EMODnet

European Marine Observation and Data Network

10 YEARS

EMODnet: A decade of achievements connecting marine data to knowledge

EMODnet

ANNUAL REPORT 2019

Acknowledgements

This Annual 2019 report is produced by the EMODnet Secretariat, with input from EMODnet thematic lot Coordinators & Trust-IT (design).

References

Further information on EMODnet can be found on the Maritime Forum (webgate.ec.europa.eu/maritimeforum). More detailed information on thematic lot progress, together with access to the latest data and data products can be found on the Central Portal **www.emodnet.eu**

EMODnet Thematic Portals

- EMODnet Bathymetry - www.emodnet-bathymetry.eu
- EMODnet Biology - www.emodnet-biology.eu
- EMODnet Chemistry - www.emodnet-chemistry.eu
- EMODnet Data Ingestion Portal - www.emodnet-ingestion.eu
- EMODnet Geology - www.emodnet-geology.eu
- EMODnet Human Activities - www.emodnet-humanactivities.eu
- EMODnet Physics - www.emodnet-physics.eu
- EMODnet Seabed Habitats - www.emodnet-seabedhabitats.eu

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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.

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.

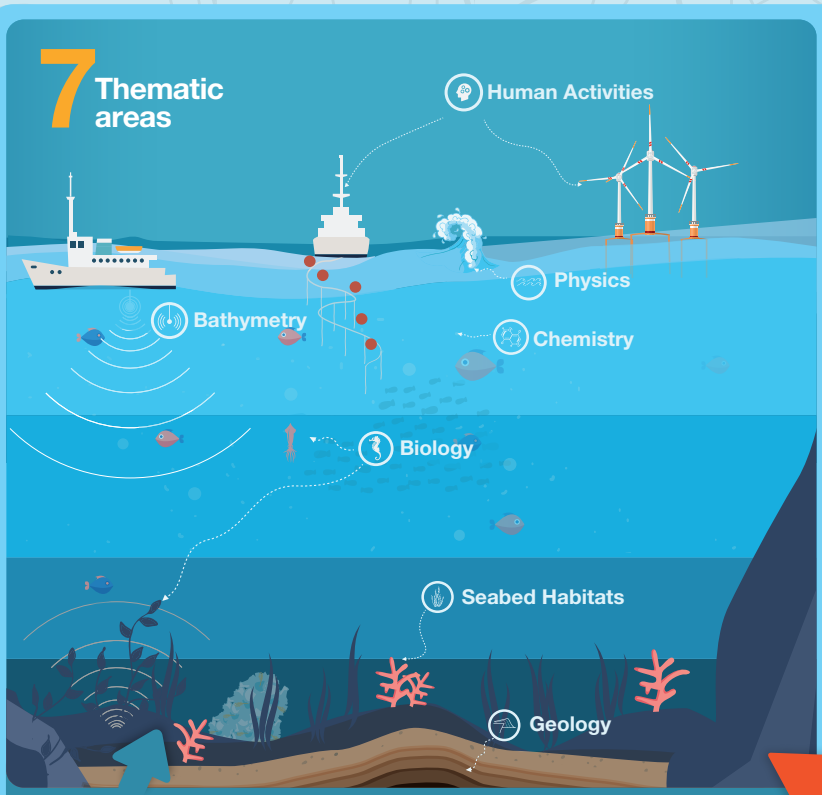
To demonstrate the power of opening up Europe's wealth of marine observations and data, EMODnet turns marine data into maps, digital terrain models, time series & statistics, dynamic plots, map viewers and other applications ready to support researchers, industries and policy makers to tackle grand societal challenges.

THE EUROPEAN MARINE OBSERVATION AND DATA NETWORK - AT A GLANCE

EMODnet

Over **150 organisations** assembling and making available **marine data, metadata & products**

7 Thematic areas



1 Central Portal - www.emodnet.eu
Gateway to all EMODnet data resources and tools allowing users to retrieve data layers from multiple themes

EMODnet Timeline

- **2009** – Phase I
  - Limited sea basins
  - 59 institutes
- **2013** – Phase II
  - Low resolution all basins
  - 120 institutes
- **2017** – Phase III
  - Multi-resolution
  - Over 150 institutes
- **2020** – We are here
- **Beyond 2020**
  - Further increase volume, coverage & resolution of data resources
  - All data & products made available directly via EMODnet Central Portal emodnet.eu
  - Expand the network of associated data providers, users and associated partners

1 Ingestion Portal
facilitating submission of new datasets

EMODnet Secretariat

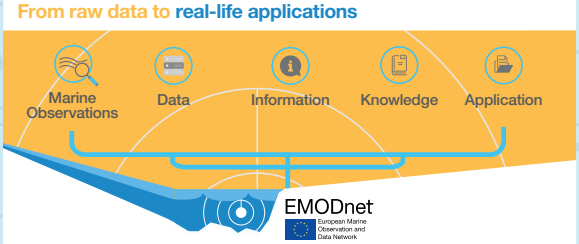
Why EMODnet?

Every year, the EU & its Member States invest a huge amount in marine observations and data collection.

Most of these data end up in different databases and systems scattered around Europe and are difficult to find, access, assemble and use.

EMODnet is making a difference

From raw data to real-life applications



Who is EMODnet for?

Professionals from: **Public Sector** **Civil Society** **Private Sector** **Research Community**

Benefits

- **Increased productivity:** Avoid costs of repeated collection of data by improving access to already existing data in compatible formats
- **Stimulation of innovation:** Anyone (including SMEs) can build value added services using data from different sources
- **Reduction of uncertainty:** Better access to data improves forecasts of the behaviour of the seas, reducing costs of protecting life and property in coastal areas and offshore
- **Adding value to your own data:** Sharing data with EMODnet allows your own data to be combined with data from others to generate better value added products and information and supports the global open data movement.

The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) No. 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund.

emodnet.eu
@EMODnet

Jan-Bart Calewaert
Head of the EMODnet Secretariat

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Introduction from the Head of the EMODnet Secretariat

2019 was a highly productive year for EMODnet, with all seven EMODnet thematic lots releasing many exciting new products and data sets and starting a new two-year cycle, focused on maintaining and evolving key services for users, and improving interoperability between the thematic data services to make EMODnet more fit for purpose and increase its use at national, regional, European and global levels.

Some highlights include the much anticipated release of EMODnet's new digital vessel density maps from Human Activities in March 2019. These products allow users to visualise and download vessel movement patterns and the distribution of maritime traffic in European waters. They were followed by the release of complementary route density maps created by the European Maritime Safety Agency (EMSA) using an alternative method, and also made available via the Human Activities Portal. New maps showing the extent of marine litter in European seas from EMODnet Chemistry marked a significant achievement for the wider marine observation community who worked collaboratively with EMODnet to assemble the scattered data sets, allowing users to detect trends in litter accumulation on our beaches and the seafloor.

Throughout the year, EMODnet Geology's team continued to release a series of products, including the first pan-European shoreline-migration map of its kind since 2004, helping us to monitor coastal change in Europe. EMODnet Bathymetry also released several new layers and products in 2019, expanding the wealth of resources already available, including the latest release of the EMODnet Digital Bathymetry with resolution up to 1/16*1/16 arc minutes (circa 115*115 metres). EMODnet Physics were happy to announce the inclusion and availability of data sets from both the T-MED network and the Saildrone network during 2019. Together with the Southern Ocean Observing System (SOOS) community, EMODnet Physics has also re-initiated the collaboration with PANGAEA in order to integrate some of their data into the EMODnet Physics Portal.

Addressing user needs is our priority at EMODnet so the network has put considerable effort into improving the user-driven services as well as connecting with new communities. EMODnet Seabed Habitats launched a new and improved interactive mapper, making it easier for users to view, query and download their unique seabed habitat maps. EMODnet Biology continues to provide data and information on the status of Europe's marine biodiversity and launched a call for proposals in late 2019 providing grants to initiatives to help them cover existing geographical, temporal and/or taxonomic data gaps. EMODnet Thematic Portals also registered in the FAIRsharing.org Portal, supporting the community-driven efforts

to promote the adoption of the FAIR Principles to make data Findable Accessible Interoperable and Reusable.

Fueling all our Thematic Portals, EMODnet's Data Ingestion Portal provides a facility to identify and ingest relevant data sets. The 'Data Wanted' service flags the types of data sets that are needed and tries to prioritise these when considering the ingestion of new data sets.

EMODnet Bathymetry's Digital Terrain Model continues to be EMODnet's most downloaded product. The role of EMODnet Bathymetry as a global actor in the provision of bathymetric data was recognised by the Seabed 2030 initiative, led by the International Hydrographic Organization - Intergovernmental Oceanographic Commission (IHO-IOC) General Bathymetric Chart of the Oceans (GEBCO) under the financial sponsorships of the Nippon Foundation. EMODnet actively collaborates with key players in the global ocean observing arena, to reduce duplication of efforts and provide the best possible service for users. To this end it has also signed a Memorandum of Understanding between the Copernicus Marine Service *in situ* Thematic Assembly Centre (INSTAC) and EMODnet Chemistry in June 2019, on cooperation regarding *in situ* biogeochemical marine data.

Last but not least: EMODnet's Central Portal provides a single gateway to all of EMODnet's resources, as well as news on new EMODnet data and product releases, use cases and events so it's well worth a visit. In the next phase of EMODnet, we will see further integration of all thematic websites and services into the Central Portal to streamline and facilitate the access and retrieval of EMODnet data and products.

The European Atlas of the Seas forges new partnerships with education initiatives

In September 2017, the EMODnet Secretariat took on the maintenance and further development of the European Atlas of the Seas. Since then the Atlas has undergone an extensive revamp. The catalogue grew from around 60 to more than 250 map layers in 2019, making the Atlas a valuable and user-friendly resource of marine and maritime maps for non-data-savvy professionals, students and citizens alike. The large majority of new map layers were based on EMODnet data products, highlighting the benefits of closer alignment of both efforts and the importance of EMODnet data assembly and harmonisation for generating downstream information services. Other exciting collaborations and the signing of Memoranda of Understanding with Escola Azul in Portugal and Nausicaá, France - the biggest aquarium in Europe with an important marine education program - were key highlights. These collaborations as well as various workshops with schools and teachers demonstrate how the Secretariat is bringing the Atlas into Europe's classrooms and nurturing a more ocean literate European society.

Extending our network and reaching new communities

EMODnet's visibility and reach continues to grow, in Europe and beyond. In 2019, EMODnet was showcased at various international meetings of the global ocean observation community such as Ocean Obs 2019, EGU General Assembly 2019, International Oceanographic Data and Information Exchange (IODE)-XXV Scientific Conference and the World Ocean Council (WOC) Sustainable Ocean Summit. EMODnet has featured frequently in scientific papers with a major collaborative effort coming to fruition in July 2019 with the publication of an EMODnet Community White Paper in Frontiers in Marine Science. Throughout 2019, we have been maintaining the momentum towards building a better coordinated European Ocean Observing Capacity, with the release in May of the EOOS Conference Report and follow up actions to promote the implementation of the EOOS Conference call to Action.

EMODnet's second Open Sea Lab: a user-focused approach to create novel applications from marine data

2019 saw the launch of EMODnet's second Open Sea Lab (OSL II) in Ghent in search of bright people with new and innovative ideas to exploit the wealth of EMODnet data resources. Together with the Flanders Marine Institute (VLIZ) and imec and with support from the European Commission's Directorate General for Maritime Affairs and Fisheries (DG MARE), we were delighted to welcome to the OSL II organising committee both the Copernicus Marine Environmental Monitoring Service (CMEMS) and the International Council for the Exploration of the Seas (ICES). We welcomed further collaboration from Marine@UGent, Global Fishing Watch and OVH. With 70 participants from 19 nations, OSL II proved to be a very creative and productive 3 days resulting in many demonstrations and prototypes of new products developed building on our resources. It also worked as a stress-test of EMODnet services helping our technical teams better understand what works well and what doesn't, so that we continuously keep improving.

In August 2019, in time for the event, the Secretariat had updated the EMODnet Data and Data Product portfolio of which printed copies were available to the OSL II teams. This update involved input and interaction between the EMODnet Secretariat and all Portal Coordinators.

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Thanks to our Associated Partnership scheme, EMODnet further expanded and diversified in 2019. We have been delighted to welcome new associated partners such as Lange Research Aircraft GmbH (LRA), Polytechnic University of Catalonia (Obsea), MARETEC, Thames Estuary Partnership (TEP),

Helzel Messtechnik GmbH, Nodalpoint System, Saildrone and Sofar Ocean.

The 'EMODnet for Business' strategy has fostered better connections with the private sector, and with guidance from the Marine Knowledge Expert Group, EMODnet is ensuring it continues to take into account the needs of businesses and deliver to the blue economy. EMODnet is also developing closer partnerships with industry through various channels including maritime clusters, business fora and research projects which often include industry partners.

Although until now a largely European Network, EMODnet's data coverage and scope are increasingly extending beyond Europe. EMODnet Physics for example provides data from around the entire globe. EMODnet Bathymetry has signed a MoU with the Nippon Foundation /GEBCO Seabed 2030 which has consolidated a collaboration between European and International Bathymetry, with EMODnet Bathymetry meeting the goal of the EU Marine Knowledge 2020 initiative, to deliver a high resolution seabed topography map of European seas by 2020. Other initiatives are being developed to connect to marine data services around the world, including among others close collaboration with the International Oceanographic Data and Information Exchange (IODE) programme of the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

Our engagements are underpinned by our continuous communication campaigns, through organising or participating in events, our newsletters and social media channels. In 2019, we gained over 1000 new twitter followers, reaching a total of 4306 followers. At the time of writing our followers are now > 4500 and we thank our growing community of data producers, providers and users for your key role in the marine knowledge value chain. We encourage you to join us on Twitter and stay informed of all things EMODnet, particularly with exciting plans on the horizon for 10 years of EMODnet in 2020, and beyond!

EMODnet new associated partners 2019

Ostend, Belgian coast.
© Kate Larkin

EMODnet
European Marine Observation and Data Network

2019 - A very special year as we celebrate 10 years of EMODnet

The European Commission's vision for EMODnet was clear from its inception in 2009, with 2020 as the landmark year to deliver maps of our European seas covering topography, geology, habitats and ecosystems, at the highest resolution possible in areas that have been surveyed. These were to be accompanied by collated, harmonized and integrated marine data spanning from ocean surface to seafloor, providing timely information on the physical, chemical and biological state of the overlying water column.

As EMODnet celebrates a decade of progress in 2019, we can be very proud to have achieved these Marine Knowledge 2020 vision objectives!

But we also went well beyond: just think of the EMODnet Checkpoints which have assessed the data adequacy at sea-basin level by stress-testing the system; think of the EMODnet data ingestion Portal which enables data holders to unlock their data; think of the diversity of EMODnet Human Activities data from offshore windfarm sites to vessel density maps, all now available to view alongside ocean and environment data. Together these provide a real opportunity to assess both the ocean health and its many and varied human pressures, providing a holistic view of our shared Ocean and expanding our knowledge about our Ocean and our influences on it.

And what is more - we have done so working together across borders and across disciplines, with more than 120 organisations exchanging best practices, agreeing on common standards and most importantly assembling data and products of Europe's seas and oceans and making them easily accessible, interoperable and free of restrictions on use. As a result of this immense work, EMODnet has become the pan-European provider of multidisciplinary *in situ* marine data, data-products and services fostering a diverse and expanding user base.

Over the years, EMODnet has developed into an open and inclusive network. Close collaboration with other key European initiatives such as Copernicus Marine Service (CMEMS) have led to cross-validation of satellite and *in situ* data sets, user-driven data products and complimentary developments to further add value to the user-experience. Such partnerships are continuously strengthened to optimise the synergies between ocean observation and modelling data, to capitalise fully on the public's investment in these initiatives.

This is a special year for us and we are proud to share with you our achievements in this report and hope you will celebrate our 10 years anniversary with us, and join the movement!

1. 2019 At a glance

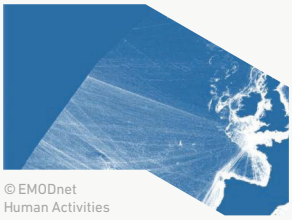
JANUARY 2019

The year started with new partnerships for the European Atlas of the Seas, including a Memorandum of Understanding with Nausicaá aquarium, to promote and further develop the Atlas as an educational tool. This was followed later in the year with a Memorandum of Understanding (MoU) with Escola Azul a national initiative in Portugal that works with schools, teachers and wider educators to increase ocean literacy in the classroom.

