance is rapidly developing (Crosman et al., 2022; Jaeckel et al., 2023; Spalding et al., 2023), such issues appear to be less thoroughly addressed in data science or AI focused on representing the physical world, despite the recognition that human-environment interfaces should be included as a central contributor to such representations.

If ingested data reflecting economic value derived from high-commercial value activities (e.g., large, commercial fisheries) are more available and more tractable to digital representation input, policy derived from such tools will privilege economic constructions of the value humans derive from ecosystems, and the (more powerful) actors that hold and benefit from those values (e.g., wealthy nation-states, large fishing companies). Relatedly, failing to represent non-economic values, lower-economic-value activities, and how policy and management costs and benefits are distributed across stakeholders will come at the expense of (less powerful) actors who hold and benefit from those values (e.g., Small Island Developing States, politically and economically marginalized Indigenous fishers) (Crosman et al., 2022).

If the representation of the system provided by a digital representation of the ocean systematically excludes some types of human uses, values, or human/ecosystem interactions, the Digital Twin will be a systematically biased representation of the reality it seeks to capture. Biased recommendations or policy actions are a likely result. Real-world links between political and economic systems result, in many contexts, in greater political power for better-resourced, more-organized stakeholders. Thus decision-support tools that preferentially reflect the activities and concerns of better-resourced, more-organized stakeholders are likely to reinforce existing social inequities. Management or policy resulting from uncritical reliance on such tools is likely to fail ethically (e.g., by exacerbating social inequity) and instrumentally (e.g., by failing to account for the full suite of human/ecosystem interactions and their effects, thus mis-specifying policy and management). In short, we manage what we see, and what we see is a function of where we put our attention. Reliance on data that meet potentially narrow criteria is likely to constrain our vision, and thus our decision-making and management.

3.3. Integration, synergies and interdependencies with other Challenges

This Strategic Ambition is interdependent on the priority data and information needs identified by the other challenges, these will contribute to identifying the consensus-base layers and local case studies via the consultation and selection process outlined in Section 1.1, but also in the development of fit-for-purpose tools and services to share and serve the knowledge products developed by Decade Actions and relevant communities.

4. Milestones and indicators

4.1. Key milestones to measure progress and success

Linked to our main vision targets, here are some of the main milestones along the way towards achieving them by 2030.

Vision Target	Milestone						
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Global Base layers **Who leads?** Relevant communities developing existing products, identified via consensus process Decade Actions.	Minimum 10 potential layers and communities of practice identified and prioritized	Minimum 10 priority layers agreed and associated communities of practice committed	Methodology and approach agreed and made available via knowledge sharing platform		Preliminary layers available via prototype Action		Minimum 10 societally relevant layers available via Global Digital Atlas and usable on mobile apps…
Local Case Studies	Minimum 10 potential case studies and leads identified and prioritized	Minimum 10 potential case studies agreed	Work initiated on all case studies. Stakeholder satisfaction survey is		Preliminary data products available via prototype digital Atlas		Minimum 10 societally relevant layers available via Global Digital Atlas and usable on mobile apps

Who leads? – Identified by process			issued, and results incorporated.					
Global data discovery and access service **Who leads?** DSIG and Ocean Data 2030	Development plan drafted by Data Strategy Implementation Group and Ocean Data 2030 Programme	Resource mobilized			Prototype ready			Core architecture compatible with Digital Atlas and Decision support tools (forecasting services, digital representations)
Global Atlas **Who leads?** Call for new programme	ICAN and members of the global community of practice on digital coastal and marine atlases to further elaborate and define the functionality of the Atlas, cost it and recommend it as Decade Programme	Call issued for a new Decade Programme to create a Global Digital Atlas	Resources mobilized		Prototype Atlas available and survey to solicit initial feedback towards co-design is issued.			Global Digital Atlas exists with full functionality for viewing and interacting with diverse layers and data products, including interrogation of underlying data.
Marine knowledge exchange mechanism **Who leads?** IODE working group on marine	Working group established, key platforms and mechanisms identified	Promo-campaign to position platforms as knowledge sharing mechanisms						Marine knowledge exchange mechanism supporting multi-lingual access and actively used to share contributions

