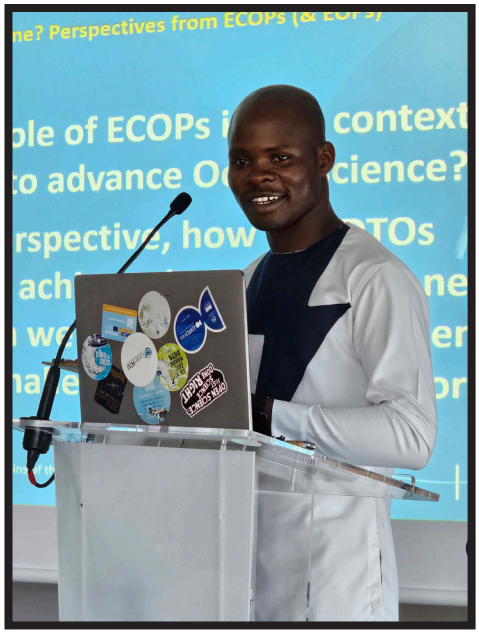

DTO4ECOPS: A REPORT

DIGITAL TWINS OF THE OCEAN & EARLY CAREER PROFESSIONALS (

LEVERAGING OCEAN DATA NETWORKS WITH CLOUD TECHNOLOGIES TO DELIVER THE OCEAN WE WANT, TODAY AND TOMORROW

unesco
Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

THE DTO4ECOPS EVENT TEAM

EU MISSIONS
RESTORE OUR OCEAN & WATERS

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GEO BLUE PLANET

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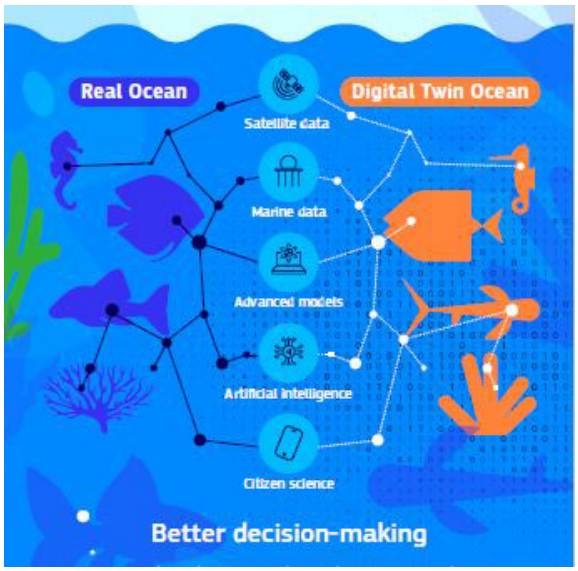
INTRODUCTION

Digital twins of the ocean (DTO) provide online, virtual platforms into which sets of big data (large, complex data sets) are uploaded and integrated. These data sets can include everything from ocean biogeochemistry models to satellite data to marine data collected by scientists aboard ships on oceanic expeditions - even human use data, such as where people fish or the location of commercial oil platforms and piplines. With access to DTOs, a variety of stakeholders, including decision-makers, scientists, and industry experts, can manipulate the data sets to anaylse “what if” scenarios: how might changes in policy affect fish populations or what if we installed this array of wind turbines. DTOs can also be harnessed for other purposes, such as creating capacity in ocean sciences or supporting STEM education.



Graphic courtesy EC RTD

The UN Decade of Ocean Science for Sustainable Development aims to ensure transformative ocean science solutions for sustainable development, providing us with science we need for the ocean we want. By using the 10 Ocean Decade challenges as a framework, the global community seeks to identify, generate and use the ocean data needed to sustainably conserve and manage the ocean, as well as better connect people with the ocean. DTOs largely address challenges 7 “expanding global observing systems”; 8 “creating a digital representation of the ocean”; and 9 “ensuring skills, knowledge and technology for all”, thus contributing to the broader Ocean Decade agenda.