FEBRUARY 2019

EMODnet Head of Secretariat, Jan-Bart Calewaert, attended the IOC UNESCO Intergovernmental Oceanographic Data Exchange (IODE)-XXV meeting in Tokyo, Japan. This led to strengthened collaborations and EMODnet becoming the key European marine data focal point for the Ocean Information Hub, a new initiative contributing to the UN Decade of Ocean Science for Sustainable Development.

© IODE Secretariat



© EMODnet Human Activities

MARCH 2019

EMODnet Human Activities released the long awaited data product "vessel density maps", together with a webinar and a detailed methodology. These maps enable users to visualise vessel movement patterns and the distribution of maritime traffic in European waters and quickly became EMODnet Human Activities' most downloaded data product. These were complemented in December 2019 by route density maps, created by the European Maritime Safety Agency (EMSA), through a collaboration with DG MARE.

EMODnet Chemistry released the consolidated digital maps of beach and seafloor litter distribution on a European scale. These include litter density distribution, mean abundance of cigarette related items, fishing related items and plastic bags. Marine litter data collection, data management and aggregation was a collaborative effort, involving among others OSPAR, JRC, DeFishGear, EMBLAS, ICES, MEDITS, and the MSFD Technical Group on Marine Litter.

APRIL 2019

EMODnet Geology launched new pan-European maps and products on submerged landscapes and palaeoenvironmental indicators of the European coast, seafloor geology, marine minerals, harmonised multi-scale maps of seabed substrates and geological events and probabilities, and the first shoreline-migration visualising pan-European coastal behaviour for the decade 2007-2017 at different spatial scales. This new suite of data products provides information on underlying geology from the ancient past (more than 2500 million years ago) through to modern Quaternary deposits and features. Amongst other developments the coastal behaviour maps were also updated with the release of a new satellite-derived coastal migration map, with online zooming functionality. These were further presented at EGU2019 by colleagues from EMODnet Geology and the Secretariat.

EMODnet Chemistry signed a Memorandum of Understanding with the Copernicus Marine Environment Monitoring Service (CMEMS) *in situ* thematic assembly centre (INSTAC) leading to a closer cooperation for contributing oxygen, chlorophyll-a, and nutrients aggregated, validated and harmonised data to CMEMS INSTAC. In turn, CMEMS INSTAC is encouraging additional data providers to include their data sets in EMODnet Chemistry.

© EMD2019

MAY 2019

EMODnet Secretariat co-organised a workshop on Big Data at European Maritime Day 2019, in collaboration with Campus Mondial de la Mer and the European Marine Board (EMB), and further inputs relating to regional and thematic Marine Spatial Planning (MSP).

EMODnet Biology organised an End-User Event on 15 May 2020 in Lisbon, to showcase the European Atlas of Marine Life and Essential Biological Data Products to end-users and wider stakeholders, including the OSPAR adoption of EMODnet Products.

EMODnet's second Open Sea Lab (II) was officially launched at a kick-off event on 24th May in Brussels. This included presentations from key marine open data initiatives EMODnet, CMEMS and ICES. The event also launched the three main challenges of the OSL II, namely Marine environmental management and protection, Blue Society and Ocean Literacy and Sustainable Blue Economy.

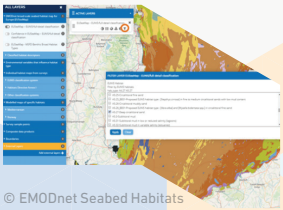
The European Ocean Observing conference report was released, containing key conclusions of the November 2018 Conference, with a related Call to Action, co-organised by EMODnet, EMB and EuroGOOS.

JUNE 2019

EMODnet Seabed Habitats launched a range of new features, including a new and improved interactive map viewer, built on open-source software, in addition to improving the ability to exchange information with external marine data sources.

The "Blue Time Machine" (from Spain) achieved 2nd place at the EUDatathon 2019 with an innovative app using EMODnet and CMEMS data that visualises the complex impact of climate change by providing a digital representation of the past, present and future conditions of our oceans.

EMODnet was presented at the Blue Bioeconomy Forum and EurOCEAN2019, and is showcased at a meeting of the Marine Strategy Framework Directive (MSFD) TG-SEABED.



© EMODnet Seabed Habitats

JULY 2019

While EMODnet data services remained operational 24/7 during the summer period, EMODnet technical experts and Secretariat engaged in a series of internal meetings to build the foundations for future international collaborations with other global marine data initiatives and organisations including UNESCO-IOC's International Oceanographic Data and Information Exchange Programme (IODE).

AUGUST 2019

The EMODnet Secretariat released an updated "EMODnet data and data product portfolio" from all seven thematic lots. This included data from new sources, including data collected by scuba divers from temperature data loggers in the Mediterranean Sea, made available through EMODnet Physics and the T-MEDNet.

© Rich Carey

SEPTEMBER 2019

The second edition of the Open Sea Lab hackathon was a great success with 70 participants from 19 nations gathering in Ghent, Belgium, for 3 days of innovative and inspiring ideas and application creation. For this EMODnet worked in close collaboration with CMEMS and ICES, with support from IMEC, VLIZ, EC DG MARE and the University of Ghent. Coaches from the EMODnet Secretariat and from every thematic lot were present at the event to provide support to the teams.

An EMODnet delegation participated in the OceanObs'19, presenting a paper on EMODnet's achievements and data, data product and services offer, involving 30 co-authors across the network. Those attending the Conference spanned the Secretariat, thematic lots Bathymetry, Biology, Chemistry, Geology, Physics and Data Ingestion Service together with sea-basin Checkpoint Coordinators.

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OCTOBER 2019

EMODnet Human Activities published a new blog on wastewater to highlight the release of two new geodatabases on its Portal. In the EU, the Urban Wastewater Treatment Directive (UWWTD; Council Directive 91/271/EEC) requires Member States to set up collecting and treatment systems for urban wastewaters. The Member States are required to monitor discharges from urban wastewater treatment as well as the amounts and composition of sludges disposed to surface waters. Based on data corresponding to year 2014, EMODnet Human Activities created two new geodatabases, one on urban wastewater treatment plants (Urban Wastewater Treatment Plants, UWWTPs) and one on discharge points.

EMODnet is one of nine key marine data infrastructures in the H2020 Blue-Cloud project, which kicked off on 2-4 October 2019 in Pisa, Italy. In this project, EMODnet is working with Copernicus Marine Service (CMEMS) and the WeKEO DIAS, together with SeaDataNet, ICOS and other infrastructures to create a smart federation of data resources and services for a Blue-Cloud cyber platform, with an interoperable Data Discovery and Access service and a Virtual Research Platform, with access to analytical tools and computing resources.

NOVEMBER 2019

EMODnet Physics - CMEMS for the Polar Data Forum: collaboration on polar data in the Arctic.

EMODnet Biology completed their second round of EMODnet Biology data grants (following the first round in April 2010), with 32 applications received and 16 selected for funding, which should lead to the additional 85 new datasets to the EMODnet Biology data catalogue.

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DECEMBER 2019

A Memorandum of Understanding (MoU) between EMODnet Bathymetry and the Nippon Foundation /GEBCO Seabed 2030 was signed, consolidating a collaboration between European and International Bathymetry actors including the International Hydrographic Office (IHO) as a culmination of EMODnet Bathymetry meeting the goal of the EU Marine Knowledge 2020 initiative by delivering a high resolution seabed topography map of European seas.

2. One year of EMODnet

2.1 EMODnet Thematic Portals

2.1.1 BATHYMETRY

Portal:

EMODnet Bathymetry

emodnet-bathymetry.eu

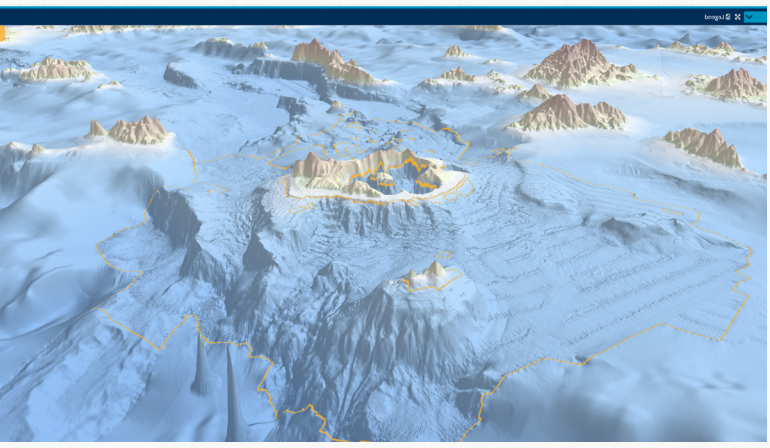
Bathymetry describes the topography of the seabed, by measuring the distance from the sea surface to the seafloor. It provides essential information to understand the dynamics of the marine environment: the shape of the seabed can influence ocean circulation and currents, local fauna and seafloor habitats.

The EMODnet Bathymetry Portal provides access to data and data products on bathymetry (water depth), depth contours, survey tracks and geographical location of underwater features such as wrecks for all European sea-basins.

2019 key facts

The number of bathymetry survey data sets included amounts to 26447 data sets, while the number of Composite DTMs has increased considerably to 181. These data sets are made available by data providers, consisting of national hydrographic services, marine research institutes, and industry. Their number has increased from 39 from 18 countries in 2018 to 51 from 24 countries in 2019. Further gathering is on-going and a major selection of these data sets will be used for preparing a new release of the EMODnet Digital Terrain Model (DTM) for all European waters, which is planned for the end of 2020.

The current EMODnet Digital Terrain Model (DTM) was released in September 2018 and has a grid resolution of 1/16 * 1/16 arc minutes (circa 115 * 115 m2), covering all European seas including part of the Arctic Ocean and Barents Sea. This DTM is based upon circa 9,400 *in situ* data sets and 18 Satellite Derived Bathymetry data products for coastal stretches of Spain and Greece. Overall, the new DTM contains approximately 12.3 billion grid nodes. The DTM can be freely viewed, also in 3D, downloaded (by 64 tiles), and shared by OGC web services.



@EMODnet Bathymetry

Next to the DTM, EMODnet Bathymetry provides access to: 1) a layer with digital Satellite Derived Coastlines for the Lowest Astronomical Tide (LAT), the Mean Sea Level (MSL) and the Mean

High Water (MHW) tidal reference levels; 2) a layer with High Resolution hotspots, consisting of a collection of circa 200 high resolution composite DTMs for selected areas. Their resolution varies between 1/32 and 1/512 arc minutes, depending on the local data policy of data providers; 3) a layer with Digital Terrain Model Quality Indicators for vertical and horizontal precision, survey age, purpose of the survey, and combined quality; and 4) an inventory of national baselines and coastlines collected from 21 national authorities.

The EMODnet Bathymetry Portal and its DTM viewing and download service in 2019 have continued to be very popular with > 50.000 Portal visitors, of whom circa 4.000 users from 2.100 organisations from 115 countries have downloaded altogether 38.000 EMODnet DTM tiles in 11.000 transactions. The user community roughly consists of 20% industry, 20% research, 40% universities, and 20% others. In 2019 a major milestone was reached of more than 200.000 DTM tile downloads since the start of EMODnet Bathymetry in 2008. These statistics together with many direct contacts and received mail feedbacks indicate that EMODnet Bathymetry serves a large number of users and use cases and is very much appreciated by all sectors. This is amplified by the intense use of the OGC web services (machine-to-machine) as many users also apply the EMODnet DTM and its various information layers as base layers in their own Portal and applications.

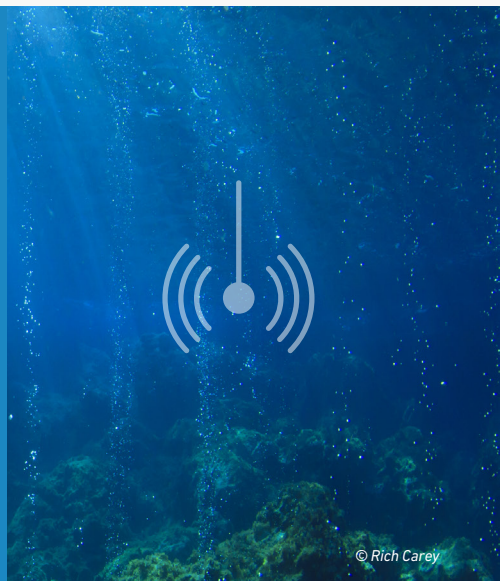
In Google Scholar, more than 150 references to EMODnet Bathymetry can be found in accepted papers and edited books during 2019.

EMODnet Bathymetry is managing the European contribution to the international Seabed 2030 project.

BATHYMETRY 2019 ROADSHOWS

EMODnet Bathymetry was presented at several events, including:

- Institute of Electrical and Electronics Engineers (IEEE) Oceans 2019 conference, 17-20 June 2019, Marseille, France
- Ocean Obs' 2019 conference, 16-20 Sept 2019, Honolulu, USA
- UK Seabed 2030 meeting, 22-23 Oct 2019, London, United Kingdom
- Naval Hydrographic and Oceanographic Service (SHOM) meeting "Journée de l'information scientifique du Shom", 3 November 2019, France, meeting
- General Bathymetric Chart of the Oceans (GEBCO) symposium, 4-9 November 2019, Portsmouth, USA



Portal:

EMODnet Biology

emodnet-biology.eu

2.1.2 BIOLOGY

Europe's seas and oceans are home to a staggering abundance and diversity of life. More than 36,000 known species of marine plants and animals are found in Europe, and understanding their geographical distribution, abundance and seasonal, annual or decadal variation is key to detecting change in the marine ecosystem.

The EMODnet Biology Portal provides access to data and data products on species temporal and spatial occurrences, biotic measurements, and abiotic parameters.

2019 key facts

From just under 899 data sets at the end of 2018, the number increased to 920 in 2019. The number of occurrence records also saw an increase, from 24.8 million in 2018 to 25.5 million in 2019.

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A new version of the data download toolbox was released in February and now allows users to include additional parameter and data precision filters, as well as choosing between different download types and visualising the final selection on the Geoviewer.

A 2-year automatic renewal allows the project to run until the end of April 2021, with more data sets being identified and prioritised for ingestion into the system. One of the main objectives is to make older data sets (referred to as archaeological data) to be made available and discoverable throughout this period.

A couple of events stand out, namely the showcase for the European Atlas of Marine Life, that took place in May in Lisbon and the 2nd edition of the OpenSeaLab in September, in Ghent.

In April 2019, the first round of data grants ended, which made data from 8 new data partners discoverable and downloadable via the Biology Portal. In November 2019, a second round was announced and from the 32 applications received, 16 were selected and will contribute with a total of 85 new data sets.

The new partners are the Ukrainian Scientific Centre of Ecology of the Sea (Ukraine), Station Biologique Roscoff (France), Klaipeda University Marine Research Institute (Lithuania), Department of Evolutionary Biology of the University of Barcelona (Spain), Institute of Marine Sciences (Spain), Institute of Agriculture and Food Research and Technology (Spain), Laboratoire d'Océanographie de Villefranche-sur-Mer of the Sorbonne University (France), University of Plymouth (UK), University of Las Palmas de Gran Canaria (Spain), Istituto per le Risorse Biologiche e le Biotecnologie Marine (Italy), Gaia Research Institute Onlus (Italy), Accademia Leviatano Onlus (Italy), Marine Institute (Ireland), Associazione Marecamp Onlus (Italy), Association Reef Check Onlus from

the Università Politecnica delle Marche (Italy) and Association Nereide (Spain).

Following the publication, in 2018, of the online course on "How to contribute data to EMODnet Biology", almost 6000 users have enrolled and of those, 2407 in 2019. This course is hosted by the International Oceanographic Data and Information Exchange (IODE) Ocean Teacher platform.

2019 key data providers and users

In 2019 a big effort was undertaken to make older data available, by the end of the year, 23 data sets of these older data sets were available online. The ongoing effort will continue throughout 2020.

The Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS) was by far the biggest provider in terms of data sets in 2019, thus fully delivering the data sets stipulated for the project. Alongside OGS, ILVO (Research Institute for Agriculture, Fisheries and Food), IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer) and SYKE (Finnish Environment Institute) have also completely delivered the data sets inventoried for the renewal period.

