EMODnet

European Marine Observation and Data Network

Connecting Open Data, Delivering Marine Knowledge: A Vision for 2030

Second EMODnet Open Conference: Summary Report

14-16 June 2021, Oostende and online

"EMODnet has become a reference - not just in the EU but globally - and its importance will only grow in the future as marine knowledge is at the core of our fight against climate change."

Virginijus Sinkevičius, European Commissioner for Environment, Oceans and Fisheries

emodnet.ec.europa.eu

The EMODnet Open Conference 2021 was organised by the EMODnet Secretariat and wider partnership, together with the European Commission (DG MARE), in collaboration with the Flanders Marine Institute (VLIZ).

The organisers would like to thank all the speakers, panelists and participants for their engaging and invaluable contributions at the European Marine Observation and Data Network (EMODnet) Open Conference 2021 to discuss EMODnet achievements, partnerships and vision for the coming decade. The organisers would also like to acknowledge the support of the European Commission, sponsors of the Conference, and the collaboration with the Flanders Marine Institute (VLIZ) without whom this event would not have been possible.

The Conference Report was prepared by the European Marine and Observation Data Network (EMODnet), in collaboration with the European Commission, DG MARE.

This Conference report can be cited as: Larkin, K., Depoorter, M., Tonné, N., Collart, T., Van Isacker, N., Strobbe, F., Delaney, C., Calewaert, J-B. (Eds.). 2021. EMODnet Open Conference 2021 report, Connecting Open Data, Delivering Marine Knowledge: A Vision for 2030. Oostende, 14-16 June 2021.

ISBN: 9789464206098

Design layout by TIPIK.

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The illustrations in the Breakout Session summaries were prepared by graphic illustrators : Frederic Thonar, Silvia Robertelli and Alix Garin (also Ocean Observation event graphics, Annex II).

This Conference report and all related information can be viewed and download at:
https://emodnet.ec.europa.eu/en/conference2021

EMODnet

European Marine Observation and Data Network

About EMODnet

The European Marine Observation and Data Network (EMODnet) is a long-term, marine data initiative funded by the European Maritime and Fisheries Fund, which, together with the Copernicus space programme and the Data Collection Framework for fisheries, implements the EU's Marine Knowledge 2020 strategy, in support of the EU's Integrated Maritime Policy and the EU Green Deal, in the context of international initiatives including the UN 2030 Agenda and the UN Decade of Ocean Science for Sustainable Development.

EMODnet connects a network of over 120 organisations supported by the EU's Integrated Maritime Policy who work together to observe the sea, process the data according to international standards and make that information freely available as interoperable data layers and data products.

This 'collect once and use many times' philosophy benefits all marine data users, including policy makers, scientists, private industry and the public. It has been estimated that this kind of integrated marine data policy will save off shore operators at least one billion Euro per year, as well as opening up new opportunities for innovation and growth.

The aim of EMODnet is to increase productivity in all tasks involving marine data, to promote innovation and to reduce uncertainty about the behaviour of the sea. This will lessen the risks associated with private and public investments in the blue economy, and facilitate more effective protection of the marine environment.

EMODnet provides easy and free access to marine data, metadata and data products and services spanning seven broad disciplinary themes: bathymetry, geology, physics, chemistry, biology, seabed habitats and human activities. Each theme is dealt with by a partnership of organisations that possess the expertise necessary to standardise the presentation of data and create data products. To demonstrate the power of opening up Europe's wealth of marine observations and data, EMODnet turns marine data into maps, digital terrain models, time series & statistics, dynamic plots, map viewers and other applications ready to support researchers, industries and policy makers to tackle grand societal challenges.

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Executive Summary

From 14 to 16 June 2021, more than 400 participants from 50 countries and over 70 speakers and panelists gathered online for the 3-day **European Marine Observation and Data Network (EMODnet) Open Conference 2021** to discuss EMODnet achievements, partnerships and vision for the coming decade. The timing for this event could not have been better, with 2021 as a 'super year' for ocean, biodiversity, ecosystem, environment and climate with the official kick-off of the UN Decade of Ocean Science for Sustainable Development, the recent 47th G7 Leaders' Summit, related Climate & Environment Ministers meetings and Science & Technology dialogues.

The need for high-quality open data from the marine environment and related human activities has never been greater, and in Europe this is particularly relevant for meeting the ambitious targets of the European Green Deal to make Europe the world's first climate-neutral continent by 2050, and the related Climate Pact and package of proposals adopted by the European Commission in summer 2021.

Responding to this need, EMODnet has developed since its inception in 2009 into a mature, operational data service, becoming a global leader in marine data management and sharing, providing essential marine knowledge brokerage and open-access to the most comprehensive *in situ* marine datasets. Bringing together many EMODnet partners, data providers, users and stakeholders from Europe and beyond, the Conference was all about celebrating existing partnerships, connecting with new and emerging marine and maritime sectors stakeholders, highlighting the added value of EMODnet for society and looking ahead to co-design EMODnet's next phase. The event was skillfully moderated by **Paul Rose - National Geographic Pristine Seas Expedition leader, Broadcaster** and a well-known public figure in the field of environment and exploration.

With more than 45 presentations and panels, the event was divided in 6 sessions, in addition to breakout group discussions and the presentation of about 55 community posters and pitches. A virtual exhibition, open until November 2021, was also an integral part of the event, with its rich content and information on the diverse activities of EMODnet, resources and services, as well as those from related initiatives.

Opening the Conference, **Virginijus Sinkevičius, European Commissioner for Environment, Oceans and Fisheries** stated, *"EMODnet has become a reference - not just in the EU but globally - and its importance will only grow in the future as marine knowledge is at the core of our fight against climate change [...], at the centre of conserving the invaluable marine biodiversity [...] and is the key to unlocking the potential of the Blue Economy in line with the European Green Deal and the digital transition."*

Reflecting on the past decade of achievements, **Jan-Bart Calewaert, Head of the EMODnet Secretariat,** noted that, *"EMODnet has seen a tremendous evolution and enormous growth in the amount of data and products provided, but also in the number of interested users. In 2020 for example, the Central Portal alone attracted over 26,000 more unique visitors than the year before, and the user-demand continues to rise and diversify."*

Building on these opening speeches, the first session on EMODnet Achievements brought together all Coordinators from the seven EMODnet thematic assembly groups and the EMODnet data ingestion facility, for a showcase on EMODnet outputs and the high number of diverse and high-quality integrated data sets

and added value data products and services developed by the EMODnet partners over the last 10 years. This highlighted the diversity and progress in the wealth of EMODnet's data, data products and data service offer, spanning seven themes (each including tens to hundreds of parameters): bathymetry, biology, chemistry, geology, physics, seabed habitats and human activities related to the sea.

The EMODnet for Users Session kicked off with a keynote from **Claire Jolly, Organisation for Economic Cooperation and Development (OECD)**, addressing the positive impacts of how open data stimulates innovation and productivity. The rest of the session included a wide range of stakeholders presenting concrete and insightful examples of how EMODnet is being used in industry, research, policy and in civil society.

Day two of the Conference celebrated existing partnerships, such as the key collaboration with Copernicus Marine Service, a complimentary long-term EU marine data service which has a strong and ongoing partnership with EMODnet at both operational and coordination levels, and wider European collaborators from across the full marine knowledge value chain. Following the official launch of the UN Decade of Ocean Science for Sustainable Development on 1 June 2021, an entire session was dedicated to EMODnet's expanding global partnerships, with keynote talks by **Vladimir Ryabinin, Executive Secretary of the Intergovernmental Oceanographic Commission (IOC) of UNESCO**, and by **Peter Pissierssens, Head of the IOC Project Office for the International Oceanographic Data and Information Exchange (IODE)**.

In the global community talks that followed, **Jamie McMichael-Phillips, CEO for the Nippon Foundation-GEBCO-Seabed 2030 initiative,** noted that **EMODnet is the third largest contributor of bathymetry data to Seabed 2030 worldwide**, a project that aims to produce the definitive map of the world ocean floor by 2030, making data available to all. Moreover, EMODnet's ongoing success with the EMODnet Partnership for China and Europe (EMOD-PACE) served as inspiration for discussing potential future regional collaborations e.g., expanding the EU - China partnerships across Asia, and building on emerging partnerships with Russia, Canada and wider countries bordering the Arctic, as well as connecting North Atlantic efforts to those in the South Atlantic, e.g., with South Africa.

Building on plenary presentations, panel discussions and community poster pitches, the **Conference breakout discussions** brought together the wider community to discuss how EMODnet's services can evolve into the next decade to 2030, across three key themes: (i) EMODnet for the EU Green Deal; (ii) EMODnet for Global; and (iii) EMODnet in the Digital era. The key messages from these discussions have been summarised into visual graphics that are accessible on the event virtual exhibition (see Annex I).

The last day of the EMODnet Open Conference included a session on connecting across the marine knowledge value chain, with a spotlight on the diverse *in situ* data collection efforts across Europe. This kicked off with a keynote presentation on the EC Ocean Observation – Sharing Responsibility initiative, by **Zoi Konstantinou, EC, DG MARE**, followed by community presentations which included the EMODnet Sea-basin Checkpoints as a key user-driven methodology for assessing ocean observing gaps and requirements, together with national efforts to further strengthen and coordinate existing ocean observation and marine monitoring efforts.

In her closing speech, **Charlina Vitcheva, Director-General for Maritime Affairs and Fisheries of the European Commission** noted, *"We now need to consolidate all the achievements and new ideas, all the valuable input received and move forward, pursuing higher goals. [....] The future that the Commission envisages is bringing forward innovative technological tools like the Digital Twin of the Ocean and the elaborate system models of Destination Earth. [....] EMODnet together with Copernicus Marine and other European Commission assets will be at the forefront of these developments"*.

Concluding the Conference, a round-table of experts addressed how EMODnet will evolve into the future, and priority areas for the next decade. **Kate Larkin, Deputy Head of the EMODnet Secretariat,** noted that *"EMODnet will look, feel and operate differently over the coming years, consolidating the existing capability and strengthening user-focused services, in collaboration with the Copernicus Marine Service, whilst further expanding the data parameters and the sources of data to include more diverse knowledge sources e.g., citizen science."* She also noted that metadata – the information paired to data to track the provenance of data from data collection to user – would be an increasingly important focus for EMODnet, to ensure EMODnet's services – in collaboration with Copernicus Marine Service – continue to move towards achieving full interoperability and transparency for easy discovery, access and use of marine data, by all and for all.

As EMODnet moves into a new phase, the EMODnet Open Conference provided a unique forum for the marine observation and data community, policy makers, advisors and stakeholders from various sectors and societal domains to meet, discuss and respond to the many challenges and opportunities that lie ahead, both for EMODnet and for the wider European marine observation and data community. Key evolution steps outlined at the Conference included:

1. The repatriation of the EMODnet Central Portal to become fully embedded into the EU domain with a distinct EU look and feel. This also shows the engagement of the EC for EMODnet as a long-term trustworthy service;
2. The centralisation of EMODnet services, simplifying access to data and products through one single central data portal. This has already begun and when completed by early 2023 will be a game changer for the user as it will integrate all the access, download and visualization services;
3. Interoperability and versatility of EMODnet data, data products and services: EMODnet will continue to share best practice and expertise in data and metadata standards, working with others at European and global levels to further progress in the area of interoperability so that EMODnet data and services are truly Findable, Accessible, Interoperable and Reusable (FAIR) for users worldwide;
4. Consolidation and expansion of EMODnet's marine data services, which will be guided by societal priorities identified by the EU Green Deal and data requirements to support the green transition of the Blue Economy and wider society, together with playing a key role – in collaboration with the Copernicus Marine Service – for the digital transformation in Europe and worldwide. EMODnet will be a key contributor to achieving a transparent and accessible Ocean with open and interoperable access to marine data, information and services in a global context which is a key challenge and objective of the UN Decade of Ocean Science for Sustainable Development.

To view and download all the presentations, poster abstracts and report, and to watch the Conference video and Virtual Exhibition walkthrough, visit: https://emodnet.ec.europa.eu/en/conference2021

Conference programme

Conference Master of Ceremonies (MoC): Paul Rose, National Geographic Pristine Seas Expedition leader, Explorer, Broadcaster and science support authority.

Day 1: Monday 14 June 2021

13:30-15:40 [1]	**Welcome by Master of Ceremonies (MoC) Paul Rose** **Opening addresses** • Virginijus Sinkevičius, **European Commissioner for Environment, Oceans and Fisheries** • Andreea Strachinescu, **EC, DG MARE** • Gert Verreet, **Flanders Government (EWI)** • Jan-Bart Calewaert, **EMODnet Secretariat** **Session 1: EMODnet Achievements and forward look** **EMODnet Thematic Coordinators: highlights and achievements** Short showcase talks by the 7 EMODnet Thematic Coordinators & EMODnet Data Ingestion • Thierry Schmitt, SHOM: **EMODnet Bathymetry** • Joana Beja, VLIZ: **EMODnet Biology** • Alessandra Giorgetti, OGS: **EMODnet Chemistry** • Henry Vallius, GTK: **EMODnet Geology** • Alessandro Pittito, COGEA: **EMODnet Human Activities** • Antonio Novellino, ETT: **EMODnet Physics** • Mickaël Vasquez, Ifremer & Helen Lillis, JNCC: **EMODnet Seabed Habitats** • Sissy Iona, HCMR: **EMODnet Data Ingestion** **Dialogue with EMODnet thematic experts, facilitated by MoC** **EC Round-table discussion, facilitated by MoC** • Iain Shepherd, **EC, DG MARE** • Fabienne Jacq, **EC, DG DEFIS** • Nicolas Segebarth, **EC, DG RTD**
15:40-16:00	**Coffee break**

1 / All times are indicated in central European summer time (CEST).

16:00-17:45

Session 2: EMODnet for Users: From open data to societal applications

Keynote: Socio-economic value and impact of open data

- Claire Jolly, **OECD**

EMODnet for Policy

- **EMODnet Marine litter data for the MSFD:** Georg Hanke, **EC, JRC**
- **Use Case: preparing pan-European MSP map:** Joni Kaitaranta, **HELCOM**
- Community poster pitch presentations: **EMODnet for Policy**

EMODnet for Industry

- **EMODnet for Industry- Van Oord perspective:** Gerben de Boer, **Van Oord**
- **EMODnet for Industry- Deltares perspective:** Lőrinc Mészáros, **Deltares**

Community poster pitch presentations: **EMODnet for Industry**

EMODnet for Research

- **EMODnet's contribution to research:** Vera Van Lancker, **RBINS**
- **Lambda project: Land-Marine Boundary Development Analysis:** Francisco Campuzano, **+ATLANTIC CoLAB**
- Community poster pitch presentations: **EMODnet for Research**

EMODnet for Civil Society and citizens

- **Paddling to monitor or monitoring to paddle? :** Arianna Liconti, **Outdoor Portofino**
- **Berring Data Collective: Fishing for Data:** Berthe Vastenhoud, **Berring Data Collective**
- Community poster pitch presentations: **EMODnet for Civil Society and citizens**

Panel: EMODnet for Users Forward Look

- **Chair:** Alessandro Pititto, COGEA, **EMODnet Human Activities**
- Felix Leineman, **EC, DG MARE**
- Jacques Delsalle, **EC, DG ENV**
- Berthe Vastenhoud, **Berring Data Collective**
- Joaquin Tintore, **SOCIB**
- Rémi Collombet, **Ocean Energy Europe**
- Marian Paiu, **MARE NOSTRUM**

Day 2: Tuesday 15 June 2021

09:00-10:40	**Session 3: EMODnet Partnerships (Europe)** **Keynote presentation: The Copernicus Marine Service** • Pierre-Yves Le Traon, **Mercator Ocean International (MOi)** **EMODnet-CMEMS dialogue, facilitated by Paul Rose, MoC** • Alessandra Giorgetti, **OGS, EMODnet Chemistry** • Antonio Novellino, **ETT, EMODnet Physics** • Kate Larkin, **EMODnet Secretariat** • Pierre-Yves Le Traon, **CMEMS/MOi** • Laurence Crosnier, **CMEMS/MOi** **Panel: EMODnet and the European data landscape** **Chair:** Dick Schaap, **MARIS, EMODnet Data Ingestion & SeaDataNet** • Sylvie Pouliquen, **Ifremer, CMEMS** ***in situ*** **TAC** • Neil Holdsworth, **ICES** • Richard Sanders, **ICOS OTC** • Ivan Rodero, **EMSO** **Presentations: Data sharing by diverse communities** • **Opportunities for data sharing with EMODnet:** Antonella Battaglini, **Renewables Grid Initiative** • **FUGRO's Leading approach in supporting data sharing:** Marco Filippone, **FUGRO** • **Marine Litter in the Black Sea- A Growing Challenge, Mare Nostrum Experience:** Angelica Paiu**, MARE Nostrum** Community poster pitch presentations: **Data partnerships** **Panel: EMODnet's existing and emerging EU partnerships** **Facilitator:** Paul Rose, **MoC** • Christian Kirchsteiger, **EC, DG CONNECT** • Thorsten Kiefer, **JPI Oceans** • Jaume Piera, **CSIC** • Iryna Makarenko, **Black Sea Commission** • Laurent Delauney, **Ifremer, JERICO RI**
10:40-11:00	**Coffee break**

11:00-13:00	**Session 4: EMODnet for Global** **Keynote presentations:** **UN Decade of Ocean Science for Sustainable Development** • Vladimir Ryabinin, **IOC-UNESCO** **ODIS & the Ocean InfoHub** • Peter Pissierssens, **IOC-IODE UNESCO** **EMODnet for Global dialogue, facilitated by MoC** • Vladimir Ryabinin, **IOC-UNESCO** • Peter Pissierssens, **IOC-IODE** **Community presentations: Global partnerships** • **EMODnet for Seabed 2030:** Jamie McMichael-Phillips, **Nippon Foundation-GEBCO-Seabed 2030** • **EMODnet for Global biodiversity** Ward Appeltans, OBIS; Leen Vandepitte, **VLIZ, EurOBIS** • **EMODnet EU-China partnership:** » **EMOD-PACE** Jun She, **DMI** » **CEMD-NET** Yu Ting, **NMDIS** • **EMODnet Geology: Caspian Sea Community:** Daria Ryabchuk, **VSEGEI** • **Canadian Integrated Ocean Observing System (CIOOS) and The Shared Basins:** Mike Smit, **Dalhousie, CIOOS** **EMODnet global dialogues Panel** **Chair:** Patrick Gorringe, **SMHI, EMODnet Physics** • Martin Visbeck, **GEOMAR** • Maria Hood, **EU4OceanObs** • Isabel Sousa Pinto, **CIIMAR** • Paul Holthus, **World Ocean Council** • Jo Øvstass, **C4IR Ocean** • Audrey Hasson, **GEO Blue Planet EU office** Community poster pitch presentations: **Global partnerships**
13:00-14:00	**Lunch Break**
14:00-17:30	**Breakout group discussions:** 2 sessions: 14:00-15:30; 16:00-17:30 **EMODnet for Global:** towards a transparent and accessible ocean (Ocean Decade, UN 2030, existing and emerging regional partnerships); **EMODnet for the EU Green Deal:** EMODnet data and data products providing trusted data and marine knowledge to underpin evidence-based policy making for the EU Green Deal and wider policy, and support the blue economy and wider stakeholders in the green transition; **EMODnet in the Digital era:** EMODnet data, data products and services for the Digital Twin Ocean, Destination Earth, simulations and visualisations, Ocean ICT, etc.

Day 3: Wednesday 16 June 2021

09:00-09:30	**Welcome: Paul Rose, MoC** **Breakout session key message reports :** • **EMODnet for EU Green Deal:** Helen Lillis, **JNCC, EMODnet Seabed Habitats** • **EMODnet for Global:** Alessandra Giorgetti, **OGS, EMODnet Chemistry** • **EMODnet in the Digital Era:** Leen Vandepitte, **VLIZ, EurOBIS**
09:30-11:00	**Session 5: Ocean Observing & Data Collection** **Keynote presentation: EC Ocean Observation: Sharing responsibility** • Zoi Konstaninou, **EC, DG MARE** **Community presentations:** • **Ocean Observing gaps and requirements: The EMODnet Sea-basin Checkpoint approach:** Nadia Pinardi, **Univ. Bologna** • **Towards national coordination of the marine knowledge value chain: The Swedish example:** Patrick Gorringe, **SMHI** • **Earth Observation data for marine monitoring and sustainable aquaculture:** The Italian case study: Francesco Cardia, **ISPRA** • Community poster pitch presentations: **Ocean Observing and data collection** **Panel: Coordinating EU ocean observing and data flow: connecting the marine knowledge value chain** **Chair:** Quillon Harpham, **HR Wallingford** • Toste Tanhua, **GEOMAR, H2020 EuroSea** • Inga Lipps, **EuroGOOS** • Sheila Heymans, **EMB** • Mathieu Belbeoch, **OceanOPS** • Corinne Lochet, **SHOM** • Jörn Schmidt, **ICES**
11:00-11:30	**Coffee break**
11:30-13:00	**Session 6: Key messages, next steps and closing** **Keynote:** • Charlina Vitcheva**, EC DG MARE Director General** **Closing round-table: Delivering the vision for EMODnet to 2030** • **Facilitator:** Paul Rose, **MoC** • Sigi Gruber, **EC Advising Senior, DG RTD** • Nadia Pinardi, **Univ. Bologna** • Jan Mees, **VLIZ** • Pierre Bahurel, **CMEMS, MOi** • Kate Larkin, **EMODnet Secretariat** **Closing remarks:** Zoi Konstantinou, **EC DG MARE**

Opening Session: Welcome and opening addresses

The Master of Ceremonies, **Paul Rose**, kicked off the EMODnet Open Conference 2021 by acknowledging the support of the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE) and of the EMODnet Secretariat and wider partnership for the organisation of the Conference, in collaboration with the Flanders Marine Institute (VLIZ). He noted that due to the extraordinary circumstances, this flagship EMODnet gathering was organised as a hybrid event with a fully online audience and live broadcasting from a studio installed at the InnovOcean site in Ostend, Belgium. Remarking on the excellent turnout, he highlighted the event had attracted more than 400 registrations from 50 countries, while the programme featured over 70 speakers and panellists, plus 56 community posters and pitches for online viewing and downloading.

He noted that the event marked a decade of progress of EMODnet, celebrated in September 2020 with the 10 years webinar, and the start of a new era and evolution of EMODnet services for the coming decade. He believed the timing could not be better, since 2021 is a super year for ocean biodiversity, ecosystem, environment and climate. He cited the official start of the UN Decade of the Ocean Science for sustainable development, the UN Decade on Ecosystem Restoration, the recent 47th G7 Leaders' Summit in the UK, and related climate and environment meetings and science and technology dialogues, not to mention European initiatives such as the EU Green Deal and EU Digital Strategy.

Paul Rose concluded that whilst the Conference was in hybrid format with a fully online audience, the programme had been designed to be very interactive, thanks to the extensive use of Slido for questions and polling, numerous Panel discussions, community poster pitch presentations, breakout discussions and use of social media, e.g., twitter. Without further ado, Paul Rose then opened the first poll on the spread of participants' sectors and affiliations. The poll results highlighted the diversity of the audience, including representatives from public research institutes and organisations (33 %), government public administration (26 %), universities (14 %) the private sector (11 %) and NGOs and civil society (5 %).

Virginijus Sinkevičius (European Commissioner for Environment, Oceans and Fisheries) welcomed participants in his opening address. The Commissioner stressed that in just over 10 years, EMODnet has become a reference for marine data collection and sharing, in the EU and globally, and its importance will only grow in the future. He emphasised that marine knowledge is at the core of our fight against climate change and in unlocking the Blue Economy and that the creation of EMODnet has been a game changer,

enabling for the first time the connection of so many people, organisations and datasets related to the marine environment. Moreover, access to high quality marine data and related information on human activities at sea – as delivered by EMODnet – is showing its impact, providing better knowledge of the ocean and its ecosystems, enabling and supporting Blue Economy operations, and providing the scientific evidence to underpin decision-making on ocean use, management and conservation. He explained that the EC would soon propose an initiative to improve the governance of ocean observation at EU level, building upon public stakeholder consultations in 2020 and 2021, with the aim to foster further synergies, coordination and efficiency of effort to consolidate the European ocean observation capability, across all sectors. Summing up, Commissioner Sinkevičius noted that EMODnet is a key enabler and contributor to the EU Green Deal and digital transition and that EC, DG MARE will support EMODnet for full coverage of data for the EU seas and it will provide the Blue Economy a solid basis to grow while conserving the marine environment.

"EMODnet has become a reference - not just in the EU but globally - and its importance will only grow in the future as marine knowledge is at the core of our fight against climate change [...], at the centre of conserving the invaluable marine biodiversity [...] and is the key to unlocking the potential of the Blue Economy in line with the European Green Deal and the digital transition." *Virginijus Sinkevičius, European Commissioner for Environment, Oceans and Fisheries*

Andreea Strachinescu (European Commission (EC), Directorate-General for Maritime Affairs and Fisheries (DG MARE)) acknowledged the many successful outcomes of 10 years of EMODnet, delivered by a network of experts and specialists focused on developing, improving and adopting marine data and knowledge standards. She underlined the need for marine data, as the basis of knowledge and the importance of EMODnet as an operational marine data service for supporting all marine data users' needs and requirements, including the Blue Economy. She also emphasised the notable success of EMODnet's global partnerships, including the ongoing collaboration with China through the EMOD-PACE project (see Session 4: EMODnet for Global). She noted the Commission is committed to support EMODnet in international collaboration, because the ocean doesn't stop at the borders of Europe.

Andreea Strachinescu shared her hope that EMODnet would play a major role in supporting the younger generation, to make them better aware of ocean opportunities and challenges, building on the excellent example of EMODnet's collaboration with, and role in, the European Atlas of the Seas. She also noted the important collaboration between Copernicus Marine Service and EMODnet that has proved very successful and that continues to strengthen and develop at both operational and coordination levels. She concluded noting that EMODnet can be a key vehicle for the European Commission's initiative on ocean observation, aimed at improving Europe's marine *in situ* governance, and that the EMOD-network also has an important contribution to make to the UN Decade of Ocean Science for Sustainable Development.

"The EC Initiative on ocean observation will help to improve the in situ marine data governance. EMODnet will be the vehicle to enlarge open access and sharing of data." *Andreea Strachinescu, European Commission, DG MARE*

Gert Verreet (Flanders Government , Department of Economy, Science and Innovation, EWI) started his intervention stating that the Flanders Government has been supporting EMODnet from the onset, in particular by enabling the Flanders Marine Institute to host the EMODnet Secretariat, plus developing and maintaining the EMODnet Central Portal. He highlighted the revolutionary mission-based approach of Horizon Europe. Delivering it will require huge efforts from both research and innovation communities and EMODnet should be able to help achieve its objectives. To strengthen the impact of European Research Infrastructures, it will be necessary to connect and engage with downstream value creators. He noted that EMODnet communities are well placed to foster clear dialogue across the value chain and to set up delivery mechanisms. Lastly, Gert Verreet concluded that EMODnet can make marine data less expensive, by having them serve many different customers and allowing value creation in many different contexts.

"There's a saying: 'If you think education is expensive, try ignorance.' It's clear that EMODnet opens up marine data, making marine data less expensive by serving many different customers."
Gert Verreet, Flanders Government

Speaking live from the Ostend Conference studio, **Jan-Bart Calewaert** (Head, EMODnet Secretariat) concluded the opening interventions by welcoming the audience to the 2nd EMODnet Open Conference on behalf of the EMODnet Secretariat and the entire partnership. He reminded the audience that EMODnet has come a long way since its inception in 2009, evolving from a concept into a mature operational European marine *in situ* data service, providing an indispensable resource for knowledge generators and consumers from public bodies, scientific institutions, civil society and private sector in Europe and beyond.

Calewaert remarked that EMODnet is at a pivotal stage as the Conference marks the end of an era and the beginning of a new one, since the network has largely met the Marine Knowledge 2020 vision targets. For instance, it has produced a multi-resolution map of European seas with information on the biology, chemistry and physics of the overlying water column. In the next phase which has already started, he continued EMODnet will become fully embedded into the EU domain, as a fully operational user-driven service. This will entail new developments such as the centralisation and integration of all thematic data access, download and visualisation services into the EMODnet Central Portal, and will come with responsibilities for more stringent performance as well as quality standards and requirements.

He concluded that the network's future will be guided by the green and digital transitions in Europe and worldwide, marked by the UN Decade of Ocean Science.

"The EMODnet Open Conference 2021 comes at a good time as - in several ways - we are at the end of an era and the beginning of a new one. We have largely met our Marine Knowledge 2020 vision targets producing a multi-resolution map of European seas. And now we have moved into a phase with EMODnet as a fully operational user-driven service."
Jan-Bart Calewaert, EMODnet Secretariat

The EMODnet Vision

"(EMODnet is) a flagship project to prepare a seamless multi-resolution digital seabed map of European waters by 2020… of the highest resolution possible, covering topography, geology, habitats and ecosystems … accompanied by access to timely observations and information on the present and past physical, chemical and biological state of the overlying water column, by associated data on human activities, by their impact on the sea and by oceanographic forecasts. All this should be easily accessible, interoperable and free of restrictions on use. It should be nourished by a sustainable process that progressively improves its fitness for purpose and helps Member States maximise the potential of their marine observation, sampling and surveying programmes." *European Commission's Green Paper Marine Knowledge 2020 – from seabed mapping to ocean forecasting. 2012.*

Beyond 2020, EMODnet continues as an operational EU *in situ* marine data service, an essential tool for scientists, engineers, managers and policy-makers from the public and private sectors who are analysing the state and dynamics of Europe's seas. In the next phase of EMODnet, all data and data products should be findable, visible and downloadable through the EMODnet Central portal. And, working with Copernicus Marine Service, EMODnet will undergo continual development to ensure its services evolve to continue meeting the needs of a growing and diversifying user community.