knowledge exchange							from all Decade actors
Capacity building and training facility **Who leads?** IODE-OTGA, Capacity Development Facility – consider working group	Working group established			Multilingual courses available in using DDAS and Global Atlas	Story-telling apps developed for each consensus-base layer	Wide consultation to assess usability and inclusiveness of developing elements of digital representation (DDAS, Atlas and base layers/ data products and feedback incorporated in co-creation.	
Help-desk DCO-ODS	Protype help-desk available online via the website of the DCO for Ocean Data Sharing and trailed at Decade conference in Barcelona	Commitments from relevant bodies to provide expertise to support help-desk facility	Satisfaction survey of help-desk facility is issued, and feedback incorporated in new iteration				Help desk included as a permanent feature in DDAS service post-Decade

4.2. Indicators to track the achievement of the Strategic Ambition

These common milestones and indicators, below, have been developed by the DCU. Please add any thoughts/proposals on how to adapt/tailor to be specific to WG8. [in yellow highlight modifications/suggestions added based on conversations with WG]

Disclaimer: While specific milestones and indicators for measuring progress and success may vary across the different Working Groups and their related White Papers, there are several common key milestones that could be considered to track the achievement of the Decade Challenges. To ensure effective progress assessment, each Working Group is encouraged to develop 2-3 indicators for each of these specific milestones, ensuring that they are Specific, Measurable, Achievable, Relevant and Time-bound (SMART). A couple of <u>broad suggestions for indicators</u> are included under each Milestone as examples that WGs can discharge, merge, modify and refine to meet their needs and make them SMART. This is meant to be a living document that will evolve considering the upcoming results of the Working Groups. At this stage the specific information (who, how and when) on measuring the specific indicators is not necessary. Any comments and feedback are highly appreciated.

Generic comment: Milestones and Indicators seem more related to the challenge area than to the specific Strategic Ambition. For example, publications according to the challenge area (ecosystems health, digital representations, marine pollution) may have nothing to do with the Strategic Ambition. So, the indicators should be specifically linked to elements of the Strategic Ambition. In the case of WG8 we attempt to do, below.

Milestone	Indicators relevant to Working Group 8
Milestone 1: Enhanced Ocean Data Accessibility and Availability Increased availability and accessibility of ocean data, including the streamlining of data-sharing platforms, standardized data formats, and open access policies.	Indicator 1.1: Percentage of relevant data made accessible (i) per consensus base layer and (ii) per local case study at specific time intervals. The proportion of ocean data that is made available to create consensus base layers. It can be measured by calculating the percentage of relevant data sets that are publicly accessible, considering factors such as data completeness, timeliness, and data quality.
	Indicator 1.2: Level of data interoperability achieved (i) per consensus base layers and (ii) per local use case, differentiating between the data sources and the data products. The extent to which different data sources and formats are harmonized and interoperable. It can be measured by evaluating the adoption of standardized data formats, metadata standards, and data integration protocols across different data providers. The indicator can also consider the ease of data integration and data exchange between different platforms or systems.
	Indicator 1.3: Adoption of open access policies by Decade Actions. The extent to which open access policies are implemented to promote data sharing and reuse. It can be measured by tracking the number of Actions, organizations and/or institutions that have adopted open access policies for their ocean data.