The expansion of The Atlas of Marine Life continued with the addition of a new product on Seagrass, Macroalgae and Live coral from EMODnet Seabed Habitats.

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BIOLOGY 2019 ROADSHOWS

EMODnet Biology was presented at several events, including:

- Young Environmental Scientists - Society of Environmental Toxicology and Chemistry (YES-SETAC) training course, 8 February 2019, Ghent, Belgium
- Progress meeting and Scientific Committee of the World Wildlife Fund (WWF) Living Planet Index Report, 1 March 2019, Brussels, Belgium
- VLIZ Marine Science Day (VMSD), 13 March 2019, Bredene, Belgium
- Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems (AtlantOS) Final meeting, 25-28 March 2019, Paris, France
- EMODnet Biology stakeholder event, 15 May 2019, Lisbon, Portugal
- Findable, Accessible, Interoperable, Reusable Data (FAIR data) workshop (Assemble +),13-14 June 2019, Oostende, Belgium
- SeaDataCloud (SDC) Training session, 19 & 24 June 2019, Oostende, Belgium
- Evidence-based improvements in the Birds and Habitats Directives (E-BIND) focus group meeting, 28 June 2019, Brussels, Belgium
- EOSC Blue-Cloud Kick-off meeting, 2-4 October 2019, Pisa, Italy
- BioDiversity Next Conference, 22-25 October 2019, Leiden, Netherlands
- International Oceanographic Data and Information Exchange Steering Group for Ocean Biodiversity Information System (SG-OBIS) Eighth session, 5 -8 November 2019, Santa Marta, Colombia

Portal:

EMODnet Chemistry

emodnet-chemistry.eu

2.1.3 CHEMISTRY

A good understanding of seawater chemistry and its natural variability in a given region is fundamental in detecting short, medium and long-term changes in the environmental ecosystem, such as the increase of pH due to ocean acidification, influx of nitrates in run-off from agricultural fertilisers, emissions from land-based industry, oil leaks or chemical spills, as well as pollution from shipping or dredging activities.

The EMODnet Chemistry Portal provides access to data and data products on concentrations of chemicals related to eutrophication and contamination in water, sediments and biota, and marine litter.

2019 key facts

In January 2019, EMODnet Chemistry finalised the release of the beach litter data set, with the harmonization of the OSPAR, Marine Strategy Framework Directive (MSFD) Technical Group on Marine Litter (TG-ML), United Nations Environment Programme (UNEP) and UNEP Marlin lists. The data set was used to compute MSFD Baselines as described in Hanke et al., EU Marine Beach Litter Baselines, EUR 30022 EN, PO of the EU, Luxemburg, 2019, ISBN 978-92-76-14243-0, https://doi.org/10.2760/16903, JRC114129.

In March 2019, EMODnet Chemistry released the consolidated maps of beach and seafloor litter distribution on a European scale as OGC services. These include litter density distribution, mean abundance of cigarette related items, fishing related items and plastic bags. Marine litter data collection was only possible thanks to the synergy and active interaction with OSPAR, Joint Research Centre (JRC), the International Council for the Exploration of the Sea (ICES), and projects DeFishGear, EMBLAS, and MEDITS, and to the work of the EMODnet-Chemistry consortium cooperating with MSFD Technical Group on Marine Litter.

In October 2019, EMODnet Chemistry Portal was renewed for two years and the cooperation with Copernicus Marine Environment Monitoring Service (CMEMS) on *in situ* biogeochemical marine data was signed.

In December 2019, EMODnet Chemistry prepared the release of the dedicated maps for contaminants as OGS web services, showing data distribution below and above Limit of Quantification (LOQ), data with LOQ above or below 30 percent of EQSD threshold values, as well as the information on the sampled matrix.

During 2019, EMODnet Chemistry reached a number of important milestones, marking a significant change for its visibility and consideration:

- The European Environment Agency (EEA) decided to follow-up on the use of EMODnet Chemistry data for three EEA indicators (i.e. 'Hazardous substances in marine organisms', 'Nutrients in TCM waters' and 'Chlorophyll in TCM waters'). This opportunity demonstrated the robustness of EMODnet to support the long-term availability of data and the completeness of EMODnet to provide qualified and updated information by complementing OSPAR and HELCOM data available at ICES and proving to be an alternative data resource for the Mediterranean Sea and Black Sea;
- The Marine Strategy Framework Directive (MSFD) Technical Group on Marine Litter (TG-ML) endorsed EMODnet Chemistry marine litter database, for gathering beach litter data on a European scale. As a result, EMODnet gathered all Member States monitoring data from 2012 to 2016, provided an integrated and harmonised data layer for baselines computation and is ready to gather the updates from 2017 onwards. In addition, sea floor litter database is made available for further use;
- EMODnet Chemistry started a close cooperation with Copernicus for contributing oxygen, chlorophyll-a, and nutrients aggregated, validated and harmonized data to Copernicus Marine Environment Monitoring Service (CMEMS) INSTAC. As part of this synergy and established Memorandum of Understanding, CMEMS INSTAC will encourage additional data providers to include their data sets in EMODnet Chemistry.

2019 key data providers

EMODnet Chemistry network of data providers consists of SeaDataNet partners, which are the national oceanographic data centres of 35 countries, active in data collection. In 2019, key data providers for marine litter data were EEA and the Volvo Ocean Race.

CHEMISTRY 2019 ROADSHOWS

EMODnet Chemistry was presented at several events, including:

- 25th Session of the IOC Committee on International Oceanographic Data and Information Exchange and Scientific Conference, 18-22 February 2019, Tokyo, Japan
- Ocean Dialogue 2019, 18-19 March 2019, Brussels, Belgium
- Copernicus *in situ* Thematic Assemble Centre (Copernicus INSTAC) General Assembly, 19-21 March 2019, Brest, France
- Marine Strategy Framework Directive (MSFD) Board of experts meeting on contaminants, 29 March 2019, Remote Meeting
- United Nations Environment Programme Mediterranean Action Plan (UNEP MAP) Meeting of the Ecosystem Approach Correspondence Group on Pollution Monitoring, 2-5 April 2019, Podgorica, Montenegro
- European Geosciences Union (EGU) General Assembly, 8-12 April 2019, Vienna, Austria
- EMODnet – Copernicus Marine Environment Monitoring Service Coordination (CMEMS) meeting, 17 April 2019, Brussels, Belgium
- Naval technique and didactic equipment exhibition for naval education "SAILING TO THE FUTURE" organised by "Mircea cel Batran" Naval Academy, 17-18 May 2019, Constanta, Romania
- Open Sea Lab 2019 kick-off event, 24 May 2019, Belgium
- The Marine Litter Stakeholders Workshop, 12-13 June 2019, Copenhagen, Denmark
- Baltic Sea Science Conference (BSSC), 19-23 August 2019, Stockholm, Sweden
- Ocean Obs 2019, 16-20 September 2019, Honolulu, Hawaii, USA
- Workshop on marine observations execution problems, 16-18 September 2019, Mykolaiv, Ukraine
- Mediterranean coast and macro-regional strategies week, 17-28 September 2019, zola, Koper, Piran, Slovenia
- Trieste Next, festival della ricerca scientifica and European Researchers' Night, 27-29 September 2019, Video showing
- Workshop "Copernicus Marine for MSFD", 2 October 2019, Brussels, Belgium
- 42nd Mediterranean Science Commission (CIEMS) Congress, 7-11 October 2019, Cascais, Portugal

Portal:

EMODnet Geology

emodnet-geology.eu

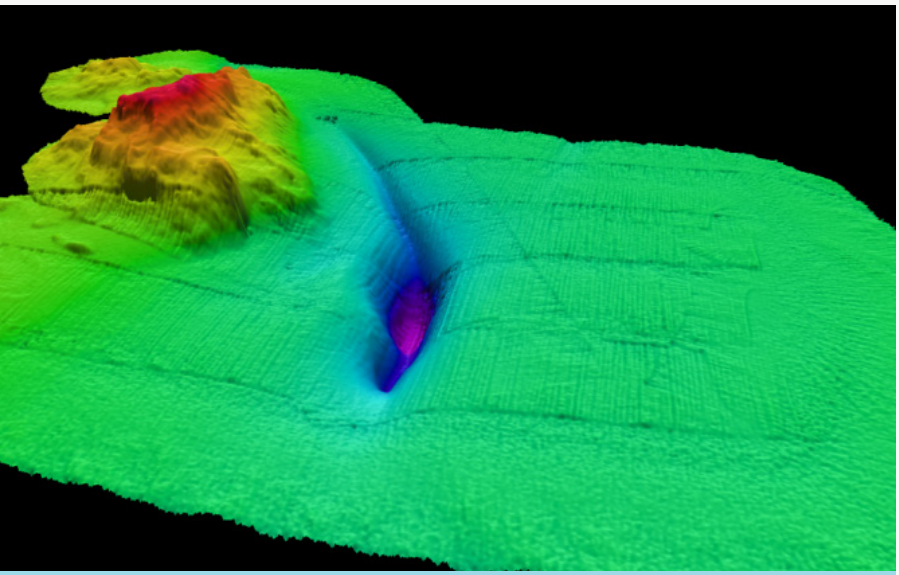
2.1.4 GEOLOGY

The geology of Europe's seafloor is diverse, ranging from hard rock outcrops to glacial sediment layers that may reach hundreds of metres in thickness. The geological picture is further complicated by structural faults, episodic events such as earthquakes, submarine landslides and volcanic activity. Geological data is essential to support maritime spatial planning, coastline prediction, offshore installation design and environmental conservation.

The EMODnet Geology Portal provides access to data and data products on seabed substrate, seafloor geology, coastal behaviour, sediment accumulation rates, geological events and probabilities, and mineral occurrences, as well as submerged landscapes.

2019 key facts

All EMODnet Geology map products were updated and several new ones were released in April 2019. New products available on the EMODnet Geology Portal by the end of April 2019 were: Completely new maps on submerged landscapes of the European coasts, on geomorphology as well as Quaternary geology. The Coastal Behaviour maps were updated with the release of a new satellite-derived coastal migration map with online zooming functionality. Other updates were: Marine Minerals - Update of available maps and release of one new mineral, sapropel; Seabed substrate, update of the substrate map to 1:100.000 scale with multi-scale functionality enabling the visualization of even finer resolutions, harmonized up to scale 1:50.000; Geological events and Probabilities; update of the events and probabilities products, including information on fluid emissions and tsunamis; and Seafloor Geology; update of available maps. In September 2019 the contract was renewed for an additional 2 years and work on the different data products continued through the year.



A sea hole known as Paskamonttu, a deep erosional scar in clayey Holocene sediments, situated in the Gulf of Finland.
© EMODnet Geology

Throughout the year EMODnet Geology was marketed at a multitude of various events, from lay-mans' level to highly scientific meetings, such as the worlds' largest geo-scientific meeting, the American Geophysical Union (AGU) Fall meeting in San Francisco, the ocean community driven decadal OceanObs'19 Conference in Honolulu, USA. A real boost came from having an EMODnet Geology booth at the European Geosciences Union (EGU) Annual meeting in Vienna in April 2019.

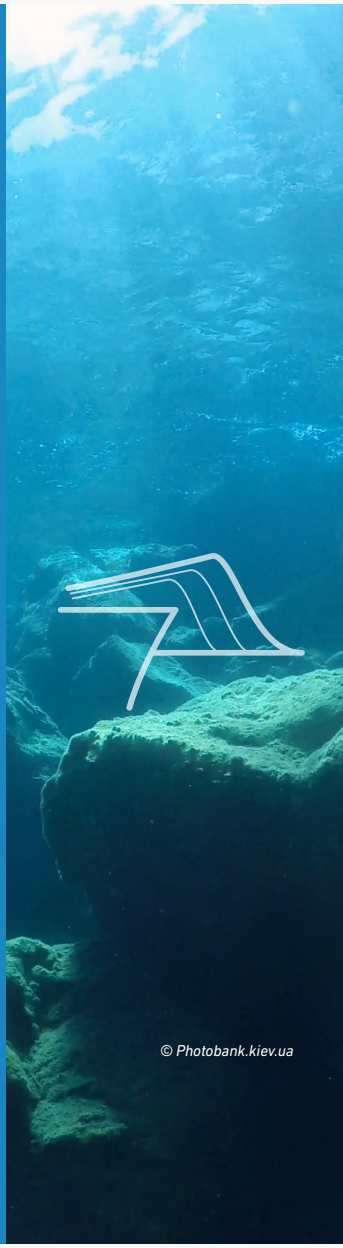
2019 key data providers and users

Because the European national geological surveys make up the core of the EMODnet Geology consortium and these organisations are usually the national geological data centres of each participating country, the key data providers for EMODnet Geology are partners in the project. Thus data input is easily guaranteed. EMODnet Geology also looks for scattered third party data such as the Mediterranean landslides database by Camerlenghi *et al.* (2010) and while communicating we promote the use of EMODnet data and products.

GEOLOGY 2019 ROADSHOWS

EMODnet Geology was presented at several events, including:

- EuroGeoSurveys (EGS) Expert Group Chairs Meeting and 42nd EGS National Delegates Forum, 12 February 2019, Brussels, Belgium
- Periodical meeting of the Italian marine geologists (organised by Italian Geological Society), 21-22 February 2019, Rome, Italy
- Annual Meeting of the Netherlands Centre for Coastal Research (NCK Days), 20 March 2019, Enkhuizen, Netherlands
- European Geosciences Union (EGU) Annual meeting, 8-12 April 2019, Vienna, Austria
- Integrated Mapping for the Sustainable Development of Ireland's Marine Resource (INFOMAR) Seminar 2019, Irelands seabed mapping conference, 16 October 2019, Ireland
- Global Ocean Observing System (GOOS) Workshop on Marine Data during the Polar Data Forum III, 21 November 2019, Helsinki, Finland
- Metallogeny and Geological Potential for Strategic and Critical Raw Materials (MINDeSEA) Project meeting, 26 November 2019, Norway
- 2019 Fall Meeting of the American Geophysical Union (AGU), 9-13 December 2019, San Francisco - CA, USA



Portal:

Human Activities

emodnet-humanactivities.eu

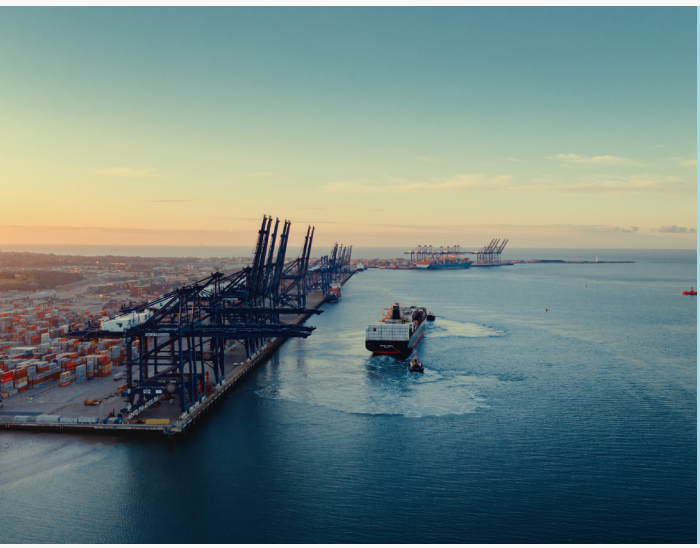
2.1.5 HUMAN ACTIVITIES

Pressure on Europe's marine space and resources is high. Continual demand for resources such as oil and gas, marine minerals and fish must be managed alongside the need to use marine space for renewable energy installations, communications cables, waste disposal sites and shipping. Additionally, societal demand for marine tourism and leisure activities, and the need to conserve marine ecosystems and habitats is leading to increased competition and conflict between different marine sectors.

The EMODnet Human Activities Portal provides access to data and data products on the intensity and spatial extent of human activities at sea.

2019 key facts

2019 marked the release of a much-awaited data product for EMODnet Human Activities users: vessel density maps. These maps enable users to visualise vessel movement patterns and the distribution of maritime traffic in European waters. As expected, with nearly 1,500 downloads in just 9 months, they quickly became EMODnet Human Activities' most downloaded data product, overtaking wind farms which had consistently ranked first since the onset of the project.