Session 1 – EMODnet Achievements and forward look

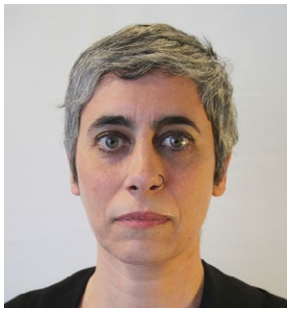
Jan-Bart Calewaert (EMODnet Secretariat) provided an overview of EMODnet, highlighting that the European Commission created EMODnet as a European Union Flagship Initiative central to the delivery of the Marine Knowledge 2020 Strategy. It was set up in 2009 as a partnership, a network of people, organisations and technology that work together to compile and distribute marine *in situ* data, metadata and data products on European coastal and ocean waters. He noted that this Conference session would present and showcase the key achievements across all seven thematic areas of EMODnet, namely bathymetry, biology, chemistry, geology, physics, seabed habitats and human activities. Looking to the future, he noted there is still a long way to go, explaining that EMODnet will be further consolidated as the focal point for marine *in situ* data in Europe and beyond, becoming a key service to deliver transparent, predictable Ocean data accessible to all. To concluded by noting that this can only be achieved through enhanced collaboration, dialogue and co-development both across the EMOD-network and through key partnerships and collaborations both in Europe and worldwide.

Showcase talks by the 7 EMODnet thematic Coordinators & EMODnet Data Ingestion

All seven of the EMODnet Thematic Coordinators and the Coordinator of EMODnet Data Ingestion presented highlights from their theme over the past decade of activity, on behalf of the wider EMODnet partnership of over 120 organisations.

Thierry Schmitt (French Naval Hydrographic and Oceanographic Service (SHOM), EMODnet Bathymetry) noted that the EMODnet Bathymetry Consortium is a group of nearly 40 partners wide spread across Europe. Their main product is the Bathymetry Digital Terrain Model (DTM), a 100-metre resolution product, based on an inventory of bathymetric information held by hydrographic organisations or sonographic centres. Work continues on improving both the resolution and the extent of the area for which information is provided. The Consortium also collaborates on international level e.g., by contributing bathymetric gridded products for uptake by the Seabed 2030 initiative. The goal is to keep on providing updates to the DTM every two years with new bathymetric data and to provide more intelligence to the data. He said work has already started with the Quality Index, a cartographic representation of different qualitative descriptors of the surveys that make up the DTM in order to inform the user about the quality of the product.

"EMODnet Bathymetry has a strong and operational link with Seabed 2030, contributing EMODnet's integrated and harmonised bathymetry gridded products from European seas and beyond to this international initiative." *Thierry Schmitt, SHOM, EMODnet Bathymetry*



Joana Beja (Flanders Marine Institute (VLIZ), Belgium, EMODnet Biology) explained that EMODnet Biology focuses on making European marine biological data freely and openly available. It covers six European marine regions and nine functional groups, from angiosperms to zooplankton. EMODnet Biology has also developed several interoperable data products, enabling assessment of the environmental state of the overall ecosystem and sea basins. Its data, which include more than 1.100 datasets and comply with the FAIR principles, have also been used in international biodiversity assessments and in support of a variety of legislation. There are currently 31 data products available, and several tools are available for both data providers and data users. EMODnet Biology closely collaborates with and makes use of the key infrastructure of the European Ocean Biodiversity Information System (EurOBIS), with EMODnet Biology being a top contributor of marine biological and biodiversity data to the international community via EurOBIS and OBIS. Over the next two years, the goal is to incorporate other types of data like 'omics' or imagery, to expand web services and to create new data products for stakeholders. EMODnet Biology is expected to move to the Central Portal in October 2021, providing an opportunity to reach more users and increase collaboration with other thematic lots.

"EMODnet Biology closely collaborates with and makes use of the key infrastructure of the European Ocean Biodiversity Information System (EurOBIS), with EMODnet Biology being a top contributor of marine biological and biodiversity data to the international community via EurOBIS and OBIS." *Joana Beja, VLIZ, EMODnet Biology*

Alessandra Giorgetti (National Institute of Oceanography and Experimental Geophysics (OGS), Italy, EMODnet Chemistry) indicated that EMODnet Chemistry focuses on the collection, aggregation, standardisation and quality control of marine water quality data. Its aim is to provide open access to high quality information and data products. EMODnet Chemistry – which covers all European seas, divided into six marine regions – adopts and adapts standards and services of SeaDataNet, the pan-European infrastructure for ocean and marine data management. The EMODnet Chemistry partnership which spans over 32 countries and 5 international organizations releases new regional, standardised, harmonised and validated data collections on eutrophication, ocean acidification, contaminants, and beach and seafloor litter. The pan-European Beach Litter Database has been updated thanks to the collection of new monitoring data by all EU members. This has helped to consolidate EMODnet Chemistry's role as the European data management hub for many kinds of marine litter data. Several key co-operations were initiated e.g., with Copernicus Marine Service and Mercator Ocean International. EMODnet Chemistry contributes to the EU level e.g., with Marine Strategy Framework Directive (MSFD) implementation, as well as contributing to global initiatives like the Global Oxygen Data Network.

"EMODnet Chemistry plays a crucial role as the European data management hub for many kinds of marine litter data, contributing high quality data and information used for the EU Marine Strategy Framework Directive (MSFD) Good Environmental Status Assessments."
Alessandra Giorgetti, OGS, EMODnet Chemistry

Henry Vallius (Geological Survey of Finland (GTK), EMODnet Geology) explained that EMODnet Geology covers today a variety of different marine geological maps from all over Europe, such as seabed substrates, sediment accumulation rates, sea floor geology, geomorphology, coastal behaviour, geological events and probabilities, marine minerals and submerged landscapes. In 2019, EMODnet Geology produced the first-ever harmonised European-wide classification of submerged landscapes features and palaeoenvironmental indicators in a map. Thanks to its partner contributions, it has also contributed to parts of the EU Blue Economy report 2020 on non-living marine resources, namely on oil, gas and marine minerals. Its products have often been used for planning of various engineering works, such as offshore cable or pipeline planning, plus for geo-hazards evaluation, national habitat mapping projects, and marine spatial planning. Looking to the future, he noted the goal is to continue offering the best-available marine geological information for society.

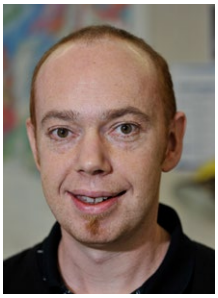
"In 2019, EMODnet Geology produced the first-ever harmonised European-wide classification of submerged landscapes features and palaeoenvironmental indicators in a map."
Henry Vallius, GTK, EMODnet Geology

Alessandro Pittito (COGEA, Italy, EMODnet Human Activities) said that EMODnet Human Activities has worked hard to be the entry point for marine data on human uses of the ocean, mapping all human activities in the EU waters. It covers a broad range of topics, such as aggregate extraction, algae production, telecommunication & power cables, cultural heritage, dredging, environment protected areas, military areas, nuclear power plants, Ocean Energy facilities, oil and gas pipelines, waste disposal, and wind farms. It has been expanding its data on fisheries, and covers main ports and maritime spatial planning. In 2019, the vessel density maps were released and quickly became very popular in terms of downloads. In the future, new datasets will cover desalination plants, and there are plans to expand data on fishing intensity and to explore the visibility of human pressure index.

"EMODnet Human Activities vessel density maps have been very important for cooperation, and are now used by the National Geospatial-Intelligence Agency (NGA) for a project to map shipping traffic globally." *Alessandro Pittito, COGEA, EMODnet Human Activities*

Antonio Novellino (ETT S.p.A., Italy, EMODnet Physics) noted that the role of EMODnet Physics is a focal point for integrating, harmonising and making available *in situ* datasets on the physical oceanographic environment, spanning many tens of parameters from temperature and salinity to sea level rise, and most recently underwater noise and river runoff. It covers both real and near-real-time themes and research-related marine data sets. One of its latest milestones, in 2020, was conducting an Arctic Data Portal workshop together with the INTAROS project, Copernicus *In Situ* Coordination Group, and EUROGOOS for setting up a dedicated data portal for the Arctic community in collaboration with EMODnet Data Ingestion. Future plans include the usability and accessibility of the portal, which receives over 3.500 visits monthly. Goals include working towards an accessible, transparent and predicted ocean, in line with the UN Decade of Ocean Science for Sustainability.

"EMODnet Physics is a focal point for integrating, harmonising and making available in situ datasets on the physical oceanographic environment, spanning many tens of parameters from temperature and salinity to sea level rise, and most recently underwater noise and river runoff." *Antonio Novellino, ETT, EMODnet Physics*

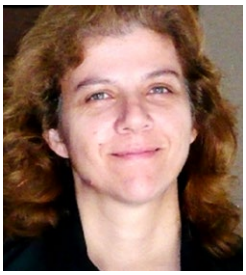


Mickaël Vasquez (Ifremer, France, EMODnet Seabed Habitats) called EMODnet Seabed Habitats a one-stop-shop for accessing seabed habitat data in Europe. It developed the flagship product EUSeaMap, a pan-European full coverage seabed habitat map, which has been progressively improved over the last 10 years for spatial coverage and spatial accuracy. The map's habitats are described according to the European EUNIS classification and the MSFD Benthic broad habitat types. EMODnet Seabed Habitats has also been collating, and making publicly available via web services, existing survey datasets or data products. Examples include habitat maps based on surveys, habitat observations and products on Oslo/Paris (OSPAR) convention (for the Protection of the Marine Environment of the North-East Atlantic) threatened and/or declining products in the North East Atlantic. EMODnet Seabed Habitats has also developed composite data products based on the habitat maps from collated surveys, and one on Essential Ocean Variables (EOV's) such as macroalgal canopy extent, seagrass extent and live hard coral extent.

"EMODnet Seabed Habitats is a one-stop-shop for accessing seabed habitat data in Europe."
Mickaël Vasquez, Ifremer EMODnet Seabed Habitats

Helen Lillis (Joint Nature Conservation Committee (JNCC), UK, EMODnet Seabed Habitats) underlined how EMODnet Seabed Habitats works with others thematic lots, which is essential in the realm of marine biodiversity data. With the UN World Conservation Monitoring Centre (UNEP-WCMC), it maintains global datasets on the extent of important marine habitats, and EMODnet Seabed Habitats contributes the European portion of some of these datasets. Some project members also contribute to the EMODnet partnership for China and Europe (EMOD-PACE), to apply the principles of the EUSeaMap to other seas of the world. Coming work includes updating some existing products, namely EUSeaMap and EOV products, and providing new composite products. From October 2021, a new phase will start including all of Europe and expanding into some European territories in the Caribbean, plus the Caspian Sea, as well as starting on new themes such as essential fish habitats and coastal wetlands.

"The EMODnet Seabed Habitats EUSeaMap principles are now being applied to other parts of the world, including Asia thanks to the collaboration between EMODnet and the EU-China initiative EMOD-PACE." *Helen Lillis, JNCC, EMODnet Seabed Habitats*

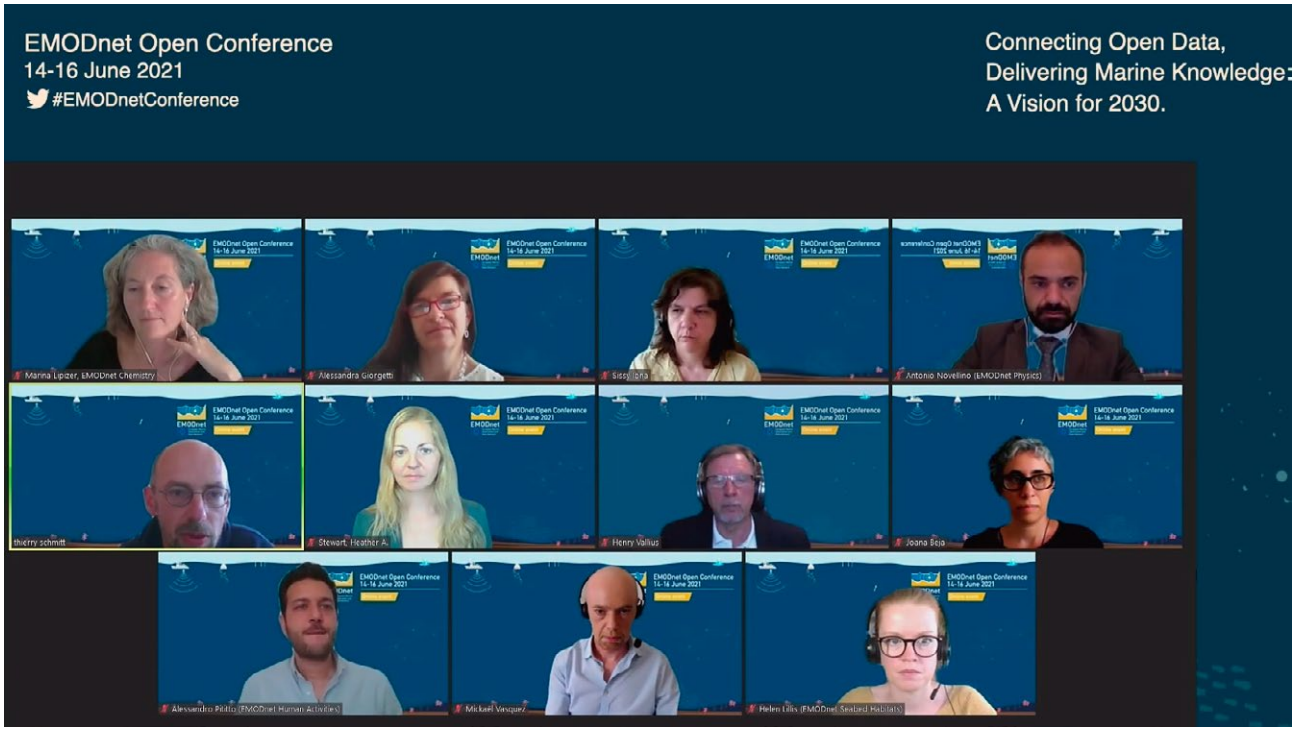


Sissy Iona (Hellenic Centre for Marine Research (HCMR), Greece, EMODnet Data Ingestion) explained that a key aim of EMODnet Data Ingestion is to identify, encourage and support data holders to share their data with EMODnet and to become a partner in the European data management infrastructures for data exchanges. EMODnet Data Ingestion makes use and collaborates with existing European marine data management infrastructures and pathways feeding into EMODnet data portals. The service is mainly focused on data providers not yet routinely submitting datasets to the existing systems at national, regional and/or European levels. EMODnet Data Ingestion has two phases in the lifecycle of data submission. The coordinators of all EMODnet thematics are involved as well as the SeaDataNetwork of national oceanographic data centres (NODC's), to ensure the linkages with a network for the necessary process of the incoming submissions. Currently, EMODnet Data Ingestion network has 50 data centres covering all data thematics. EMODnet Data Ingestion also promotes real-time data exchange by means of Sensor Web Enablement (SWE) standards. Jointly with EMODnet Physics, EMODnet Data Ingestion contributes to the integration of data streams into the European Operational Oceanography Data Exchange managed by Copernicus Marine Service, EuroGOOS and SeaDataNet. Iona highlighted the importance of other collaborations, namely with the SeaDataNet/SEANOE data citing service, and with the private sector, e.g., with Nord Stream 2 Pipeline AG, and marine research infrastructures e.g., EuroFleets+ project. EMODnet Data Ingestion also plays an essential role for Member States submitting marine litter datasets.

"After three years of successful operation, EMODnet Data Ingestion has received almost 1,000 submissions, including from national authorities, industry, civil society and citizen science, further expanding the data diversity available in EMODnet." *Sissy Iona, HCMR, EMODnet Data Ingestion*

EMODnet thematic dialogue

MoC Paul Rose invited EMODnet thematic and data ingestion Coordinators and experts to join a live dialogue, to further discuss the many achievements of EMODnet over the past decade, and to look to the future evolution of the thematic data, data products and services.



How has EMODnet added value to marine data management, access and services?

Thierry Schmitt (SHOM, EMODnet Bathymetry) explained that bathymetric data are the foundation for a broad range of research and engineering projects, spanning archaeology, coastal engineering, habitat mapping, geology, marine spatial planning and wider Blue Economy operations at sea, to name a few. He noted that one of the main examples of added value has been the mutual benefit that oceanographic models (currents, wave and most notably tidal heights) are gaining from improved European bathymetry. Those improved models have helped to increase the accuracy of our bathymetric products. Recent examples include the Met Office (UK) improving its meteorological models and the private sector e.g., Deltares for improving its worldwide precision of tidal modelling.

Joana Beja (VLIZ, EMODnet Biology) remarked that EMODnet Biology data are used to support ecosystem assessments, e.g., Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), as well as in the harmful algal blooms assessments. She noted the data can be accessed via EMODnet Biology, as well as through the OBIS thanks to the close collaboration with EurOBIS and OBIS. Data flows have also been established with the Global Biodiversity Information Facility (GBIF). She concluded noting that several of EMODnet Biology's data products are also made available in operational services, such as the Operational Oceanographic Products and Services (OOPS) for zooplankton, developed by EMODnet Biology and currently used by the International Council for the Exploration of the Sea (ICES).

Alessandra Giorgetti (OGS, EMODnet Chemistry) highlighted two notable products of EMODnet Chemistry that offer harmonised and validated collections of open data, aggregated for the European sea basins. These products focus on firstly eutrophication, contaminants, and secondly marine litter and are commonly requested by several stakeholders, such as the Regional Seas Conventions (RSCs), the European Environment Agency (EEA) and the EC Joint Research Centre (JRC) e.g., to establish the European beach litter baselines for all European seas, as well as by several EU projects dealing with environmental impacts.

Heather Stewart (British Geological Survey (BGS), EMODnet Geology) explained that EMODnet Geology offers a fully attributed one-stop shop for anyone interested in the geology of our marine and coastal environment. She noted the map products reflecting the submerged landscapes of the continental shelf are a key highlight of the EMODnet Geology project, which are important considering that sea levels have fluctuated by more than 100 metres over repeated glacial cycles, resulting in recurring exposure, inundation and migration of coastlines – across Europe and worldwide, and the importance of providing harmonised and high quality information on submerged features to avoid these disappearing due to commercial activities and natural erosion.

Alessandro Pittito (COGEA, EMODnet Human Activities) summarised that EMODnet Human Activities has built a large repository of data on what humans are doing in the ocean – the first of its kind in Europe - which complements the six EMODnet marine environmental thematics and is now attracting 40 % of users from the private sector, including the Blue Economy and beyond.

Antonio Novellino (ETT S.p.A., EMODnet Physics) noted that EMODnet Physics has developed a one-stop shop system offering near real-time and historical data as a platform. Users appreciate having quick access to data and different parameters. One key product is on river data, now being collected and offered to a broad community. These data are very valuable for the EU MSFD assessments, and as input to environmental computer models assessing land-sea interactions.

Helen Lillis (JNCC, EMODnet Seabed Habitats) explained that the EMODnet Seabed Habitats partnership uses a combination of geographical data skills, knowledge of the data landscape and expert ecological interpretation to produce a predictive habitat map for the seabed of Europe. EUSeaMap allows users to fill in gaps where direct survey data is missing and to calculate the percent coverage of various habitats in a sea basin. For example, this was done in the Western Mediterranean to assess the adequacy of the Marine Protected Area (MPA) network against the targets of the Convention on Biological Diversity (CBD) and the EU Habitats Directive.

How has EMODnet Data Ingestion contributed to the improvement of marine data and data product quality over decade?

Sissy Iona (HCMR, EMODnet Data Ingestion) highlighted that EMODnet Data Ingestion has substantially improved the quality of integrated marine data sets and data products over the last decade by involving experienced data centres which quality control, harmonise and standardise the submitted data. The data centres quality control the data following common and internationally accepted procedures and standards, or modernize them in terms of units and codes and standardize them in terms of metadata and exchange format. If the quality does not meet specific requirements, then there is no further data update into the system. This data process ensures that data forwarded to the EMODnet thematic lots and the derived EMODnet products are reliable, valid, and of the highest possible quality, prior to inclusion in the EMODnet thematic portal and data products.

How is EMODnet evolving to meet the needs of users now and into the future?

Sissy Iona (HCMR, EMODnet Data Ingestion) continued, noting that future activities of EMODnet Data Ingestion would include the establishment of automatic linkages with additional data repositories, as well to enhance cooperation and exchanges with the industry communities. She noted this is already under development with the Renewable Grid Initiative and other communities, which hold key data for EMODnet users and applications. There is also a need for more funds for training and education of industry groups, to ensure uptake and adoption of data management standards. This would facilitate higher throughput of interesting datasets.

Mickaël Vasquez (Ifremer, EMODnet Seabed Habitats) suggested that stakeholders will need data products on the spatial distribution of targeted habitats or biotopes. Examples could be those of conservation interest, such as kelp forests or seagrass meadows. These habitats can be effectively mapped by techniques such as habitat suitability modelling. The EU should consider funding a programme to use these techniques in order to map such habitats consistently.

Antonio Novellino (ETT S.p.A., EMODnet Physics) highlighted the need for diversifying the data sources in EMODnet Phsyics, e.g., civil society and citizens, to expand the coverage in time and space of a transparent and predictable Digital Ocean. For this he explained EMODnet Physics is moving towards a new typology of data, involving the ingestion and use of citizen science data. EMODnet Physics already started but it involves a lot of work and it will require extensive training. EMODnet Physics would also continue to develop collaborations with other key data providers and aggregators, e.g., EuroGOOSand Copernicus Marine Service.

Alessandro Pittito (COGEA, EMODnet Human Activities) noted three key areas of future development for EMODnet Human Activities: (i) further work on neighbouring regions bordering Europe; (ii) increasing the resolution for areas where coverage is still unsatisfactory for user needs, such as fisheries and aquaculture and; (iii) including submarine cables, which are increasingly important because of connections with windfarm and renewable energy devices. He noted that there remain some barriers for the private sector and other data holders to sharing these data and make it freely available, which would involve further dialogue on win-win benefits to ingest more data.

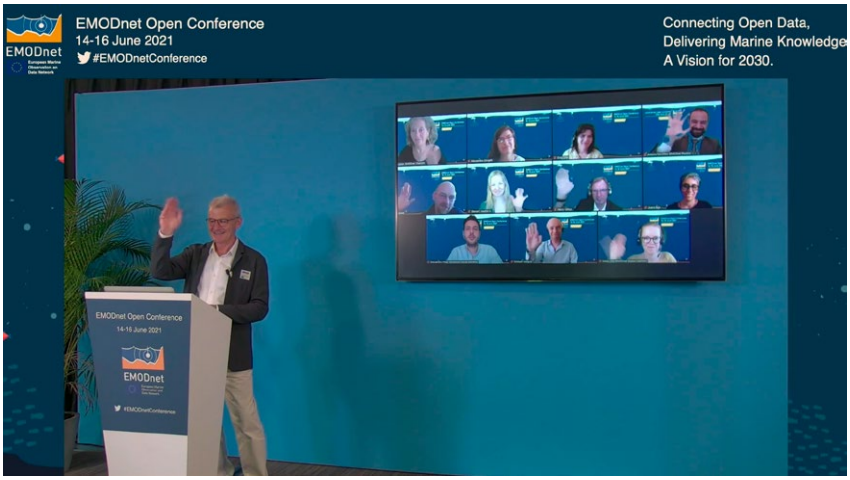
Henry Vallius (GTK, EMODnet Geology) noted that EMODnet Geology would continue to expand its geographical range of partners and data sets, including most recently partners and data sets from countries bordering the Caspian Sea region. He added that further expansion was planned to start in second half of 2021, to include all jurisdictional waters of the Caribbean Sea, which will lead to a further increase in the work programme's geographical scope. In the future, he highlighted that EMODnet Geology envisages exploring and adopting new visuals and techniques. This will facilitate study of complex geological patterns that are difficult to capture, in standard 2D maps. The thematic also works with the European Geological Data Infrastructure of the European Geological Surveys on prototypes for viewing and downloading 2.5D layer models. This new viewer allows viewers to explore subsurface landscapes of local areas in 3D, with an overview of marine subsurface geology and in particular vertical stack layer sequences.

Marina Lipizer (OGS, EMODnet Chemistry) explained that there continues to be an increasing use and reliance on EMODnet Chemistry products and services in particular by the MSFD stakeholders, which therefore have to be updated continuously to follow new trends and user requirements. This requires further streamlining of the flows of data, from data observers to the SeaDataNet network of data centres. EMODnet Chemistry would also continue the ongoing work on the development and adoption of common standards and services, and additional metadata to improve their fairness and fitness for purpose when deriving high quality MSFD indicators.

Joana Beja (VLIZ, EMODnet Biology) commented that future goals for EMODnet Biology included further alignment with its expanding stakeholder community, to meet their evolving needs in terms of data and products, while better addressing gaps in data. She recognised that some data providers or sectors are reluctant to share data, making it harder to create products that could improve the knowledge and information available for those areas. She added EMODnet Biology is always looking at new data types and ways to support and collaborate in community discussions. Over the next two years, it will focus on genomics and image data, whilst defining and implementing the best data management practices agreed by the community.

Thierry Schmitt (SHOM, EMODnet Bathymetry) expressed that whilst EMODnet Bathymetry's philosophy appeals to growing numbers of new data providers, more can be done to operationalise the data flow. He proposed that all bathymetric data acquired under EU-funded projects could be shared with EMODnet Bathymetry. This would benefit the entire European and global community by further increasing the integration, harmonisation and – ultimately – the resolution and coverage of bathymetry across European seas, bordering Ocean and beyond, especially in the coastal zone and in deeper areas that remain poorly covered.

Concluding the EMODnet thematic dialogue, Paul Rose noted that the session had shown the diversity of EMODnet's offer of *in situ* marine data, from the sea surface to the sea floor and from the coast to the open ocean across seven large thematic areas and 100's of environmental parameters and human activities. He encouraged participants to imagine the possibilities of these diverse data sets. And he noted that the next session would do just that, presenting concrete uses of EMODnet data and data products, and discussing opportunities for further application and use by the diverse user community in Europe and beyond.



EC Round-table discussion

Moving to a round-table discussion with European Commission representatives, MoC Paul Rose invited three key experts from the European Commission DG MARE, DG Defis and DG Research and Innovation to discuss EMODnet's achievements over the past decade, and how EMODnet could evolve over the coming decade.

What are the biggest achievements, partnerships and progress of EMODnet in the past decade?

Fabienne Jacq, European Commission, Directorate-General for Defence Industry and Space (DG DEFIS) started by explaining that Copernicus Marine Service (CMEMS) has been the main user of EMODnet since its inception over a decade ago, and CMEMS recognises that *in situ* data are just as essential for the service as satellite data is for marine areas, especially for ocean climate prediction and ocean forecasting. She noted that over the last decade, EMODnet has reached a full operational level with high-quality data plus a very diverse and comprehensive source of data. All of this is important for CMEMS since it's data needs continue to grow, with CMEMS assimilating these data in order to validate its own work and to provide intelligence and information services on the ocean, e.g., for high-frequency radar data.

"Copernicus Marine Service (CMEMS) has been the main user of EMODnet since its inception over a decade ago, and CMEMS recognises that in situ data are just as essential for the service as satellite data is for marine areas, especially for ocean climate prediction and ocean forecasting." *Fabienne Jacq, EC, DG DEFIS.*

Nicolas Segebarth, EC, Directorate-General for Research and Innovation (DG RTD) noted that EMODnet is an excellent example of translating research into real-life operations. He recognised that over at least the last 15 years, the European Commission Research Framework Programmes have continuously supported the development of a European infrastructure providing high-quality access to marine data and to data products, noting the strength of EMODnet and the many crucial contributions from data management services and infrastructures including SeaDataNet that have together seen the development of essential technical and semantic interoperability standards which are considered essential. He noted a further key aspect for EMODnet is ensuring that the services and products provided are useful for end-users. Having many of the EMODnet partners involved in various EU research projects is very helpful for that purpose, because they provide the perspective of end-users. They also facilitate the speed at which the results and outcomes are turned into real-life products.

"EMODnet is an excellent example of translating research in real life operations"
Nicolas Segebarth, EC DG RTD

Iain Shepherd, EC, Directorate-General for Maritime Affairs and Fisheries (DG MARE) highlighted the impact of EMODnet's marine data and data products with an example from the UK Met Office, noting that EMODnet's high resolution, integrated bathymetry (topography) data sets of the North Sea seabed had made "massive improvements" in the UK Met Office forecasting of storm surges. He noted this exemplified the core philosophy of EMODnet to "collect once, use many times", offering open access to marine data and data products that allow all users to discover and innovate these data into new applications for society. He also noted the success of the partnership between EMODnet and the Chinese National marine data and information service (NMDIS) through the EU-China project EMOD-PACE, noting this collaboration was proving essential to promote data sharing and exchange of information on the marine environment and human activities at sea in Europe and Asia, to inform our understanding of the global Ocean, e.g., for assessing the impacts of climate change on marine ecosystems biodiversity and functioning.