During the 2024 Ocean Decade Conference in Barcelona, the ocean community came together to celebrate the achievements by showcasing the innovative science initiatives that have been established since 2021. Additionally, the discussions in the satellite events, plenary, and parallel sessions gave recommendations for how to validate common strategic ambitions for the Decade. The discussions during the DTO4ECOPs event, which approximately 70 people attended, contribute to the outcomes of the conference, while providing further opportunities to engage Early Career Ocean Professionals (ECOPs) in the DTO process.

BACKGROUND BEHIND DTO4ECOPS

The Satellite Event was proposed to accomplish multiple goals:

- Revisit existing ocean data sharing efforts across regions, including data and information management, DTO interoperability methods, and capacity building initiatives and networks (e.g., SPINCAM, Ocean Info Hub, etc.).
- Take stock of onoing DTO efforts (e.g., EDITO, ILIAD) as key components of the European Digital Twin of the Ocean with a view to discuss how ECOPs can leverage these efforts and technologies to catalyse successful delivery of Ocean Decade goals.

- To bring the perspective of ECOPs on these developments, identifying barriers that might yet prevent them from seizing the emerging opportunities they bring for ocean science, and proposing solutions based on their needs and expectations.

EVENT PREPARATION

In preparation for this Satellite Event, the DTO4ECOPs organising institutions hosted a warm-up webinar on March 13, 2024, as part of the European Marine Board (EMB) ECOP Wednesday series. The webinar, titled "DTO4ECOPs Warm-Up: Shaping Early Careers' Perspectives of Digital Twins of the Ocean," contributed to set the stage for discussions during the DTO4ECOPs event.

The DTO4ECOPs team also worked collaboratively to develop an online survey to help guide the discussion questions that would be asked during the satellite event. The survey was designed to provide insight into how familiar ECOPs are with the concept of DTOs; what challenges have limited their own research; what barriers they anticipate for using DTO data and tools; and what features of DTOs they find most appealing, among others. The survey was sent through various ECOP networks and communities (e.g., Oyster, ECOP Ocean Decade, and Iliad); to those individuals who confirmed their attendance at the DTO4ECOPS event; in a newsletter mailing to the EDITO audience; and via EDITO social media.

The event organisers and ECOPs also worked collaboratively to develop a comprehensive list of questions, based largely on the survey results, to form the basis for the ECOPs interactive discussion session of the event. These questions were refined over a period of weeks as more ideas were added and exiting ideas were thought through.

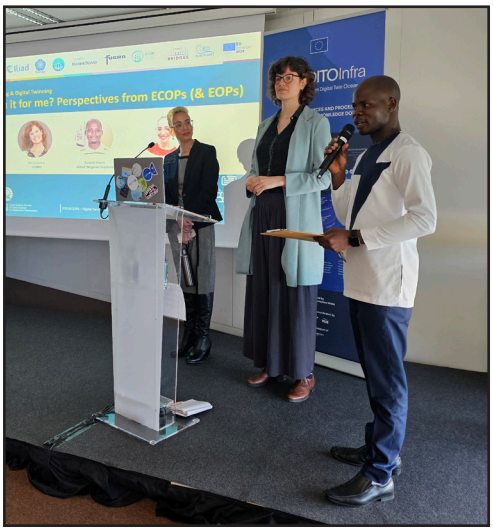
Graphic courtesy ESA, EUMETSAT

EVENT STRUCTURE

The event began with an introduction from Julia Vera (Seascape Belgium) and welcome words from representatives of all the co-organising institutions. This was followed by presentations on EDITO-Infra (the project that is building the public infrastructure of the European DTO); from Alain Arnaud, Head of Digital Ocean Program at Mercator Ocean International; Iliad, from Bente Lilja, founder of BLB; and Ocean InfoHub and SPINCAM from Paula Sierra, Coordinator OTGA-IODE-COI-UNESCO with INVEMAR. The presentations were designed to give attendees an overview of each progamme, existing and upcoming initiatives, how they support regional capacity development and information sharing efforts, and what they see as current and potential future applications of DTOs. The presenters then convened for a Q&A session.