@ SciPhi.tv

Based on AIS data that are transmitted from ships' on-board transponders, the method to create the vessel density maps was developed by the EMODnet Human Activities team in close consultation with scientists from the JRC of the European Commission. Vessel density is expressed as the number of hours spent by ships in a square kilometre over a month. The process entailed crunching data on billions of ship positions and proved quite challenging from the technical point of view. However, on the online map viewer everything's quite easy: a colour gradient makes it possible to quickly distinguish whether an area is characterised by high or low shipping traffic. Traffic is broken down by ship types: cargo, dredging or underwater operations, high-speed craft, fishing, military and law enforcement, passenger, pleasure craft, sailing, service, tanker, tug and towing, other, or unknown.

Initially released to cover 2017, the maps received an update with 2018 data towards the end of the year. From now on, they will receive regular updates each year.

Moreover, in December 2019 EMODnet's vessel density maps were complemented by route density maps. While at first glance they look very much like vessel density, route density maps measure the number of ship routes that cross a square kilometre over a month. The maps were created by the European Maritime Safety Agency (EMSA), based on an agreement with

DG MARE. They are updated each month.
Other new data sets were also released: nuclear power plants, urban wastewater discharge points, and treatment plant enriched the EMODnet Human Activities' data portfolio to the benefit of the EU maritime open-

2019 key data providers and users

EMODnet Human Activities collates data from a network of over 150 sources. Listing them all here would be impossible, but all of them deserve special thanks and are acknowledged both on the Portal and in metadata files. Most of them are public authorities, but there are also research organisations and private companies. In 2019, EMSA became a data provider by contributing their route density maps to the project, whereas the AIS data that powers the vessel density maps is purchased from Collecte Localisation Satellites (CLS) and Orbcomm.

EMODnet Human Activities' user base is ever expanding, also thanks to the addition of new data sets to its portfolio. Most users are from academia and / or research, but, as testified by the use cases available online, there is increasing interest from industry, which accounts for 25% of total user base. Stakeholder feedback and anecdotal evidence suggests that an increasing number of companies have been using EMODnet to retrieve data and information to use in the initial phase of their projects, upon identifying the best suitable areas to build a wind farm, the best route for a cable or a pipeline, etc. Before EMODnet, this information was usually purchased from commercial providers, while now it can be accessed for free and with no restrictions to use, thus leading to higher savings and increased productivity.

HUMAN ACTIVITIES 2019 ROADSHOWS

EMODnet Human Activities was presented at several events, including:

- Digitalisation, Artificial Intelligence (AI) & Big Data for Maritime Applications: workshop, 17 May 2019, Lisbon, Portugal
- Macaronesian Maritime Spatial Planning (MarSP): European Maritime Day (EMD) 2019 Workshop, 17 May 2019, Lisbon, Portugal
- SEALINES Workshop, 24 June 2019, Athens, Greece
- Open Sea Lab, 4-6 September 2019, Ghent, Belgium
- Workshop on data for Maritime Spatial Planning (MSP) implementation, 3 October 2019, Brussels, Belgium

Portal:

Physics

emodnet-physics.eu

2.1.6 PHYSICS

EMODnet Physics provides a gateway to a vast resource of ocean physics data. Users can access near-real time data (within a few hours of measurement) and historical validated archives. EMODnet Physics is strongly federated with two other European data aggregating infrastructures. One is the Copernicus Marine Environment Monitoring Service - *in situ* Thematic Assembly Centre for operational data flow, while historical validated data sets are organised in collaboration with SeaDataNet and its network of National Oceanographic Data Centres. These data are integrated with other European data sources (e.g. ICES, PANGAEA) and combined with supplementary data from ongoing Global Oceans Observing programmes such as ARGO, DPCP, GLOSS, GO-SHIP, etc. to make the most comprehensive physical parameter data catalogues available. Moreover, thanks to international collaborative relationships to provide data access to – and preview of– coastal data in non-European areas (e.g. NOAA platforms for the US, IAPB platforms for the Arctic area, IMOS for Australia and others), EMODnet Physics catalogues are going beyond European borders to offer an even more exhaustive entry point to global ocean physical observations.

In 2019, EMODnet Physics has been enhancing and expanding existing services to reach the 2020 target of a seamless multi-resolution access to timely observations and information on the present and past physical, state of the overlying water column as well as by oceanographic forecasts.

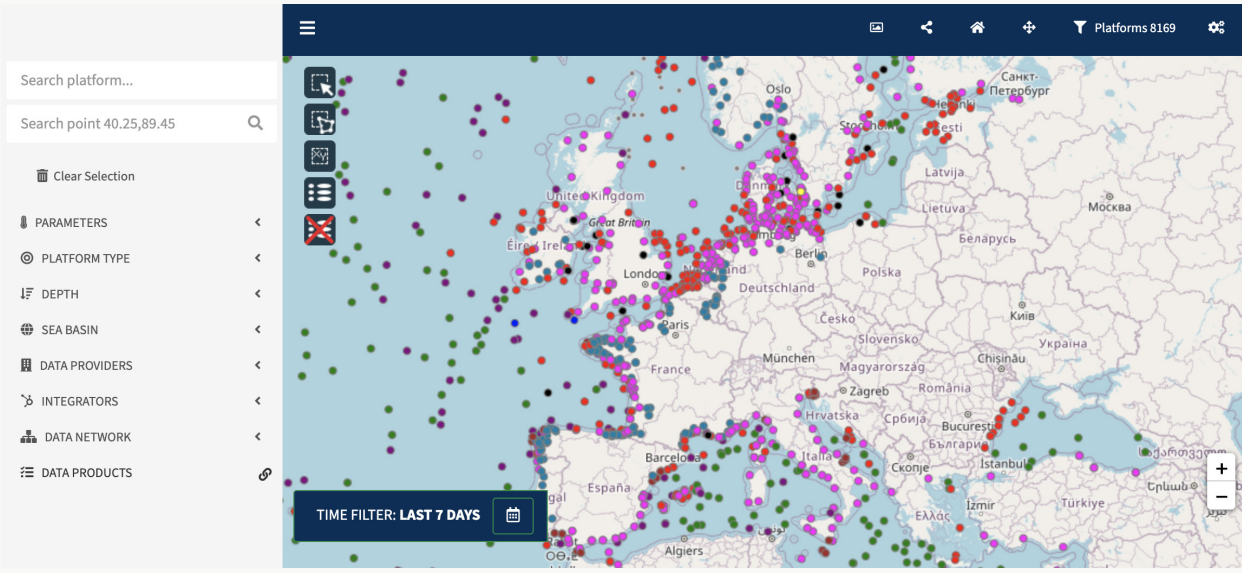
2019 key facts

EMODnet Physics worked continuously to foster the interoperability between the major European data management infrastructures such as the International Council for the Exploration of the Sea (ICES) Database, SeaDataNet, PANGAEA, and the COPERNICUS Marine Environmental Monitoring Service (CMEMS) - *in situ* Thematic Assembly Center (INSTAC). As a result of this, 2019 saw a massive increase in the number of available data sets where EMODnet Physics linked about 600.000 new platforms to the Portal.

Data, products and metadata were re-organised in a series of catalogues and interfaces. More specifically EMODnet Physics provides the users with following key catalogies and interfaces:

- Catalogue.emodnet-physics.eu is based on geonetwork and provides the list and description of available data sets and products;
- Map.emodnet-physics.eu is the dynamic map facility for viewing and downloading that provides a central tool for users to search, visualize and download data, metadata and products;
- Erddap.emodnet-physics.eu, thredds.emodnet-physics.eu, geoserver.emodnet-physics.eu and SOAP are the key interoperability services to facilitate machine-to-machine interaction and to provide further systems and services with European seas and ocean physical data and metadata.

By means of these interfaces, EMODnet Physics registered more than 12,000 requests of manual data download and more than 900,000 APIs transactions. Google scholar lists more than 1,000 items for "EMODnet Physics".



@ EMODnet Physics

2019 key data providers and users

EMODnet Physics is a huge network of data providers covering Europe and linking international partners from the US to Australia and beyond.

EMODnet Physics data sets and products are available without registration nor authentication system. Very few data (historical data from European coastal moorings) may require authentication and based on this limited snapshot of users it is possible to see that researchers are the main EMODnet Physics user. The interest and use from the private business sector is continuously increasing. Geographical user provenance is well distributed.

Popular themes are ocean waves and currents. 2019 also saw an increased interest in river outflow. EMODnet Physics river data management was discussed in the services supporting the European Environment Agency's (EEA) implementation of cross-cutting activities for coordination of the *in situ* component of the Copernicus Programme Services report.

PHYSICS 2019 ROADSHOWS

EMODnet Physics was presented at several events, including:

- European Space Agency (ESA) Atlantic from Space Workshop, 23-25 January 2019, Southampton, UK
- Joint meeting of the CBS Expert Team on WMO Information System Centres (ET-WISC) and Task Team on Data Centres (TT-DC) - Meterological – marine communities tech. coordination meeting, (2019 Joint ET-WISC-TT-DC), 12-15 March 2019, Beijing, China
- European Geosciences Union (EGU) General Assembly 2019 session Earth & Space Science Informatics (ESSI), 9-11 April 2019, Wien, Austria
- Ferrybox workshop, 24-26 April 2019, Genova, Italy
- European Global Ocean Observing System (EuroGOOS) Annual Meeting, 8-9 May 2019, Herakliom, Greece
- Oceans'19, 18-19 June 2019, Marseille, France
- The 8th European Gliding Observatories (EGO) Meeting & International Glider Workshop Meeting, 21-29 May 2019, New Jersey, USA
- Intergovernmental Oceanographic Commission (IOC) Assembly, 25 June - 2 July 2019, Paris, France
- Open Sea Lab, 4-5 September 2019, Ghent, Belgium
- OceanObs'19, 16-22 September 2019, Hawaii, USA
- SeaDataCloud General Assembly, 16-18 October 2019, Brest, France
- Workshop "High-frequency radar (HF) Task Team" , 13-14 November 2019, S. Sebastian, Spain
- H2020 Southern Ocean Carbon and Heat Impact on Climate (SO-CHIC) project kick-off meeting, 13-15 November 2019, Paris, France
- 3rd Polar Forum Workshop, 18-22 November 2019 , Helsinki, Finland
- Workshop "Modelling and observations in the Coastal Mediterranean Sea: physical and biogeochemical process", 3-4 December 2019, Trieste, Italy
- Mediterranean Oceanography Network for the Global Ocean Observing System (MONGOOS) Annual Meeting, 4-5 December 2019, Trieste, Italy

© Radu Bercan

2.1.7 SEABED HABITATS

Understanding the occurrence and distribution of different seafloor habitats around Europe is important for effective planning, conservation and sustainable development of the marine environment.

The EMODnet Seabed Habitats Portal provides access to data and data products on seabed habitats and surveys, environmental variables and seabed habitat models.

Portal:

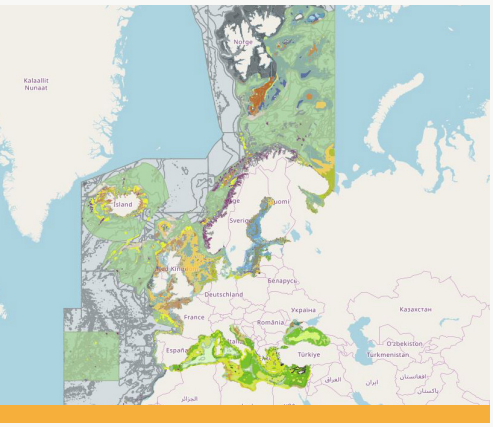
Seabed Habitats

emodnet.eu/seabed-habitats

2019 key facts

EMODnet Seabed Habitats launched a fresh new interactive map viewer on its Portal in 2019 which is more user-friendly and has additional tools, including the ability to control layer transparency and layer order.

The Portal contains the most comprehensive collection of habitat maps, sample points and predictive habitat models in Europe, collated from multiple sources. EMODnet Seabed Habitats also produced new data products related to seabed habitats in Europe. All these data and data products are freely available to view on the interactive map viewer and access via web services, and almost all are freely available to download.



© EMODnet Seabed Habitats

The main data updates are summarised below:

- The compilation of spatial data and products on European seabed habitats has continued to grow. In 2019, the collection grew to a total of 434,022 survey sample points, 855 habitat maps from surveys and 72 modelled maps of specific habitats.
- The growing compilation of habitat maps and sample points has provided an opportunity to combine data from multiple sources into new products that show the known extent and distribution of important habitats at a regional or international scale. We published the first such composite products in 2019, which show the known extent of three "Essential Ocean Variables" in Europe: Live hard coral, Macroalgal canopy and Seagrass. These are also available alongside data on other Essential Ocean Variables as part of the European Atlas of Marine Life.
- The broad-scale seabed habitat map for Europe ("EUSeaMap") has been updated for all European seas and increased its coverage to include the Barents Sea. Its spatial detail has also increased, as were used the best available seabed substrate polygon data from EMODnet Geology and the 100m DTM provided by EMODnet Bathymetry.
- In order to update EUSeaMap, new data products have been created to show the environmental conditions near the seabed. This includes kinetic energy due to waves and currents for the Mediterranean, Black Sea, Iberian Peninsula and Macaronesia. These were produced using inputs from the Copernicus Marine Environmental Monitoring Service and EMODnet Bathymetry. These products may be useful to anybody who wishes to model biodiversity at a regional scale.

In May 2019, Seabed Habitats published a review of habitat modelling in Europe, which provides a qualitative review of the current trends and status of seabed habitat modelling within European seas.
May 2019 saw the end of JNCC's tenure as coordinator of the Seabed Habitats consortium. After a summer break, a new contract began in September, with Ifremer taking the helm and JNCC remaining key in terms of providing technical expertise.

2019 key data providers and users

In 2019, 7 **data providers** contributed 156 maps to the compilation of habitat maps from surveys. Top 3 habitat map providers:

- **66 maps** from French institute for the research and exploitation of the sea (Institut français de recherche pour l'exploitation de la mer) (Ifremer), France
- **65 maps** from Hellenic National Oceanographic Data Centre, Hellenic Centre for Marine Research (HCMR), Greece
- **13 maps** from Lower Saxon Wadden Sea National Park / Lower Saxon State Department for Waterway, Coastal and Nature Conservation (Nationalpark Niedersächsisches Wattenmeer / Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz), Germany

To date, there are more than 80 **data providers** to the survey sample points compilation. Of these, 7 data providers have contributed over 10,000 samples each:

- Finnish Environmental Institute (SYKE), Finland
- French Biodiversity Agency (OFB), France
- Joint Nature Conservation Committee (JNCC), UK
- Centre for Environment, Fisheries and Aquaculture Science (Cefas), UK
- Scottish Natural Heritage (SNH), UK
- Seasearch, UK
- Natural England, UK

Examples of **users** of EMODnet Seabed Habitats outputs in 2019 are shown in the publications list at the end of the Annual Report.

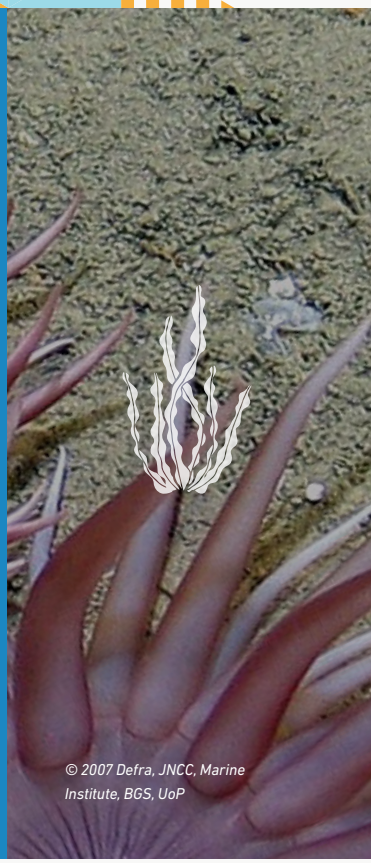
More examples of how EMODnet Seabed Habitats outputs has been used by business, policy makers and research can be found on the Use Cases section of the website.