"The UK Met Office noted that EMODnet's high resolution, integrated bathymetry (topography) data sets of the North Sea seabed had made "massive improvements" in the forecasting of storm surges. This exemplifies the impact of EMODnet's decade of progress, offering free and open access to marine data and data products for all users, stimulating discovery, innovation and application of marine knowledge for society." *Iain Shepherd, EC, DG MARE*

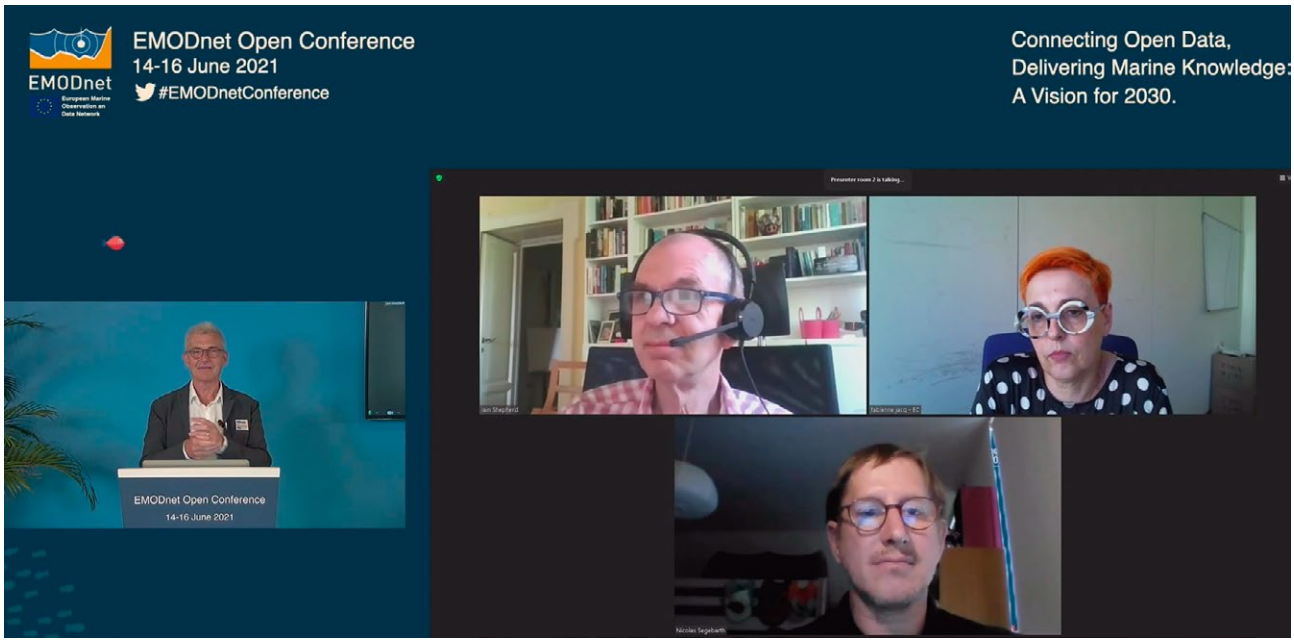
How could EMODnet evolve in the coming decade in terms of thematic areas, spatial-temporal resolution, etc. to further develop the EU's marine data and knowledge capability?

Iain Shepherd (EC, DG MARE) noted that having developed and applied marine data standards for 22 coastal countries, EMODnet had developed a strong basis that can now be used elsewhere, through international co-operation and dialogue. He noted that EMODnet is excellent at distributing data and making data accessible, but it must also assess the way that it currently collects data for separate areas such as fisheries, environment, and research. He referred to the recent EC public consultation on Ocean Observation: Sharing responsibility, where he noted that stakeholders indicated that better collaboration, more transparency and collectiveness could really improve the way EMODnet works. The Commission has promised a proposal on how to do this early in 2022.

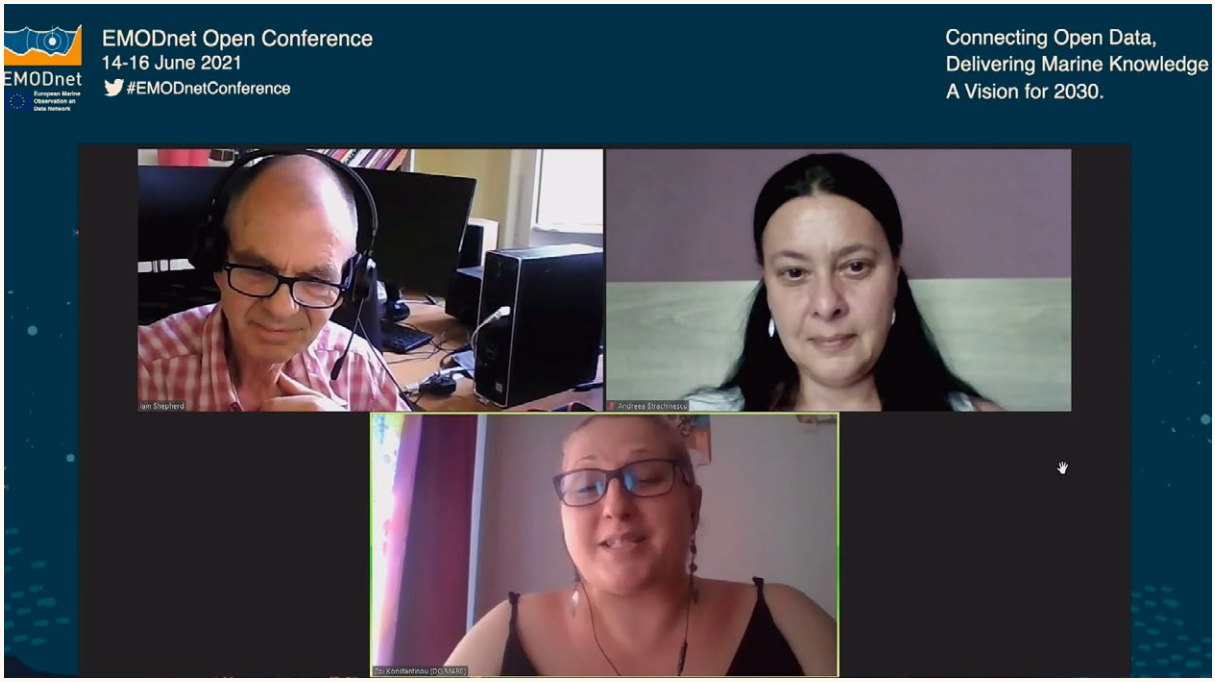
Nicolas Segebarth (EC, DG RTD) explained that one challenge for EMODnet is increasing the basis of data sources beyond those we already have coming from the national data centres. He noted that a lot of data are not yet captured by EMODnet, such as industrial data or citizen science data. Doing this will strain the data ingestion process and particularly data quality control, so EMODnet must find new ways of managing all this. He also recognised another challenge is ensuring there is a rapid data update, providing near real-time data when useful and maybe expanding to other relevant initiatives beyond the traditional realm, such as the -omics or imaging. He noted that fortunately, many of the EMODnet partners are already active in these emerging developments, notably in the Blue-Cloud project which links different data infrastructures. He explained that these infrastructures are now creating a single data- and model space, where a broad range of ocean data can be easily accessed and used in a space where different models can be connected and used to develop what-if scenarios, etc, which will benefit a wide range of stakeholders and users. To that end, EMODnet is considered a key data service that will take up an important role in developing the Digital Twin of the Ocean.

Fabienne Jacq (EC, DG DEFIS) noted that in the coming years, the first challenge is to increase the resolution at the local scale, e.g., with better coverage of coastal areas, a task that requires a lot of data ingestion and integration. She also referred to the need for a holistic view, noting that this requires *in situ* data, space data and complex modelling, plus policies for a sustainable Blue Economy to support operations at sea and promote data sharing. She also noted a second big challenge is biodiversity, with close links to climate and the impact of human activities on the 'food web'. Oceans can play a role in becoming carbon-neutral. The European Commission is working on the Mission Healthy oceans, seas, coastal and inland waters, to develop all the science needed in biodiversity, climate, coastal and so on. She noted that EMODnet could further expand its data from citizen science or emerging data collection efforts related to the Internet of Things. It also needs digital power, such as for the Digital Twin of the Ocean, which will require cloud, high-performance computing and artificial intelligence. She also recognised the importance of building on existing efforts that plans must also be made for systems to cooperate and interact seamlessly. She concluded stating that the political instruments are in place for international ocean governance and Europe is fully recognised at the international level, especially for the UN Decade of Ocean Science. Here EMODnet can offer a key contribution in the area of *in situ* marine data, data products and services.

Nicolas Segebarth (EC, DG RTD) summarised that EMODnet is very well positioned to be leading many of the activities of the UN Ocean Decade, such as contributing directly through the EU partnership, the Galway and Bélem statements with pan-Atlantic partners, and the G7. Underpinning all these efforts is access to data, before transforming data into knowledge and information. This will be crucial in the coming decade in order to protect the ocean and ourselves.



Retirement of EC policy officer Iain Shepherd, 'father of EMODnet'



Session 1 was concluded by a series of short presentations to mark the retirement of Iain Shepherd, policy officer at EC DG MARE and long-term advocate and driver of EMODnet. Taking the stage, Jan-Bart Calewaert (EMODnet Secretariat) warmly thanked Iain Shepherd, on behalf of the full EMODnet partnership, for all his support noting "Your imprint on EMODnet cannot be overestimated, as you were instrumental in its creation and successful results." Jan-Bart added that working personally with Iain had been an "exciting and great learning experience, to help realise the vision and roadmap for EMODnet." EC DG MARE colleagues Andreea Strachinescu and Zoi Konstaninou also joined the celebration noting the visionary work that Iain had conducted for EMODnet, ocean observation and marine knowledge and wider DG MARE activities.

As a final surprise speaker, Rudy Herman, now retired and formerly with the Flemish Department of Innovation and Science wished Iain well, recalling a meeting with Iain 12 years ago during the preparation of the vision document for EMODnet and all the various steps that led up to the official inauguration of its Secretariat at the InnovOcean site in Ostend in 2014. He continued to outline further notable milestones including negotiations with the Flemish Government and allocation of a dedicated budget to launch EMODnet under the European Commission's Marine Knowledge 2020 programme. Rudy wished his former colleague a happy retirement and hoped that he remain in contact to voluntarily offer EMODnet direction on its future evolution, given the importance of the upcoming decade.

Session 2 – EMODnet for Users: From open data to societal applications

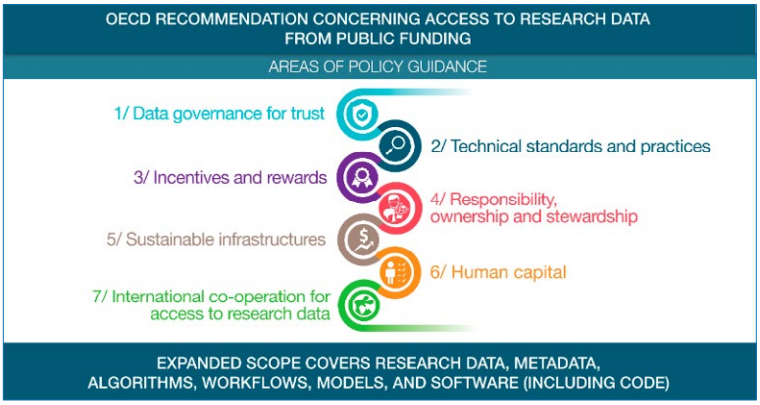
Keynote presentation: The socio-economic value and impact of open data

Claire Jolly, Organisation for Economic Co-operation and Development (OECD)

In her keynote presentation, Claire Jolly addressed the importance of open marine data and valuation. She noted that data infrastructure and public data and their reuse generate considerable social and economic benefits. Access to - and sharing of – publicly funded data for science, technology and innovation are estimated to generate benefits worth up to 1.5 % of a nation's GDP (actual percentage is variable depending on the nation). Key benefits are very diverse, ranging from opportunities for new scientific discoveries to facilitating cross-disciplinary cooperation, as well as increasing public trust in research in general. She explained that despite all the benefits of open data, including for marine data, enhancing data access also comes with risks related to privacy, intellectual property, national security, and public interest, including the protection of rare and endangered species. These risks must be communicated and responsibly managed, she stated, and ideally, a staged approach should be taken for sharing sensitive data, within communities of certified users in a controlled environment.

Jolly concluded with two take-home messages. First, enhancing access to research data has many benefits, as shown by recent work by the OECD on this and EMODnet. While many partners are actively making marine data; Findable, Accessible Interoperable, Reusable (FAIR), openness must be balanced with some of the risks of data sharing. Second, marine data can bring many types of benefits, but more effort must be made to make the case for this.

"The OECD believes that efficient public marine observing and data infrastructure systems, and enhancing access to research data will be crucial in the coming years, as society needs to tackle climate change, biodiversity loss, and the COVID-19 pandemic. EMODnet is well placed to do this and contribute to the international effort." *Claire Jolly, OECD*



OECD Recommendation concerning access to research data from public funding, following the adoption by the OECD Council in January 2021 of a revised Council Recommendation on Access to Research Data from Public Funding https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0347

Following the keynote presentation, a series of short talks from diverse stakeholders were presented, exemplifying concrete uses of EMODnet data and data products ranging from policy to research and from industry to civil society.

EMODnet for Policy

Georg Hanke (EC Joint Research Centre (JRC)) explained that EMODnet Chemistry is working closely with the EC JRC and has ingested beach litter data from 300 beaches across Europe from 6.000 surveys into a common database. He noted this is a key contribution to setting baselines and thresholds, plus it made it possible to create a joint list of marine litter categories for Member States to be able to carry out assessments on MSFD Descriptor 10 on Marine Litter. Collected data enabled the first identification of the most common items in beach litter, a direct input to developing the EU Single Use Plastics Directive, while addressing fishery-related plastics. The baselines derived from the data have also enabled a pan-European overview and regional comparisons across the EU, while serving as a basis to derive thresholds. Future plans include providing baselines for micro litter. Analysis of this data has enabled improvements to harmonisation, with joint lists of litter categories developed, based on the data and guidance for monitoring now being updated. In the wider MSFD range, JRC is working on marine chemical contaminants data with EMODnet Chemicals module, and potentially other relevant datasets.

"The collaboration between EMODnet Chemistry and the EC Joint Research Centre has led to a common database with harmonised beach litter data from 300 beaches across Europe. This is a key contribution to enable Member States to carry out marine litter assessments for the Marine Strategy Framework Descriptor 10..... and as a direct input to develop the EU Single Use Plastics Directive." *Georg Hanke, EC JRC*

Joni Kaitaranta (Baltic Marine Environment Protection Commission, HELCOM) spoke about harmonising EU maritime spatial planning (MSP) within EMODnet, with a view to preparing pan-European MSP maps. He noted that EMODnet already has a close co-operation with the Technical Expert Group on Maritime Spatial Planning (TEG MSP) and EMODnet Human Activities Portal since they started hosting national Maritime Spatial Plans, e.g., from Finland and Belgium in 2021, which will further expand in the coming months and years. The collaboration with TEG MSP is also leading to the development of guidelines and a data model for harmonising the MSP output data from the plans. The output is a simple flat data model, which can be used to harmonise spatial data in these plans, enabling creation of maps with similar parameters harmonised across different national plans. This has been done in the Baltics and offers many possibilities for analysing and comparing these plans. In the future, EMODnet could be not only a focal point for the plans themselves but also providing data and data products from the Maritime Spatial Planning, towards a MSP data product at European level.

"EMODnet Human Activities is a focal point for EU Member State Maritime Spatial Plans and in the future this can be expanded to include MSP data products, for example at the European level."
Joni Kaitaranta, HELCOM

EMODnet for Industry

Gerben de Boer (Van Oord) presented a private sector perspective as a user of EMODnet services. He noted that EMODnet has improved offshore energy operators' efficiency and costs, e.g., at windfarm sites in the North Sea. He noted that data and data products from EMODnet Bathymetry and EMODnet Physics were the most used thematics for Van Oord, e.g., using bathymetry data when planning new sites , or selecting the best routing of cables, taking into account the dynamic nature of the coastal environment with shifting sandbanks as well as waves and dunes. Regarding ocean physics data, he noted that wave data are also used in the execution and design stage, often thanks to a wave climate product compiled with validation and assimilation of EMODnet data. He added another concrete example

where EMODnet Human Activities offers the most comprehensive open access to Automatic Identification system (AIS) data products. This is crucial since AIS data are often hard and/or expensive to obtain and the AIS data are needed to simulate vessel movements.

"EMODnet's open access data and data products, including from bathymetry, physics and human activities thematics, has improved offshore energy operators' efficiency and costs, e.g., at windfarm sites in the North Sea." *Gerben de Boer, Van Oord*

Lőrinc Mészáros (Deltares) explained that EMODnet helps Deltares to deliver high resolution models in any region in Europe, any sector and any community. For example, Deltares can take the Dutch government's baseline bathymetry and use EMODnet Bathymetry's integrated and harmonised datasets and Digital Terrain Model (DTM) to create a 3-D North Sea model, with highly accurate bathymetric data for the rest of the North West Shelf. EMODnet also enables Deltares to expand its models and applications for bathymetry, as well as for accessing water levels, temperature, salinity, biogeochemical and biological data to validate models. Calibrated data models enable the institute to deliver decision-support systems to a wide range of sectors, such as dredging offshore industry, rescue operations, and increasingly to port operations and fisheries. He noted that EMODnet provides not only sustainable downstream flow data, but also pre-processed and aggregated data through a single entry point and adhering to international standards. This saves Deltares significant time and money, enabling it to help society and industry and deliver tailored services to different communities, sectors and regions.

"EMODnet's pre-processed and aggregated marine data, available through a single entry point and adhering to international standards, saves Deltares significant time and money, enabling it to help society and industry and deliver tailored services to different communities, sectors and regions." *Lőrinc Mészáros, Deltares*

EMODnet for Research

Vera Van Lancker (Royal Belgian Institute of Natural Sciences, RBINS) commented that after 10 years of cooperation, EMODnet has become more than just a data and information portal. From her experience at RBINS, marine scientists are increasingly relying on EMODnet products, e.g., for implementation of the MSFD in Belgium, while the institute provides data and human expertise back into the EMOD-network. She gave a concrete example of conducting MSFD Good Environmental Status assessments, noting that data from all of the seven EMODnet themes are useful, including integrated themes such as seabed habitats where broad-scale seabed habitats maps are at the heart of seafloor assessments. Van Lancker recommended that further cross-fertilisation between thematics would further enhance the EMODnet offer into the future. For marine forecasting, she noted the latest bathymetric information enables RBINS to extend existing forecast models beyond the shelf break, thus enlarging the application portfolio. She provided the example of EMODnet bathymetry data being used by the Belgian Marine Forecasting Centre (BMM), resulting in 40 years of trend analyses based on monitoring data. She concluded by stating that RBINS – and marine / environmental research in general – needs more FAIR data at increasing resolution that can be traced easily back to the source data collector and provider. EMODnet is a key focal point for obtaining these data for the scientific research community.

"Marine scientists are increasingly relying on EMODnet products, e.g., for implementation of the MSFD in Belgium, while the institute provides data and human expertise back into the EMOD-network." *Vera Van Lancker, RBINS*

Francisco Campuzano (Instituto Superior Técnico, IST, Portugal) highlighted EMODnet's collaboration with the Copernicus Marine Service (CMEMS) LAnd-Marine Boundary Development and Analysis (LAMBDA) project for better characterisation of the land-marine boundary. He highlighted that IST used the EMODnet Physics river data that has more than 350 stations that are present near real time, both in Europe and in the United States. The LAMBA project also designed a one-stop shop platform to access the development product and user interface, further enabling work and interaction between CMEMS and EMODnet data and data products.

"The Copernicus Marine Service LAMBA project is a key example of collaboration between CMEMs and EMODnet, using EMODnet Physics river data to inform models and a user platform for assessing the land-marine boundary." *Francisco Campuzano, IST*

EMODnet for Civil Society and citizens

Arianna Liconti (Outdoor Portofino) explained that EMODnet data can be used for science and to support other activities, such as coastal eco-tourism. Outdoor Portofino runs citizen science projects where watersport users such as kayakers, paddlers and swimmers can help marine conservation by collecting data, making observations and taking samples, etc. She noted that these participants can survey for micro-plastics as they paddle around or monitor for oceanographic data using innovative devices attached to a kayak. EMODnet supports Outdoor Portofino, because EMODnet information allows for a better understanding of the ocean and provides for better weather forecasting models so Outdoor Portofino can plan for touristic and stakeholder activities. Liconti expressed gratitude to EMODnet, especially to EMODnet Physics and Data Ingestion Portal, for providing Outdoor Portofino the opportunity through SINDBAD+ and other projects to share the data and to involve people who are not professionals in collecting data.

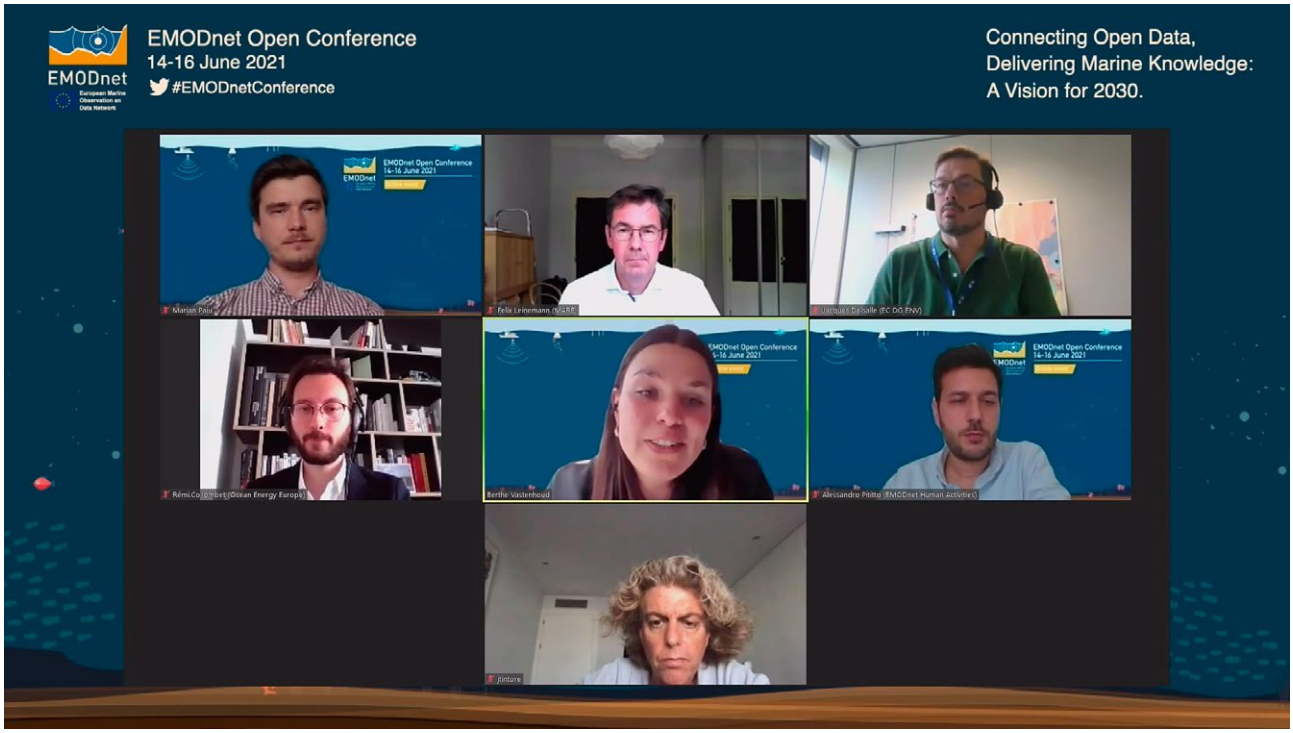
EMODnet data can be used to support coastal eco-tourism, for example providing information to give citizens a better understanding of the ocean and providing marine data for better weather and physical ocean forecasting models so Outdoor Portofino can plan for touristic and stakeholder activities." *Arianna Liconti, Outdoor Portofino*

Berthe Vastenhoud (Berring Data Collective, BDC) noted that BDC is built around the concept of 'fishing for data'. Fishing nets are an ideal platform for Internet of Things (IoT) sensors to observe the ocean, enabling fishing vessels to catch data profiles of the water column while they're catching fish. Vastenhoud explained that BDC was looking at maps on the EMODnet Physics portal when it realised that the gaps in the ocean observing network overlap exactly with commercial fishing activity. As such BDC brings communities together to promote technology transfer, knowledge sharing and data management, enabling the scaling up of the 'fishing for data' concept. BDC works with EMODnet Physics and vice-versa with BDC supplying marine data collected on fishing vessels to EMODnet Physics and EMODnet Physics provides integrated near real-time maps of the observing network and data availability, which in turn helps to identify further gaps.

"BDC supplies marine data collected on fishing vessels to EMODnet Physics and EMODnet Physics provides integrated near real-time maps of the observing network and data availability, which in turn helps to identify further gaps." *Berthe Vastenhoud, BDC*

Panel: EMODnet for Users: Forward Look

MoC Paul Rose passed the floor to Panel Chair **Alessandro Pititto** (COGEA, EMODnet Human Activities) to discuss a future look at how EMODnet could evolve its services and connections with the user community to suit user needs and requirements into the future. Alessandro Pititto introduced this panel noting that many people now use EMODnet – among them entrepreneurs, researchers, NGOs and policymakers – and they come from a wide range of sectors. He reflected that from his own experience of working at EMODnet Human Activities, users often combined data from several EMODnet thematic groups, and that the centralisation of EMODnet thematics and data services would be a good step towards this increasing demand for a one-stop-shop and integrated approach, with fully interoperable data. Panelists were then asked a series of questions, including input from the Conference audience.



What has been the biggest value of EMODnet open access integrated data and data products/applications for your sector?

Jacques Delsalle (EC, Directorate-General for Environment, DG ENV) highlighted that EMODnet has definitely been a key part of the major developments in marine data publication and aggregation over the last few years, as outlined in DG Environment's 2020 implementation report on the MSFD. He noted that data from the EMODnet Chemistry and Seabed Habitats themes are very useful for the MSFD implementation, because they fit directly some of the criteria that DG ENV uses for determining Good Environmental Status (GES). Looking forward, he recommended there's a need to ensure the transparency and public access to more relevant data, particularly for fisheries and vessel positioning, as well as increasing the offer of socio-economic information, as a way to ensure the use of EMODnet marine data for MSFD criteria evaluation and implementation.

Berthe Vastenhoud (BDC) noted that the EMODnet Physics map viewer's user-friendliness and visualisations are of great value for two reasons. Firstly, many of the fishermen BDC works with visit EMODnet Physics to check changes in the data they have been collecting. Secondly, EMODnet increases the visibility and use of oceanographic data collected by fisherman and BDC, since data are sent in real time to the EMODnet Physics portal for display alongside data collected through globally established networks such as the international ARGO programme. This is a great stamp of approval for BDC and effectively communicates the value proposition of data collection in ocean, coastal and shelf regions.

Joaquin Tintoré (Balearic Islands Coastal Observing and Forecasting System, SOCIB, Spain) explained that SOCIB has a good co-operation with EMODnet as a marine research infrastructure which is committed to provide observations, predictions, products and services. He noted EMODnet's free and open data availability across seven thematics is widely used by SOCIB and by different sectors and end-users. He suggested that the ongoing centralisation of EMODnet services would further facilitate and enhance the visibility of EMODnet as a whole. Giving a concrete example, he explained that SOCIB uses EMODnet Bathymetry Web Map Services for education, such as for piloting and optimising the course of SOCIB's autonomous ocean platforms. SOCIB also uses data for the glider application, bringing real-time data to classrooms, and in a Mediterranean exploration tool for planning ocean cruises.

Rémi Collombet (Ocean Energy Europe) spoke about data needs for the next generation of offshore renewables, including wind energy users who need reliable ocean data to find the best sites for their projects through resources assessment. He highlighted that EMODnet data are essential for first assessments of a potential site, designing Ocean Energy devices such as moorings and cables that have to survive harsh environments at sea, environmental impact assessments, and current, wave and weather forecasts during device installation, operations and maintenance. Looking to the future, he explained that since ocean energy is a growing sector, there would most likely be a further increase in Blue Economy users of EMODnet services.

Marian Paiu (MARE NOSTRUM, Romania) noted that as a Non-Governmental Organisation (NGO), MARE NOSTRUM works a lot on environmental protection and the effects of measures taken nationally and regionally. It uses EMODnet data and data products to prepare reports and also submits data to EMODnet e.g., from NGO data collection efforts and citizen science initiatives, and also disseminates EMODnet data.

Felix Leinemann (EC, DG MARE) highlighted that some Member States have used EMODnet data for their maritime spatial planning (MSP) processes, in compliance with the EU Maritime Spatial Planning Directive, and EMODnet integrated data can be useful for cross-border planning. He noted the use of maritime space is sure to rise in order to reach the climate and biodiversity objectives of the European Green Deal. He noted that EMODnet is highlighted as a 'repository' for MSP in a recent DG MARE MSP technical expert group on data, and he recommended that EMODnet could play a role in solving the issue of compatibility of data, something that was an ongoing issue raised in EC funded cross-border maritime spatial planning cooperation projects.

Take-home message

EMODnet is really that mature EU marine knowledge service, a focal point for *in situ* data in Europe offering hugh amounts of environmental and human activities data. This is made possible by the large and diverse EMODnet partnership and experts. Users are central to EMODnet and, currently, EMODnet data and products are used for policy, research, industry and civil society applications. The user-friendliness of the EMODnet services is continuously evolving and improving, which currently includes the ongoing centralisation of all EMODnet data, data products and services with a future common map viewer.