	Remarks: • *Could consider categories - types of data/ topics/ geographic extent (horizontal and vertical), temporal coverage, thematic coverage* • *Gaps identified - spatial/temporal/interoperability gaps* • *On interoperability the DCO for Ocean Data Sharing is tasked to monitor the extent to which Decade Actions are adopting standards and have interlocuters with the Actions so this could be tracked.* • *On interoperability - differentiate the data sources from the products. Are the sources open and available?* • *Level of openness - open for any use/ open access policy. This is something that the DCO can track/ policies adopted* • *The Ocean Data and Information System dashboard should be able to provide meaningful information as to the evolution of number of references, sources, data and products made discoverable and ultimately accessible, but does not show what isn't there*
Milestone 2: Advancement in Ocean Knowledge Sharing Increased the generation and sharing of scientific knowledge and information related to the UN Ocean Decade Challenges.	Indicator 2.1: Number of research publications. Quantity of scientific research publications related to the UN Ocean Decade challenges. It can be tracked by counting the number of peer-reviewed journal articles, conference papers, and reports that contribute new knowledge or insights to the field. (OK - but who tracks and how to actually define, could be any publication related to ocean data) Indicator 2.1: Number of research publications related specifically to new Challenge 8 outputs of Strategic Ambition, i.e. creation of consensus base layers, local case studies, Global Digital Atlas etc. [criteria/terms to be specified]. Indicator 2.2: Number of knowledge products developed associated to creation of consensus base layers and local case studies, and new tools and services created as part of Challenge 8 Strategic Ambition. Production of knowledge products such as reports,

guidelines, toolkits, and manuals that provide practical information and guidance on addressing the challenges. It can be measured by counting the number of knowledge products developed and made available to stakeholders.

Indicator 2.3: Number of best practices identified and shared ==associated to creation of consensus base layers and local case studies, and new tools and services created as part of Challenge 8 Strategic Ambition==. Identifying and sharing best practices or successful case studies that demonstrate effective approaches to addressing the challenge. It can be measured by tracking the number of documented best practices, success stories, or lessons learned that are shared with stakeholders.

Indicator 2.4: Level of stakeholder engagement in knowledge sharing activities. Level of engagement and participation of stakeholders in knowledge sharing activities, such as workshops, conferences, webinars, and online platforms. It can be measured by tracking the number of participants, the diversity of stakeholder groups involved, and the feedback received from participants regarding the usefulness and relevance of the knowledge shared.

==*Alternatives to 2.4*==

==*Indicator 2.4: Level of stakeholder engagement in knowledge sharing activities: Number of times consensus base layers and local case studies (data-products) are accessed or downloaded, measured by location, language and stakeholder group (if possible, to track/ask)*==

==*Level of stakeholder engagement in local case studies: willingness of local communities to be involved in case studies. Metrics developed bottom-up, to assess inclusiveness of the process (communication, platforms to engage, feedback-incorporated)*==

Milestone 3: Building Capacity for Ocean Decade Challenges Increased the capacity of individuals, institutions, and communities to effectively address the UN Ocean Decade Challenges.	Indicator 3.1: Number of capacity building initiatives ==[to improve digital literacy and addressing challenge 8]==. Quantity of initiatives or programs specifically designed to build capacity in addressing the challenge. It can be tracked by counting the number of capacity-building initiatives, workshops, training programs, and educational activities implemented. ==OK (and could be related specifically to proposed capacity-building mechanism)== Indicator 3.2: Number of participants trained ==[to improve digital literacy and addressing challenge 8]==. Reach and impact of capacity building initiatives by measuring the number of individuals who have participated in training programs or capacity building activities. It can be measured by tracking the number of participants enrolled, trained, or certified through these initiatives. ==OK== Indicator 3.3: Level of institutional partnerships ==established in consortia creating consensus base layers and local case studies==. Establishment of partnerships and collaborations between different institutions, organizations, and stakeholders to facilitate capacity development. It can be measured by tracking the number of formal partnerships, memoranda of understanding (MoUs), or collaborative agreements established. Indicator 3.4: Assessment of skills and knowledge improvement. Perception of individuals or organizations regarding their skills and knowledge improvement after participating in capacity-building activities. It can be measured through self-assessment surveys or evaluations conducted before and after the training programs==. (OK -)==
Milestone 4: Sustainable Policy and Governance Implementation Increased development and implementation of policy and governance frameworks that	Indicator 4.1: Adoption of relevant policies, legislation, and regulations. Extent to which relevant policies, legislation, and regulations have been adopted at the national or international level to address the challenges. It can be measured by tracking the number of policy documents, acts, laws, or regulations specifically targeting the challenge. ==Not clear how this could be measured and proven to have been related to CH8, e.g. a new policy/regulation on the use/application of Digital Twins or AI in marine spatial planning, for example, could be considered within the scope but may have nothing to do with it.==