ECOP PERSPECTIVES

Next it was time for the ECOPs to take the stage and lead the interactive discussion portion of the event. Gabrial Akoko, from Kenya, affiliated with the Alfred-Wegener-Institute; Paula Garcia, from Germany, affiliated with FUGRO; and Ali Hochberg, from Bermuda, affiliated with IOCARIBE. They prepared six questions to ask the audience, which comprised both ECOPs and experienced ocean professionals (EOPs); however, the discussion was so rich that only four could be asked. For the purposes of this report and future discussions regarding DTOs and ECOPs, the full suite of questions were:



- In your region, what are the most pressing issues that DTOs could potentially address?
- What features of DTOs are most appealing to you? What challenges in accessing/using ocean data have you faced?
- What is the role of ECOPs in the context of DTOs to advance ocean science? How can DTOs contribute to achieve the science we need, for the ocean we want. What other Ocean Decade challenges can DTOs address?
- DTOs can bridge communities by offering layers of information that cater to different audiences. Would an interface for ECOPs be useful; what would this look like?
- How can we improve engagement of ECOPs in DTO development and trigger interest among youth on this topic? Would funding/technical support for DTO applications led by ECOPs be important?
- How do you think access to DTOs could contribute to supporting the career development of ECOPs?

KEY MESSAGES: INTRODUCTION

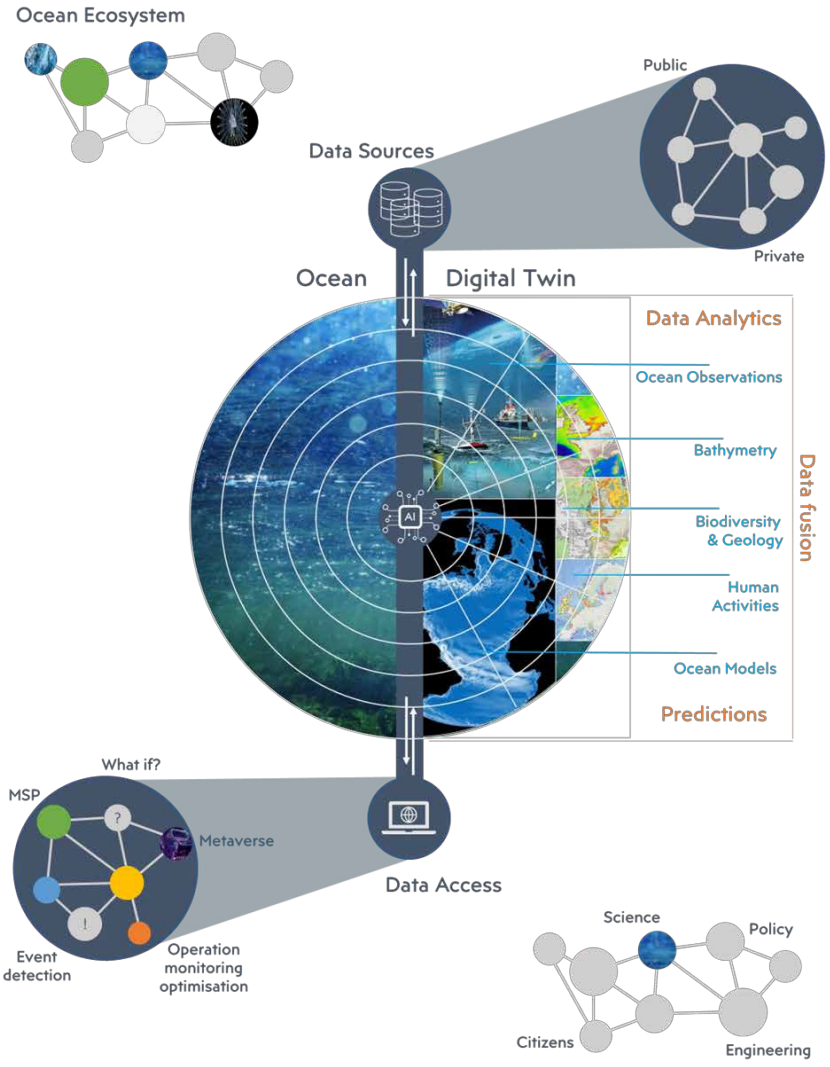
Key messages stemming from the discussion will be conveyed to relevant Working Groups of the Ocean Decade, specifically those connected to Challenge 8 “Develop a Digital Representation of the Ocean”, and to the conveners of the Digital Ocean Forum 2024.