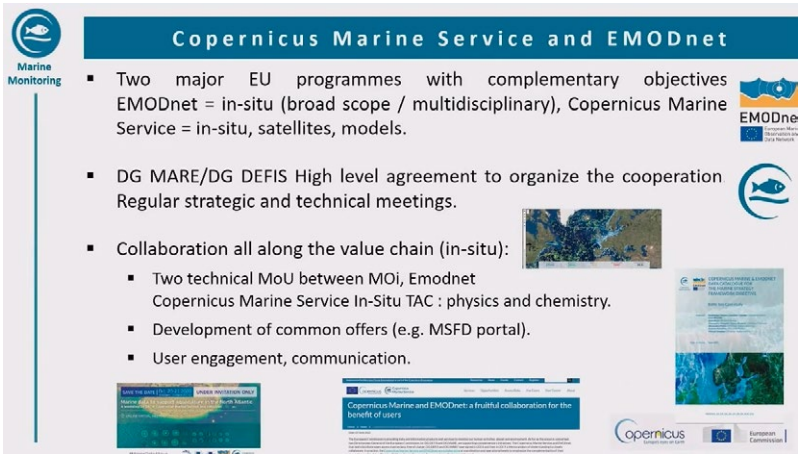
Session 3 – EMODnet Partnerships (Europe)

Keynote presentation: The Copernicus Marine Service

Pierre-Yves Le Traon, Mercator Ocean International (MOi), Copernicus Marine Service (CMEMS)

In his presentation, Pierre-Yves Le Traon gave an overview of the Copernicus Marine Service, noting that it's one of the six services of the Copernicus programme implemented by Mercator Ocean International. CMEMS is dealing with global and regional ocean monitoring and forecasting for all essential ocean variables. He noted that EMODnet and CMEMS work hand in hand and are two complementary EU programmes. EMODnet broadly deals with *in situ* data on services and is very multidisciplinary, while CMEMS involves *in situ* satellites images and models. They have a high-level agreement between DG Maritime affairs and Fisheries (MARE) and DG Defence Industry and Space (DG DEFIS) to organise cooperation between the two programmes and regular strategic meetings. Collaboration therefore flows along the value chain, having implemented the 2020 Marine Strategy through Memorandum of Understandings (MoUs) with EMODnet Physics and Chemistry, and continues this through other thematic lots as well. The combination of Sentinel satellite information with EMODnet (*in situ*) is crucial. One example being on ocean surface currents. The MoU combining Physics and Chemistry *in situ* data with Copernicus data has proven to be extremely efficient and supports FAIR access to data and products. Other collaborations are related to user engagement and the development of common offers. A new phase of CMEMS – Copernicus 2 - will begin in July 2021, for the next seven years, and there will be major evolutions, i.e. for coastal, digital services, and also the Arctic coverage, further increasing the offer for ocean analysis and prediction and wider user needs.

He concluded noting that EMODnet and CMEMS provide a very strong offer, serving as a backbone for the challenges to come, and that the collaboration is only set to strengthen and evolve in the coming decade.

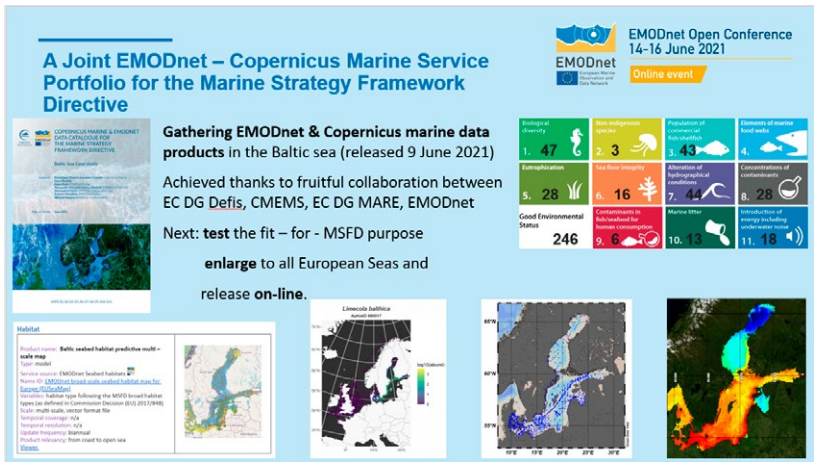


"Together, EMODnet and CMEMS provide a very strong offer, serving as a backbone for the challenges to come. Together they also provide the seamless, free and open access to marine environmental and human activities data that are needed to support the 'blue' knowledge-base for the green recovery from the COVID-19 pandemic, the green transition to meet the EU Green Deal's ambitious targets and the digital transformation that is already underway."
Pierre-Yves Le Traon, Moi, CMEMS

EMODnet-CMEMS expert dialogue

MoC Paul Rose introduced further experts from Copernicus Marine Service and EMODnet, for a live dialogue to further discuss the existing collaborations and joint activities between EMODnet and CMEMS and how these could develop in the future.

Antonio Novellino (ETT S.p.A, EMODnet Physics) remarked that the MoU between EMODnet Physics and CMEMS – in place since 2016 - was a very important milestone. It signified a formal agreement to inform users that there was a collaboration on a daily basis with the best available data and products. Collaboration actually started before Copernicus became a programme. This collaboration is key to the end-to-end value chain.



Alessandra Giorgetti (OGS, EMODnet Chemistry) underlined how a further MoU between EMODnet Chemistry and CMEMS, signed in 2019, had strengthened collaboration related to biogeochemical marine data operations, bringing added value and mutual benefits for both parties. She highlighted a recent and ongoing joint activity where EMODnet and CMEMS had designed a joint portfolio for the Marine Strategy Framework Directive, gathering all open access marine data and data products relevant to support the marine strategy. The current portfolio was focused on the Baltic Sea and the next goal would be to assess the usefulness with MSFD stakeholders and then to extend its coverage to all European seas.

Laurence Crosnier (CMEMS/MOi) highlighted the collaboration between EMODnet and CMEMS for joint use cases, including a joint communication campaign launched in June 2021, and other activities engaging with the user community e.g., the 'Marine Data for Aquaculture' workshops for the Northeast Atlantic and Mediterranean and Black Sea regions organised in 2020 and 2021 respectively as a joint initiative by the EC (DG MARE and DG DEFIS), the European Aquaculture Technology and Innovation Platform (EATiP), EMODnet and CMEMS. She also noted that CMEMS data are also made available to the European Atlas of the Seas, an EC communication tool for wider society, administered by EMODnet. She added that most recently, two CMEMS ocean monitoring indicators were added as map layers, further extending the diversity of marine and related human activities data layers available through the Atlas.

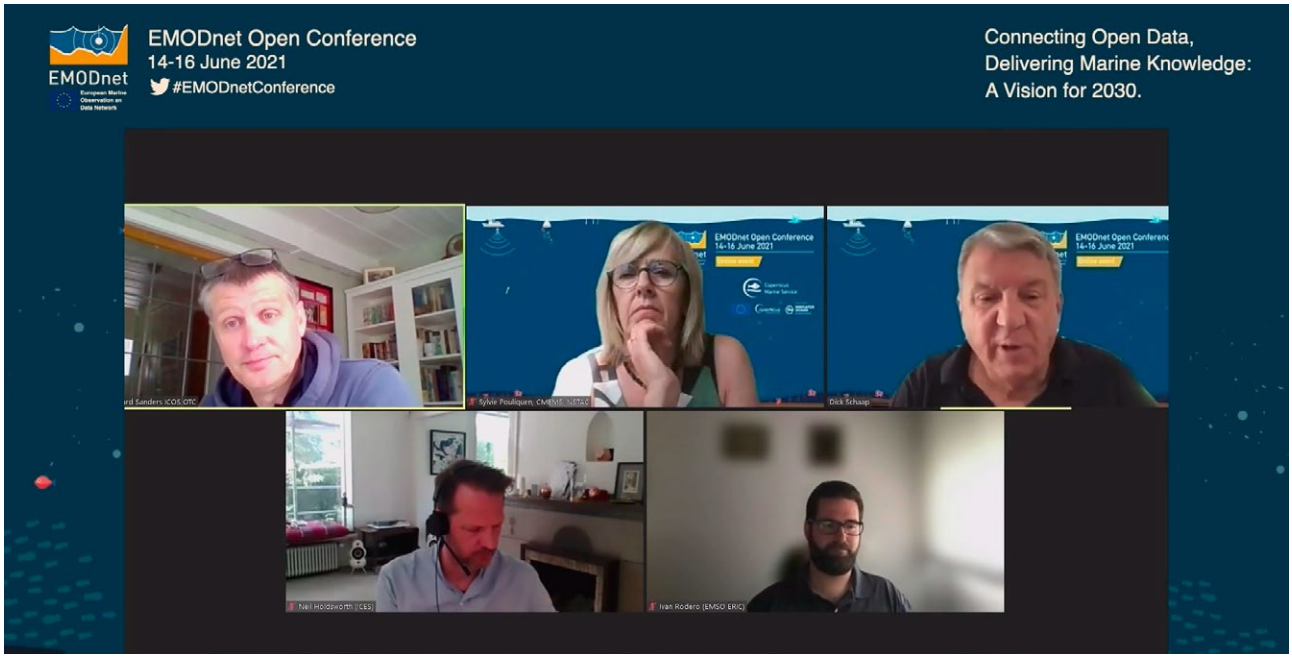
Looking to the future, **Pierre-Yves Le Traon** (CMEMS/MOi) referred to the cooperation with EMODnet Physics and Chemistry, noting that he hoped this could be extended to other EMODnet thematics such as Bathymetry, Biology, Geology, Human Activities, and Seabed Habitats. He also suggested that, building on the good co-operation for a joint MSFD portfolio, EMODnet and CMEMS could consider Maritime Spatial Planning as a further area for collaboration, contributing to the wider community effort to produce a digital representation of the ocean.

Kate Larkin (EMODnet Secretariat) noted the progress that she had seen in the partnership between CMEMS and EMODnet over the past few years that was continuously strengthening at both the coordination and operational levels, including the flow and exchange of data and expertise across the many thematics and components of both programmes. She highlighted that EMODnet and CMEMS had also held joint workshops to identify emerging gaps and requirements spanning *in situ* and satellite-derived marine data and data products that will be needed over the next decade, most recently in a joint workshop dedicated to the coastal zone. She also noted the expanding user community noting that EMODnet and CMEMS could in the future further collaborate on demonstrations and training for Blue Economy sectors in Europe, and beyond. She concluded that EMODnet and CMEMS are becoming the backbone of European marine data services for digital applications and together – in collaboration with the wider community – EMODnet and CMEMS can contribute a strong European offer to global efforts in marine data services, best practices and use cases.

Panel: EMODnet and the European data landscape

Chair of the Panel, **Dick Schaap** (Marine Information Service Maris BV (MARIS), EMODnet Data Ingestion & SeaDataNet) introduced the topic by explaining there are three levels of stakeholders involved in the marine data value chain: those who collect data, of which there are thousands; data aggregators whose main task is to manage or bring data together and do the harmonisation/validation; and users as the top layer. Users include intermediary services that take the output from the aggregators and add value and applications to make the data more fit and downstream for users of marine data and products. He noted that EMODnet, together with CMEMS – are two leading European aggregators. Both and require support from wider data infrastructures and research infrastructures, developed over time and largely funded by the EC DG Research and Innovation and by national and regional funding mechanisms. He concluded by noting that EMODnet and marine data services in general are continuously evolving, including closer collaboration across infrastructures and services, optimised interoperability and enhanced data services for discovery and access by society.

"It would be really great if marine data services could evolve so we could share our data as easily as it is to share all photos and video on social media." *Dick Schaap, MARIS*



Dick Schaap then introduced the panelists, noting that the majority were representatives of marine data aggregators, and asked panellists to respond to the following two questions:

How does your organisation/initiative/infrastructure/network currently cooperate with EMODnet and how do you see it developing over time?

How would you like to see EMODnet evolve in the future, in the EU Data landscape and what are the expectations/recommendations to help you realise your organisation's objectives? What are your expectations from EMODnet in the future to further develop synergies?

Sylvie Pouliquen (Ifremer, CMEMS *in situ* Thematic Assembly Centre, (TAC)) noted it's important to avoid duplication of effort in the development of products. She explained that CMEMS benefits from actions taken by EMODnet to unlock access to data, as well as the state-of-the-art visualisation services set up by EMODnet Physics, focusing on *in situ* observation. In turn, she added that EMODnet Physics benefits from integration of *in situ* observation into aggregated quality control standardised products at European and global scale. Speaking about EMODnet Chemistry, she noted the collaboration on biogeochemical data is more recent (MoU since 2019), but that this is providing very effective. She emphasised that working on quality control is also a priority, and ensuring interoperability across services. Looking to the future, she suggested that EMODnet could consider how to further contribute to a well-coordinated and sustained European ocean observing effort in partnership with Member States and the European Research Infrastructures set up over the last decade.

Neil Holdsworth (International Council for the Exploration of the Sea, (ICES)) explained that ICES is an International initiative focusing on the North Atlantic, with a coordination hub in Denmark and both European, U.S. and Canadian partners. ICES' main mission is to provide the best science and management advice to bodies including the European Commission and Regional Sea partners, e.g., HELCOM, OSPAR and the Arctic Monitoring & Assessment Programme (AMAP). He highlighted that ICES has an excellent collaboration with EMODnet and this is long-standing and continues to strengthen. ICES provides data to EMODnet Biology, and in turn, EMODnet Biology provides a large array of biological data to ICES, such as on fish populations. In EMODnet Physics, ICES acts as a regional product creator (on behalf of OSPAR and HELCOM), and provides services that allow visualisation of regional underwater noise indicators. As a facilitator, ICES has a decade of cooperation to create a dialogue with the EEA and Regional Sea Conventions to ensure that Quality Controlled (QC) data is coming through the 'pipeline' through EMODnet Chemistry, for use in regional assessments or regional science. He emphasised the challenge is the transparency of the value chain to the user, with adequate accountability. There are so many potential users of these services, i.e. management advice that requires a professional level of accountability. He proposed that EMODnet could connect further across the thematics moving to a new governance model, to reduce fragmentation, and concluded that EMODnet can play a pivotal role in the coming decade in reaching wider society with marine data and knowledge for non-experts.

Richard Sanders (Integrated Carbon Observation System – Ocean Thematic Centre, (ICOS - OTC)) said that the ICOS OTC facility supports the community of stations making observations of CO_2 on the surface ocean in European waters. ICOS is part of the global effort to track ocean carbon uptake, to understand how climates are evolving. The data are ingested and stored by ICOS, quality controlled and sent to the Surface Ocean CO_2 Atlas (SOCAT), before being made publicly available, including via EMODnet. He emphasised that whilst progress in connecting and sustaining ocean observations had been made in the past decade, the *in situ* ocean observation component remained largely un-sustained. This had implications for the value chain since a seamless marine knowledge value chain is only as strong as its weakest component. He proposed that EMODnet has a pivotal role to play in this effort, as it is centrally placed across the marine knowledge value chain. Going forward, he could see EMODnet taking on this role and acting as a central focal point, to connect upstream and downstream to make these connections, across the full marine knowledge value chain.

Ivan Rodero (European Multidisciplinary Seafloor and water-column Observatory, (EMSO)) noted that EMODnet has been a useful and convenient mechanism to offer data access through the web. EMSO has since started to harmonise data itself in order to provide its services to the community. He noted the usefulness of EMODnet's 'feedback' loop, i.e. looking at the statistics of uptake and tracking data use, highlighting that this provides important information to data providers and serves as an incentive to continue delivering data through EMODnet and other aggregators. He added that feedback from users enables improvements in the quality and fairness of data, making it fit for purpose, as is done throughout EMODnet. He proposed that a meta-catalogue concept should be centralised across the various Research Infrastructures. The latter should be provided with interfaces (beyond data and metadata), but also to process intermediate data and translating it into knowledge. This would require cloud systems.

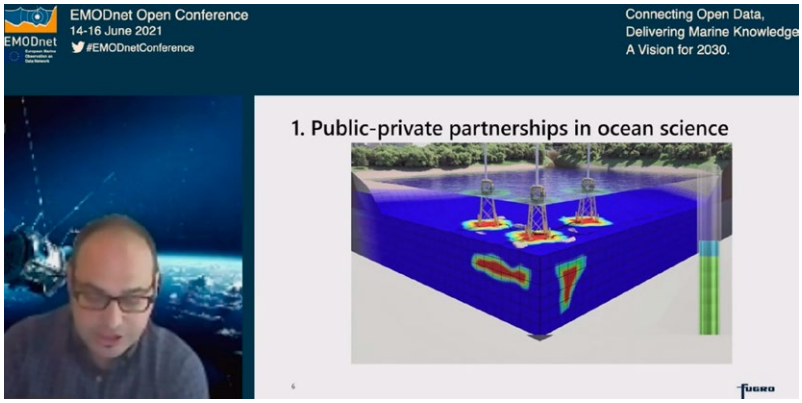
Take-home message

EMODnet has a number of key partnerships at European level which span the marine knowledge value chain. (Marine) Research Infrastructures and wider ocean observation and marine monitoring supply crucial data and consolidating and sustaining the *in situ* ocean observation and data collection is vital to ensure a seamless marine knowledge value chain. Ensuring the tracking of data use and uptake and providing this information back to the original data collectors and providers is a key aspect of showing the impact and driving further sustained funding. EMODnet and CMEMS are two key European aggregators which both rely upon multiple data- and research- infrastructures and other aggregators and data services e.g., ICES. Interoperability is increasing across the European marine data service landscape and EMODnet is a catalyst for standards.

Presentations: Data sharing by diverse communities

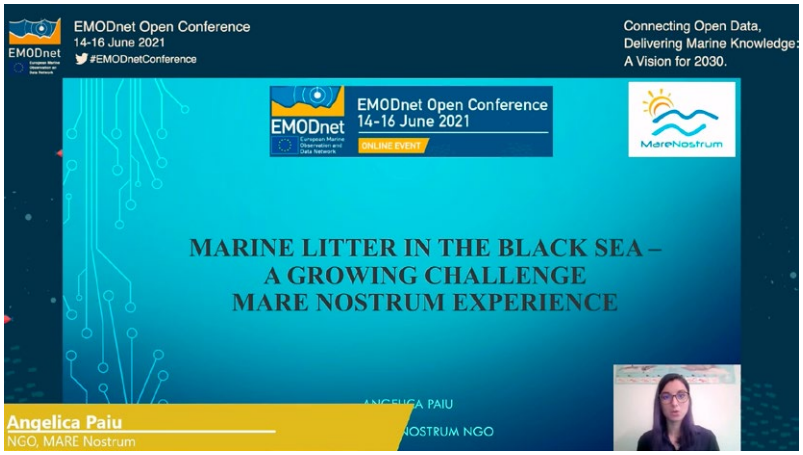
Antonella Battaglini (Renewables Grid Initiative, RGI) highlighted the opportunities of data sharing with EMODnet. The RGI is a unique cooperation between industry and civil society with a focus on energy transition. In 2019 RGI set up a coalition named Ocean (Offshore Coalition for Energy and Nature), and together they address key topics such as data sharing. She expressed that RGI is keen to exchange with EMODnet and other actors in the network, to find opportunities for data sharing and best practice exchange, for the benefit of all.

"Data should be available to all and shared across borders, as data collection is a costly business. The Renewables Grid Initiative is keen to work further with EMODnet to explore opportunities for data sharing and best practice exchange" Antonella Battaglini, Renewables Grid Initiative



Marco Filippone (FUGRO) explained how FUGRO supports the sharing of marine environment data collected from private sector activities and public-private partnerships. Opportunities for sharing data exist in public-private partnerships related to ocean science, as well as through participation in citizen science and crowdsourcing of ocean science contributions. For instance, FUGRO has already gathered vessel transit data (bathymetry, etc.) on 1.5 million square kilometres of ocean using nine vessels. Clients of this data include the Norwegian hydrography service and Ifremer. Data is shared through EMODnet and Ifremer and FUGRO is keen to explore further opportunities. He also noted that citizen science and crowd-sourced contributions to seabed surveying could become more important in the future.

"FUGRO supports the sharing - where possible - of marine environment data from private sector activities so data can be used to inform future governance and policy to improve ocean sustainability." *Marco Filippone, FUGRO*

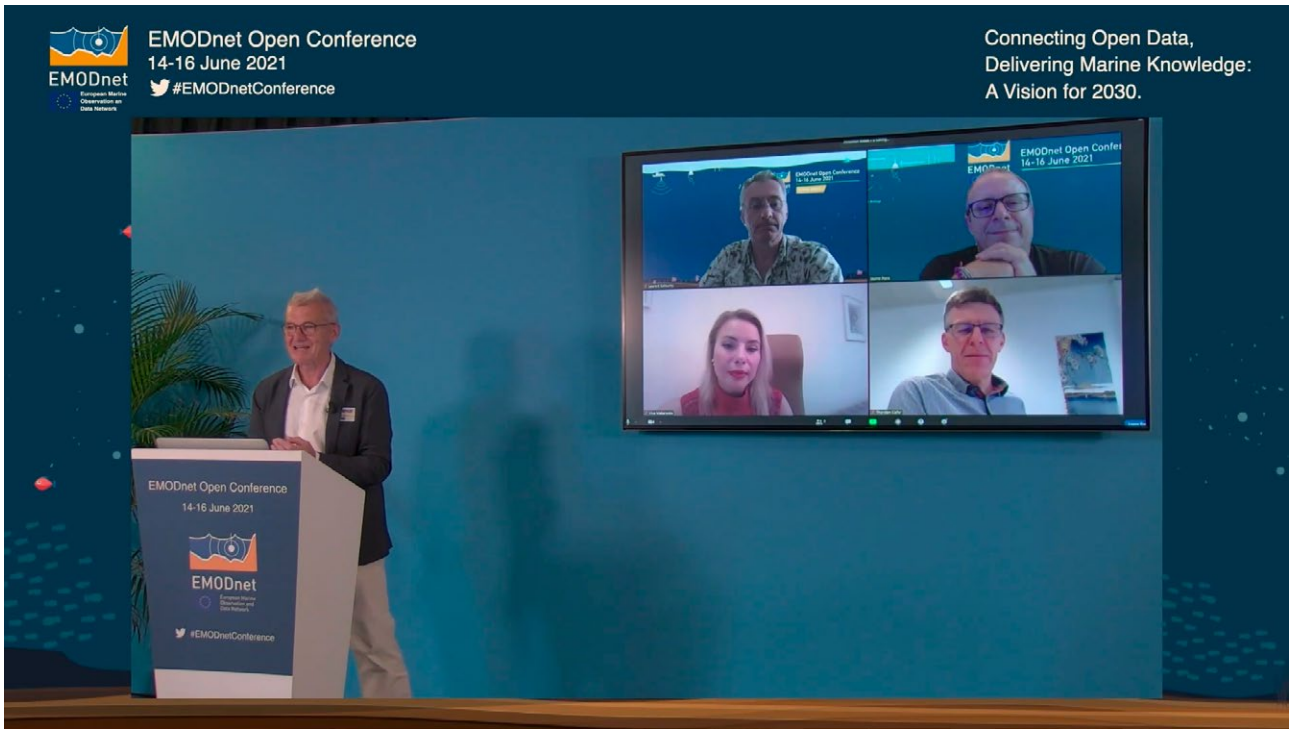


Angelica Paiu (NGO, MARE NOSTRUM) talked about tackling marine litter survey in the Black Sea. The MARE NOSTRUM NGO started the first awareness-raising campaigns in 1997, focusing on Romanian beaches and has since contributed to various European projects. MARE NOSTRUM calls on citizen science with students, teachers and researchers to raise awareness of marine litter and waste in general. Since 2019, the NGO has supported EMODnet Chemistry and vice versa, by making its beach marine litter surveys and seafloor data collected using demersal trawl nets available through the EMODnet Chemistry thematic.

"Citizen science can be a crucial tool for educating a new generation to prevent the problems of marine litter. MARE NOSTRUM NGO is working with EMODnet Chemistry to make beach marine litter surveys from the Black Sea available to all." *Angelica Paiu, MARE NOSTRUM*

Panel: EMODnet's existing and emerging EU partnerships

MoC Paul Rose introduced the Panel, noting that the discussions would remain focused on EMODnet's EU partnerships, bringing in further experts to discuss both current and future opportunities.



What emerging areas and initiatives at EU level could EMODnet most align with in the coming decade?

Christian Kirchsteiger (EC, Directorate-General for Communications Networks, Content and Technology (DG CNECT), EU Digital Strategy and Destination Earth) remarked it was important to talk about the Commission's Digital Strategy, as the wealth of available data can be transformed into knowledge and actionable knowledge. He focused on Destination Earth (DestinE), which would go beyond current capabilities in terms of precision and impact sector modelling, and includes an initiative to build a future innovative Digital Twin of the Ocean (DTO), where there will be many cooperation possibilities. He noted that data interoperability and analysis between existing services such as EMODnet would be a crucial component. To ensure EMODnet continues to evolve to meet user needs he recommended a gap analysis on EMODnet's offer, linked to the future needs of the Ocean community. He also encouraged EMODnet to actively participate in the science/research aspect of DestinE and DTO, noting that EMODnet could play a role as a data integrator in the data and knowledge integrating into development of the concept for a Digital Twin of the Ocean.

Thorsten Kiefer (Joint Programming Initiative Healthy and Productive Seas and Oceans, (JPI Oceans)) highlighted that EMODnet plays a key role in generating impact, both downstream and upstream. He explained that EMODnet is engaged in a JPI Oceans regional-local sea level rise expert group to tackle issues on coastal protection, climate change adaptation, etc, where EMODnet could further assist to streamline the data flow from national data collectors and EU marine data services, and connecting these data to users. He also noted that here is also great potential for synergy between EMODnet and JPI Oceans in ocean carbon observation. He underlined the importance of consolidating the EMOD-network, and added that opportunities to expand the current portfolio of data could include social sciences, including economic data, behavioural data and consumer data, to make the connection to developing the sustainable blue economy.

Iryna Makarenko (Black Sea Commission, Regional Sea Convention (RSC)) noted that the Black Sea Commission signed an MoU with EMODnet Chemistry a few years ago, and this had led to a very effective mechanism in terms of the exchange of data e.g., between the regional Black Sea pollution database and EMODnet, identifying and filling gaps in ocean observation and data collection and coordination of activities across national, regional and European levels. This led to EMODnet's contribution to the latest five-year report on the status of the Black Sea's marine environment, which helped to further improve quality assurance and quality control capacity. She reflected that data in the Black Sea Commission is not always in open access, due to decisions by contracting parties, but that EMODnet's open and free access approach to marine data was contributing to a culture change. She added that future collaboration between the Black Sea Commission and EMODnet could be extended to include the thematics of Biology and Human Activities, and to look at opportuntiies to bring in more data on socio-economics.

Laurent Delauney (Ifremer, Joint European Research Infrastructure for Coastal Observation (JERICO RI)) recommended that EMODnet invest time to further strengthen links with ocean observing operators and research infrastructures, emphasising that EMODnet is focused on data and data products for end-users and these are dependent on the Research Infrastructures e.g., JERICO RI, wider data collectors and data infrastructures, which are very diverse and remain largely fragmented. Giving an example, he explained that EMODnet could work with JERICO RI and other research infrastructures in order to innovate the data flow to increase the fairness of the data and interoperability, and best practices, etc. The partnership should start at the data acquisition level. He added that investments in cloud processing services would likely drive the demand for marine data and data products and make data as FAIR as possible.

Jaume Piera (CSIC - Spanish National Research Council, EU H2020 Cos4Cloud Coordinator, Citizen Science) highlighted how citizen science is highly dependent on volunteers. He recommended that Citizens' Observatories should be connected to EMODnet to provide access to the data and create data products. He underlined that a key issue is the acknowledgement of all actors, from volunteers to data validators. EMODnet could help provide feedback on the uptake and impact of data to help acknowledge the contribution of citizen science volunteers, amongst other data providers, for the effort for data collection and curation. Giving an example, he noted there's a need to know who is using the data and one way to motivate the volunteers and secure them for long-term observations is to provide long-term answers and conclusions and products. He also called for more data products that can be interpreted by citizens and young people, connecting EMODnet to wider society. He concluded by noting that tracking the impact of EMODnet data use and uptake is very important and that expanding the existing web metrics, asking for data registration (of user name etc) and (meta)data tagging (e.g., of Essential Ocean Variables) could be key to tracking and also maximising the use e.g., as an EMODnet "label" or "badge" to show it is a trusted data management quality "stamp".

Session 4 – EMODnet for Global

MoC Paul Rose introduced the "EMODnet for Global" Session, highlighting that EMODnet already has many strong collaborations at the global level, including operational data flows, technical advise, input to international ocean best practices, and regional collaborations most notably between the EU and China. He reiterated that 2021 was a 'super year' for the global ocean community, and that the UN Decade of Ocean Science for Sustainable Development had officially kicked off some days before the Conference in early June 2021. With that, he welcomed Vladimir Ryabinin (Intergovernmental Oceanographic Commission of UNESCO, (IOC-UNESCO)) to deliver the first keynote presentation of the session.

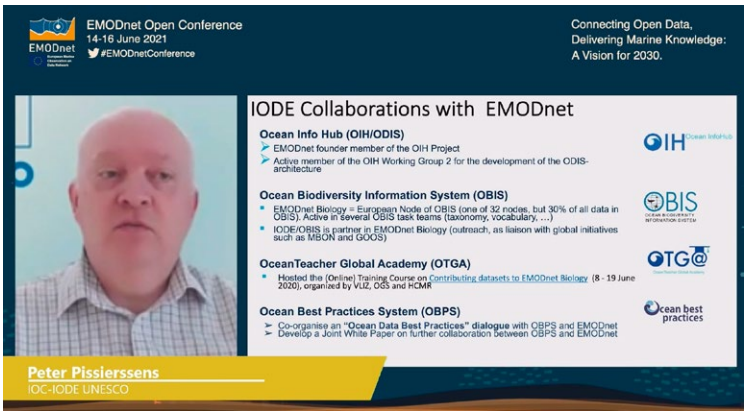
Keynote presentations: UN Decade of Ocean Science for Sustainable Development

Vladimir Ryabinin (Intergovernmental Oceanographic Commission of UNESCO, (IOC-UNESCO)) delivered a presentation of the current state of the United Nations Decade of Ocean Science for Sustainable Development. He explained the mission of the UN Ocean Decade is to become a transformative ocean science solution for sustainable development, connecting people and our ocean. And that, following the official launch on 1 June 2021, the Ocean Decade Implementation Plan is now being worked on by thousands people, hundreds of organisations and dozens of countries, including EMODnet. He highlighted one of the biggest challenges is open access to high-quality data, for all, noting that the recent High-level Panel for a Sustainable Ocean Economy identified data reform as a cross-cutting enabler for a sustainable ocean economy. He noted that EMODnet is well placed to contribute, as a global leader for marine services. He added that standards for ocean data management need to be global, which is what International Oceanographic Data and Information Exchange (IODE) is trying to achieve, with global data exchange and global standards. In his opinion, EMODnet is perfectly positioned as a role model for data processing and opening data for all, moving data processes forward and to open data to underpin sustainable development.