support sustainable ocean management and address the UN Ocean Decade Challenges at hand.	Indicator 4.2: Integration into national and international agendas. Level of integration of the challenges into national and international agendas, strategies, or action plans. It can be assessed by examining the inclusion of the challenges in relevant policy documents, national development plans, or international frameworks and conventions. ==In theory could be applicable to proposed consensus base layers.==
	Indicator 4.3: Stakeholder engagement in policy development. Engagement of stakeholders in the development of policies and governance frameworks related to the challenge. It can be measured by assessing the level of stakeholder participation, consultation processes, or the establishment of multi-stakeholder platforms. ==Again, how to prove that actually related to the outcomes of the strategic vision==
	Indicator 4.4: Policy implementation and enforcement. Implementation and enforcement of policies and regulations related to the challenge. It can be measured by evaluating the extent to which policies are effectively implemented, monitored, and enforced. ==Again, how to prove that actually related to the outcomes of the strategic vision==
Milestone 5: Inclusive Stakeholder Engagement Increased inclusive and meaningful stakeholder engagement and participation in addressing the UN Ocean Decade Challenges.	Indicator 5.1: Diversity of stakeholders involved. Diversity of stakeholders engaged in ==creating the consensus base layers and local case studies.== It can be measured by evaluating the representation of different stakeholder groups, such as government agencies, research institutions, civil society organizations, local communities, industry representatives, and indigenous groups.
	Indicator 5.2: Level of active participation. Level of active engagement and participation of stakeholders in activities related to the challenges. It can be assessed by tracking the number and quality of interactions, involvement in decision-making processes, and contributions to the development and implementation of initiatives. ==(similar to above?)==
	Indicator 5.3: Incorporation of stakeholder perspectives. Extent to which stakeholder perspectives and contributions are incorporated into decision-making processes and the development of initiatives (==including the consensus base layers and local case studies. It can be measured by incorporating a feedback mechanism in the co-design process,==

	evaluating the degree to which stakeholder inputs are integrated into ==the consensus base layers, local case studies and tools and services,== policy documents, action plans, or project designs.
	~~Indicator 5.4: Effectiveness of stakeholder feedback mechanisms. Effectiveness of feedback mechanisms in capturing stakeholder inputs, concerns, and recommendations. It can be measured by assessing the existence and functionality of mechanisms such as public consultations, stakeholder surveys, or feedback channels.~~
Milestone 6: Societal and Environmental Impact *Increased positive societal and environmental impacts.* ==*[maybe too indirectly and less relevant for this challenge]*==	*Indicator 6.1: Ecosystem health. Improvement in the health and integrity of the ecosystems affected by the challenge. It can be assessed by tracking indicators such as biodiversity indices, water quality parameters, habitat restoration, and the recovery of key species.* ==*Since CH8 is related to the entire ocean and all data typologies, this would be hard to measure. Could be adapted to the extent to which the base layers/ local case studies have contributed to improved knowledge on the health and integrity of the ecosystems?*== *Indicator 6.2: Livelihood improvement. Positive impacts on livelihoods, particularly those of communities dependent on the ocean and its resources. It can be measured by indicators such as increased income, employment opportunities, and diversification of livelihood options.* ==*Not sure this can be measured as related to this Strategic Ambition in the proposed timeframe, unless related to new training?*== *Indicator 6.3: Resilience enhancement. Increased resilience of communities, ecosystems, and sectors to the impacts of the challenge. It can be assessed by indicators such as reduced vulnerability to climate change, improved adaptive capacity, and the implementation of risk reduction measures.* ==*Again, not really something related to this challenge, specifically, but could instead measure the ability to measure resilience as a result of increased access to digital representation?*== *Indicator 6.4: Reduced vulnerability. Reduction in vulnerability of communities and ecosystems to the specific challenge. It can be measured by tracking indicators such as decreased exposure to hazards, improved preparedness, and enhanced coping*