In the following sections you will find the key messages broken down into broad categories.

KEY MESSAGES: ROLES OF DTOS

For those familiar with DTOs and their related initiatives, the utility of DTOs to assist in addressing multiple “real world” scenarios came as no surprise. However, there were event attendees who were not familiar with the concept, and so it may be with readers of this report. Some of the most frequently mentioned applications were:

- Assessing marine development alternatives (e.g., other locations).
- Determining the placement, impacts, and effectiveness of marine protected areas, including potential impacts on local communities.
- Investigating climate change and using data to develop climate adaptation and resilience plans.
- Providing access to decision-makers to explore “what if” scenarios before implementing policy (e.g., pollution regulations).
- Helping island nations better understand coastal sediment transport that negatively impacts coastal infrastructure.
- Bringing awareness to important ocean issues other than microplastics and loss of marine biodiversity.
- Helping to understand and monitor critical ecosystems such as corals, mangroves, seagrass and other vulnerable areas.



Graphic courtesy International Hydrographic Organization

Graphic courtesy Govt Technology

- Helping to make data, that were (or are) regulated by governments, industries, and the private sector, more accessible and user-friendly.
- Developing tools to model and forecast ocean processes to enhance safety and early warning systems.

One key point that was raised is that data are the input products and DTOs are the tool. As such, the tool should be accessible to a variety of end users, not just scientists and policymakers, but everyday citizens trying to solve real world problems impacting their daily lives, but who lack the capacity for funding. Another key point raised was that for DTOs to effectively address ocean-related challenges, they must be specific to local and/or regional communities. Thus, they must be built with a "fit-for-purpose" approach, so they can repond to the needs and expectations of different users, across a range of sectors and geographies.

KEY MESSAGES: CHALLENGES FACING DTOS

Many of these challenges were touched on during the panel discussion in the first half of the event. The fact that they arose during the second half of the event reinforces how real these challenges are. The most frequently mentioned challenges by participants were:

- The lack of international standards for how data are collected and used, which often leads to data interoperability issues, as well as a lack of trust from government, industry, and scientists about how their data will be used once they are available to the public.
- Some models (inputs and outputs) from DTOs are not at a resolution that is useful to address certain issues (e.g., the impats of climate change on coastal infrastructure).
- Using marine protected areas (MPAs) as an example. Many countries have their MPAs located in the open ocean; however, the acute environmental issues (e.g., loss of seagrass habitat, the impacts of coastal development, etc.) occur in the nearshore environment. This makes it difficult to make a "one-size-fits-all" DTO or to integrate the numerous existing programmes.

Graphic courtesy DITTO

- Private industry collects and owns a lot of data that would be beneficial for DTOs. There must be a concerted effort with IOC UNESCO to develop a working group specifically with private industry to access these data for the sole purpose of DTOs, but also to build confidence in how the data will be used: to develop a tool that will benefit the region.

KEY MESSAGES: WHAT FEATURES SHOULD DTOS INCLUDE?

The feedback during this discussion focused primarily on what aspects or components DTOs should feature in order to make them most useful for the largest number of end-users to address the widest number of issues. Critical components of DTOs included:

- A user-friendly platform to facilitate the data-to-product process.
- An integrated platform where all the data are in one place. Building this will help identify knowledge gaps and, hopefully, a system to collectively manage the data.
- The ability for end-users to "play around" with the platform to see what data are available and how they can define what data they are looking for in order to "solve" or better understand the problem they are investigating.
- The ability to link with different sectors (e.g., layering hydrographic and human use data).
- A reduction in the use of jargon by hiring or collaborating with a science communicator who can ensure the information on the platform can be readily understood by a lay audience, as well as policymakers.

KEY MESSAGES: THE ROLE OF ECOPS IN DTOS

The discussion during this portion of the event was greatly contributed to by the ECOPs in the audience and hit on three major areas: how can ECOPs interface with DTOs today, why is their involvement at this stage of DTO development valuable, and how can ECOPs get involved with DTOs now. Each bears equal weight and importance, so we'll address them separately below.