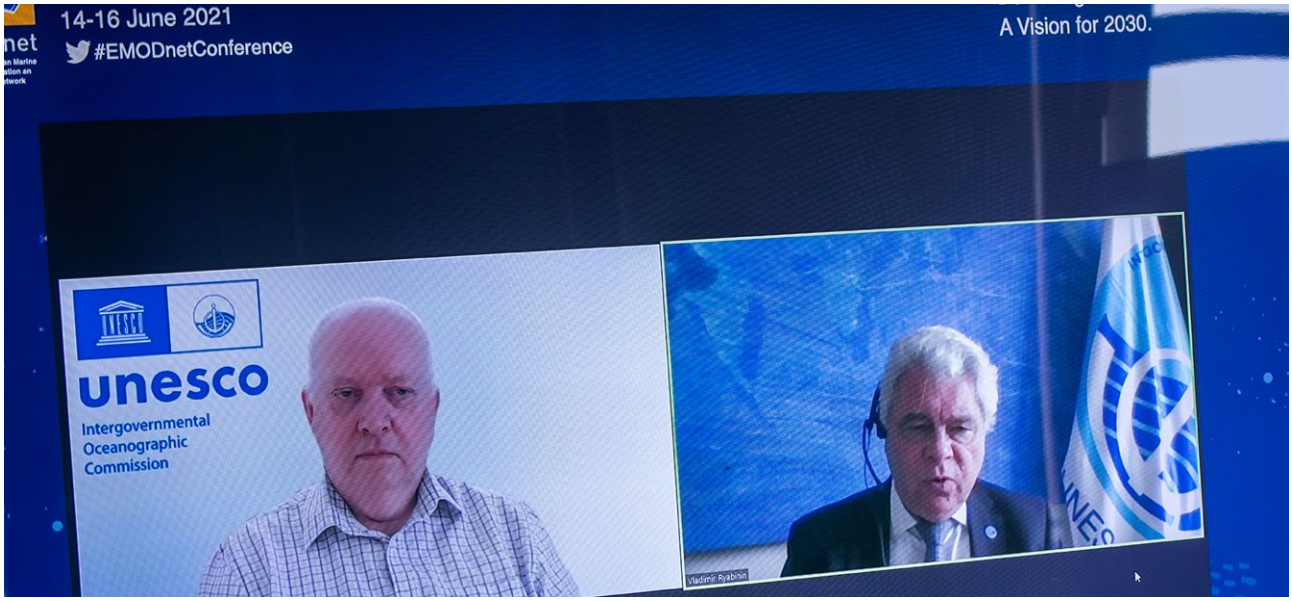
"EMODnet is one of the leading communities of the world for marine data services."
Vladimir Ryabinin, IOC-UNESCO

Paul Rose (MoC) thanked Vladimir Ryabinin noting the huge opportunity that the UN Ocean Decade presented for the international ocean community and wider society. He then introduced the second keynote presentation from Peter Pissierssens (Intergovernmental Oceanographic Commission-International Oceanographic Data and Information Exchange, (IOC-IODE UNESCO)).

ODIS & the Ocean InfoHub



Peter Pissierssens (Intergovernmental Oceanographic Commission-International Oceanographic Data and Information Exchange, (IOC-IODE UNESCO)) explained that IODE collaborates with EMODnet through the IOC Ocean InfoHub (OIH/ODIS) project, which aims to create interoperability between existing information systems. It aims to achieve this by building on the existing global network of Internet of Things (IOT) data centres – many of which are already partners in EMODnet – while linking to regional and global data systems. Goals include creating a network of hubs, developing a proof of concept for an underlying Ocean Data and Information System (ODIS) architecture, and developing end-user communities of practice at regional or thematic levels. He highlighted that EMODnet is one of the project founders of the Ocean Information Hub and a regional focal point for Europe. Peter Pissierssens concluded that IOC-IODE aims to continue cooperating in designing this architecture and expanding collaboration through all the bodies it works with, including EMODnet. He looked forward to collaboration with EMODnet including co-design of the ODIS-architecture, expansion of collaboration through the Ocean InfoHub, and IOC/IODE as a bridging partner between EU and other regions. Asked how EMODnet can contribute to IODE development, Pissierssens was convinced that the EMODnet-IODE relationship is mutually beneficial. IOC has strong contact within science, observation and data management centres and through IODE these can provide a global network. EMODnet has developed guidelines, communities and practice, so could be used as a good example to be shared with other regions.



"We want global data and information systems and EMODnet's guidelines are great for community of practice. The network is also a role model for other regions."
Peter Pissierssens, IOC-IODE UNESCO

Global community presentations

Jan-Bart Calewaert (EMODnet Secretariat) introduced the community presentations from global stakeholders, emphasising the session included many win-win collaborations at global and regional levels that make EMODnet's activities more efficient and impactful, together with emerging partnerships for the coming years.

EMODnet for Seabed 2030

Jamie McMichael-Phillips (Nippon Foundation, GEBCO, Seabed 2030) explained that Seabed 2030's main aim is to inspire the complete mapping of the world's ocean floor by 2030 and to make that bathymetric information available via the General Bathymetric Chart of the Oceans (GEBCO) grid for free. In the last four years, he explained that data has been assembled from a wide variety of collaborators, and EMODnet is the third largest contributor of bathymetry to Seabed 2030, worldwide. He added that EMODnet is also within the top three data contributors to GEBCO data grid. Looking forward, he highlighted new focus is on gathering new data, also with EMODnet, but more widely – such as mapping parts of the ocean that have yet to generate or attract any interest (ocean frontier mapping). Other areas of focus are crowdsourced bathymetry for citizen science and technical innovation to accelerate ocean mapping. He encouraged data providers to submit data through EMODnet, so it's controlled, to extend Seabed 2030 in a more global fashion. He said the project could use its EMODnet links to encourage data providers who may be more reluctant to release data at a comfortable resolution for the Seabed 2030 product and ultimately the GEBCO grid. He concluded by saying that Seabed 2030 is now an endorsed programme within the UN Decade of the Ocean and this higher visibility should accelerate the initiatives towards its target of 2030.

"EMODnet is the third largest contributor of bathymetry to Seabed 2030, worldwide and EMODnet is also within the top three data contributors to GEBCO data grid. This is thanks to a trusting and pragmatic collaboration between Seabed 2030 and EMODnet, not just of sharing data, but also sharing views, strategies and best practices." *Jamie McMichael-Phillips, Nippon Foundation, GEBCO, Seabed 2030*

EMODnet for global biodiversity

Ward Appeltans (Ocean Biodiversity Information, OBIS) and **Leen Vandepitte** (European Ocean Biodiversity Information System, EurOBIS) jointly presented the long-established relationship between EMODnet OBIS, and its European counterpart EurOBIS. They noted that both are important collaborators for EMODnet Biology, with bidirectional data flow between the two ensuring Europe's marine biological and biodiversity data are made available at the European and global levels e.g., World Ocean Assessment.

"OBIS, EurOBIS and EMODnet collaborate on many fronts to build a globally connected system for Ocean Biodiversity Information." *Ward Appeltans, OBIS*

Vandepitte explained that EurOBIS (the backbone of EMODnet Biology since 2009) centralises largely scattered biogeographical marine data (largely aggregated by EMODnet Biology) into a searchable database, which is made freely and widely available. EurOBIS offers more than 1.000 datasets and data on more than 98.000 species names, occurrence records, measurements and records: these cover the 1700s to the present day. Its content can be explored through EMODnet Biology, LifeWatch or EurOBIS IPT. EurOBIS now also stores abiotic variables which are important for Essential Ocean Variables. OBIS supports also multiple data types that have been developed together with EMODnet. In addition, EMODnet and EurOBIS collaborate in training activities with on publishing OBIS data and use of data. They also jointly develop support for multiple data types, such as Essential Ocean Variables.

"EMODnet is a key data aggregator for EurOBIS which is the European contrition to the international OBIS ensuring European marine biological and biodiversity data are made available for the international community, e.g., as used in the World Ocean Assessment."
Leen Vandepitte, EurOBIS

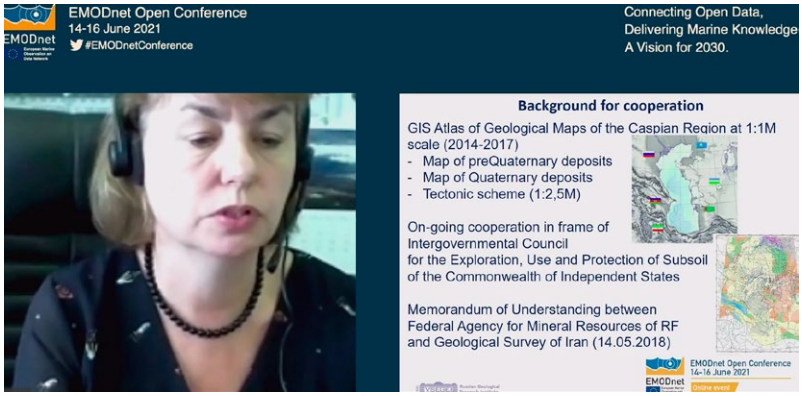
EMODnet EU-China partnership

Jun She (Danish Meteorological Institute, DMI) presented a major initative of EMODnet for Global, namely the EU and China Blue Partnership. He noted that the European Union had funded the EMODnet Partnership for China and Europe (EMOD-PACE), coordinated by EMODnet, with China funding a counterpart project called China-EU Marine Data Network Partnership (CEMDnet), coordinated by the National Marine Data and Information Service (NMDIS). He explained that the projects aim for bilateral data sharing and improved data interoperability, plus the promotion of common interests in international ocean governance issues such as climate change, coastal and ocean protection and marine traffic. Jun She said this is not easy to achieve, but it depends very much on establishing trust. In the first year of these two projects, he highlighted that a common workplan has been co-designed, with a collective approach, and a MoU was signed in January 2021 to further strengthen the cooperation, with 20 partners involved. He concluded that this confirms the commitment of EMODnet and NMDIS to exchange data and standards and to make ocean data/products more accessible.

"The EU-China Blue Partnership, a collaboration between the EMODnet partnership through EMOD-PACE and the National Marine Data and Information Service of China through CEMDnet has led to strengthened trust, cooperation, and data sharing with the result that more observations can now be used for validating our ocean models." *Jun She, DMI*

Julia Ting Yu (National Marine Data and Information Service (NMDIS) of China) talked about the China-EU Marine Data Network Partnership (CEMDnet) project, which is working on collaborative ocean data sharing and services together with its counterpart initiative, EMOD-PACE. She explained that cooperation between the EU and China in the marine data domain started in 2017, and spans strategy, research and operations. She noted the two projects CEMDnet and EMOD-PACE are a great chance for China and the EU to enhance cooperation in the area of marine information technology, ocean environmental protection and adaptation to global climate change. Discussing the future outlook she noted that the joint work plan would be further implemented, including the inter-comparison and reanalysis of sea level, coastal erosion wetland, degradation, marine traffic, ecological carrying capacity and expansion of thematic data exchange to include chemistry, biology, bathymetry and physics. She added that further links would be established across Asia, and results would be promoted across the Indian Ocean and North West Pacific by establishing links with data centres in other countries. Ultimately, the EU-China Blue Partnership aims to establish a sustained China-EU partnership on ocean data management, exchange, service and sharing of data to benefit larger regions.

"The EU-China partnership EMOD-PACE and CEMD-NET shows the value of both regional cooperation and of data diplomacy and dialogue for data sharing and interoperability. It could be used as a model going forward for other regions." *Julia Ting Yu, NMDIS*



Daria Ryabchuk (Russian Geological Research Institute, VSEGEI) explained that VSEGEI has participated in the EMODnet Geology project since 2014 to map the Barents Sea, White Sea and Baltic Sea. This cooperation was expanded to the Caspian Sea in 2019, an area with significant challenges, including sea-level fluctuations, climate change, environmental challenges due especially to oil and gas exploration, and transboundary cooperation. Russia, Azerbaijan and Kazakhstan are cooperating on producing a GIS Atlas of geological maps of the Caspian Region, use and protection of subsoil of the Commonwealth of Independent States, and a MoU between Russia's Federal Agency of Mineral Resources and the Geological Survey of Iran.

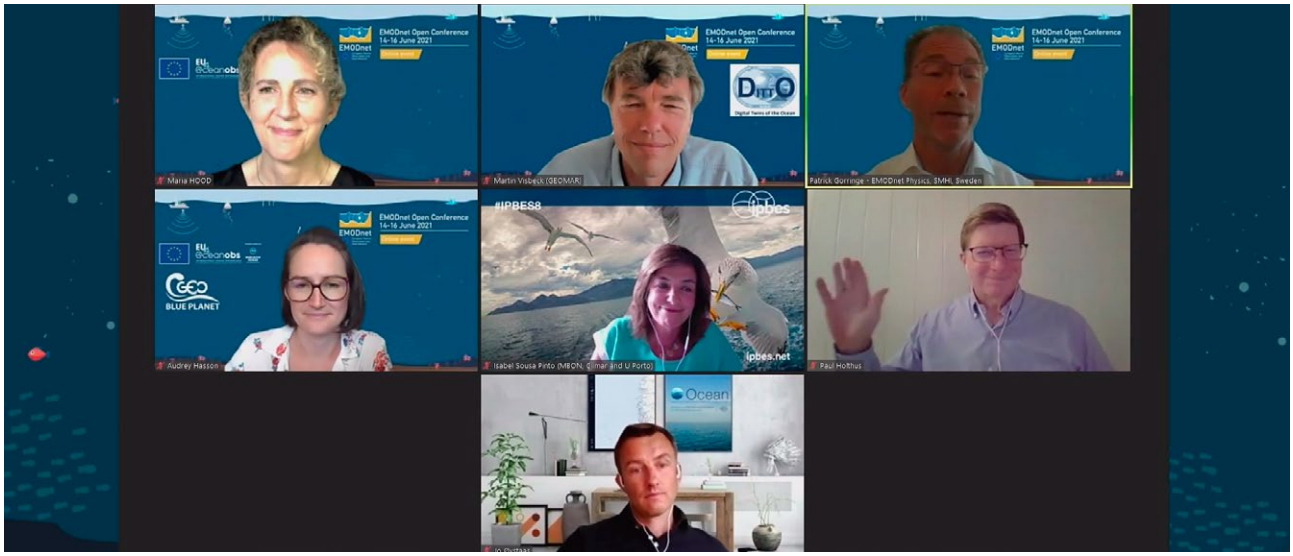
"The cooperation between VSEGEI and EMODnet Geology is long-standing and, since 2019, has enabled data sharing from the Caspian Sea region, an area with significant challenges, including sea-level fluctuations, climate change, environmental challenges due especially to oil and gas exploration, and transboundary cooperation." *Daria Ryabchuk, VSEGEI*

Mike Smit (Dalhousie, Canadian Integrated Ocean Observing System, CIOOS) noted that CIOOS collects "ocean data for our ocean nation" by building on existing networks. CIOOS often calls on external expertise, including EMODnet's, and aims to further strengthen partnerships and collaborations to improve the discoverability, accessibility and interoperability to convert ocean data into information and knowledge. Current challenges include sustained funding, significant observation gaps, core fundamental data management, achieving meaningful inclusion of the Arctic, and demand for more complicated data such as for marine plastics.

"Canadian Integrated Ocean Observing System often calls on external expertise, including EMODnet's, and aims to further strengthen partnerships and collaborations to improve the discoverability, accessibility and interoperability to convert ocean data into information and knowledge." *Mike Smit, CIOOS*

Global dialogues: Existing and Emerging Partnerships

Panel Chair **Patrick Gorringe** (SMHI, EMODnet Physics) opened the Panel on EMODnet in the global ocean data landscape. He noted this is a busy time for the global ocean community, especially because of the UN Ocean Decade, and that EMODnet is already contributing to a number of ongoing activities. He noted the Panel brought together key experts representing international activities, and European contributions to global initiatives, and was a good opportunity to explore EMODnet's partnerships and contributions worldwide in the coming decade.



Maria Hood (EU4OceanObs) said the previous week had been important for any ocean projects, thanks to the 47th G7 Summit in the UK. She explained the G7 Nature Compact includes several ocean initiatives, with all G7 members signing up to the global '30x30' initiative to conserve or protect at least 30 %of the world's oceans by 2030. She said perhaps most relevant to marine data was that the G7 Ocean Decade Navigation Plan had announced three spotlight activities: Ocean indicators, Net-zero ocean initiatives, and Digital Twin Ocean. She noted all three will push the frontiers of data management in the coming decade, and for this to work marine data services need to work together to establish interoperability, FAIR data principles and align data initiatives internationally (G7 and beyond). She also noted that the Arctic was a crucial region for the global community as a "hot spot" for climate change, and considering the technological and political challenges. She concluded by saying that EMODnet can build on its existing capability in this region, including the EMODnet Physics Arctic Data, to further promote data sharing of this important region.

Audrey Hasson (GEO Blue Planet, EU office, Mercator Ocean International, MOi) explained that GEO Blue Planet promotes the sustainable development and use of Earth Observation for the benefit of society, focusing on ocean and coastal zones. The EU office of GEO Blue Planet promotes the use of data and data products as well as use cases of marine data e.g., from aggregators like EMODnet and CMEMS, at the international level. She noted that EMODnet already contributes to GEO Blue Planet e.g., through the Marine Litter working group and this cooperation was likely to strengthen in the future, in collaboration with CMEMS e.g., through joint use cases, hackathons and other activities.

Paul Holthus (World Ocean Council, WOC) said that the WOC is a global ocean business and investment organisation, connecting all the industries that depend on the ocean or use space and resources from the ocean. He noted that the WOC has long focused on working with EMODnet to further engage with the private sector, especially through the network's portals. He acknowledged the ocean business community is diverse and complex, so a platform like the WOC's could be of use. The WOC is interested to work with intermediaries like EMODnet and ingest more data from industry. There is an opportunity to develop pilot projects and use cases, e.g., the fishing for data seminars or the WOC Sustainable Ocean Summit. WOC organises some functional webinars on promoting data sharing by companies, focused on bathymetric data but also on other sectoral level. Holthus concluded that thematic and sectoral approaches can increase companies' interest in sharing data, so would then be more likely to contribute to EMODnet, among others.

Jo Østvass (Centre for the Fourth Industrial Revolution and the Ocean, C4IR Ocean) explained that C4IR Ocean is leading ODAC (Ocean Data Action Coalition), a collaboration with Microsoft. The objective is to break down technical barriers for ocean data sharing, and making it ready for Artificial Intelligence (AI) applications. He noted this is a good opportunity for building interoperability with EMODnet and the different thematic portals, building on the ongoing collaboration between C4IR Ocean and EMODnet Physics. He added that ongoing work includes enabling data services that can tap into data sources and fusing different sources together to make them more machine-readable, so that this data can be used for modelling and prediction. He concluded that data are a resource that has a value chain, one where EMODnet plays an important role and where EMODnet enables C4IR Ocean projects to focus on AI work further down the value chain. This collaboration is a win-win, as C4IR Ocean also provides useful feedback to EMODnet.

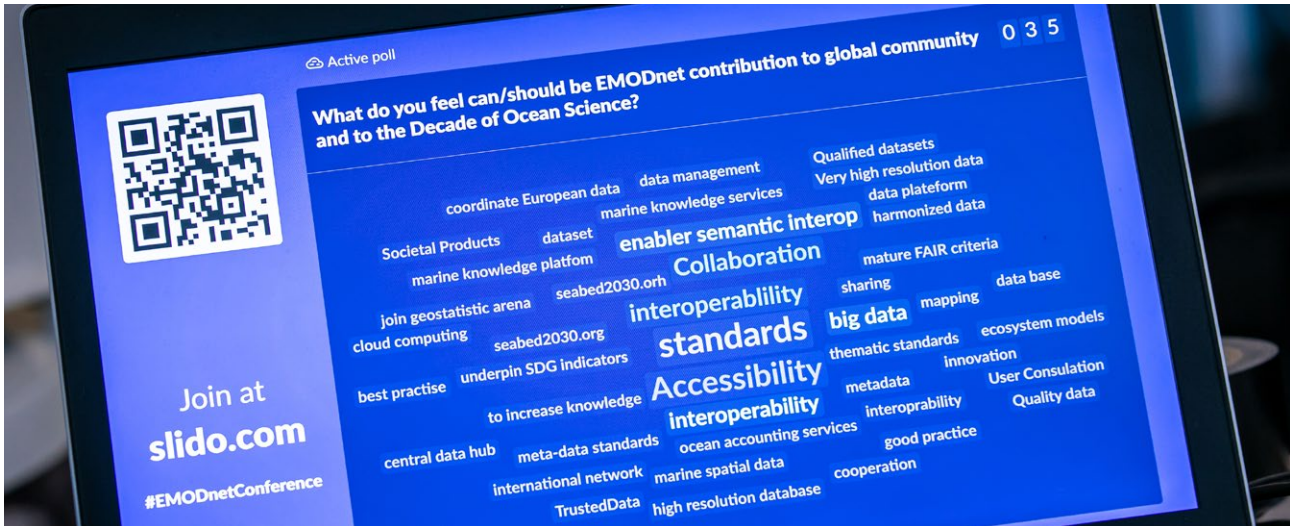
Martin Visbeck (GEOMAR Helmholtz-Centre for Ocean Research) noted that EMODnet is already a strong player in the global marine data services landscape and would be a key contributor to the creation of a Digital Twin Ocean (DTO), a framework to explore the ocean and provide knowledge for fact-based decision-making. This depends on interoperable and trusted data from a wide range of sources. He explained that a DTO could be explained as Ocean 5D, including a time element (past, current and future), three space dimensions, plus a fifth dimension which is society-driven and impact-oriented, focused on the potential for generating knowledge to answer specific applications e.g., risks of sea level, rip tide activity in a local coastal zone, etc. He noted that the DTO concept is new in environmental science yet very helpful for assessing marine data models and simulation, so it would enable users to explore future scenarios – areas where EMODnet has a very strong role to play in digital assets.

Visbeck also praised the collaboration of EMODnet with Russia and China, noting this was leading to a cultural shift towards (marine) data sharing and collaboration. He noted that in the future building collaboration with Africa would be important since it is Europe's closest neighbouring continent.

Isabel Sousa Pinto (Interdisciplinary Centre of Marine and Environmental Research, CIIMAR) highlighted the biodiversity and biological ocean observation efforts and related data management. She noted that at the global level, the Marine Biodiversity Observation Network (MBON), part of the Group on Earth Observations Biodiversity Observation Network (GEO BON), is a flagship activity for biodiversity observation and data product creation for society. The aim is to create a community and increase biodiversity observation in oceans. A further goal is to promote the publication of data on biodiversity observations in open access databases. She noted that EMODnet already links well with EurOBIS and OBIS and further connection with other global initiatives including MBON and GEO BON would be important to further promote transparent access to (marine) biodiversity data, also in connection with human activities data.

Take Home Message

Delivery of the G7 Future of Seas and Oceans key objectives will rely on partnerships with the wider community, e.g., with EMODnet, Copernicus Marine Service and Horizon 2020 projects and programmes to push the frontiers of data management and deliver the required Ocean indicators, Net-zero ocean initiatives, and Digital Twin Ocean. Coordination at the EU level e.g., through EU4OceanObs and the GEO Blue Planet EU office will be important to promote a connected European contribution to global efforts. EMODnet is already working with many partners at a global level and contributes to the GEO Blue Planet e.g., through EMODnet Chemistry's contribution to the Marine Litter Working Group, and future collaboration could include joint use cases between EMODnet and CMEMS promoted at the international level through the GEO Blue Planet EU office. EMODnet also shares data from regions beyond Europe and offers marine data services to wider regions e.g., the Arctic Data Portal by EMODnet Physics. EMODnet with its sister organisations around the world provides interoperable and trusted data and also has a lot to offer the global community e.g., in terms of FAIR data principles and creation of data standards. In the future, EMODnet could be a key contributor to an All-Atlantic Data Space for the Ocean. Going forward, EMODnet's cooperation with wider Information Communication and Technology, building on existing cooperations e.g., through C4IR Ocean's collaboration with EMODnet (Physics) will be important to move towards holistic and transdisciplinary data sets from multiple sources that are machine-readable, so that these data can be used for modelling and prediction, and for Artificial Intelligence (AI) applications.



Community Posters

In the weeks leading up to the EMODnet Open Conference 2021, EMODnet invited the wider community to submit abstracts for posters presenting activities and initiatives from the international marine and maritime stakeholders that had relevance to EMODnet, spanning the marine knowledge value chain. The community was very active with >55 posters being exhibited at the EMODnet Virtual exhibition and many pitch presentations being screened during the EMODnet Open Conference live sessions. Authors ranged from businesses, research institutes and organisations, civil society, citizen science initiatives, policy makers and more. On Day 3, a poster competition was held where all participants were invited to vote for their favourite poster, by means of Slido online polling tool. The winners are presented below.

Winners of the "Best community poster" EMODnet Open Conference 2021

First prize:

Poster 13
Marina Lipizer & Alessandra Giorgetti, OGS; Joana Beja, VLIZ; Alessandro Pititto, COGEA.
Combining multidisciplinary interoperable EMODnet data products to support conservation and management of Mediterranean Sensitive Habitats.

Second prize (joint award to five posters, in order of the virtual exhibition poster number):

Poster 5
Fabien Roquet, University of Gothenburg; Clive McMahon, IMOS.
Animal Borne Ocean Sensors –AniBOS: Introducing a new Global Ocean Observing System network.

Poster 12
Corine Lochet, Gael Morvan, SHOM.
Coastal Mapping project results: Towards a European strategy for HR bathymetric data.

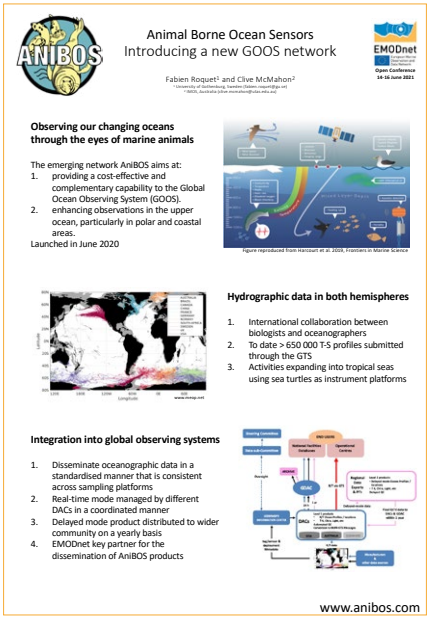
Poster 16
Marianne Schlesser, Ruth Lagring, Hong Minh Le, RBINS / Belgian Marine Data Center; Chiara Altobelli, Alessandra Giorgetti, OGS; Dick Schaap, MARIS.
EMODnet Chemistry, a value for Marine Strategies.

Poster 29
Angelica PAIU, Mihaela MIREA CÂNDEA, Romulus-Marian PAIU, Mare Nostrum NGO.
Marine litter in the Black Sea – a growing challenge.

Poster 52
Adam Leadbetter, Brendan Whittle, Tara Keena, Dave Clarke, David Currie, Louise Healy, David Stokes, Rob Thomas, Marine Institute Ireland.
Use of Web-based Data Server Software at the Marine Institute, Ireland to deliver biodiversity data to EMODnet Biology as one of many data aggregators.

Poster 13

Poster 5

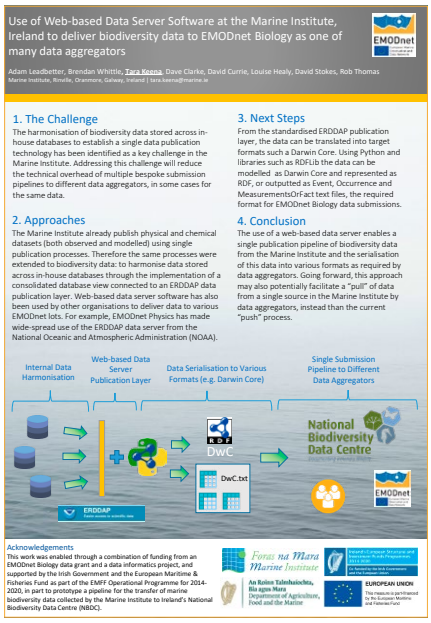


Poster 12

Poster 16

Poster 29

Poster 52



Winning posters in the EMODnet Open Conference 2021 "best community poster" online competition.

The Book of Abstracts and the live recordings including poster pitches are available for viewing and download via: https://emodnetconference2021.eu/page-1321

All posters were also exhibited in the EMODnet Open Conference 2021, which was open from 14 June 2021 – 30 November 2021. A legacy video was also produced and all content remains available through the EMODnet Central Portal (see Annex I and emodnet.ec.europa.eu).

Breakout session key messages

Community breakout sessions took place during the EMODnet Open Conference on Tuesday 15 June 2021 afternoon Central European Time (CET). On registration, participants selected two out of three topics of interest, and were then randomly assigned to a time slot and group to discuss these two topics, together with a diverse range of wider stakeholders. Graphic illustrations were produced to summarise each topic which are shown at the end of each summary and also displayed on the Virtual Exhibition (see Annex I). The section below presents key highlights from each of the three topics, as presented by the lead rapporteurs in the plenary session on Wednesday 16 June 2021 morning session.

EMODnet for EU Green Deal

Facilitators:
Kate Larkin (EMODnet Secretariat) (lead)
Alessandro Pititto (COGEA, EMODnet Human Activities)
Sheila Heymans (EMB)

Rapporteurs:
Helen Lillis (JNCC, EMODnet Seabed Habitats) (lead rapporteur to plenary)
Sytze van Heteren (TNO, EMODnet Geology)
Ángel Muñiz Piniella (EMB)

EMODnet data and data products already provide trusted data and marine knowledge to underpin evidence-based policy making. This topics will address how EMODnet can further enhance and diversify its current services to support marine data and information needs for the EU Green Deal, including the green transition for the blue economy, and all Integrated Maritime Policy Directives e.g., Marine Strategy Framework Directive (MSFD), Marine Spatial Planning Directive (MSPD), Birds and Habitats Directive, etc.