©JNCC

SEABED HABITAT 2019 ROADSHOWS

EMODnet Seabed Habitats was presented at several events, including:

- International Council for the Exploration of the Sea (ICES) Working Group on Marine Habitat Mapping meeting, 3-7 June 2019, Mallorca, Spain
- Marine Strategy Framework Directive Technical Group (MSFD TG) Seabed meeting, 12-13 June 2019, Brussels, Belgium
- Sustainable Development at the Black Sea (SUST-BLACK) Conference, 8-9 May 2019, Bucharest, Romania
- Marine Geological and Biological Habitat Mapping (GEOHAB), 13-17 May 2019, Saint-Petersburg, Russia



2.2 EMODnet Central Portal

emodnet.eu

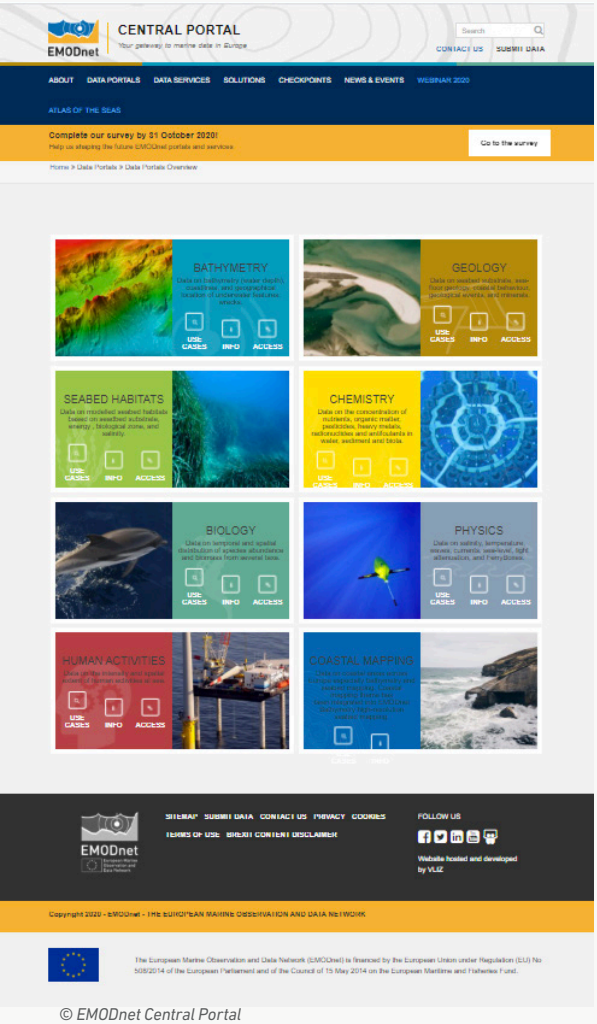
The EMODnet Central Portal is the gateway to all the EMODnet Thematic Portals and related data products and services. Supported by the Flanders Government, the Central Portal gives access to data provided by all the Thematic Portals and allows the retrieval of data layers from multiple Portals at the same time.

2019 key facts

There was a large year-on-year increase of unique visitors to the EMODnet Central Portal, reaching 42,900 in 2019.

There was a drive towards more user-friendly presentation of information, including the display of numbers in the statistics calculated in the query tool.

Where necessary, layer names that were changed in the lots were also adapted within the query tool. For example, change of EMODnet Biology layer names in web services.



© EMODnet Central Portal

New layers from different lots were added to the query tool and map viewer. Layer names were made more consistent across the query tool and webservices. Layers were cached in order to improve the performance of the layer.

An updated data and data product portfolio was published (August 2020).

EMODnet community pages were further developed, including for regional seas and ocean basins e.g. Atlantic Ocean, and for Global.

Updates to the Portal were implemented in order to comply with the General Data Protection Regulation. The changes included the inclusion/update of the data protection notice, enforcement of https encrypted connection and authorisation mechanism to request user permission for the use of third party cookies.

CENTRAL PORTAL 2019 ROADSHOWS

EMODnet Central Portal was presented at several events, including:

- JPI Oceans seminar, 17 January 2019, Brussels, Belgium
- Blauwe Cluster, 25/01/2019, West Flanders, Belgium
- EuroMarine General Assembly, 29-30 January 2019, Spain
- 25th Session of the IOC Committee on International Oceanographic Data and Information Exchange and Scientific Conference, 18-22/02/2019, Tokyo, Japan
- MARINE Conference, 12-13 March 2019, Boulogne-sur-Mer, France
- Ocean dialogues, 18-19 March 2019, Brussels, Belgium
- Conference EU Parliament, 19 March 2019, Brussels, Belgium
- Webinar on the European Aquaculture Society (EAS) and the new map European Maritime Day (EMD) in my country, 20 March 2019, Brussels, Belgium/remotely

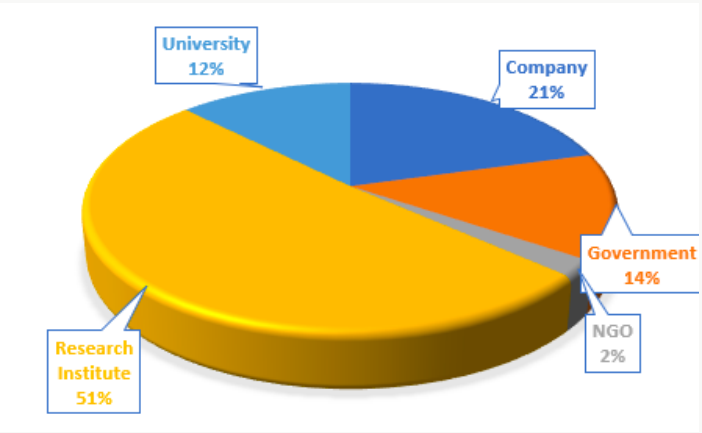
© SHIN-db

2.3 Data Ingestion

emodnet-ingestion.eu

There is a wealth of marine data collected in Europe by public and private users, such as governmental organisations carrying out environmental monitoring, academic researchers studying the marine environment, private companies planning and building marine infrastructures, such as pipelines and wind farms, and even citizens science initiatives. In recent years, EMODnet has made huge progress in facilitating access to data from many sources. However, numerous data still remain hidden or unusable.

EMODnet's Data Ingestion Portal tackles these problems by reaching out to data holders, explaining the benefits of sharing their data and offering a support service to assist them in releasing their data for subsequent processing and quality control.



EMODnet Data Ingestion division of published submissions (total 565) by organisation types in 2019

2019 key facts

The Data Submissions service achieved a steady increase of the number of submissions from 351 in early 2019 to 638 at the end of 2019. The number of completed submissions more than doubled from 263 to 565, which are published and made available for discovery and downloading by users via the View Submissions service. Most of these data sets are published 'as-is', however, already data sets of 207 submissions have been elaborated by assigned data centres to common formats and are made available by EMODnet Thematic Portals and as input for EMODnet data products.

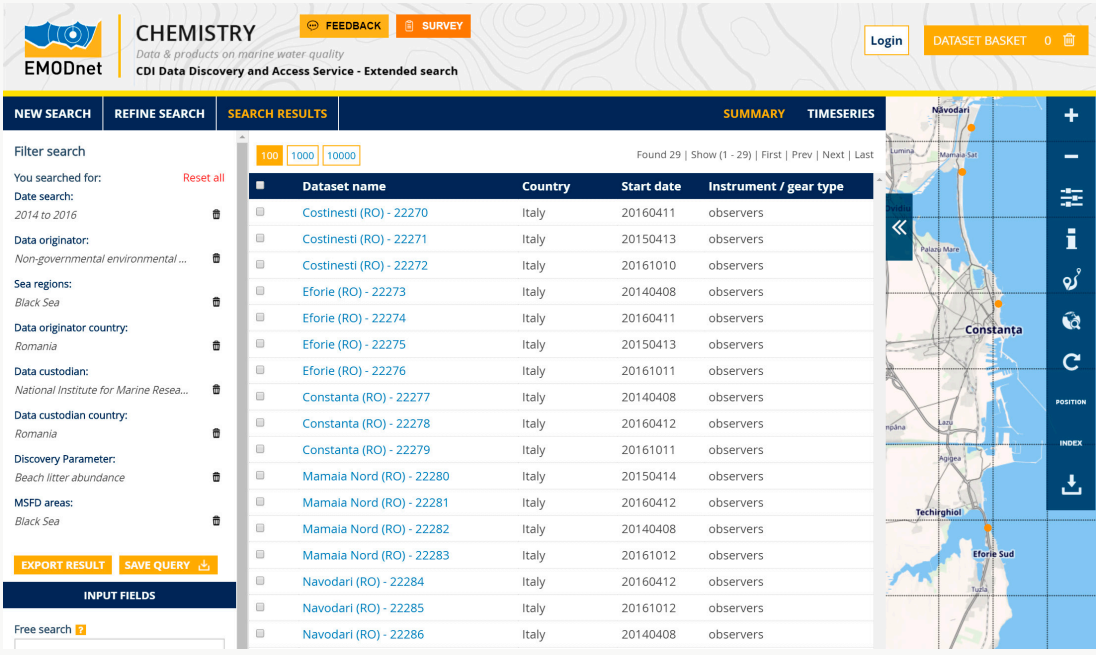
The network of qualified data centres now counts 49 data centres from EU countries. These data centres are experts in marine data management for specific EMODnet data themes and are also populating European marine data management infrastructures such as SeaDataNet, EurOBIS, ICES, and others which feed into EMODnet.

A (semi-)automatic coupling was established between SEANOE and EMODnet Ingestion. SEANOE, operated by IFREMER, is a SeaDataNet service, inviting European scientists to publish their scientific papers and associated data collections in return for a DOI which will facilitate their wider citation. The coupling facilitates that (selected) scientific submissions from SEANOE are harvested by EMODnet Ingestion for further metadata completion, publishing 'as-is', and elaboration of data sets for inclusion and publishing in national, European and EMODnet Thematic Portals.

EMODnet Ingestion not only aims at making archived marine data sets available, but this also concerns Near Real Time (NRT) and even Real Time (RT) operational oceanography data that are collected by fixed and moving platforms such as fixed stations, moorings, buoys, tide gauges, surface drifters, ferryboxes, argo floats, gliders, HF radars and other platforms.

Together with EMODnet Physics, in 2019 several operators of operational oceanography networks and platforms were motivated and given guidance for making their data sets part of the European oceanography data exchange as managed by Copernicus CMEMS-INSTAC, EuroGOOS, and SeaDataNet, which are pillars under EMODnet Physics.

And again, in cooperation between EMODnet Ingestion and EMODnet Physics, the Sensor Web Enablement (SWE) pilot concerning giving discovery and access to real time oceanographic monitoring systems has been expanded with more operators and platforms, allowing direct standardised access to selected data types from selected monitoring instruments.



Example of Marine Litter data submission with elaborated data sets included in EMODnet Chemistry
© EMODnet Chemistry

INGESTION 2019 ROADSHOWS

EMODnet Ingestion was presented at several events, including:

- Dedicated workshops were held for observing communities in February and April 2019 in Italy to promote joining the European operational oceanography data exchange and the uptake of the pilot with Sensor Web Enablement (SWE) standards and Real Time (RT) Portal
- National EMODnet events in The Hague, The Netherlands, in January 2019, Helsinki, Finland, in February 2019, Athens, Greece, in March and May 2019, Oninsk, Russia, in March 2019, Rotterdam, The Netherlands, in March 2019, Rijswijk, The Netherlands, in April 2019, Barcelona, Spain, in May 2019
- Dansk Havforskermøde - The Danish Marine Research Meeting, 23-25 January 2019, Odense, Denmark
- European Space Agency (ESA), Atlantic from Space Workshop, 23-25 Jan 2019, Southampton, United Kingdom
- Organisation for Economic Co-operation and Development (OECD) meeting, 14 February 2019, Lisbon, Portugal
- WG DIKE – Marine Strategy Framework Directive (MSFD) meeting, 26 February 2019, Brussels, Belgium
- INTERREG (EU's Interreg Baltic Sea Region Programme) CW Pharma project meeting, 5-7 March 2019, Tallinn, Estonia
- Joint Meeting of the Expert Team on WIS Centres (ET WISC) and Task Team on Data Centres (TT DC), 12-15 March 2019, Beijing, China
- Civil Hydrography Annual Seminar, 14-15 March 2019, London, United Kingdom
- SEANSE project meeting, 18-19 March 2019, Brussels, Belgium
- World Meteorological Organization (WMO), Inter-Programme Expert Team on Integrated Marine Meteorological and Oceanographic Services within WMO and IOC Information Systems (IPET-MOIS) 20-22 March 2019, Geneve, Switzerland
- JRC (Joint Research Centre) Algae Workshop, 26-27 March 2019, Brussels, Belgium
- Knowledge Exchange Day for Offshore Wind Ecological Programme (WOZEP) (wind pilots), 16 April 2019, Scheveningen, The Netherlands
- FOCUS General Assemby, 29 April 2019, Liege, Belgium
- DigiShape meeting, 30 April 2019, Delft, The Netherlands
- International Conference "Sustainable Development at the Black Sea", 8-9 May 2019, Bucharest, Romania
- 50th Anniversary of British Oceanographic Data Centre (BODC), 8 May 2019, Liverpool, United Kingdom
- Knowledge Exchange Day for Northsea projects, 9 May 2019, Scheveningen, The Netherlands
- European Maritime Day 2019, 16-17 May 2019, Lisbon, Portugal
- International Conference SEA-CONF 2019 and "Sailing to the future" Exhibition, 18 May 2019, Constanta, Romania
- Nord Stream 2 pipeline data exchange meeting, 10-11 July 2019, Zürich, Switzerland
- OceanObs 2019 conference, 16-20 Sept 2019, Honolulu, USA

EMODnet

YOUR GATEWAY TO *IN SITU* MARINE DATA, DATA PRODUCTS AND SERVICES IN EUROPE AND BEYOND

EMODnet
European Marine Observation and Data Network

DISCOVER THE EMODNET PORTFOLIO, A CATALOGUE OF ALL EMODNET DATA AND DATA PRODUCTS

VISUALISE

DISCOVER

DOWNLOAD

WEB SERVICES

EMODnet
European Marine Observation and Data Network

OPEN SOURCE MARINE KNOWLEDGE BROKER

EMODNET IMPLEMENTS THE MARINE KNOWLEDGE 2020 STRATEGY TOGETHER WITH THE MARINE SERVICE OF THE COPERNICUS SPACE PROGRAMME AND THE DATA COLLECTION FRAMEWORK (FISHERIES AND ENVIRONMENTAL DATA THROUGH ICES)

ICES CIEM

Copernicus Marine Service

EMODNET SERVES AN INTERNATIONAL, PROFESSIONAL USER COMMUNITY SPANNING RESEARCH, POLICY, BLUE ECONOMY AND CIVIL SOCIETY

HUMAN ACTIVITIES

Aggregate extraction - Algae production - Aquaculture - Cables - Cultural heritage - Dredging - Environment - Fisheries - Oil and Gas - Main ports - Ocean energy facilities - Other forms of area management/ designation - Pipelines - Waste disposal - Vessel density - Wind farms

GEOLOGY

Seabed substrate-Seabed accumulation rates-Seafloor lithology, stratigraphy and fault maps - Coastal behaviour - Geological events distributions - Mineral occurrences - Submerged landscapes - Quaternary geology - Geomorphology - Boreholes locations - Seismic tracks

BIOLOGY

Phytoplankton - Zooplankton - Macro algae - Seagrass - Fish - Reptile - Bird - Sea mammals - Benthos - Functional traits - Introduced species - Protected species - Indicator species

BATHYMETRY

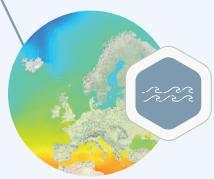
Digital Terrain Model - Survey tracks and bathymetric survey data - Source references - Depth contours

SEABED HABITATS

Survey point data - Broad scale seabed habitat map - Environmental variables influencing habitat type - Individual seabed habitat maps from surveys - Modelled maps of specific habitats - Composite data products

CHEMISTRY

Acidity - Antifoulants - Chlorophyll - Dissolved gases - Fertilizers - Heavy metals - Hydrocarbons - Marine litter (micro, beach, seafloor) - Organic matter - Pesticides and biocides - Polychlorinated biphenyls - Radionuclides - Silicates



PHYSICS

Wave height and duration - Sea temperature - Wind speed and direction - Salinity - Horizontal speed of the water column - Water clarity - Changes in sea level - Inflow from rivers - Water conductivity / biochemical parameters - Atmospheric parameters - Underwater noise

www.emodnet.eu @EMODnet EMODnet

For full list of data and data products visit emodnet.eu/data-portfolio

The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund.

3. EMODnet in practice: our users' opinions

Users are at the centre of EMODnet's strategy. It is clear that the data and the products provided by EMODnet are important for many applications. If one takes bathymetry as an example: bathymetry data has become a fundamental data set for multiple scientific disciplines, including physical oceanography, marine geology, and benthic ecology, as well as 3D-multichannel seismic information for oil- and gas exploration and bathymetric and geophysical information for the stability of platforms and planning of pipeline routes.