HOW CAN ECOPS INTERFACE WITH DTOS TODAY?

Both ECOPs and EOPs contributed to this discussion and had the following suggestions for how ECOPs can already begin interfacing with DTOs:

- Participating in training, capacity development activities on data sharing and application, and leveraging digital technologies.
- Involvement in information sharing and societal applications, beyond the science.
- Participating in data collection and generation.

Graphic courtesy Ocean Decade Northeast Pacific

- Using DTOs as an education asset to connect with a younger audience, teach ocean literacy, and raise awareness about the complex issues facing the global ocean, including climate change.
- DTOs address all of the Ocean Decade Challenges and ECOPs can help bring new, novel, and exciting ideas that are regionally specific to the table.
- Working with EOPs to create professional development for ECOPs, which may lead to ECOPs being onboarded in DTO developments though internship programs.

WHY IS ECOP INVOLVEMENT NOW SO VALUABLE?

Again, both ECOPs and EOPs (including those involved with DTO projects) contributed to this discussion and had the following to say about why ECOP involvement is valuable:

- They can use their knowledge of new technology (and diversity, equity, access, and inclusion issues) to develop a user-friendly interface for easy accessibility and usage of data.
- They can bring new insights to the discussion.
- Taking part in developing DTOs allows ECOPs to work on their "soft skills" (e.g., communication, organisation, presentation) as well as their scientific skills, both of which will be sought after by employers.
- Being involved in the development of DTOs provides advantages such as potential career and networking opportunities.
- Finally, there was recognition that involving ECOPs in the development of DTOs is a two-way street. One on hand, ECOPs can learn from EOPs and improve their skills; on the other hand, ECOPs will be the ones actively using DTOs when they are mid-career scientists, so it makes sense for them to be involved in their development to better learn how to use and apply these technologies.

HOW CAN ECOPS GET INVOLVED WITH DTOS NOW?

The overwhelming answer to this question was for ECOPs to participate in "hackathons." These interactive events are an opportunity to get to know and understand the field, the community, and to "play" with the DTO resources that are already under development. Many of these hackathons are held on-line, which means that participants aren't burdened with finding funding for travel. ECOPs can utilise the hackathons, as well as events such as DTO4ECOPs, as opportunities to become involved (or at least intro-duced) to different disciplines. DTOs involve a wide range of professionals: engineers, scientists, policy makers, IT specialists, educators/teachers. These events provide ECOPs with the opportunity to ensure they are not thinking inside an echo chamber.

Graphic courtesy AWS Public Sector Blog

And, as mentioned in a previous session, ECOPs can actively seek out and attend professional development events, or work with EOPs to create them, which may lead to onboarding ECOPs into DTO development through internship programmes.

CLOSING REMARKS

We will close this report with what can best be described as a set of short-term recommendations, or pathways forward, to gain visibility for DTO initiatives and their utility. Both are focused on policymakers and decision-makers and the list is not exhaustive, but represents remarks captured during the discussion at the DTO4ECOPs event. The first suggestion was to improve communication between DTO initiatives and government officials, demonstrating how policy and decision-making can be improved by leveraging existing DTOs and focusing on regionally specific, publicly visible "what if" scenarios. The second recommendation was to show policymakers, particularly in areas with established MPA networks and monitoring progammes, the value of DTOs in contributing to monitoring in a cost-effective, less invasive way. The shared element behind both of these recommendations was a sense of urgency: they need to happen now, not in a year, not in five years, but in a matter of months.

ACKNOWLEDGEMENTS

We would like to thank the following, without whose efforts this report would not have been possible: Ali Hochberg (lead author); Gabriel Akoko and Paula Garcia (main authors); and a host of contributors including: Julia Vera (Seascape Belgium), Audrey Hasson, Lillian Diarra and Alain Arnaud (MOi), Bente Lilja (BLB), Francisco Arias, Paula Sierra and Isabela Katime (INVEMAR), Sheila Heymans and Paula Kellet (EMB), Lorna Inniss (IOCARIBE), Kate Larkin (EMODnet Secretariat).

We would also like to thank the European Union for providing financial support for this event. For more information on DTO4ECOPs, please visit the **event website.**