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	mechanisms. <mark>*Again, not really something related to this challenge, specifically, but could instead measure the ability to measure resilience as a result of increased access to digital representation?*</mark>
	Indicator 6.4: Resource efficiency and sustainable practices. Adoption and promotion of resource-efficient and sustainable practices. It can be measured by evaluating factors such as energy consumption, water usage, waste management, greenhouse gas emissions, sustainable procurement practices, and the integration of environmental considerations into decision-making processes<mark>*. Again, not really something related to this challenge, specifically, but could instead measure the ability to measure resilience as a result of increased access to digital representation?*</mark>
Milestone 7: Increased Funding for Decade Actions Increased funding for the implementation of actions addressing the UN Ocean Decade Challenges	Indicator 7.1: Funding raised. Amount of funding secured for the implementation of Decade Actions addressing the challenge. It can be assessed by tracking the total financial and in-kind resources mobilized from various sources, including government funding, private sector investments, and philanthropic contributions. <mark>OK</mark> Indicator 7.2: Diversification of funding sources. Diversification of funding sources for addressing the challenge<mark>, (consensus bae layers, local case studies and tools and services)</mark>. It can be measured by tracking the proportion of funding received from different sectors, such as government, private sector, civil society organizations, and international funding mechanisms.<mark> OK</mark> Indicator 7.3: Sustainable financial mechanisms. Establishment of sustainable financial mechanisms to support the long-term implementation of actions <mark>(consensus base layers, local case studies and tools and services)</mark> (also beyond the timeframe of the Decade). It can be assessed by indicators such as the development of trust funds, endowments, public-private partnerships, or innovative financing mechanisms.

	<u>Indicator 7.4: Leveraging of resources.</u> Ability to leverage additional resources <mark>to support creation/development of consensus bae layers, local case studies and tools and services</mark> through partnerships and collaborations. It can be assessed by tracking indicators such as the value of co-financing arrangements, in-kind contributions from partners, and the mobilization of resources through leveraging networks and alliances.
Milestone 8: Diverse and Inclusive Decade Actions Increased diversity and inclusivity within actions of the UN Ocean Decade.	<u>Indicator 8.1: New programmes and projects.</u> Number of new programmes and projects initiated that focus on addressing underrepresented topics or geographical regions. This indicator measures the concrete actions taken to prioritize and address gaps in representation within the UN Ocean Decade. <mark>OK</mark> <u>Indicator 8.2: Diverse allocation of resources.</u> Percentage increase in the allocation of resources to Decade actions targeting underrepresented areas. This indicator tracks the shift in resource allocation to ensure that adequate funding, expertise, and technology are dedicated to initiatives focusing on underrepresented topics or regions. <mark>OK</mark> <u>Indicator 8.3: Improved partnerships.</u> Number of partnerships established with organizations and stakeholders from underrepresented regions to foster collaboration and knowledge exchange. This indicator measures the extent of collaboration and engagement with entities from underrepresented regions. <mark>OK</mark> <u>Indicator 8.4: Stakeholder satisfaction and feedback.</u> Measurement of stakeholder satisfaction and feedback on the implementation of programs and projects. It can involve conducting surveys or feedback mechanisms to gather stakeholders' perspectives on the relevance, efficiency, and outcomes of the initiatives. <mark>OK</mark>
Milestone 9. Advancement in Ocean Technology and Innovation	<u>Indicator 9.1: Technological innovations implemented.</u> Number of new technological innovations integrated into ocean research and management practices, reflecting the progress in advancing technology within specific timeframes. <mark>OK< but important to be able to prove were specifically related to this Strategic Ambition/outputs</mark>