Helen Lillis (JNCC, EMODnet Seabed Habitats) presented a summary of the "EMODnet for EU Green Deal" Breakout sessions, on behalf of the wider community. Below are the key highlights."

Current status:

EMODnet data and data products already provide trusted data and marine knowledge to underpin evidence-based policy making, including:

- **Marine Strategy Framework Directive (MSFD)**: EMODnet Chemistry developed the first pan-European marine litter database, with EC JRC and EEA; EMODnet and CMEMS developed the first joint catalogue of marine data and data products to support MSFD, now released for the Baltic Sea;
- **Marine Spatial Planning Directive (MSPD)**: good quality data are essential for MSP. EMODnet provides access to transboundary data and products on a range of marine environmental parameters and human maritime activities, e.g., aquaculture, shipping, pipelines, energy installations, oil and gas, and renewable energy. Since 2021, EMODnet Human Activities hosts National Marine Spatial Plans, this could be extended to more regional planning;
- **Birds and Habitats Directive**: EMODnet Seabed Habitats uses Habitats Directive Annex I habitat types and EUNIS classification system; supports Member States in Habitats Directive Article 17 reporting; provides metadata and links to gridded Annex I Habitats distribution datasets; Marine Protected Area methodologies. For Birds Directive, EUSeaMap mapping approach and EMODnet Seabed Habitats environmental layers help support proposed Special Protection Areas (pSPA) designation.

In the coming decade:

- EMODnet and the Copernicus Marine Service (CMEMS) are already very mature and can be a focal point going forward for marine data, as a core backbone for the future digital transformation of marine data services in Europe;
- More of a focus is needed on producing integrated marine data and added value data products, in collaboration with Copernicus Marine Service and others;
- Increased focus on data gathering was noted as required to fill missing or inadequate data gaps. Due to diverse sources, balance incentives and legislation; build on existing cooperation, joint activities with CMEMS, etc;
- EMODnet must continue to offer free and open access to marine data and data products for any use and engage with stakeholders from the start, and create new data products tailored to users' specific requirements;
- When expanding into new areas, EMODnet should focus on creating the background products for natural capital accounting; suitability analysis for wind energy for all Europe; social data, to grasp impacts on society and environment;
- EMODnet should look beyond the European marine ecosystem: North Africa, Arctic, etc, to establish more harmony and interoperability between terrestrial-coastal-oceans and cross-regional activities;
- Communication with key user groups was seen to be key in developing future EMODnet data and data products that are fit-for-use for the EU Green Deal applications e.g., the Blue Economy, building on EMODnet for Business and policy makers;
- Connection to society was seen as an emerging area where EMODnet could do more to connect EMODnet's marine data offer and the EU Green Deal with citizens e.g., through citizen science and also reaching the younger generation e.g., through cooperation with museums, aquariums, to promote Ocean Literacy;
- The ongoing centralisation of EMODnet services was seen as a way to significantly enhance the user experience of EMODnet;

- Future EMODnet data and data products could be more tailored for European policy applications, e.g., building on the recent EMODnet/Copernicus joint product portfolio for MSFD to produce more simple sign-posting to key EMODnet products and data sets for particular uses on the website, as portfolios and including common use cases and demonstrations, e.g., for Blue Economy sectors who carry out environmental impact assessments, for habitat suitability modelling, etc;
- EMODnet could further standardise common types of information across data themes and ensure the data licencing and terms of data use are up-front showing where restricted data exist. The common approach would also allow real gaps in data to be identified;
- Data products could also be accompanied with guidelines on how to interpret the data, using a common format across data themes;
- Further user-friendliness could include EMODnet making it quick and easy to add EMODnet layers to desktop GIS, e.g., create an EMODnet plug-in for ArcGIS and QGIS containing some key data products; continue attempts to integrate EMODnet Bathymetry DEM into ArcGIS OceanBaseMap.


EMODNET for EU GREEN DEAL
EMODnet
European Marine Observation and Data Network
OPEN & ACCESSIBLE DATA
stimulate INNOVATION
towards a greener & digital EUROPE
group 1
share SECOND BEST
NEED for HIGH-RES DATA
MULTI-USE data
CONFIDENTIALITY
talk to NON SCIENTISTS
« PREDICT & EXPLAIN »
BUILD UP on the EXISTING for the FUTURE
the MOMENT is CRUCIAL
group 2
DATA GAP on COASTAL AREAS
THE ROLE of INDUSTRIES in the TRANSITION
the BLUE ECONOMY
How to make COMPANIES SHARE their DATA?
INCENTIVES
SOCIAL IMAGE
EU POLICIES
+
global
destination EARTH
not only MARITIME
group 3
maritime LITER
chemicals
PROVIDE MORE GUIDANCE
we need MORE DATA!
SHALLOW
GREY AREAS
DEEP
more PARTNERSHIPS
LIMITATIONS & COUNTRY POLICIES
session 2

EMODnet for Global

Facilitators:
Jan-Bart Calewaert (EMODnet Secretariat) (lead)
Corine Lochet (SHOM) and Gaël Morvan (SHOM)
Antonio Novellino (EMODnet Physics), Patrick Gorringe (EMODnet Physics)

Rapporteurs:
Alessandra Giorgetti (OGS, EMODnet Chemistry) (lead rapporteur to plenary)
Britt Alexander (EMB)
Julie Ann Auerbach (EMODnet Secretariat)
Xiaoyu Fang (EMODnet Secretariat)

EMODnet already makes available a wide range of global datasets and resources via the central portal and across several thematics and is engaged in an increasing number of partnerships wider regions e.g., EU-China, and international collaborations e.g., IOC-UNESCO, IOC-IODE, GEOSS, to contribute to global data initiatives and make EMODnet service more relevant for users beyond Europe. This breakout topic will address how EMODnet can build on these existing efforts to become even more relevant internationally and fully contribute to achieving a transparent and accessible ocean, for all, underpinning the UN Decade of Ocean Science for Sustainable Development, the UN 2030 Agenda, GEOSS and more.

Alessandra Giorgetti (OGS, EMODnet Chemistry) presented a summary of the "EMODnet for Global" Breakout sessions, on behalf of the wider community. Below are the key highlights.

Current status:

EMODnet already provides a wide range of global datasets and resources via the Central Portal and across several thematic lots, e.g., Bathymetry, Biology and Physics, to name a few. EMODnet is also engaged in an increasing number of partnerships with wider regions, e.g., EU-China, and collaborations with international initiatives, e.g., IOC-UNESCO, IOC-IODE, GEOSS, to contribute and exchange best practice and expertise and to increase the visibility and interoperability of EMODnet services with other regions and for the expanding community of users both within – and beyond - Europe.

Future Look:

Participants discussed how EMODnet could build on existing efforts to become even more relevant internationally and fully contribute to achieving a transparent and accessible ocean, for all, underpinning the UN Decade of Ocean Science for Sustainable Development, the UN 2030 Agenda, GEOSS and more.

Priorities for expanding global data sharing

- Consolidate existing parameters and expand to wider thematics: EMODnet has key data sets at the global level (EMODnet Physics in the full Atlantic Basin, EMODnet Biology linked to international OBIS, EMODnet Bathymetry as the 3rd largest contributor worldwide to Seabed 2030). This can be strengthened in terms of resolution and coverage, and to include more thematics;
- Regions: Full Mediterranean Sea basin (including North Africa), Atlantic Ocean (pan-Atlantic), Southern Ocean and Arctic, together with a larger focus on coastal zones;
- EMODnet can help in promoting an Open Access data policy to all users and in particular the international Blue Economy, building on EMODnet for Business;
- EMODnet can progressively ingest more citizen science data, including from regions beyond Europe;
- Data types: for the Southern Ocean Observing System (SOOS) map (all global data sources), GLODAP, SOCAT, SOCOMM, iQuod, GEOTRACES, OceanSITES, GOA-ON, OBIS, PANGAEA (Earth Science Data Repository) CTD data.

EMODnet should focus on further consolidating and making available data coming from European partners, whilst looking into opportunities for wider collaborations to ingest data from collectors/providers outside Europe.

Priorities for global data interoperability

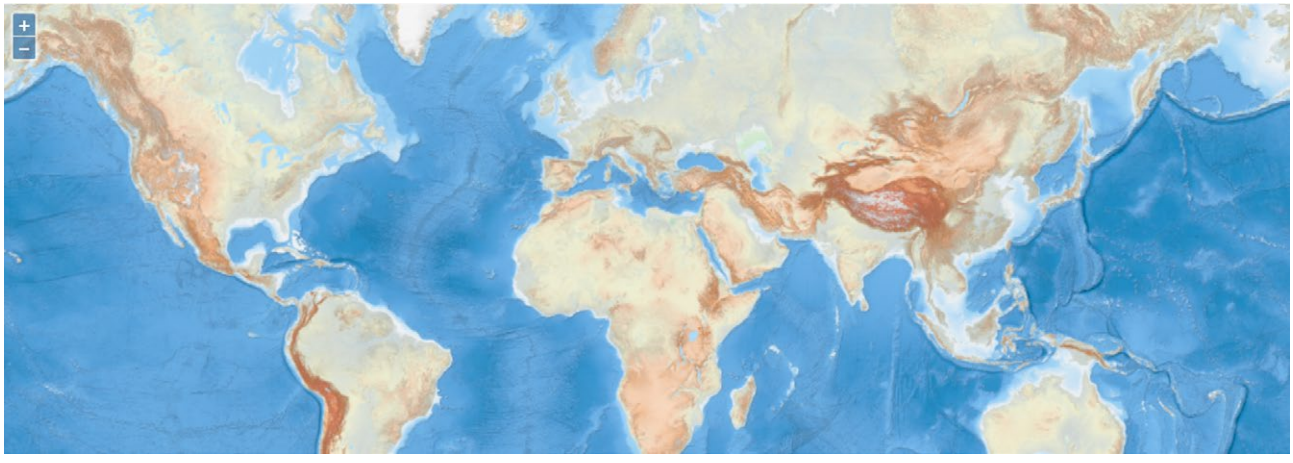
- EMODnet has been a good framework to set, actively use and promote standards. This could be expanded to more regions and contribute to the global Ocean Best Practices (OBP), to assist with aligning data standards in regions e.g., the Arctic;
- The centralisation of EMODnet is a good step towards interoperability across thematics;
- Further work can be done to link other EMODnet and other marine data services across remote services, which require FAIR data and in particular, interoperability;
- Ideally the metadata could be exhaustive, so data users can have most of the data via EMODnet;
- The SeaDataNet metadata schema can be used as a best practice for other regions;
- EMODnet can connect with other communities working on data standards, e.g., the international union of geosciences, and help with cross-thematic connections across global community;
- EMODnet can link more with the ocean observation community to exchange on data standards, methods and recommend community standards e.g., for platforms such as gliders, HF radars, etc;
- EMODnet's open data philosophy should be applied wider to ensure all technologies and software tools must be open source, to enable interoperable, optimised data discovery, access and flow;
- Data sharing and interoperability should be enhanced at the marine data service level, and across infrastructures e.g., through European Horizon 2020 project Blue Cloud that is using Geodab as a broker and the Ocean InfoHub initiative with schema.org metadata, both trying to connect the contributing nodes.

Priorities for global partnerships for the UN Ocean Decade

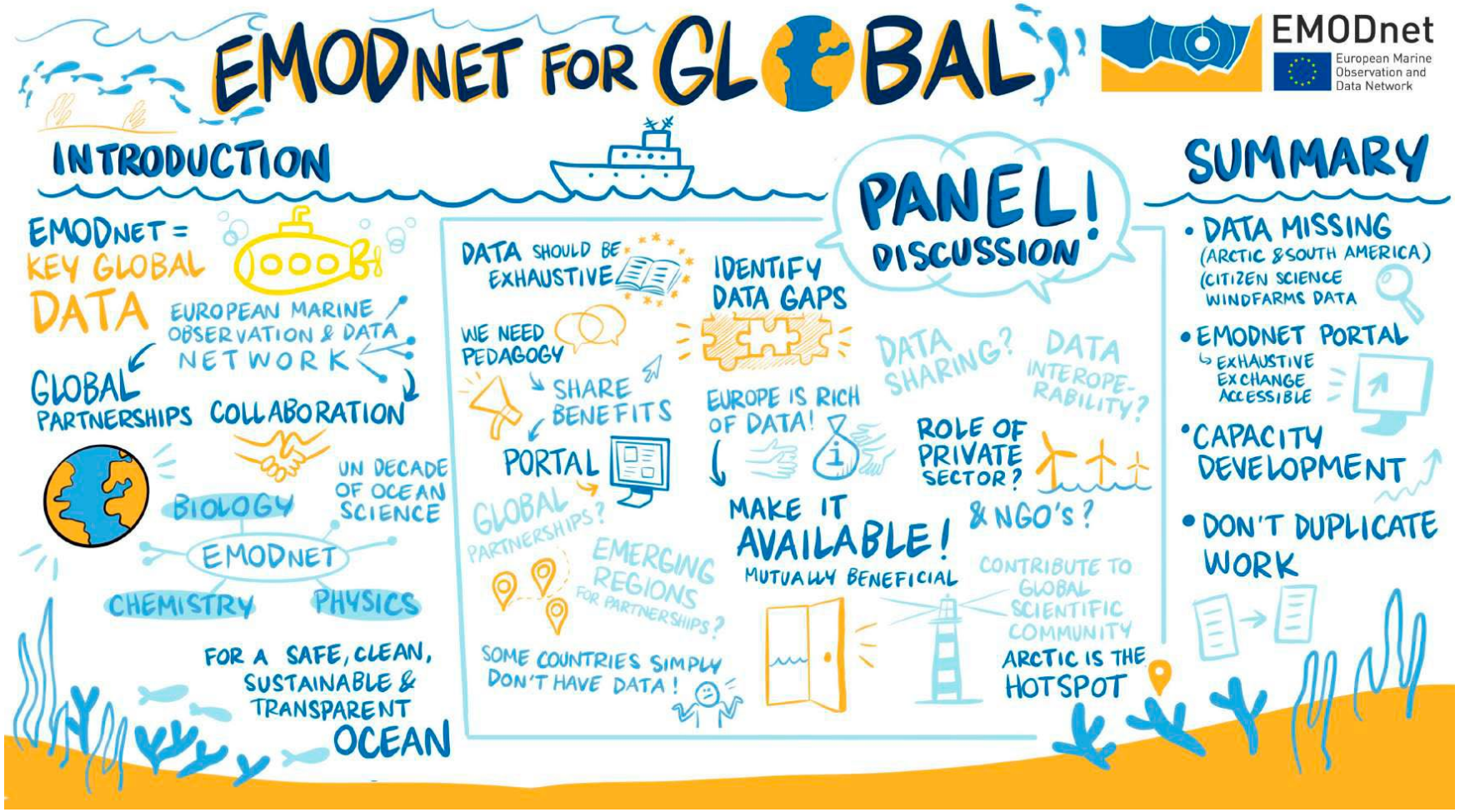
- Avoid duplication of work being done elsewhere and coordinate carefully with existing initiatives;
- Capacity development is important and EMODnet can work with existing initiatives e.g., with regional bodies of IOC, e.g., IOC-Africa regional network and ocean data information network for Africa. This structure can also be used to promote data sharing by such regions, and to identify data and data gaps;
- EMODnet should further strengthen collaboration with IOC/IODE e.g., through ODIS and the Ocean InfoHub to play an important role in the Decade, so that data exchange between countries can be mutually beneficial and providing guidance for data acquisition and sharing;
- EMODnet can actively participate in the 40 programmes endorsed by the Decade Steering Group and further contribute to proposals for the Decade, particularly in the areas of the digital transformation and digital twins, coastal zone, but also across other thematic areas;
- Polar regions could be a focal point for bringing together scientific expertise, existing open source data and agreeing on data standards.

Recommendations for emerging sectors and regions for partnerships

- Collaboration with southern countries is very important, mutual benefits including Canada, Greenland & Arctic;
- Partnerships with geological surveys in individual countries, universities, and with Organisation of African Geological Surveys (OAGS). Strengthen links with International Ocean Discovery Program (IODP);
- Capacity development for countries with fewer resources to provide physical data management services (e.g., Latin America), with local organisation doing hands-on data management. Collaborate with IODE on this? Training to teach other countries how to get data into EMODnet;
- Give regions the EMODnet portal and the know-how, provided they populate it with data and manage it themselves. EMODnet Physics has already done this;
- Need literacy and knowledge on physics and chemistry to plan good campaigns for data collection and ensure proper management and sharing. Connect with IOC OceanTeacher Global Academy, and show what data is already available.



EMODnet Bathymetry World Base layer


EMODNET FOR GLOBAL
EMODnet
European Marine Observation and Data Network
INTRODUCTION
EMODNET = KEY GLOBAL DATA
EUROPEAN MARINE OBSERVATION & DATA NETWORK
GLOBAL PARTNERSHIPS
COLLABORATION
UN DECADE OF OCEAN SCIENCE
BIOLOGY
EMODNET
CHEMISTRY
PHYSICS
FOR A SAFE, CLEAN, SUSTAINABLE & TRANSPARENT OCEAN
PANEL! DISCUSSION
DATA SHOULD BE EXHAUSTIVE
IDENTIFY DATA GAPS
WE NEED PEDAGOGY
SHARE BENEFITS
PORTAL
GLOBAL PARTNERSHIPS?
EMERGING REGIONS FOR PARTNERSHIPS?
SOME COUNTRIES SIMPLY DON'T HAVE DATA!
EUROPE IS RICH OF DATA!
MAKE IT AVAILABLE!
MUTUALLY BENEFICIAL
DATA SHARING?
DATA INTEROPERABILITY?
ROLE OF PRIVATE SECTOR?
& NGO's?
CONTRIBUTE TO GLOBAL SCIENTIFIC COMMUNITY
ARCTIC IS THE HOTSPOT
SUMMARY
• DATA MISSING (ARCTIC & SOUTH AMERICA) (CITIZEN SCIENCE WINDFARMS DATA
• EMODNET PORTAL
↳ EXHAUSTIVE EXCHANGE ACCESSIBLE
• CAPACITY DEVELOPMENT
• DON'T DUPLICATE WORK

EMODnet for the Digital era

Facilitators:
Conor Delaney (EMODnet Secretariat) (lead)
Francis Strobbe (EMODnet Secretariat),
Dick Schaap (EMODnet Bathymetry)

Rapporteurs:
Leen Vandepitte (VLIZ) (lead rapporteur to plenary)
Julia Vera (EMODnet Secretariat)
Tim Collart (EMODnet Secretariat)

EMODnet already makes available a wide range of global datasets and resources via the central portal and across several thematics and is engaged in an increasing number of partnerships wider regions e.g., EU-China, and international collaborations e.g., IOC-UNESCO, IOC-IODE, GEOSS, to contribute to global data initiatives and make EMODnet service more relevant for users beyond Europe. This breakout topic will address how EMODnet can build on these existing efforts to become even more relevant internationally and fully contribute to achieving a transparent and accessible ocean, for all, underpinning the UN Decade of Ocean Science for Sustainable Development, the UN 2030 Agenda, GEOSS and more.

Leen Vandepitte, EurOBIS) presented a summary of the "EMODnet for the Digital Era" Breakout sessions, on behalf of the wider community. Below are the key highlights.

In an era of Digital Transformation, Cloud computing has i) dramatically reduced the access barriers to fast and reliable computing and storage services; and ii) improved access to technologies useful to the marine data community, e.g., the Internet of Things (IoT), machine-to-machine communication and machine learning. A refreshed EU Open Data Directive means all data collected by public bodies could be classified as Open Data. The research community is also calling for a FAIR approach to data access. Data science has benefited from the new computing-on-demand approach and EMODnet can do more to help data scientists utilise marine data.

In the next decade, EMODnet can build on existing web services, partnerships and collaborations (e.g., infrastructures, projects, initiatives) to meet the needs of marine data users, embracing Cloud-based open science, in collaboration with CMEMS and others.

Priorities for data science

- More 'environmental data scientists' are needed, requiring a mixture of skills spanning science, information technology and data management;
- Invest more in learning process: training young people, upgrading our own capabilities;
- Cleaning data is frequently 80 % of the work to get the data analysis-ready;
- EMODnet already provides analysis-ready data and products.

Cloud-based open science provides huge opportunities, but existing Cloud possibilities are not fully used yet. It is only possible when data are easily accessible and according to standards, guidelines. EMODnet is ideal for this science, as the network is a repository (long-term storage of data for users) and harmonises data/ applies standards for interoperability.

Community building

- Further promotion of EMODnet and dialogue with the global community is required to increase the visibility, use and uptake of EMODnet data and data products, move towards greater interoperability at the global level, and promote the sharing of data with EMODnet to incresae coverage, resolution, discovery and access of marine data, for all;
- EMODnet is already providing a reliable service for Findable, Accessible, Interoperable and Reusable (FAIR) Open marine data, according to European INSPIRE geospatial data standards and with some international standards e.g., for metadata. More can be done to guarantee data traceability, extending the current Digital Object Identifier (DOI) and tracking the data provenance from data producer to user.

Parameters/thematics requiring extra attention

- Consolidate and continue improving the resolution of what exists (7 thematics, hundreds of parameters);
- Expand and operationalise Biological, biodiversity parameters;
- Human activities data, extending to socio-economics;
- Coastal – in collaboration with CMEMS for high-resolution *in situ* and satellite;
- Blue Economy: build on existing cooperation for a more streamlined, inclusive approach for data sharing and data use by marine and maritime industry;
- Citizen Science: build long-lasting cooperation with citizens through citizen science (data provision and use) and in engagement.

Partnerships

- EMODnet and CMEMS: A mature marine data backbone for the marine data and science dimension of Destination Earth and Digital Twins;
- Strengthen collaboration and operational data flow with European Research Infrastructures, to bring in a wider diversity of marine and environmental data;
- Strengthen regional collaboration with Regional Sea Conventions to leverage more national data sharing and the flow from national-regional-European;
- Ingesting data from JPI Oceans initiatives, e.g., sea-level rise knowledge hub and related activities;
- Marine Spatial Planning: EMODnet as a focal point for national MSPs;
- Global: continue with IOC-IODE for the Ocean Information Hub, GEO Blue Planet and stronger connection with other regions worldwide.

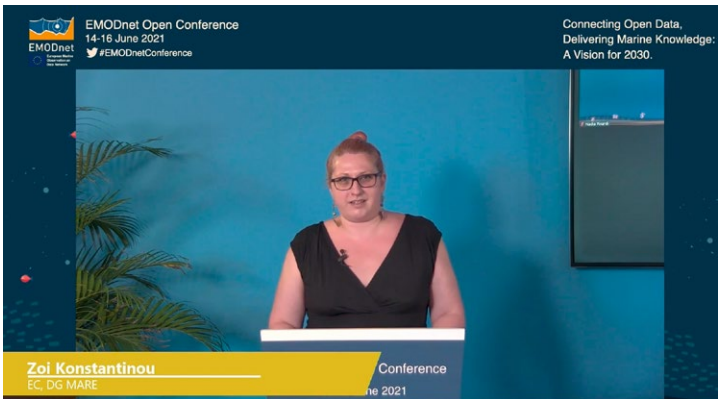
Regions to focus on

- Neighbouring countries bordering European seas, e.g., southern Mediterranean Sea, Black Sea;
- Build on emerging partnerships with Caspian Sea, Arctic, Canada;
- Continue to strengthen and expand EU-China-Asia;
- Build on Atlantic collaborations and projects already in place (AORAC, Blue Cloud, etc.). EMODnet to work with other partners across the Atlantic (e.g., Canada, South America) to develop an All-Atlantic Data Space for the Ocean.


EMODnet in the digital era
EMODnet
European Marine Observation and Data Network
DATA SCIENTIST?
A RARE BREED...
BUT MUCH NEEDED!
LET PEOPLE ACCESS THE DATA
LOOK FOR "PANGEO PROJECT"
YOU BETTER KNOW PYTHON!
REMEMBER: FAIR & INSPIRE DATA PRINCIPLES!
CLOUD BASED OPEN SCIENCE
CHEAP & INCREDIBLY USEFUL, BUT...
DOMINATED BY JUST A FEW PLAYERS
HE HE
AMAZON
BUILDING COMMUNITY
WITH TRAINING CAMPS?
COME ON!
MAKE LIFE EASIER FOR USERS
TONJE@CARTOONBASE.COM

Session 5: Ocean Observing & Data Collection

Keynote: EC Ocean Observation: Sharing responsibility



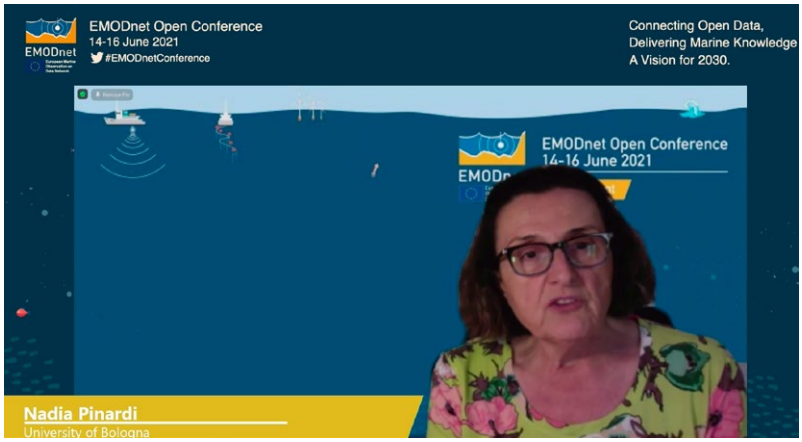
Zoi Konstantinou (EC, DG MARE) highlighted key challenges for society include climate change, environmental degradation and biodiversity loss, not to mention just access to resources. She noted the European Commission's Green Deal offers a framework to answer all these challenges, thanks to a focus on sustainability. The ocean can play a major role in the new strategy of sustainability – by providing clean energy, better and lower emission food, as well as a space for developing revolutionary innovation. To achieve Green Deal goals in the marine domain, she noted that we must improve our knowledge of the ocean and the foundation for knowledge is marine observation. She emphasised that EMODnet is an outstanding example of marine knowledge for society, and is reliant on ocean observation which includes everything we observe, monitor and collect about the marine environment, including the state and dynamics of oceans and marine biodiversity. She explained that Europe already has a large capability for ocean observation, and yet many components remain fragmented and lack sustained funding. This generates extra costs, fails to address observation gaps and can result in missed opportunities for maintaining time-series of valuable ocean information.

She then introduced the EC DG MARE initiative on Ocean Observation: Sharing responsibility, noting that the EC conducted a public consultation in Autumn 2020 – Spring 2021 to seek stakeholder feedback on how to develop an efficient and effective EU process for enabling further coordination of ocean observation and marine monitoring activities at national, regional and European levels. She noted the consultations had collected more than 150 replies from various communities. Based on feedback from wider stakeholders, the two main barriers to establishing common ocean observation were identified as precarious funding of ocean observation and a lack of interdisciplinarity in governance. Other barriers included the fact that most observation efforts lack transparency and common efforts, lack of time and resource, lack of knowledge from other interested parties, organisations collecting data being less willing to collaborate e.g., through commercial sensitivity, etc. Zoi Konstantinou concluded that the initial results of the public consultation highlight a wide consensus that action beyond business as usual is needed to strengthen the coordination of ocean observation and marine monitoring ,between national authorities and at sea basin level.

"The purpose of the DG MARE Ocean Observation initiative is to develop an efficient and effective EU process for further strengthening the existing Member State efforts in ocean observation and marine monitoring. The recent public consultation highlights a wide consensus that stakeholders support further action in this area" Zoi Konstaninou, EC DG MARE

Community presentations

Stress testing the European observing capacity: The EMODnet Sea-basin Checkpoint approach

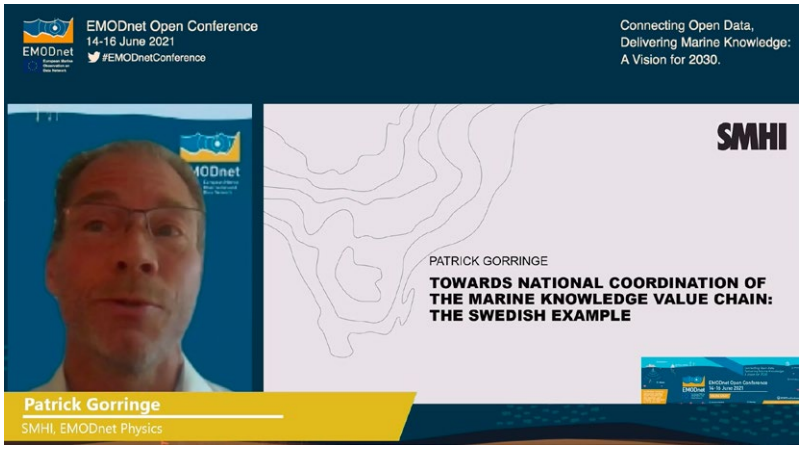


Nadia Pinardi (University of Bologna and Checkpoint Partners) presented the EMODnet Sea-basin Checkpoints noting that the methodology used concrete user applications over different European sea basins to stress-test the European ocean observing capacity and data adequacy. Developed by EMODnet, the method has been seen to be useful for determining gaps in observations and information systems. Pinardi explained how the approach works, and summarised the six challenges applied, namely wind farm siting, Marine Protected Areas (MPAs), oil platform leaks, climate and coasts, fishery management, marine environment (eutrophication), and river input. For each user application, the availability, access and adequacy to relevant data through EMODnet, Copernicus Marine Service and other marine data services was assessed, using indicators to define the level of adequacy, summarised in a Data Adequacy Report. She concluded that the EMODnet's Sea-basin Checkpoint approach is unique in the world and clearly shows monitoring gaps at the sea basin scales. It is widely applicable, and has been successfully used in e.g., the Mediterranean, Atlantic and Black Sea to detect observation gaps. She proposed a way forward could be to establish a future assessment, or service, jointly by EMODnet and Copernicus, that would periodically evaluate the system following the Checkpoint methodology.