These represent only a few of the ways in which EMODnet data products are fundamental to users, but to understand the impact of what is being done so far, users were asked to describe how EMODnet supports them in their daily work and life. Below you can find some examples of use cases for EMODnet data and data products. Further use cases can be viewed on the EMODnet Central Portal.

Use case

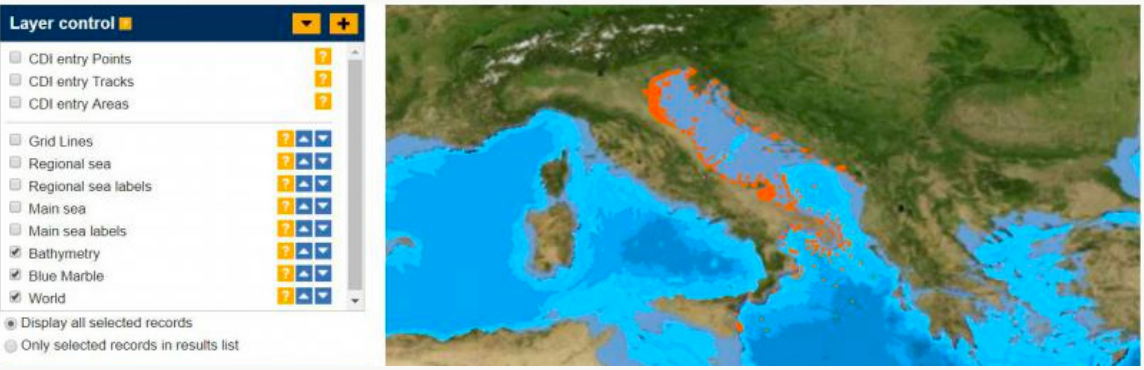
Portal: Chemistry

Field: Research
Policy Makers

EMODnet Chemistry data improving quality control guidelines

In order to promote a harmonized approach to the evaluation of quality of data of contaminants in the ADRION (Adriatic and Ionian Seas) region in the context of the HarmoNIA project, a subset of EMODnet Chemistry data were analyzed to identify measurement units used by the different laboratories, matrix characteristics, concentration ranges as well as completeness of required metadata. According to the results, a common protocol and statistical approach to assess Quality Control of data of contaminants in the marine environment will be proposed and shared within HarmoNIA as well as within EMODnet Chemistry partnerships to improve data quality and fitness for use. Through this activity, EMODnet Chemistry has contributed to best practices to support transnational harmonization for the Marine Strategy Framework Directive (MSFD) and the United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP) protocols implementation.

Read the full use case: https://bit.ly/39mBtys



Spatial distribution of research and monitoring stations used by Interreg-ADRION HarmoNIA project
© EMODnet Chemistry

Use case

Portal: Physics, Chemistry

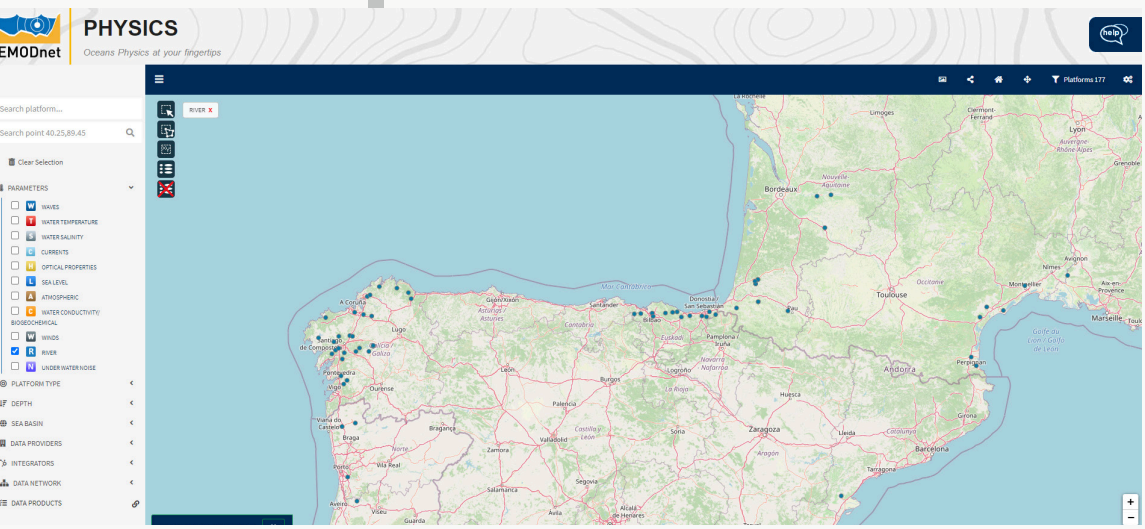
Field: Research, Policy Makers

Copernicus Marine Service

EMODnet & CMEMS together to build a framework for improving land boundary conditions in CMEMS regional products

The EMODnet river data service provided by EMODnet Physics supported the LAMBDA (LAnd-Marine Boundary Development and Analysis) project to demonstrate the quality of modelling results produced by the watershed models. The EMODnet Physics river data service provides a unique one stop shop for operational near real time river data in a standardised format for several countries facilitating the access, download and validation of this kind of data. It enhanced CMEMS by aiding in watershed models validation and quality control thus improving their forecast services.

Read the full use case: https://bit.ly/2CKnxCz



River stations
© EMODnet Physics

Use case

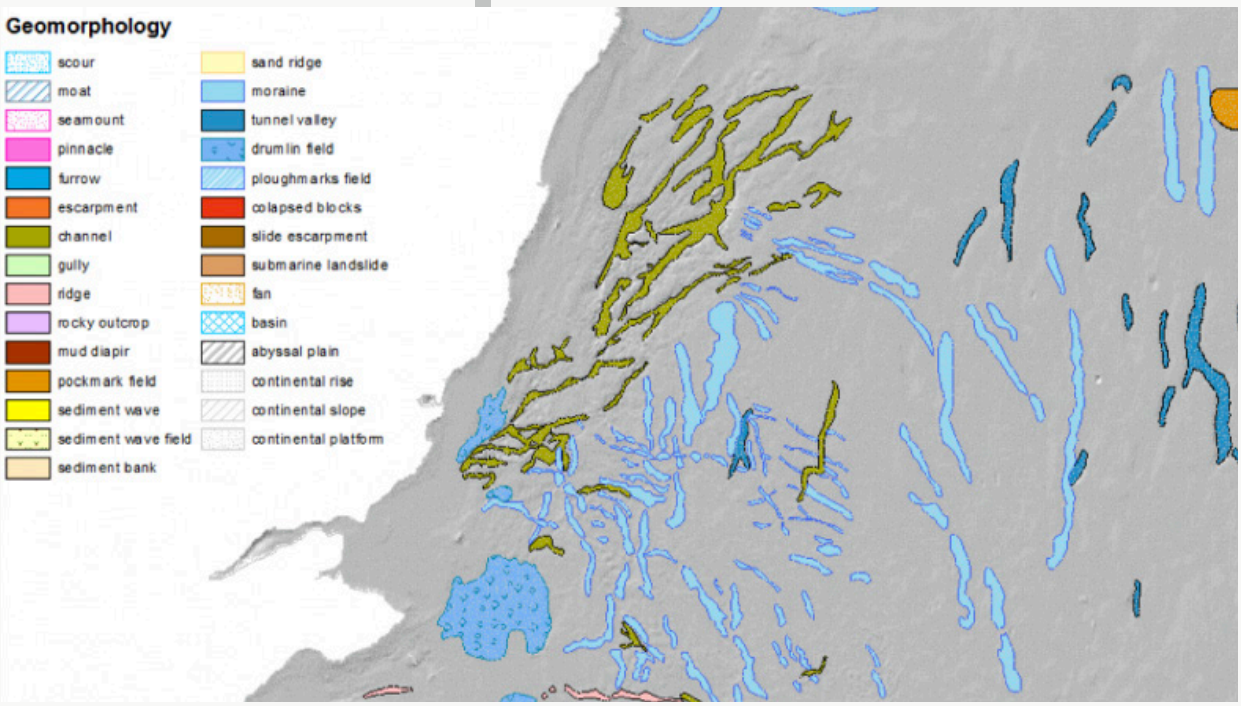
Portal: Bathymetry Geology

Field: Research

Bathymetry data at the core of geomorphological mapping

EMODnet Geology adds value to EMODnet Bathymetry data by providing geomorphological interpretations for seabed-depth data, that adds explanatory and potentially predictive capability to the EMODnet Bathymetry data set. Coupled to data products on Seabed Substrate, stratigraphy and lithology, geomorphology is being mapped both transnationally and at large spatial scales. Easy accessibility of a harmonised bathymetric data set has streamlined and accelerated this process, and has facilitated collaboration among partners.

Read the full use case: https://bit.ly/2BoPfnC



Seabed geomorphology on the east coast of Scotland.
© EMODnet Geology

Use case

Portal: Human Activities

Field: Industry

CATHIE ASSOCIATES

EMODnet data enables an international consultancy to become more efficient, provide better services and remain competitive in the market

For the international geoscience and geotechnical engineering consultancy Cathie Associates, the EMODnet Human Activities database has become an important addition to current projects, with cables, pipelines and hydrocarbon extraction being the main data sets downloaded. Cathie Associates uses EMODnet Human Activities as a primary data source in the early phases of projects and tenders as it provides an open-sourced and reliable data that adds value to the services they provide to clients.

Read the full use case: https://bit.ly/2D15sQm

Use case

Portal: Bathymetry Physics

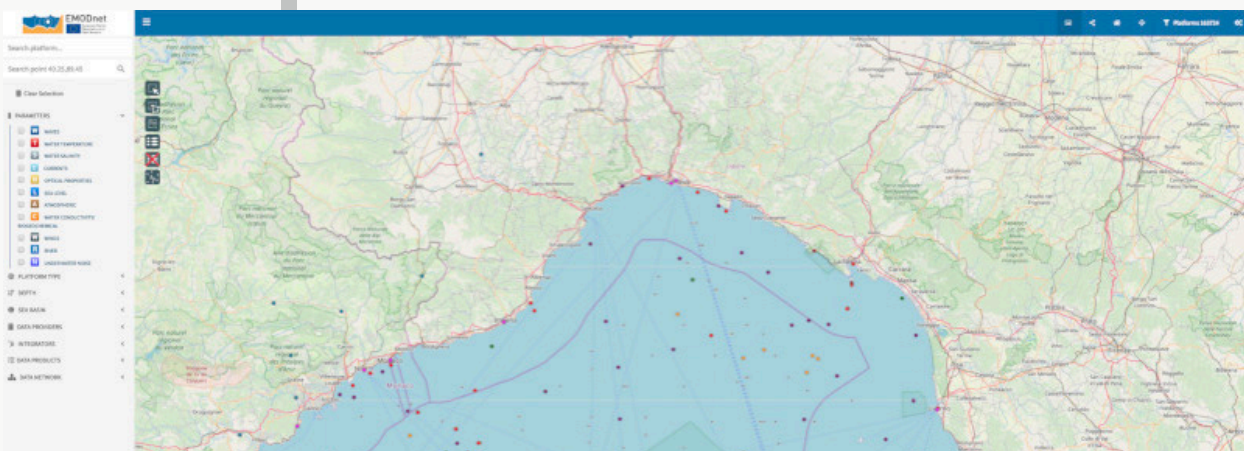
Field: Industry

SINDBAD Sicurezza della Navigazione da Diporto

EMODnet Bathymetry & Physics data supporting Sea Situational Awareness for tourist navigation

SINDBAD+ is a project co-funded by the European Commission (POR FESR 2014-2020), that aims at the development of an advanced operational service to support navigation in the Ligurian Sea (Mediterranean Sea). The project is going to develop an ICT Service Infrastructure able to support tourist navigation providing innovative "intelligent" automation functions and developing ad-hoc services, accessible through smartphones, able to really help those who have to make decisions about how and where to conduct their boat to avoid any kind of risk and to ensure comfort. The SINDBAD partners use EMODnet Physics and EMODnet Bathymetry to initiate and validate data forecast models.

Read the full use case: https://bit.ly/30DZtco



Oceanographic data platforms in the Ligurian Sea @EMODnet Physics

4. EMODnet partnerships go global

EMODnet has an even expanding global outlook, with an increasing number of data sets available through EMODnet services from seas and oceans beyond European waters, including across the Atlantic Ocean, the Southern Ocean and Arctic Ocean. EMODnet is engaging with international stakeholders outside of Europe to move towards greater harmonization and interoperability between major data sharing initiatives. The international user base is also growing from Africa to China, together with international blue economy industries.

IODE International Oceanographic Data and Information Exchange

© IODE Secretariat

EMODnet collaborates with other European and international data initiatives including the Copernicus Programme, in particular the Marine Environment Monitoring Service (Mercator Ocean International), the International Council for the Exploration of the Sea (ICES), the Global Earth Observation System of Systems (GEOSS), the International Oceanographic Data and Information Exchange (IODE) of the Intergovernmental Oceanographic Commission (IOC), and the National Marine Data and Information Service (China), through EMOD-PACE (EMODnet PArtnership for China and Europe). Partnerships are also increasingly global with EMODnet Physics providing a tailored SOOSmap interface for the Southern Ocean observing community to assemble and integrate their data in one place. EMODnet Biology, through EurOBIS, contributes 20 million data records to the international OBIS. EMODnet Bathymetry is a large European contribution to the international Seabed2030 initiative, having signed an MoU in 2019 to further strengthen collaboration.

2019 Highlights

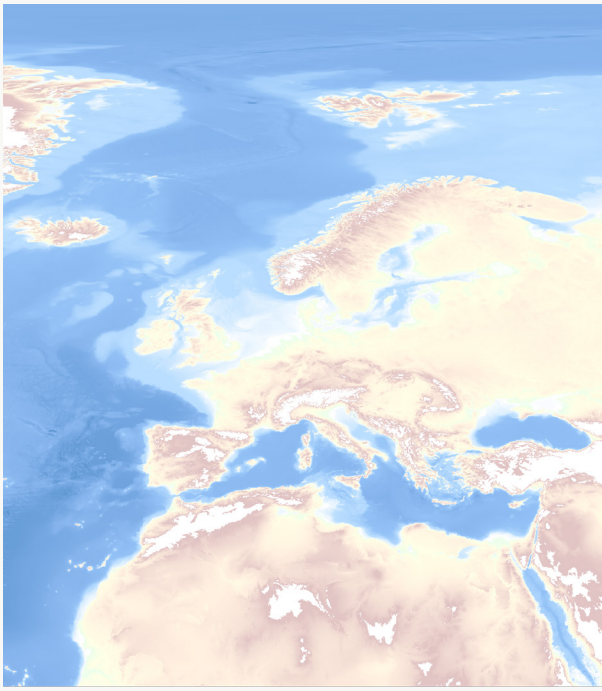
IODE meeting

On 20-22 February 2019, Head of the EMODnet Secretariat Jan-Bart Calewaert attended the 25th session of IOC UNESCO's International Data and Information Exchange (IODE) Committee in Tokyo (Japan). At the meeting, Jan-Bart Calewaert presented an overview of the progress on marine data and information sharing efforts made in Europe.

At this meeting, EMODnet was recognised as a key European marine data initiative. EMODnet committed to increase its support to the IODE programme activities, with specific contributions to the Inter-sessional Working Group on Strategy on Ocean Data and Information Stewardship (IWG-SODIS) for the UN Decade of Ocean Science for Sustainable Development, and as a European focal point for the developing IOC Ocean information Hub, working with European initiatives including EurOcean.