Increased advancement in ocean technology, innovation, and infrastructure to support ocean research and management.	Indicator 9.2: Research infrastructure enhancement. Percentage increase in research infrastructure investments dedicated to ocean-related projects ==(can we say specifically to the goals of this Strategic Ambition – i.e. proposed tools and services, e.g. Global Digital Atlas)== demonstrating the commitment to improving the tools and facilities essential for ocean exploration and research. Indicator 9.3: Collaboration with tech industries. Number of collaborations established with technology industries and startups, fostering partnerships to develop innovative solutions and enhance the utilization of cutting-edge technology in ocean science ==in creation/development of Strategic Ambition goals.==
Milestone 10. Enhanced Utilization of Ocean Science and Knowledge Increased use of ocean science and knowledge for various purposes.	Indicator 10.1: Knowledge transfer events. Number of workshops, seminars, or training sessions conducted to disseminate ocean science knowledge among diverse stakeholders, demonstrating the efforts to enhance public awareness and understanding of ocean-related issues. ==OK, but would have to be costed into the development of the specific layers, tools and services.== Indicator 10.2: Increase in data utilization. Percentage increase in the utilization of available ocean data by research institutions, governmental bodies, and non-governmental organizations, indicating the growing reliance on existing data for scientific studies and decision-making. ==OK, through dashboard of base layers/ case studies== Indicator 10.3: Increase use of ocean science and knowledge for sustainable development. Percentage increase in the integration of ==consensus base layers/local case studies/tools and or/related methodologies/best practices== in sustainable development strategies, showcasing the influence of scientific knowledge on decision-making. Number of sustainable practices and technologies derived from ocean science, indicating tangible contributions to sustainable development goals.

	Indicator 10.4: Increased educational impact. Number of educational outreach programs conducted, demonstrating efforts to enhance public knowledge and appreciation of ocean science <mark>using developed base layers, tools and services</mark>. Number of educational institutions incorporating ocean science into their curricula, demonstrating the integration of ocean knowledge into formal education systems. Percentage increase in student participation in ocean science-related extracurricular activities, showcasing enhanced interest and engagement among the youth. <mark>Incorporation of –if we can leverage ECOP, work through ECOPs network to see what is already being done</mark>

Table: Preliminary ideas as examples for proposed target local case studies to stress test the digital ecosystem, to identify challenges in the marine knowledge value chain (technical challenges, capacity limitations, ingestion facilities and DDAS usefulness)

Local case studies	Short description	Thematics, data types and layers handled/produced	Proposed by / owner	Relevant Challenge
Local fishermen in Ghana	Data sharing by indigenous fisheries communities Citizen science apps		Peter Teye Busumprah	
Aquaculture in Africa *West Africa - Ghana , Nigeria , Niger , Benin)* *North Africa - Egypt* *Southern Africa - South Africa , Namibia, Mozambique* *East Africa - Tanzania, Kenya , Somalia, Uganda* *Central Africa - Cameroon* *SIDS - Cape Verde , Comoros , Madagascar, Seychelles.*	Linkage of fish farmers to their resources through Digitalization		Peter Teye Busumprah	
Consider local pilot studies in development by Coast Predict		ASK COAST-PREDICT as they are going to focus on a range of local pilot study areas… use some of those but focusing particularly on the data challenges-		

		Impact Area 6 & 7		
Scientist and Researchers in West Africa	This project features the integration of low-cost internet of things devices using effectors and sensors to measure, record and transmit marine environment variables. Sample parameters in scope: Temperature, Dissolved CO2 dioxide, pH, salinity, alkalinity, Nitrate, wave speed and drn, and turbidity. The data parameters are leveraged towards Oceanographic environment intelligence.		Peter Teye Busumprah	
Fishers in Comoros	The project is designed to assess the impact of Climate change on the socioeconomics of the fishers and the economy of the Country.	The project will require climate change impact data and socio-economics data for fishers.	Kamal Thabiti	
Fishing activity density in selected regions (e.g. NE or NW Atlantic where bias to such map is lesser)			Marc Taconet	
Geo-referenced inventory of fisheries (artisanal and industrial) in 6 countries of the Gulf of Guinea **in 8 countries of the Gulf** **in 11 countries of the Caribbean**	about 40 fisheries are inventoried and status and trends information maintained by the Fisheries Committee for the West Central Gulf of Guinea (FCWC) as part of the FIRMS partnership. e.g. https://firms.fao.org/firms/fishery/1056/en	catch, effort, management measures by fishing unit. Qualitative and quantitative information on fisheries	Marc Taconet	