"The EMODnet's Sea-basin Checkpoint approach is unique in the world and clearly shows monitoring gaps at the sea-basin scales, applying a user-oriented approach to assessing data adequacy." *Nadia Pinardi, University of Bologna*

Towards national coordination of the marine knowledge value chain: The Swedish example

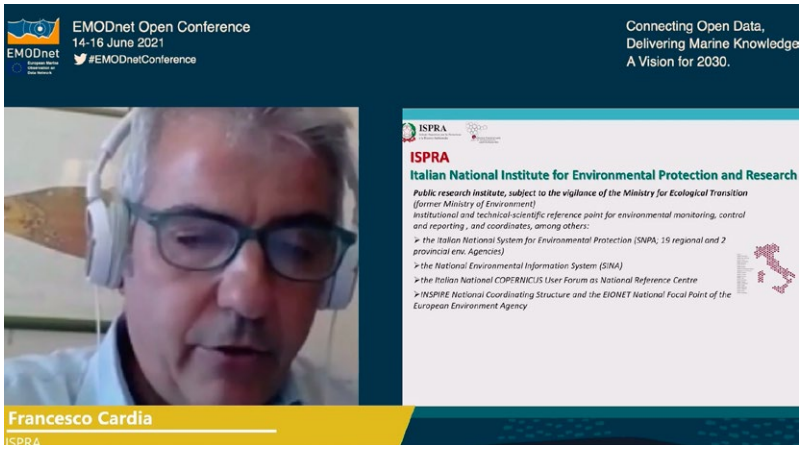
Patrick Gorringe (Swedish Meteorological and Hydrological Institute (SMHI), EMODnet Physics) explained how Sweden took a decision several years ago to provide a stronger national contribution to the UN Decade, backed by EMODnet. In October 2020, a report was submitted to the Swedish Ministry of Environment. Its four priority areas were data modelling, innovation, ocean literacy and ecosystem-based management. The country has advanced since then, pulling together Swedish marine data providers and establishing collaborations. On World Ocean Day, 8 June 2021, the country launched the Swedish National Decade Committee, which will run until 2030. Besides helping citizens to get involved in EuroGOOS and EMODnet, EMODnet has also helped to guide Sweden through the latest machine-to-machine technologies. These have boosted interoperability, ensuring Swedish data reach users in Europe and globally, while improving data management and standards. New data will be provided by the EMODnet Data Ingestion service, ensuring that it will also reach both Copernicus Marine Service and SeaDataNet.



SMHI is also promoting standards and recommendations set by EMODnet, Copernicus Marine Service and SeaDataNet on the national level. This helps to engage the ocean observing community and promotes the benefits of sharing data on all scales. This message will be communicated by Universeum Ocean Science Lab, Sweden's first UN Decade endorsed contribution. The lab will focus on marine life, ocean literacy for the public, and the value of data and science.

"Sweden has a mutually beneficial cooperation with EMODnet, providing new data into EMODnet and benefiting from the global discovery and access EMODnet brings, together with technical expertise on data management, standards, interoperability and machine-machine technologies." *Patrick Gorringe, SMHI*

Earth Observation data for marine monitoring and sustainable aquaculture: The Italian case study



Francesco Cardia (Italian National Institute for Environmental Protection and Research, (ISPRA)) noted that ISPRA, as a technical reference point for monitoring in Italy, has developed several tools for sustainable development of aquaculture. For these tools, Cardia noted that marine and spatial data are essential for analysis, enabling allocation of zones for aquaculture as well as 'suitability' analysis (maps) that requires spatial datasets for physics, biogeochemistry and marine uses. ISPRA requires *in situ* data, satellite data, and model data to make suitability maps: these determine which areas are free of constraints and which are most suitable for aquaculture. EMODnet services have helped facilitate this process and made contributions to spatial planning for aquaculture. EMODnet has tremendous potential in supporting authorities in planning aquaculture. ISPRA used either data directly or as a source of validated data to validate data already available at national level. Cardia concluded that around 20 % of data used for the identification of Allocated Zones for Aquaculture (AZA) are from EMODnet, whether for direct use of comparison, e.g., bathymetry, vessel traffic, cables, seabed habitats, main ports, seabed substrates and more.

"EMODnet data services make a significant contribution to maritime spatial planning for aquaculture in Italy." *Francesco Cardia, ISPRA*

Panel: Coordinating EU ocean observing and data flow: connecting the marine knowledge value chain

Panel Chair **Quillon Harpham** (HR Wallingford) introduced the Panel explaining that panellists were experts from the "up-stream" ocean observing and marine monitoring community representing initiatives at national, European and global levels. The Panel would discuss the current and future status of coordination of EU ocean observation and data flow, in order to better connect the marine knowledge value chain. He added that the focus would be on Europe and on the *in situ* ocean observing component at EU level, in the context of global efforts.

Toste Tanhua (GEOMAR, Coordinator H2020 EuroSea, GOOS) cited two basic concepts of the global ocean observing system, which are crucial to move forward to a sustained ocean observation system. Firstly, Essential Ocean Variables (EOVs), as they focus the ocean observing system around a number of key natural variables, allowing standardisation and inter-comparison. Secondly, the observing networks themselves including the platforms, infrastructures and people carrying out these observations are important. He noted that the observation part lacks sustainability and a long-term structure and there is a need for a strengthened coordination mechanism within and between nations doing such observations. He added the EC Consultation on Ocean Observation: Sharing responsibility is a great opportunity for the EU framework to better coordinate the observing initiatives. He also recommended rethinking the funding structure for long-term ocean observation, possibly by seeking funding from several different ministries – as happens for weather services. He concluded by noting the importance of metadata, as without it data are not useful, and that EMODnet could play a role in providing more support and guidance to data collectors and providers on use of metadata.

Inga Lips (EuroGOOS, vice-Chair EOOS Operations Committee) replied that EuroGOOS has 44 members in 18 countries serving 5 regional systems in Europe. The large network provides key ocean observation data to marine data aggregators and services including EMODnet and CMEMS. EuroGOOS has strong collaboration with EMODnet Physics network, largely built on the partnerships and framework of EuroGOOS regions and infrastructure networks. She introduced the European Ocean Observing System (EOOS) framework aiming to connect across ocean observing stakeholders, noting that EMODnet contributes to the governance mechanisms along with other key representatives of the ocean observing community and wider marine knowledge value chain. She added that a future goal under the EOOS framework includes the aim to strengthen coordination at the national level. As to how EMODnet could evolve, Lips highlighted addressing the issue of data provenance and data quality, since much data are not used for environmental assessment due to lack of information on data quality. She also recommended that EMODnet continues collaboration with European and global initiatives to enhance interoperability and data sharing.

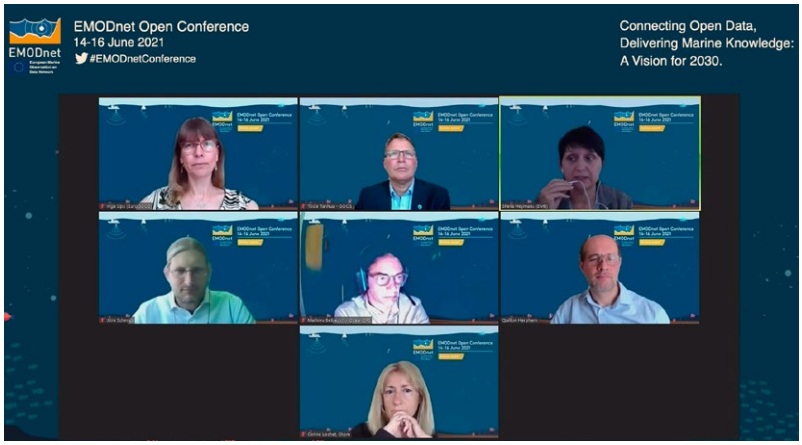
Sheila Heymans (European Marine Board, EMB, co-chair EOOS Operations Committee) noted that the EMB recently published a policy brief 'Sustaining *in situ* Ocean Observations in the Age of the Digital Ocean'. She added that the brief highlights some good examples of coordination of ocean observation, though this was often to be found lacking in Europe. She noted that the brief recommended more sustainable funding for the *in situ* ocean observing component of the wider ocean and earth observation sector. Heymans liked the suggestion from the audience that ocean data acquisition should be far more operational, modelled on the meteorological services. She concluded by stating that if we don't have sustained funding for ocean observation and monitoring, then we will not be able to do what we need to manage our oceans or our use of the oceans.

Mathieu Belbeoch (OceanOPS) noted that ocean observation systems are strong when they are integrated and when there is strong communication, alongside strong instruments and data. He also remarked there's a need to consider both funding source and funding volume, as investment in ocean observation is currently too low and often not fit-for-purpose. He noted other challenges including governance, as there should be a strong connection between oceanography and meteorology, and strong infrastructures containing good instruments when producing data . He added that the data management part of marine science and wider marine and maritime projects is not always a high priority in projects and EMODnet could play a stronger role to ensure ocean observations are made available and thus also showing the use cases and impact of such observations, in turn supporting further funding of such ocean observing programmes. He concluded by saying you cannot build the data gateway you need if data are not produced or first not made available. In Europe and internationally, we must evolve the capacity to unlock data and distribute them – then the gateway will flourish.

Corine Lochet (French Hydrographic Office, and representative of European network for International Hydrographic Organisation, SHOM) remarked that in France, as elsewhere in Europe, coordination between different organisations producing data can be difficult. EMODnet, EuroGOOS and Copernicus Marine Service help SHOM to cooperate among French organisations. Asked how EMODnet could evolve, she recommended that centralisation would deliver a better service making the network's data and products more accessible and user-friendly. She added that EMODnet is a specialist in marine data services and could bring communities around the table to share expertise, exchange best practice and share data. She concluded saying that more user-friendly explanations of using standards and tools for sharing, and training for the use of the data is needed and EMODnet could play a role in developing more tools and training courses under the framework of the UN Ocean Decade to facilitate connection with the global community.

Jörn Schmidt (University of Kiel, Chair of the Scientific Committee, ICES) noted that ICES benefits from having a regional coordination mechanism and survey planning groups, which help with fishery surveys but increasingly other variables too. As a partner to EMODnet and Copernicus Marine Service, ICES also feeds through data. He noted that ICES is discussing with EMODnet where data is flowing into the system and how data is coming back. It is also able to provide feedback on how data has been used or hasn't been used. Remarking about *in situ* ocean observation sustainability, he said that one of the challenges is to increase links to other observation platforms, when the goal is integration. He noted it can be difficult to understand the role of different players, but agreed that EMODnet brings partners to the table – which is essential due to the increasing complexity of the networks, programmes and systems. He added that metadata are crucial and they enable data to be tracked along a value chain. He concluded by highlighting that EMODnet has a very sophisticated ingestion mechanism, but what is also important is feedback on how data have been used or why they have not been used. EMODnet can play a role in showing the needs and benefits of the resulting data products.

Take Home Message



EMODnet sits in the middle of the marine knowledge value chain and relies on "up-stream" *in situ* ocean observation data. A current lack of coordination and sustainability of this large and diverse component of the ocean observation system needs to be addressed both in terms of funding levels, funding time-scales and connection to marine data services and users across the marine knowledge value chain. There's still a lot of work and progress to be made to align the current (often fragmented) ocean observation initiatives in order to ensure better coordination at the observation level e.g., monitoring process as well as the data sharing/ quality control procedures. A future coordination mechanism for ocean observing at EU-level was considered a good approach and offers great opportunities for further expansion in the area of ocean observation (even on a global scale) while simultaneously taking care of funding and the funding volume, as current investments in ocean observation are considered too low. It was concluded that EMODnet could take a pivotal role, as it should continue collaborations with European and global initiatives to enhance interoperability and data sharing. This could be coupled with further feedback on the use and uptake of *in situ* ocean observations through more feedback from marine data services e.g., EMODnet, that would further demonstrate the impact and in turn support more sustained and appropriate levels of funding.

Session 6: Closing session

Keynote presentation by Charlina Vitcheva, Director-General, EC, DG MARE

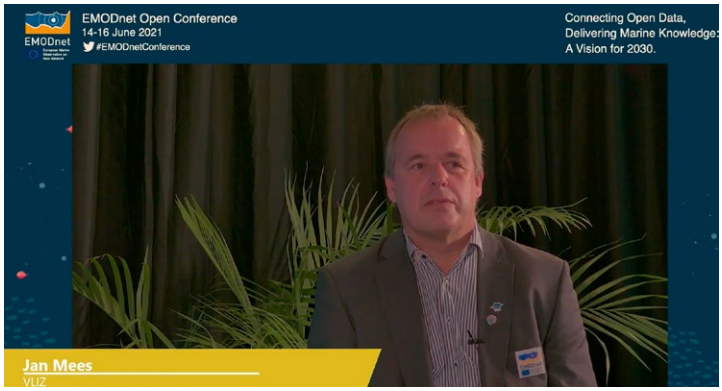
In her closing speech, **Charlina Vitcheva** (EC, DG MARE) mentioned the last three days had showcased EMODnet over the last decade, among them achievements on *in situ* data sharing and common standards that some years ago would have been unimaginable. Other notable accomplishments include the network's strong and diverse collaborations at European and international level, plus a broad range of applications, and crucially *in situ* data for policy, the marine industry, for research and society. She noted the goal now must be to consolidate these new ideas, all the valuable input received and move forward pursuing higher goals. She added that EMODnet is at the heart of DG MARE's activities and the ***network is already undertaking major change, through the integration process*** towards centralisation of data services. Looking forward, she noted that EMODnet would continue to align with the EU Green Deal and European Commission's Digital Strategy. She highlighted that EMODnet, together with Copernicus Marine Service and other EU assets, will be at the forefront of developments towards the Digital Twin of the Ocean and the elaborate system models of Destination Earth. And, since data, ocean and marine observation will be the fuel for these tools, these efforts will be backed by the European Commission's Ocean Observation Initiative. She also noted that an improvement of governance in ocean observation in the EU, although not directly related to EMODnet, will create space and opportunity for wider collaboration, synergies, implementation of common standards, and ultimately more and better *in situ* data for all. At a global level, she remarked that the UN Decade of Ocean Science for Sustainable Development is the appropriate vehicle to achieve collaboration at the international level.

"The work of EMODnet is at the heart of DG MARE's activities. It's among the highest priorities to ensure its continuity, sustainability and development" Charlina Vitcheva, EC, DG MARE

Closing round-table: Delivering the vision for EMODnet to 2030

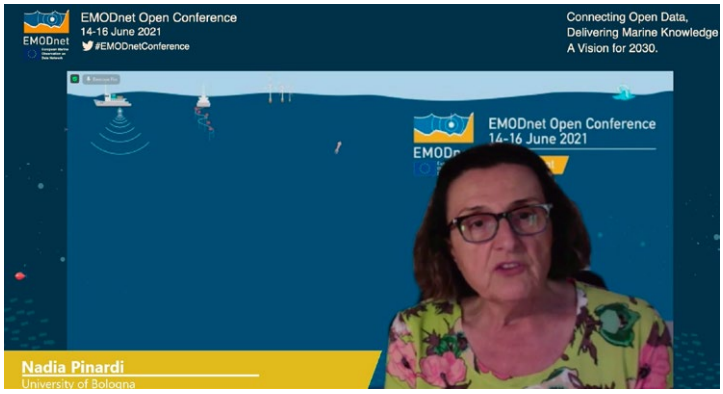
Sigi Gruber (EC Advising Senior, DG Research and Innovation (RTD) Healthy seas, oceans and inland waters) mentioned three noteworthy challenges and opportunities for EMODnet. First, Europe can only fulfil the Green Deal goals by restoring the good health of the ocean, including coastal and inland waters. A second major challenge and opportunity for EMODnet will be making marine knowledge and the associated data even more traceable data and making available more data from the private sector, with the latter requiring scrutiny of EU General Data Protection Regulation (GDPR) issues. New future legislation is by default underpinned by data, so the planning and gathering of data are going to be crucial. If the goal is to place the monitoring services and forecast services ahead for our interconnected systems (land, sea, ocean, space), then EMODnet faces a huge challenge. Thirdly, she noted that EMODnet should go beyond technological integration and data integration, in order to fully integrate society. To help citizen science, EMODnet could partner with schools, to allow them to feed data from different countries into the network, such as data on plastic litter. Also global collaboration on the development of joint protocols and forms of interoperability were themes where EMODnet will have a key role to play – though this will include the challenge of including data from the whole water system, not just marine.

"EMODnet should go beyond technological integration and data integration, in order to fully integrate society....this could include further partnerships with citizen science and schools, to allow them citizens themselves to feed data into EMODnet, including data on plastic litter".
Sigi Gruber, EC Advising Senior, DG Research and Innovation, RTD



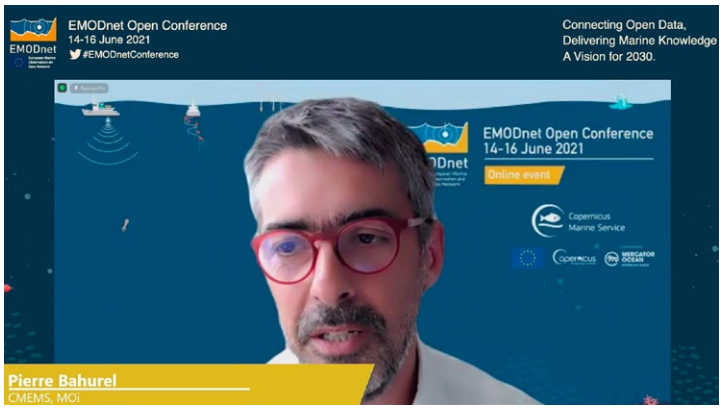
Jan Mees (VLIZ, Belgium) said EMODnet has become a solid and robust network and a great asset for Europe and beyond. For the next phase, EMODnet should consolidate what has been built as well as look for areas to expand and diversify. On the end-user side, EMODnet should expand its partnerships as it has been doing, and focus on involving new groups, especially industry. Asked for a key recommendation on what EMODnet should do next, Jan Mees replied that climate change should be on top on the agenda of EMODnet for the next 10 years, because climate is very complex and ocean-connected.

"EMODnet is strong in integrating a plethora of data, data types, from different sources, as well as different end-products." *Jan Mees, VLIZ*



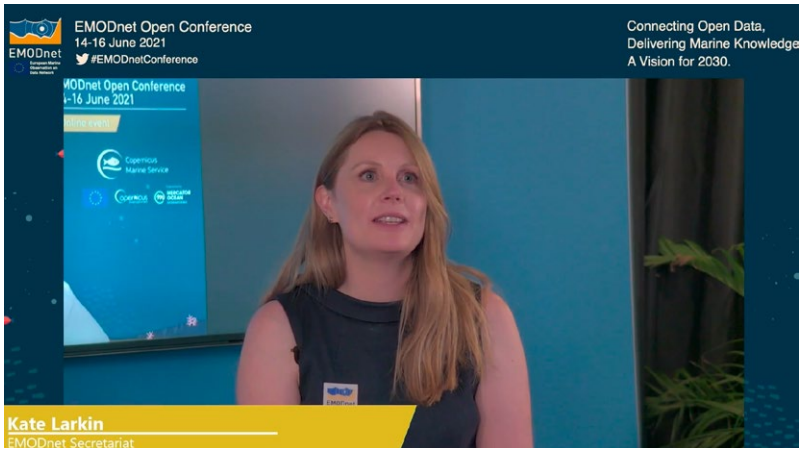
Nadia Pinardi (University of Bologna, Italy) agreed that EMODnet must build new partnerships. She also recommended concentrating on integrated products for end-users – be they governments, policymakers or private companies. Yet this can only be achieved through the integration of observations and (predictive) models – especially for coastal zones.. For integrated products, EMODnet and Copernicus Marine Service are best placed in Europe to design such a system, notably with the UN Ocean Decade as the serving framework.

"Over the next decade, EMODnet needs to develop integrated products that span thematics and disciplines towards holistic understanding of the marine environment. In addition, there should be a focus on filing in marine data gaps for the coastal zone in in order to create better early warning systems, and an understanding of nature-based solutions, in the context of climate change." *Nadia Pinardi, University of Bologna*



Pierre Bahurel (Copernicus Marine Service, MOi) commented that EMODnet is unique in what it delivers. In his view, EMODnet should above all continue to do what it's already doing, notwithstanding all the plans to be more innovative or to expand the products available. In marine services, the goal is to achieve a balance between novelty and operational oceanography, and EMODnet does this well. EMODnet should move towards becoming an operational service and longer term planning for more sustainability, noting that Copernicus Marine Service is happy to contribute to that through its partnership with EMODnet. He added that EMODnet must reinforce its services for monitoring, recommendations, assessment, and Sea-basin Checkpoints, so that anyone that will invest in ocean observation knows what and why (s)he is doing this. Bahurel acknowledged this is difficult due to the fragmented nature of ocean observation, but he expressed his confidence that EMODnet is uniquely placed to manage this diversity. He concluded that EMODnet and Copernicus will both play a key role in the future Digital Twin Ocean and that the further digitilisation of marine data services would be a great enabler.

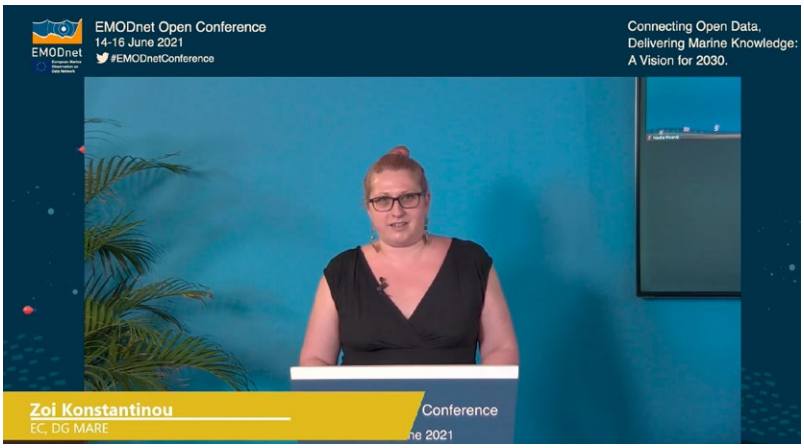
"EMODnet should move towards becoming an operational service and longer term planning for more sustainability, noting that Copernicus Marine Service is happy to contribute to that through its partnership with EMODnet." *Pierre Bahurel, CMEMS*



Kate Larkin (EMODnet Secretariat) remarked that the whole conference had underlined how much EMODnet's full partnership had achieved over the last decade. She noted that EMODnet is today a fully operational and user-driven service, working very closely with Copernicus Marine Service. However it's clear that EMODnet is going to evolve and in collaboration with others. Firstly thanks to the repatriation of the EMODnet Central Portal to the Europa web domain. Secondly, the centralisation of all the EMODnet services will be a game-changer for users, simplifying access to data and the services from all the different thematics. EMODnet will further drive interoperability in the marine community, prior to moving to the global marine data space, such as UNESCO's IOC/IODE. This interoperability will be essential for Mission Ocean and the EU Green Deal and will include new challenges such as transdisciplinarity, with data talking across domains – from marine to socioeconomics and human activities. EMODnet will continue to adapt, evolve and diversify its parameters and its sources of data to meet the needs of the EU Green Deal and digital transformation in the UN Decade. Other ambitions include to offer more support for citizen science by providing a feedback loop and to collaborate even more with partners across all ocean basins, including the Mediterranean, Black Sea, and Atlantic. EMODnet's expertise in standards and best practices can help to bring a common voice to the global level. If EMODnet is to support Mission Ocean and ensure that citizens can access the Digital Twin Ocean, then communication and awareness-raising will be vital. In her conclusions, Kate Larkin called for the wealth of marine data to be made freely open and accessible while emphasizing the importance of metadata and data provenance, as this will build more confidence in the data among policymakers and end-users.

"EMODnet is today a fully operational and user-driven service, working very closely with Copernicus Marine Service. Further emphasis on metadata and data provenance will build more confidence in the data among policymakers and end-users, and will enable marine data to be available and used by all, including wider society."
Kate Larkin, EMODnet Secretariat

Closing remarks



Zoi Konstantinou (EC, Directorate-General for Maritime Affairs and Fisheries (DG MARE)) concluded the 2nd EMODnet Open Conference 2021 by thanking all the participants – the data producers, users and stakeholders – who had attended the EMODnet Open Conference 2021 over the last three days, and the many speakers, chairs, panellists, facilitators, and rapporteurs for their active inputs making the Conference a success. Lastly, she thanked the EMODnet Secretariat and all involved in the coordination and execution of the Conference. She said it was now time to digest all the key messages and to build further political support for EMODnet and ocean observation in the European Commission and EU Member States.

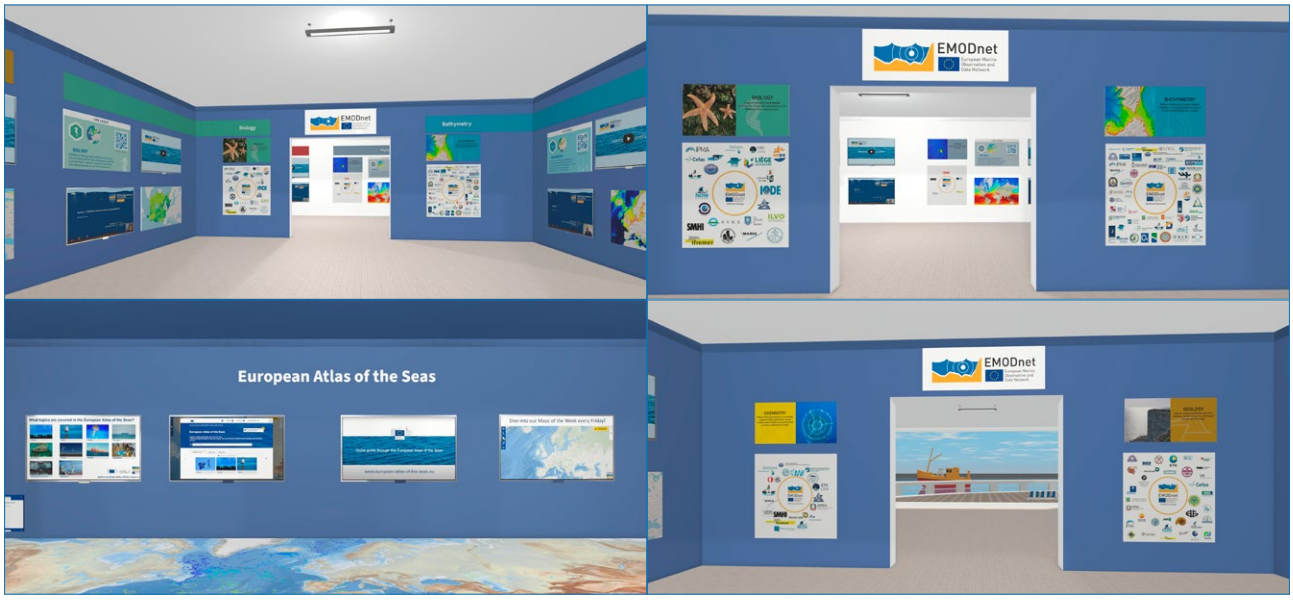
Annex I: EMODnet Open Conference 2021 Virtual Exhibition

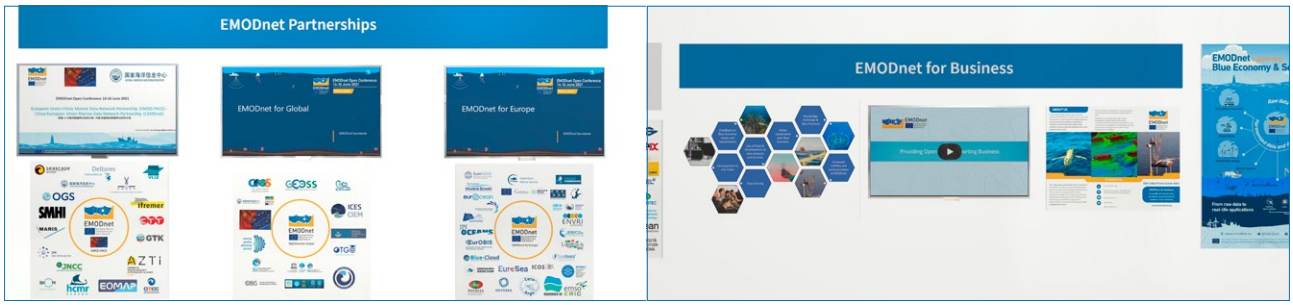
The EMODnet Secretariat and wider partnership, together with the EC, DG MARE designed a virtual exhibition as an additional resource for participants to explore, due to the hybrid nature of the EMODnet Open Conference 2021. The virtual exhibition contained key information on EMODnet and related EC and wider community initiatives, namely:

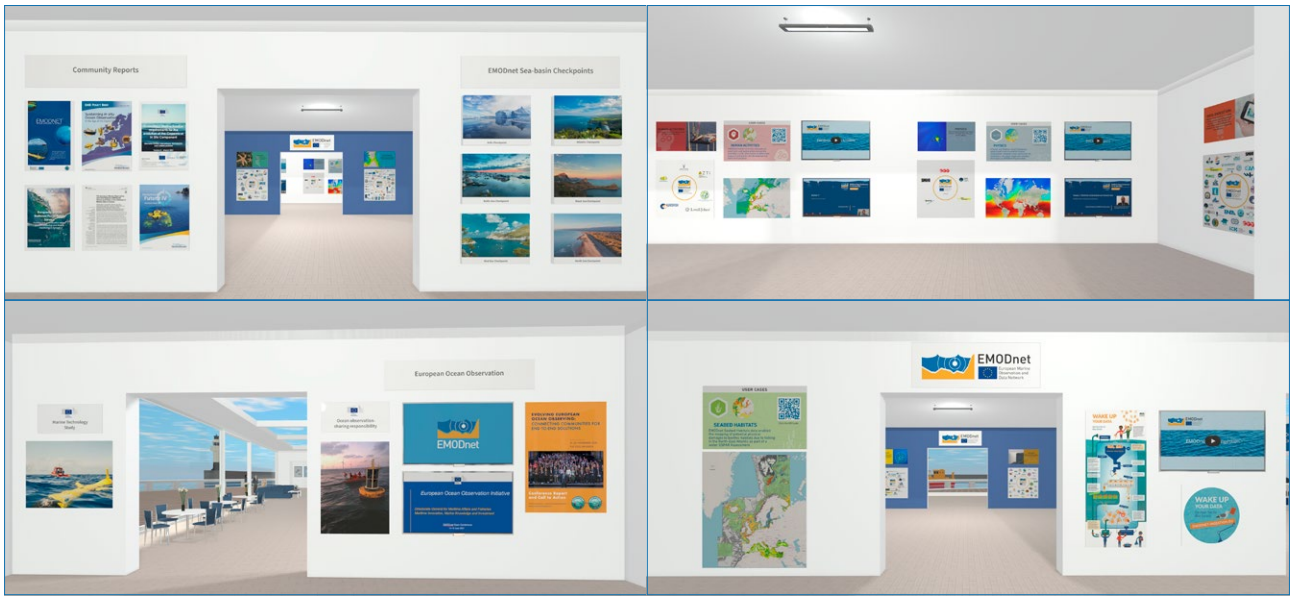
- EMODnet overview and a decade of progress EMODnet Thematics (bathymetry, biology, chemistry, geology, human activities, physics, seabed habitats);
- EMODnet Data Ingestion;
- EMODnet testimonials, videos, Annual Reports, wider documentation and social media links;
- Ocean Observation (EC initiatives, community efforts and EMODnet Sea-basin Checkpoints);
- EMODnet for Business initiative;
- EMODnet's EU and global collaborations and partnerships;
- European Atlas of the Seas (EC, DG MARE communication tool, powered by EMODnet);
- Community Posters;
- Wider initiatives and demonstrations.