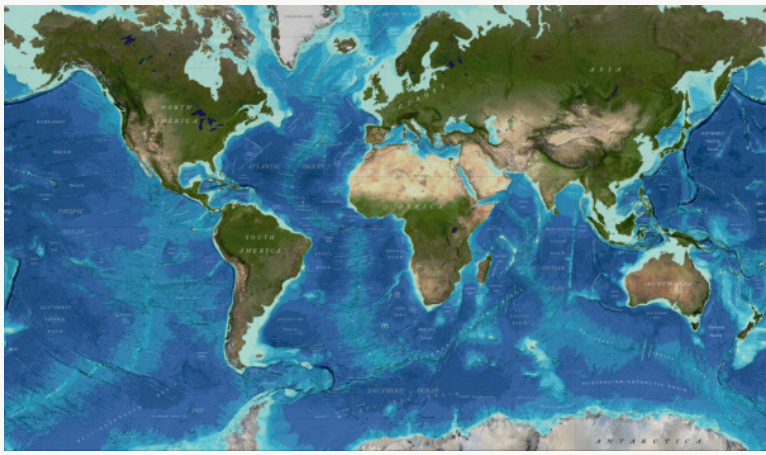
Memorandum of Understanding (MoU) EMODnet Bathymetry - Seabed 2030

Seabed 2030 was launched at the United Nations Ocean Conference in 2017. It is a collaborative project between the Nippon Foundation and the General Bathymetric Chart of the Oceans (GEBCO), with the vision to fully map the world ocean floor by 2030 and make the definitive map freely available. EMODnet Bathymetry is a major European contributor to this international initiative of mapping the World Ocean Floor. There has already been a close cooperation between the GEBCO project and EMODnet Bathymetry since its start in 2008, whereby the GEBCO digital bathymetry is used by EMODnet to cover gaps in its coverages, while the resulting EMODnet Digital Terrain Model (DTM) is used by GEBCO to improve its bathymetry for European marine basins. EMODnet Bathymetry signed a Memorandum of Understanding (MoU) with the The Nippon Foundation-GEBCO Seabed 2030 Project in September 2019. With this MoU, EMODnet Bathymetry and Seabed 2030 will work in synergy to facilitate the exchange of data products to fill gaps in ocean bathymetry, as well as to exchange and promote methods and best practices in ocean mapping and bathymetric data management.



© EMODnetBathymetry
EMODnet Bathymetry Digital Terrain Model, 2018 edition, geographic WGS84 projection.

Portal:
EMODnet Bathymetry
emodnet-bathymetry.eu



© GEBCO

EU-China: EMOD-PACE

In 2019 a new partnership project EMOD-PACE was funded under the Partnership Instrument on 31 October 2019 (EuropeAid/139904/DH/SER/CN 'Strengthening international ocean data through the EU's ocean diplomacy with China').

The ground-breaking collaboration between the EU and China aims to deliver a major part of the EU contribution to the EU-China Blue Partnership for the Oceans. The shared objective of this EU-China Partnership is to ensure a well-supported and effective ocean governance structure for the conservation and sustainable use of the oceans and their resources. These efforts will support sustainable fisheries, a thriving and sustainable maritime economy combined with good environmental status for a healthy ocean. The project involves all EMODnet thematic areas and the Chinese counterpart NMDIS (National Marine Data and Information System), and the project kicks off in 2020.

OceanObs 2019: September 2019

EMODnet showcased a decade of knowledge brokerage at the decadal Conference OceanObs'19 took place in Hawai'i in September 2019, with 1500 participants at the Hawai'I Convention Center, Honolulu. Represented by the EMODnet Secretariat, experts from EMODnet Bathymetry, Biology, Chemistry, Geology, Physics and Data Ingestion Service, and Sea-basin Checkpoint Coordinators, EMODnet illustrated its latest work in a EMODnet Community White Paper published in Frontiers journal of Marine Science in July 2019 and led by Bélen Martín Míguez and 30 other co-authors spanning all EMODnet thematics and services. In collaboration with other long-term data services in Europe (e.g. Copernicus Marine and Data Collection Framework), This high presence of EMODnet Coordinators and key experts increased the communication of EMODnet to the international community of ocean observing, monitoring and data services communities and the contribution of EMODnet to international ocean best practices and to open source FAIR data. EMODnet contributed across all four themes of OceanObs19: Information, Integration, Innovation and Interoperability. In addition, Andreea Strachinescu, Head of Unit A1 Maritime Innovation, Marine Knowledge and Investment at the European Commission Directorate-General for Maritime Affairs and Fisheries spoke on a panel looking ahead to next steps for ocean observations and marine data.

OCEAN OBS'19
AN OCEAN OF OPPORTUNITY
September 16-20, 2019

© OceanObs'19 Conference

5. Open Sea Lab hackathon II: 2019 Edition

The concept

EMODnet data hold enormous potential to create new business opportunities, to increase ocean knowledge and understanding of our marine and coastal environments and to underpin better management and protection of our precious marine resources. But how can we realise this potential and how do we demonstrate it to users? Open Sea Lab was conceived from a desire to increase the awareness and use of EMODnet resources amongst new communities of users. The first EMODnet Open Sea Lab took place in November 2017, in Antwerp (Belgium), as a collaboration between EMODnet, Flanders Marine Institute (VLIZ) and imec, and with support from the European Commission's Directorate General for Maritime Affairs and Fisheries (DG MARE).

Open Sea Lab is a hackathon, but much more, it is an expert led, deep dive into the world of marine open data. Open Sea Lab adopts a user focused approach to create novel applications from marine data.

Open Sea Lab II

EMODnet's second Open Sea Lab took place in the vibrant and historic city of Ghent from 4-6 September 2019. It sought to build on the success of the first Open Sea Lab by extending the collaboration to include the International Council of the Sea (ICES) and Copernicus Marine (CMEMS), increasing both the data resources, and expertise, available during the hackathon.

Open Sea Lab II (OSL II) was officially launched on 24th of May in Brussels, at a kick-off event. The event marked the opening of applications for OSL II, and announced the three thematic challenge areas that participants were invited to address: 'Ocean Literacy and Blue Society', 'Sustainable Blue Economy', and 'Marine Environmental Management and Protection'. EMODnet's first Open Sea Lab had 48 applications, OSL II saw that number grow to 120 applications with finally 69 participants competing. Some applicants returned for a second go, which highlights what a positive experience participating in OSL is.

@ Dirk Leemans

The 16 OSL II teams and their concepts

OSL II Team	Concept
Byte Bear	Interactive educational app linking choices humans make in their daily life to the environmental impact of these activities
ILVO (1st prize award)	Interactive fish stock assessment tool' to allow non-specialists
Team 4	Public awareness tool of key fish species status to inform responsible consumption.
Zebra Muscle	A dynamic decision-making tool for safe dumping of ship ballast waters, to reduce invasive species distribution
Oilbusters	Open, public oil spill detection service
Changing Seas (Greenbridge prize)	Educational augmented reality app to help families make responsible choices to protect their marine environment
Seeing Ear	Virtual bathyscope, an app to simulate an ocean dive for blind and partially sighted people
Digital Twin North Sea1	Tool to demonstrate suitability maps for wind farms siting
Digital Twin North Sea2	Interactive visualisation tool showing the environmental impacts of a wind-farm over time, to increase stakeholder engagement and support more holistic decision making
Py Fish	Tool to support responsible fishing to by developing maps of most suitable areas to fish in a sustainable way
Ocean Wizards	Tool to show impact of vessel traffic on some key marine species
Finding Demo	Tool to help divers record and report new sightings of invasive species
I-Fish	Tool to assist enforcement officers to carry out control tasks for overfish-ing
Ocean Ecology	Tool to enhance *in situ* survey data using open data Portals
Overlap	Predictive tool for industry or policy makers to determine the impact of a new human activity on species on the seabed
CODeFish (VLIZ prize and OVH prize)	Tool to provide near-future decision support for fisheries

Open Sea Lab was organised by the EMODnet Secretariat, in collaboration with VLIZ, Copernicus Marine and ICES, and with the contribution of imec and Marine@UGent. Supported by the European Commission and VLIZ.

The Open Sea Lab team was proud to work with:

Open Sea Lab II in numbers

- **2nd** Open Sea Lab
- **3** Days
  (4-6 September 2019, Ghent, Belgium)
- **120** Initial applicants
- **9** Challenges
- **69** Final participants
- **14** Nationalities
  (Belgium 18, France 1 , Germany 3, Ireland 4, Italian 2, Netherlands 11, Norway 7, Portugal 2, Russia 11, Singapore 1, Sweden 2, Turkey 4, United Kingdom 12, America 1)
- **26** Coaches
  (13 EMODnet (4 VLIZ), 3 ICES, 3 CMEMS, 1 GFW, 2 OVH)
- **11** Workshops
- **16** Teams
- **9** Jury members
- **8** Team prizes

First image: Team 'Ilvo' receiving the 1st prize award from Jan-Bart Calewaert (EMODnet Secretariat); second image: Team 'CODeFISH' receiving the VLIZ prize from Tina Mertens (VLIZ); third image: Team CODeFISH receiving the OVH 1st prize from Rémy Vandepoel (OVH); fourth image: Team 'Changing Seas' awarded the Greenbridge prize by Noémie Wouters (Greenbridge).

6. Strengthening the European Atlas of the Seas towards schools and educational activities

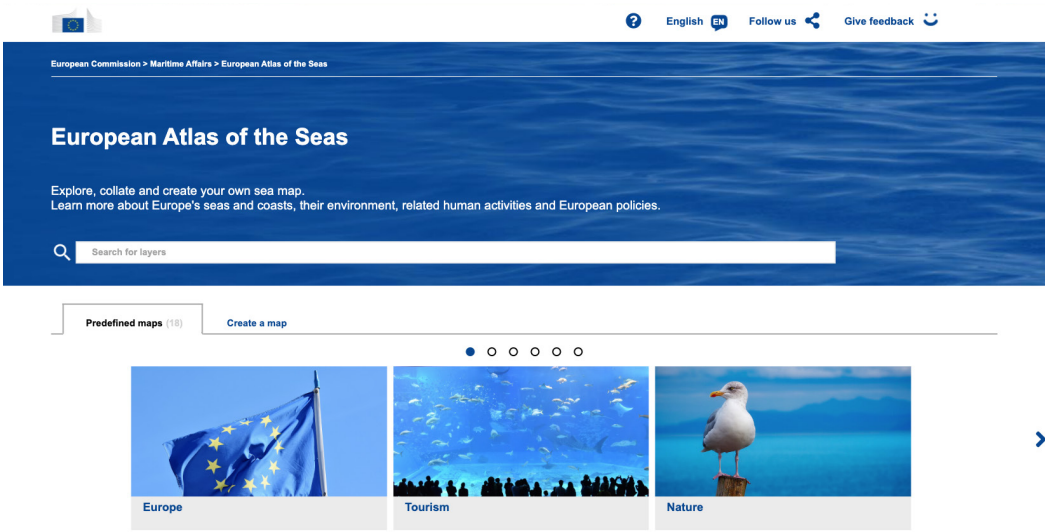
About the European Atlas of the Seas

The European Atlas of the Seas is an interactive web-based tool available for the general public, non-expert professionals and schools. First launched in 2010 by the European Commission, Directorate-General for Maritime Affairs and Fisheries (DG MARE), it brings at-a-glance data in a comprehensive and fully visual way, while at the same time serving as a support tool for marine policy and the blue economy.

The Atlas hosts a wealth of information about Europe's marine environment and related human activities, covering topics such as nature, tourism, security, energy, passenger transport, sea bottom, sea level rise, fish consumption, and much more. The data available come primarily from the European Commission and its agencies (Eurostat, the European Environment Agency, the Joint Research Centre, Copernicus, etc.) and from EMODnet.

Since September 2017, the EMODnet Secretariat has taken over the management of the Atlas with a mission to further expand the range of services and features and improve the interface, functionality and content. The brand-new version of the Atlas was released in June 2018 with many new features, and an interface more adapted to users.

https://ec.europa.eu/maritimeaffairs/atlas_en



After the important revamp of the European Atlas of the Seas by the EMODnet Secretariat in 2018, the year 2019 was the opportunity to further enrich the content of the Atlas with EMODnet data products and improve the usability of this web-based tool while enhancing partnerships and communication efforts to increase its use, especially in the context of DG MARE's ocean literacy efforts.

The European Atlas of the Seas featured in Educaá, the teachers' magazine of the aquarium Nausicaá

Atlas demo and game with Escola Azul's pupils

Key achievements in 2019:

- A significant increase of the Atlas catalogue content underpinned its use for education. In December 2019, the Atlas catalogue contains nearly 300 map layers. Among the new maps available, we note several maps on marine and beach litter (data supplied by EMODnet Chemistry), maps on the Blue Indicators (an initiative of the EC DG MARE), the European Maritime Day "EMD in my country" map and many others.
- Two Memorandums of Understanding were signed in 2019 to promote and further develop the Atlas as a strong and must-have educational tool. A partnership was established between the EMODnet Secretariat and NAUSICAÁ, the biggest aquarium in Europe, as well as with the Directorate General For Maritime Policy (DGPM) in Portugal, driving the project Escola Azul.
- The usability of the tool is constantly improved based on user feedback. A feedback form was integrated into the Atlas, making it an even more visually stimulating and easy to navigate tool.
- Communication efforts have increasingly strengthened the visibility of the Atlas. These include the presentation of the Atlas at marine and maritime events, participation at multiple webinars, development of quizzes, creation of an Instagram account (in addition of Twitter and Facebook social media accounts) and a series of four workshops with students and teachers to showcase the potential of the Atlas for education purposes.
- A teachers' corner with many exercises for different age groups was implemented reflecting and supporting an increased emphasis on furthering the ocean literacy and education content and use of the Atlas.
- In 2019, the number of users were around 3000 per month, an increase in visitors of 50% since 2017.

THE EUROPEAN ATLAS OF THE SEAS

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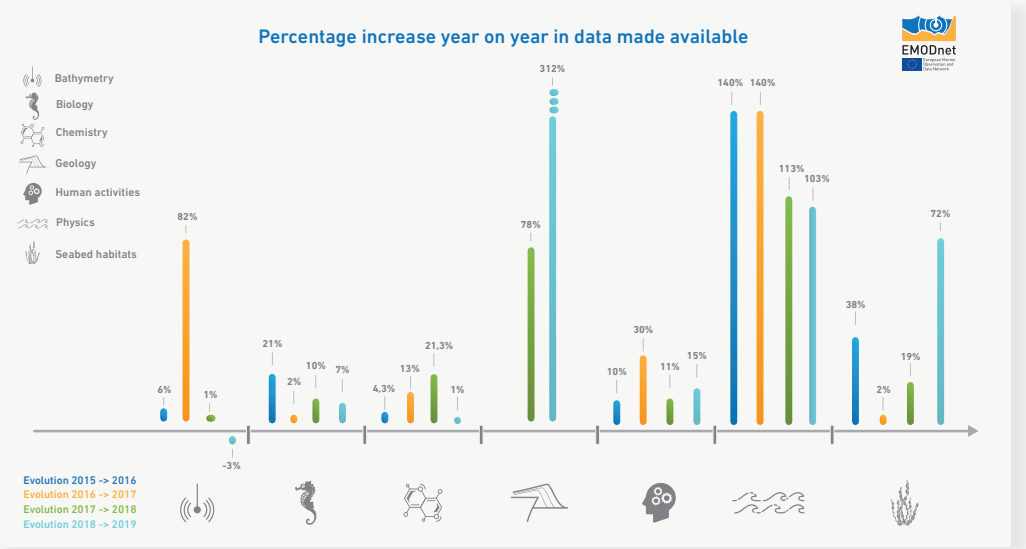
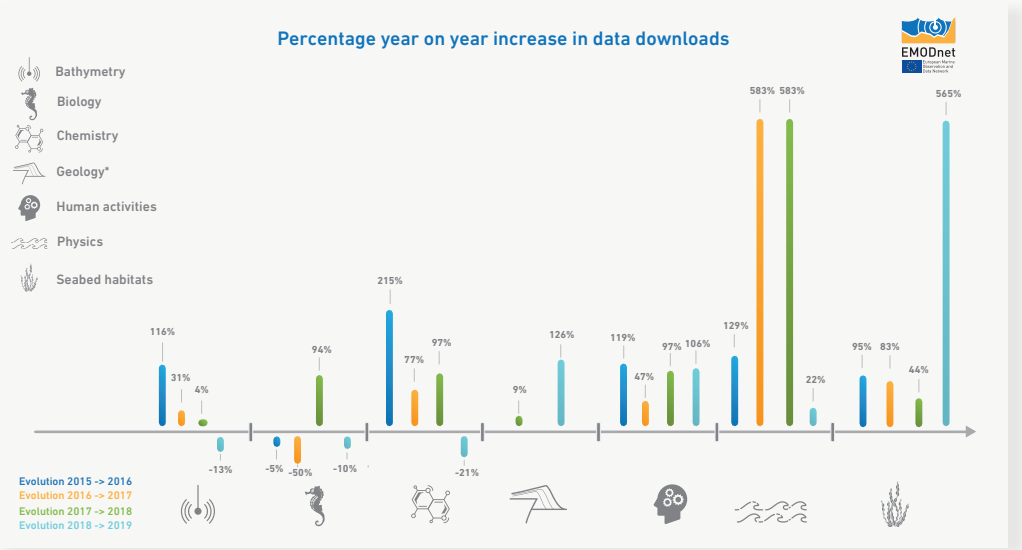
7. EMODnet in figures