	same with 109 fisheries under the Commission on Fisheries (RECOFI) e.g. https://firms.fao.org/firms/fishery/1083/en	georeferencing of these fisheries (API services)		
	same with 34 fisheries under the Western Central Atlantic Fisheries Commission (WECAFC) e.g. https://firms.fao.org/firms/fishery/907/en			

Annex 1: List of potential global data layers and case studies

Challenge Areas	Initial ideas for consensus base layers with links to examples NB - Final selection of base layers should follow the process outlined in Section XX)
1. **Understand and Beat Pollution**	– Beach litter, microplastic distribution (link to the proposed global plastics treaty.) – Nutrient outflow – Ghost gear (source: global treaty, global ghost gear initiative, …) – Spatial awareness layer that uses currents to show where pollution ends-up https://theoceancleanup.com/plastic-tracker/ – Layers on the concentration, distribution, speciation, sources, and thresholds (including proxy species) of key & emerging contaminants & their potential impacts.
2. **Protect and restore ecosystems and biodiversity**	– Consider global and regional marine life / coastal habitat layers including biodiversity, species distributions with some temporal resolution (climatological seasons if possible) and at a spatial resolution useful for the management of uses, modelled forecasts of species distribution, MPA siting and temporal boundaries/sunsetting, etc. – Marine Protected Areas and biodiversity hotspots – Vulnerable marine ecosystems (VME database https://www.fao.org/in-action/vulnerable-marine-ecosystems/vme-database/en/vme.html) – Global layer of an inventory of preservation or restoration Actions that are ongoing to make our 1 Ocean equitable and sustainable. (See as an example the African Ushahidi platform https://www.ushahidi.com/)
3. **Sustainably Nourish the Global Population**	– A global map of local ocean activities such as artisanal fishing to put coastal communities on the map, or aquaculture based on cages or coastal pond farming systems. Data does not exist but could observed in high-resolution satellite imagery and modelled – Fish catch, aquaculture production (volume and value) - source: FAO – GlobalTuna georeferenced catches by 5-degree square - Source: FAO – FIRMS (annually updated by the 5 tuna RFMOs https://www.fao.org/fishery/en/collection/firms-tuna-atlas) – A global map of aquatic animal catches (by FAO major area and by countries, also available in certain areas by sub-areas). – A global map of status of fishery stocks (at species-genus-family granularity level, by FAO major area and at higher resolution fish stock by fish stock where assessment data has been made public – A global map of marine/brackish water aquatic animals aquaculture production by FAO major area and by countries

4. **Sustainable Blue Economy**	– One common basic consensus background layer available for all sectors and for myriad Digital Twins to place them in context (Example of the Swisstopo app https://www.swisstopo.admin.ch/) . Maritime companies would pay a significant license fee to have such a reference base map at their disposal: Electronic Nautical Charts that adhere to UN IMO standards. For example, an openoceanmap based on https://map.openseamap.org/ – Resource use, sand and gravel extraction, minerals extraction, kw/hours produced, goods transported,…). – Priority datasets (those that are required for/enable MSP/SOP) – Wind farm locations
5. **Ocean-Climate Nexus**	– Blue Carbon (source: e.g. blue carbon initiative) – Climate related pressures and changes (?) – Maps that capture different aspects of climate risks/changes, e.g. how water levels scenarios impact low lying areas, changing ocean condition (temperature etc.), increased damage from storms, ecosystem changes etc. Example: https://www.smhi.se/en/research/research-departments/oceanography/climemarine-effects-of-climate-change-into-marine-spatial-planning-1.150668 (also relevant to CH6)
6. **Coastal Resilience**	– Merged topography and bathymetry data set – global seafloor map (seabed 2030) – Human activities data sets e.g. fishers or fish farmers, economic indicators across sectors and their socio-economic interactions at high spatial-temporal resolution (For Fisheries, FAO maintains annual statistics of the number of fishers and aquaculture farmers by countries, by sex. Consider what employment statistics are maintained by OECD, by ILO, by WMO, etc.) – Sociodemographic data – Global MSP maps
7. **Expand the Global Ocean Observing System**	– Argo Positions – Ship Observation Team – Data Buoys
8. **Digital Representation**	– Global seafloor map (seabed 2030) – Ocean Data-density layer to highlight gaps – Existing/developing Digital Twins
9.	– One common consensus background layer per challenge area, available to anyone with a smartphone in multilingual format – Global base layer of indigenous communities sharing data to global system