The virtual exhibition was launched on Day 1 of the Conference on 14 June 2021 and remained online for 5 months after the Conference: https://players.cupix.com/p/WtViUgBQ

As a longer-term legacy, a walk-through video was produced to showcase the virtual exhibition which is available together with all Conference information, recordings, presentations, photos and videos on the EMODnet Central Portal: https://emodnet.ec.europa.eu/en/conference2021







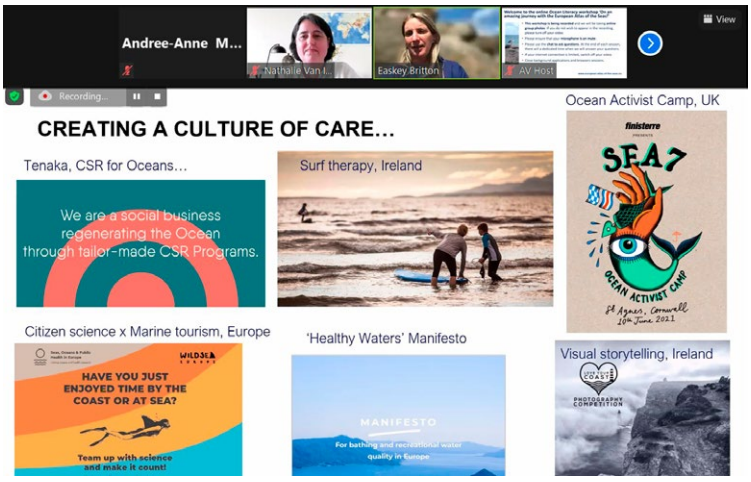
Graphical illustrations from the Conference Virtual Exhibition

Annex II: Related events and Initiatives

Back-to-back with the EMODnet Open Conference (14-16 June 2021) several initiatives took place including, the European Atlas of the Seas (EAS) workshop (16 June), the EC Ocean Observation Initiative (18 June) and the EMODnet Jamboree (16-18 June) which included individual thematic meetings, cross-thematic meetings and two topical workshops on ocean best practice and on citizen science. A short summary of each of these related events has been listed below. Further information is available on the EMODnet Central Portal[2].

1.1. European Atlas of the Seas Workshop

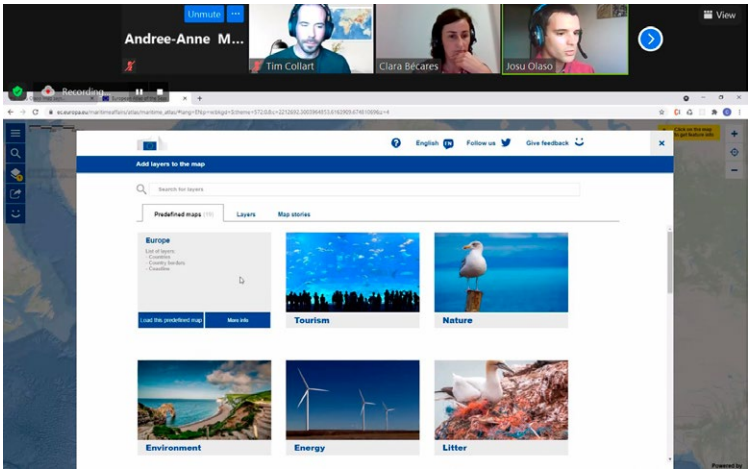
On 16 June 2021, the EMODnet Secretariat organized an online European Atlas of the Seas workshop which brought together the Atlas technical and communication teams, representatives from the European Commission Directorate General for Maritime Affairs and Fisheries (DG MARE), the Atlas partners Nausicaá and Escola Azul, data providers, members of the EU4Ocean Coalition - amongst which two Young Ocean Advocates and a representative of the Network of European Blue Schools - scientists, ocean advocates, teachers and professionals in the blue economy. Overall, 18 speakers and panelists shared their experiences and information about their work. A total of 90 participants from across Europe and beyond connected to the workshop with a peak of 54 participants at the same time. The workshop consisted of two sessions:



Session 1 'A window on the ocean, seas and coasts' demonstrated the importance of the ocean and its conservation and how the European Atlas of the Seas can help us learn about and connect with the seas and ocean. In her opening speech, European Commission Policy Officer Zoi Konstantinou pointed out that *"Today, more than ever, we need to invest and to develop further ocean literacy. We need to bring the European citizens closer to our seas and to communicate the importance of the ocean for our lives and engage them in conserving the systems"*.

2 / emodnet.ec.europa.eu

Surfer, Marine Social Scientist and Atlas Ambassador Easkey Britton, presented her activities and explained that *"One of the reasons I am an ambassador of the Atlas is because it helps creating a culture of care"*. The technical team behind the Atlas, the EMODnet Secretariat and Bilbomatica, and one of the Atlas' data providers, COGEA, explained the different steps involved in the creation of the map layers. Furthermore, participants gained insight into how they can use the Atlas and stay informed on the latest developments. Finally, Nausicaá presented the many ways that the Atlas is used at the aquarium and new ideas to reach an even wider public.



Session 2 focused on education and ocean literacy. Following a presentation by the EMODnet Secretariat on the European Atlas of the Seas' Teacher Corner, Patrícia Conceição from the Directorate General for Maritime Policy in Portugal (DGPM) presented the Escola Azul programme and the teachers' valuable contributions to the educational content in the Teachers Corner. Furthermore, Vanessa Batista from Ciência Viva– ANCCT in Portugal explained how schools across Europe can join the Network of European Blue Schools. During the panel discussion, Escola Azul teachers, Vanessa Batista from Ciência Viva– ANCCT, Young Ocean Advocates Christian Esteva Burgos and Neus Figueras and Consultant & Founder of Women4Oceans Farah Obaidullah, shared their motivation to work on the ocean and details on their inspirational projects and initiatives. Participants were encouraged to use the European Atlas of the Seas to work on their own projects, to join the EU4Ocean Coalition communities and to participate in the EU4Ocean Make Europe Blue campaign by making a pledge for the ocean. In addition to connecting people from ocean literacy communities, the workshop led to new ideas for engagement in ocean literacy and integration of the Atlas in schools. Presentations from the workshop are available on the webpage dedicated to the workshop[3]. The European Atlas of the Seas was also presented in the EMODnet Open Conference virtual exhibition (see Annex I).

1.2. EMODnet Jamboree dialogue: Ocean Best Practices

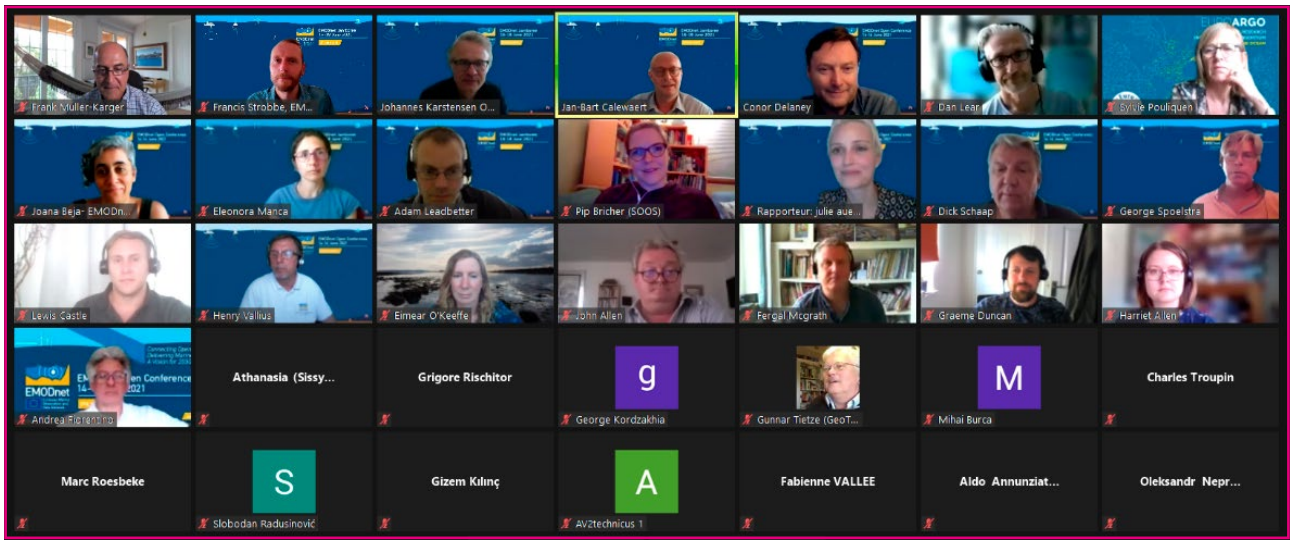
The EMODnet Jamboree cross-thematic dialogue on Ocean Best Practices: Improving data access and interoperability was held on 16 June PM CEST and co-organised by the EMODnet Secretariat and wider partnership, the International Oceanographic Data and Information Exchange (IODE) of the Intergovernmental Oceanographic Commission (IOC), and the IOC Ocean Best Practices System (OBPS) initiative. The meeting brought together key representatives from the EMODnet and wider European marine data community, and global experts to assess and discuss the current status of EMODnet's contribution to Ocean Best Practices, including presentations on OBPS, testimonials of the value of existing EMODnet community practices, as well as experiences from the perspective of a National Oceanographic Data Centre (NODC).

3 / https://www.emodnet.eu/en/atlas-workshop-16-june-2021

During the dialogue, participants agreed that EMODnet can play a role in supporting the OBPS initiative and vice-versa. The following suggestions were put forward towards this end:

- EMODnet should develop a tagging protocol to be used in the EMODnet product catalogue and/or Use Cases;
- EMODnet should assess and set up an overview of EMODnet Best Practice Methodologies;
- EMODnet should help identify examples of uses of best practices from other networks or specific best practices that EMODnet can prioritize for interoperability planning and action with other networks;
- EMODnet should more clearly clarify the distinctions in operational efforts: i.e. EMODnet is focused on publishing data and information produced by its wider community; as opposed to being actively involved in the observation process.

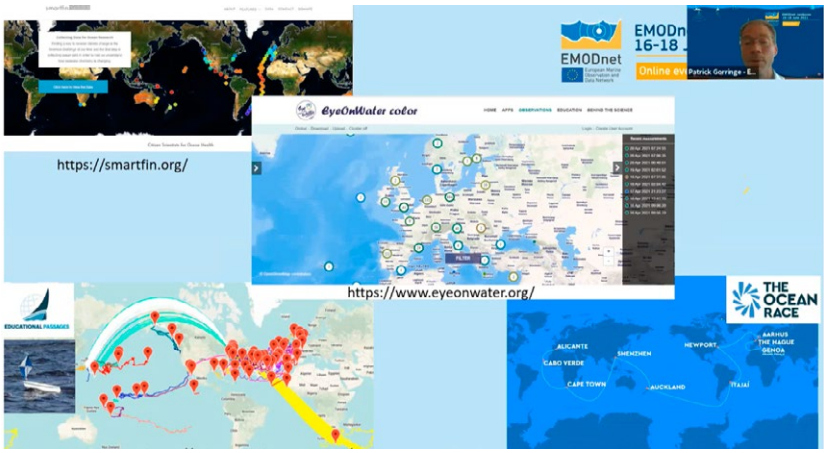
Going forward, representatives from EMODnet agreed to continue and step up its efforts to share the practical experiences and best practices of its community through the OBPS. EMODnet will work with OBPS to further record best practices across the marine knowledge value chain and to develop a community of best practice. These outcomes can be taken forward to the 5th Community Workshop of the IOC-UNESCO Ocean Best Practices System in September 2021, and the International Ocean Data Conference 2022 organized by IOC-IODE in February 2022, and can become a contribution to GEO, including Blue Planet, MBON, and regional GEO efforts. The contributions by EMODnet are important in the context of programs endorsed by the UN Decade of Ocean Science for Sustainable Development and activities that will be planned under this Ocean Decade.



1.3. EMODnet Jamboree dialogue: Citizen Science

The Special Cross-thematic EMODnet Jamboree Session on Citizen Science brought together EMODnet representatives, scientists, NGOs and blue economy SMEs from across Europe to reflect on how EMODnet is cooperating with citizen science initiatives to increasingly expand and diversify its collaborations with data providers and users across the full marine knowledge value chain. The session kicked off with an inspiring message from EC, DG MARE on the timeliness of this dialogue, highlighting the role of citizen science not only in building public awareness towards delivering the ambitious economic, environmental and social agenda targeted by the EU Green Deal, but also in empowering citizens to play an active role in its delivery. Achieving the objectives of the EU Green Deal will require more data to fill-in current spatial and temporal knowledge gaps, moving towards data coverage "everywhere, all the time". It was agreed that citizen science can contribute towards that end. Mission Starfish is targeting 20 % of marine data required to "restore our Ocean and waters by 2030" to come from citizen science by 2025.

The meeting was co-Chaired by members of the EMODnet partnership and the Coordinator of the Cos4Cloud citizen science project. Participants concurred that citizen science initiatives have multiplied in Europe in the past decade, confirming its value across different environmental topics. In spite of this progress, some important challenges remain to seize the full potential of citizen science, calling for a more systematic and consolidated approach towards working with citizen science initiatives, organizing and managing data flows from such initiatives, and breaking down barriers between "traditional" scientists and citizen scientists.



During the dialogue, participants agreed that EMODnet -as an EU open and free marine data portal- can evolve to play a valuable coordinating role for citizen marine data observations and integration. The following recommendations were put forward towards this end:

- EMODnet could develop as a focal point for EU marine citizen data, providing dedicated support to both providers and users of citizen science data;
- EMODnet could develop a Data Ingestion target action to start incorporating and connecting citizen science projects to improve data resolution in time and space in relevant areas (e.g., coastal zones where citizen scientists are most active);
- EMODnet could play a key role in facilitating citizen data collection by providing guidance on data standards; supporting improved coordination, i.e. through a dedicated citizen data portal and/or promoting technical measures; actively engaging multi-players such as private companies, local communities, NGOs, citizen science projects, etc.; and making the flow of data from citizen to EMODnet repositories easier to tackle;
- EMODnet could also contribute to wider user uptake of citizen science data by making data interoperable; providing users with easy-to-use data modelling tools (e.g., time series forecasting, pattern analysis or machine learning); performing fit-for-purpose assessment of available marine citizen science data; designing “citizen data solutions” to ensure data quality and usefulness or identifying gaps in relevant knowledge areas;
- EMODnet could contribute to upscale citizen science across Europe by building up long-term partnerships with well-established citizen science communities; working closely with these communities to identify user needs and to provide feedback to citizens on the use, added-value and impact of their efforts; and contributing to bridge citizen science and research communities, supporting data harmonization for user-oriented applications.

1.4. EC Ocean Observation Event

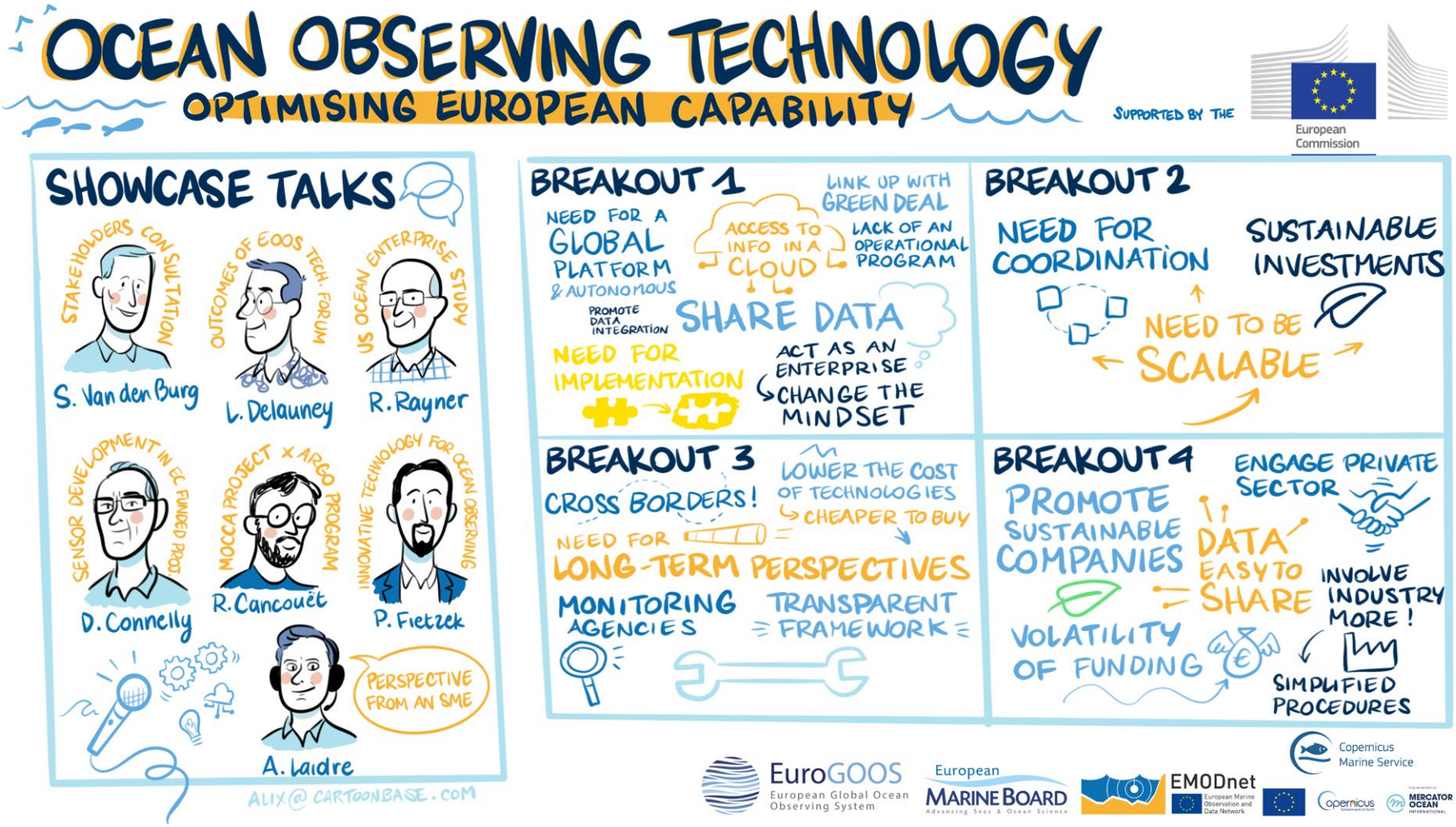
In the framework of the EC Ocean Observation – sharing responsibility[4] initiative, the European Commission Directorate-General for Maritime Affairs and Fisheries (DG MARE), unit A1 Maritime Innovation, Marine Knowledge and Investment, convened an EC Ocean Observation event on 18 June 2021. The event was co-organised by the Secretariats of EMODnet[5], European Marine Board (EMB)[6], EuroGOOS[7] and Copernicus Marine Service[8], in collaboration with Marine Research Infrastructures and the wider community.

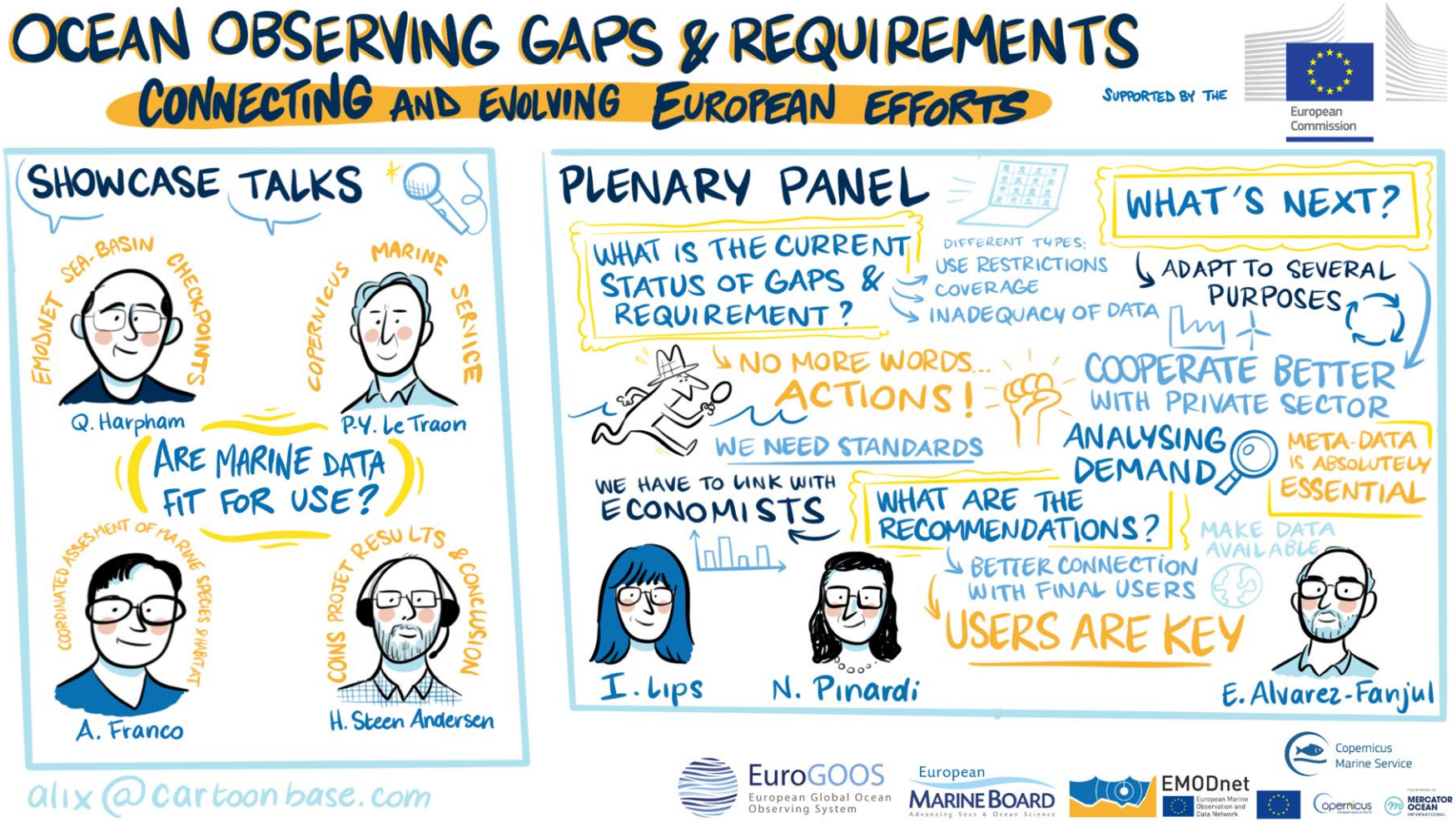
The event brought together over 90 experts from the wider European and International community to talk about two specific topics: (i) **Ocean Observing technology: optimising European capability** and (ii) **Ocean Observing gaps and requirements**. The event included showcase presentations, breakout discussions and a plenary panel dialogue.

In the first session on ocean observing technology, showcase presentations were followed by breakout discussions on ocean observing technology, facilitated and rapporteured by representatives from the EMODnet, EMB and EuroGOOS Secretariats and Marine Research Infrastructures EMBRC-ERIC, EMSO-ERIC and LifeWatch-ERIC. Expert perspectives and recommendations were gathered in three key areas of marine technology with a focus on the EU market: (1) Technological Research and Innovation, (2) Market pull and (3) Finance. The second sesson focused on ocean observing gaps and requirements. Showcase presentations were followed by a plenary panel consisting of experts from the European community to collectively assess the European capability and existing methodologies for assessing gaps and requirements in marine observation, and providing recommendations on how such efforts could evolve in the future, in the context of the EU Green Deal and global initiatives.

A full workshop report with key recommendations is available, together with the agenda, community presentations and more information on the EC Maritime Forum[9]. Two graphics illustrating highlights from the discussions were produced by graphic illustrator Alix Garin and were made available on the EMODnet Open Conference virtual exhibition (see Annex I), together with more information on the EC initiative, and wider European community efforts in ocean observation, marine monitoring and wider data collection.

4 / https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12539-Ocean-observation-sharing-responsibility/public-consultation_en
5 / emodnet.ec.europa.eu
6 / www.marineboard.eu
7 / https://eurogoos.eu/
8 / https://marine.copernicus.eu/
9 / https://webgate.ec.europa.eu/maritimeforum/en/node/6188


OCEAN OBSERVING TECHNOLOGY
OPTIMISING EUROPEAN CAPABILITY
SUPPORTED BY THE
European Commission
SHOWCASE TALKS
STAKEHOLDERS CONSULTATION
S. Van den Burg
OUTCOMES OF EOOS TECH. FORUM
L. Delauney
US OCEAN ENTERPRISE STUDY
R. Rayner
SENSOR DEVELOPMENT IN EC FUNDED PROJ.
D. Connelly
MOCCA PROJECT X ARGO PROGRAM
R. Cancouët
INNOVATIVE TECHNOLOGY FOR OCEAN OBSERVING
P. Fietzek
A. Laidre
PERSPECTIVE FROM AN SME
ALIX@CARTOONBASE.COM
BREAKOUT 1
NEED FOR A GLOBAL PLATFORM & AUTONOMOUS
PROMOTE DATA INTEGRATION
ACCESS TO INFO IN A CLOUD
LINK UP WITH GREEN DEAL
LACK OF AN OPERATIONAL PROGRAM
SHARE DATA
NEED FOR IMPLEMENTATION
ACT AS AN ENTERPRISE
CHANGE THE MINDSET
BREAKOUT 2
NEED FOR COORDINATION
SUSTAINABLE INVESTMENTS
NEED TO BE SCALABLE
BREAKOUT 3
CROSS BORDERS!
LOWER THE COST OF TECHNOLOGIES
CHEAPER TO BUY
NEED FOR LONG-TERM PERSPECTIVES
MONITORING AGENCIES
TRANSPARENT FRAMEWORK
BREAKOUT 4
ENGAGE PRIVATE SECTOR
PROMOTE SUSTAINABLE COMPANIES
DATA EASY TO SHARE
INVOLVE INDUSTRY MORE!
VOLATILITY OF FUNDING
SIMPLIFIED PROCEDURES
EuroGOOS
European Global Ocean Observing System
European MARINE BOARD
Advancing Seas & Ocean Science
EMODnet
European Marine Observation and Data Network
Copernicus Marine Service
Copernicus
MERCATOR OCEAN INTERNATIONAL


OCEAN OBSERVING GAPS & REQUIREMENTS
CONNECTING AND EVOLVING EUROPEAN EFFORTS
SUPPORTED BY THE
European Commission
SHOWCASE TALKS
EMODNET SEA-BASIN CHECKPOINTS
Q. Harpham
COPERNICUS MARINE SERVICE
P.Y. Le Traon
ARE MARINE DATA FIT FOR USE?
COORDINATED ASSESMENT OF MARINE SPECIES & HABITAT
A. Franco
COINS PROJET RESULTS & CONCLUSION
H. Steen Andersen
PLENARY PANEL
WHAT IS THE CURRENT STATUS OF GAPS & REQUIREMENT?
DIFFERENT TYPES:
USE RESTRICTIONS
COVERAGE
INADEQUACY OF DATA
WHAT'S NEXT?
ADAPT TO SEVERAL PURPOSES
NO MORE WORDS... ACTIONS!
COOPERATE BETTER WITH PRIVATE SECTOR
WE NEED STANDARDS
ANALYSING DEMAND
META-DATA IS ABSOLUTELY ESSENTIAL
WE HAVE TO LINK WITH ECONOMISTS
WHAT ARE THE RECOMMENDATIONS?
MAKE DATA AVAILABLE
BETTER CONNECTION WITH FINAL USERS
USERS ARE KEY
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N. Pinardi
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The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) No. 1255/2011 of the European Parliament and of the Council of 30 November 2011 establishing a Programme to support the further development of an Integrated Maritime Policy

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