Skills, knowledge and technology for all	– For this challenge area we note that the tools & services identified in the CH8 strategic vision, specifically the user-friendly Digital Atlas, Marine knowledge exchange mechanism, Global Data Help Desk and Capacity Building & training facility will be more relevant than specific base layers
10. Change humanity's relationship with the ocean	– Georeferenced SDG14 indicators – Traditional language translation of all consensuses base layers – A storytelling layer on top of all consensus base-layers explaining how they can contribute to the challenge area, e.g. https://theoceancleanup.com/plastic-tracker/ or https://ais-scrolly.netlify.app/ . – Global base layer of ocean literacy activities – For this challenge area we note that the tools & services identified in the CH8 strategic vision, specifically the user-friendly Digital Atlas, Marine knowledge exchange mechanism, Global Data Help Desk and Capacity Building & training facility (including games and training modules) will be more relevant than specific base layers.

References

Crosman, K.M., Allison, E.H., Ota, Y. *et al*. Social equity is key to sustainable ocean governance. npj Ocean Sustain 1, 4 (2022). https://doi.org/10.1038/s44183-022-00001-7

Jaeckel, A., Harden-Davies, H., Amon, D.J. *et al*. Deep seabed mining lacks social legitimacy. npj Ocean Sustain 2, 1 (2023). https://doi.org/10.1038/s44183-023-00009-7

Populus J., Vasquez M., Albrecht J., *et al*. EUSeaMap (2017), a European broad-scale seabed habitat map. 174p. http://doi.org/10.13155/49975

Ryabinin, V., Barbière, J., Haugan, P., Kullenberg, G., Smith, N., McLean, C., *et al*. (2019). The UN decade of ocean science for sustainable development. Front. Mar. Sci. 6, 470. https://doi.org/10.3389/fmars.2019.00470

Spalding, A. K., Grorud-Colvert, K., Allison, E. H., Amon, D. J., Collin, R., de Vos, A., *et al*. (2023). Engaging the tropical majority to make ocean governance and science more equitable and effective. npj Ocean Sustain. 2, 8. https://doi.org/10.1038/s44183-023-00015-9

Zou, J. & Schiebinger, L., AI can be sexist and racist – it's time to make it fair. Nature **559**, 324-326 (2018). https://doi.org/10.1038/d41586-018-05707-8

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United Nations Decade of Ocean Science for Sustainable Development (2021-2030)

Proclaimed in 2017 by the United Nations General Assembly, the UN Decade of Ocean Science for Sustainable Development (2021-2030), provides a convening framework to develop the scientific knowledge and partnerships needed to catalyse transformative ocean science solutions for sustainable development, connecting people and our ocean. The Ocean Decade is coordinated by UNESCO's Intergovernmental Oceanographic Commission (IOC).

Established during the Preparatory Phase and to continue throughout implementation until 2030, the IOC's Ocean Decade Series will provide key documentation about this global initiative and aims to serve as a primary resource for stakeholders seeking to consult, monitor and assess progress towards the vision and mission of the Ocean Decade.

https://oceandecade.org/

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