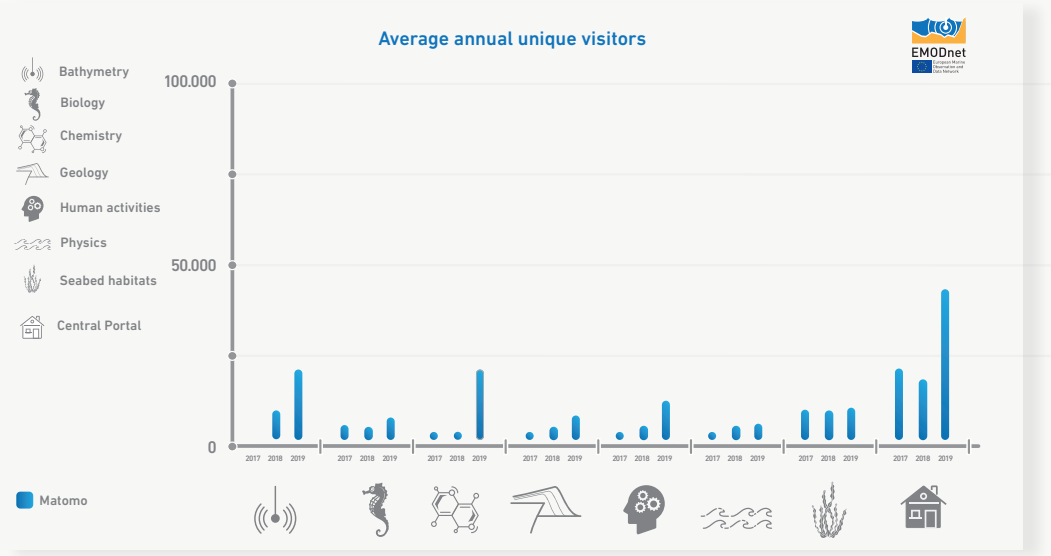
In 2019 the percentages of data made available by the Portals have varied as described below:

- **Bathymetry**: During the year, a major data provider changed its data policy, resulting in a considerable decrease in number of published data sets. This was already partly compensated in 2019 by new entries from other data providers, while a further increase is underway in 2020 as part of the preparation of the next release of the EMODnet DTM (planned for end 2020).
- **Biology**: The increase is slightly lower compared to the previous year as the data sets onboarded in 2019 contain fewer records than in the previous year and due to the time spent on standardisation and quality control procedures undertaken before data are made available online. In addition, the lower percentage of new data made available can also be attributed to the high variability of biological data and the difficulties in harmonising biological surveys, meaning that it can take more time and effort to produce new biological data sets and data products.
- **Chemistry**: The number of data sets (meaning data series along depth or along time in the water column, in the sediment or in biota) in absolute numbers is very high and the yearly increase amounting to 10.036 CDIs marks an increase rate of 1%. This optimal result shows the value of working in synergy with SeaDataCloud (and with SeaDataNet data infrastructure) that allowed to keep alive data collection even during the 6 months stop of EMODnet Chemistry financial support (this is why the percentage of 2019 represents only part of EMODnet Chemistry data Downloads during 2019).
- **Geology**: The increase in data available is due to the release of new data products in April 2019. Some of the updated products also have a significant higher number of spatial geometries compared to earlier releases.
- **Human Activity**: New data sets / products were released in 2019, among which are vessel density maps, route density maps, nuclear power plants, urban wastewater treatment facilities, MSFD reporting units and that largely explains the trend (Please note that vessel density is a data product and is reported as one data set).
- **Physics**: The increase percentage is the result of the work and collaboration with the PANGAEA initiative that allowed EMODnet Physics to increase the amount of available data especially for Temperature and Salinity in the water column (increase of 136% and 176% respectively).
- **Seabed Habitats**: The increase of the data sets made available in 2019 was because of a large upload of collated habitat maps from survey, along with publishing the individual products used to produce EUSeaMap 2019 such as the environmental layers, habitat descriptors etc.



In 2019 the percentage increase in data downloads by the Portals have varied as described below:

- **Bathymetry**: Whilst the number of downloads of Digital Terrain Model (DTM) tiles decreased from circa 44.000 in 2018 to circa 38.000 in 2019, this remains a large number and volume, clearly indicating the continued high interest in the EMODnet DTM. The downloading was done by more than 2.100 unique users, while there was also an increasing number of users of the OGC services, such as more than 20 million WMS requests in 2019.
- **Biology**: The decrease reported in 2019 is due to different factors, e.g the products available are not adequate for the type of users visiting the Portal or the data the users are looking for is not yet available for download. In addition, many existing data sets had already been downloaded in previous years, and the number of new data sets to download was low because of the increased effort required to produce new biological data sets. Measures to address these factors focus not only on promoting the products and data sets, but also releasing other type of products that can cater for various user communities.
- **Chemistry**: The decrease is due to the fact that the figures do not take into account the manual data exchange with EEA (contaminants in biota was released in early 2019) and EU Joint Research Centre (JRC) (Long time-series data of dissolved oxygen for the Baltic Sea and Greater North Sea, of eutrophication in the Black Sea). The figures also as do not consider the aggregated and validated data sets downloaded as data products.
- **Geology**: The increase in data downloads is due to the release of new data products.
- **Human Activities**: The increase in data downloads is mainly due to the release of the density maps, which quickly became the most downloaded data set / product on EMODnet Human Activities. Wind farms – which used to be the most downloaded data set ever since they were released – are now the second most downloaded data set. Generally speaking, number of downloads remained stable for all of the other data sets, so the addition of the vessel density map easily explain the upward trend. *Vessel density is a data product and is reported as one data set.
- **Physics**: While in the period 2017-2018 a massive increase of data downloads for opening new M2M service was recorded, in the period 2018-2019 the consolidated increase of data is due to system users who, according tracked behaviours, do their interaction with the EMODnet Physics by manually downloading data (increase 80%).
- **Seabed Habitats**: The larger increase on the number of downloads is likely due to the use of the web services for extracting data, as the new mapper infrastructure was deployed in March 2019, and to the Open Sea Lab II event. This reflects the gradual shift for machine-to-machine data extraction, with increasing amounts of data scientists asking for tutorials on how to access the data.



Almost all the Portals have recorded an increase in the average annual unique visitors/Portal demonstrating a consolidated community of users. A common user statistic system, Matomo Statistics tracking, is now used for all Thematic Portals. Further explanation is provided below, for each thematic Portal.

- **Bathymetry**: EMODnet Bathymetry remains one of the most visited Portals. However, in 2019 the number of unique visitors was less than previous years. This is potentially due to many people returning and using the service multiple times, whilst in 2018 there were many more unique visitors due to the release of the Digital Terrain Model (DTM). The Matomo Statistics tracking was not in place (or not comprehensively tracking) for EMODnet Bathymetry in 2017 or 2018.
- **Biology**: The more than doubling in numbers from 2018 to 2019 could be attributed to the increase in promotion of EMODnet Biology to new users, including at the end-user stakeholder workshop in May 2019, or the OpenSeaLab II in October 2019, and a popular call for data grants at the end of 2019.
- **Chemistry**: There is a steady increase in numbers showing a growing interest in the Chemistry Portal, with a higher step in 2019 partially due to the restyling of the web Portal, with more focus on marine litter and data products in general. Please note that Chemistry phase III wasn't active in the first three months of 2017 and Matomo tracking was not in place (or not comprehensively tracking) for EMODnet Chemistry until April 2018.
- **Geology**: The release of data products and associated communication by the Geology Portal partners, the EMODnet Secretariat and DG MARE e.g. on coastal behaviour products has been the most important factor for the increase of the annual visitors. The use of social media, a visible presence at the annual EGU meeting 2019 (the most important earth-science conference of Europe) and all the open-access papers on seabed substrate also increased the visibility of the Portal. Finally, improved functionality and performance of the EGDI platform have lowered the threshold of looking at geological data products.
- **Human Activities**: The number of visitors displayed a high increase in 2019 because the vessel density maps were released. The community had been waiting for this data product for a long time.
- **Physics**: The number of visitor continues to increase. And, once visitors start using Physics, they keep using it (returning visitors) and start using the available interfaces to automatically use data. The number of Machine to Machine (M2M) transactions also increased in a considerable way.
- **Seabed Habitats**: The increase in communication and outreach work, such as dedicated events like Open Sea Lab, are likely resulting in wider exposure of the individual Portals and initiative as a whole.
- **Central Portal**: The European Atlas of the Seas contributed to boost the web popularity of the Central Portal but also of all EMODnet thematic lots, with map layers being promoted through the weekly Map of the Week, Map of the Month and additional map layers and updates to existing ones made on a regular basis by the EMODnet Secretariat, in collaboration with EMODnet thematic teams.
- **Data Ingestion**: EMODnet Data Ingestion currently uses a different tracking system, not Matomo. For this reason, figures are not presented, to avoid any confusion. Instead, a summary is presented here. The number of unique visitors in 2019 decreased compared to the previous year. This might be explained by the fact that a lot of the target community of users now know what EMODnet Ingestion stands for and as it is not generating and publishing major data products, are not revisiting, unless they want to want to submit and ingest data sets. On the other hand there was a steady increase of the number of submissions from 351 in early 2019 to 638 at the end of 2019.

8. Budget

The figures below represent the money committed to signed contracts in thousands of euro. All of these, except the grant for Argo floats, were implemented through procurement procedures awarded following open calls for tender.

	Preparatory Actions[1]	Maritime Policy Fund[2]	European Maritime & Fisheries Fund[3]						
Theme & Project	**2008-2010 (k€)**	**2011-2013 (k€)**	**2014 (k€)**	**2015 (k€)**	**2016 (k€)**	**2017 (k€)**	**2018 (k€)**	**2019[4] (k€)**	**Grand Total (k€)**
Central services		520		4,565	155	1,420	1,000	1,420	9,080
Data Ingestion				4,045			1,000		5,045
Office and Infrastructure									
Secretariat		520		520		1,420		1,420	3,880
Secretariat Support					155				155
Sea-basin Checkpoints		1,695	4,175						5,870
Arctic			906						906
Atlantic			1,590						1,590
Baltic Sea			784						784
Black Sea			895						895
Mediterranean		1,095							1,095
North Sea		600							600
Observation				4,000					4,000
Argo				4,000					4,000
Studies	230	450			52	250			982
Costs and benefits		450							450
Current status	230								230
Evaluation						250			250
Observation benefits					52				52
Thematic Groups	6,350	16,350	1,194	4,917	13,483	7,098	4,671	5,836	59,899
Bathymetry	2,175	2,000		4,917		3,720		2,800	15,612
Biology	750	1,700			1,770	1,770		1,500	7,490
Chemistry	700	4,000			2,805		1,399		8,904
Coastal mapping			1,194						1,194
Geology	925	4,200			4,500		1,770		11,395
Human Activities		2,060			1,608	1,608		1,536	6,812
Physics	1,000	1,000			1,400		950		4,350
Seabed Habitats	800	1,390			1,400		552		4,142
Grand Total (K€)	6,580	19,015	5,369	13,482	13,690	8,768	5,671	7,256	79,831

[1] As defined in article 54 of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union
[2] 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
[3] Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund
[4] Amount budgeted in the 2019 work programme for the implementation of the EMFF.

9. EMODnet at 2020 and beyond

2020 will see EMODnet further strengthening its user-oriented service and strengthening partnerships and collaborations. In fact, in 2020 EMODnet's international collaborations will include our partners in the UK! Science transcends geographical and political boundaries and we would like to stress that the close relationship with our valued UK partners, such as JNCC, who have played a pivotal role in developing the Seabed Habitats Portal and its products, will continue in the future. EMODnet remains an open and inclusive network, both in terms of connecting people and organisations, as well as with regard to data sharing and use, and that will never change.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In 2020 EMODnet will build on the 10 years celebration in 2019, recognising a decade of progress and achievements, connecting marine data to knowledge and looking to the future decade. Join us at a webinar on 22 September 2020 to celebrate progress together with EMODnet thematic Coordinators, policy makers and representatives active along the entire marine knowledge value chain, from data providers, data infrastructures and users. The webinar will set the scene for the 2nd EMODnet Open Conference and Jamboree in Oostende Belgium during the week 14-18 June 2021. Unfortunately, due to COVID-19, these flagship EMODnet events were postponed from 2020 to 2021, but not cancelled. These EMODnet events remain important as a unique opportunity for the entire EMODnet Community to come together, reflect on the past decade of EMODnet and exchange ideas about the future of EMODnet, with sessions on EMODnet for Europe, use cases and testimonies, EOOS, global partnerships and initiatives and more.

Strengthening international partnerships

As we reach our 2020 vision target, EMODnet will continue to evolve its services, building on the step-wise developments with tangible results. Enhancing EMODnet's international partnerships will be a major focus of our work in 2020 and beyond. We are delighted to announce a new EU-China collaborative project which is expected to kick-off early 2020 called EMOD-PACE, connecting EMODnet with the Chinese counterpart NMDIS (National Marine Data and Information System).

EMODnet: A key partner for Open Data and Open Science in Europe, and beyond

The upcoming UN Decade of Ocean Science for Sustainable Development calls to simplify data discovery, access and interfaces for multiple users. This is already a core goal of EMODnet, which will be a key European partner in the Ocean Information Hub, a critical information and knowledge initiative in support of the UN Ocean Decade, launching in 2020. EMODnet will take part in preparatory regional workshops for the Ocean Decade and looks forward to contributing its existing infrastructure, services and expertise to the Transparent and Accessible Ocean and the Ocean Information Hub.

Data usage and demand worldwide is growing each day. And to achieve truly Open Data and Open Science it is crucial to have truly innovative data infrastructure services with interoperable data discovery and access. EMODnet has paved the way over the past decade and offers the most advanced, diverse and comprehensive *in situ* data sets and data products in Europe, together with data services and web services that are driving a new wave of data discovery and use. Building on existing capability, EMODnet is also working with other key marine data infrastructures and horizontal e-infrastructures across Europe to explore, test and demonstrate how the federation of these infrastructures can add further value and impact to drive research and innovation. This is being developed through the Horizon 2020 project Blue-Cloud which started in October 2019 and will showcase the potential for a future cyber platform for "blue" data and services access, offering access to Virtual Research Environments, analytical tools and computing resources and storage. In 2020 stakeholder consultations will also start, to create a fit-for-use Blue-Cloud and a community Roadmap to 2030 outlining key steps to implementation and future exploitation and sustainability.

EMODnet team

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Paula Oset Garcia

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January – September 2019:
Central Portal and Biology

EMODnet Bathymetry

Thierry Schmitt

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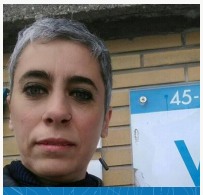
EMODnet Biology



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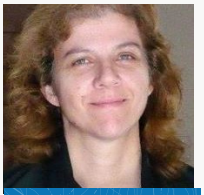
EMODnet Data Ingestion



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From September 2019

EMODnet Seabed Habitats

Helen Lillis

www.emodnet-seabedhabitats.eu

EMODnet Steering Committee and Technical Working Group, September 2019

EMODnet

EMODnet publications

In 2019, the wider EMODnet community has produced, or been cited in hundreds of publications, with some examples reported below.

	Portal
Martín Míguez, B., Novellino, A., Vinci, M., Claus, S., Calewaert, J. B., Vallius, H., Schmitt, T., Pititto, A., Giorgetti, A., Askew, N., Iona, S., Schaap, D., Pinardi, N., Harpham, Q., Kater, B.J., Populus, J., She J., Palazov, A, V., McMeel, O., Oset, P., Lear, D., Manzella, G. M. R., Gorringe, P., Simoncelli, S., Larkin, K., Holdsworth, N., Arvanitidis, C. D., Molina Jack, M. E., del Mar Chaves Montero, M., Herman, P. M. J., Hernandez, F (2019) The European marine observation and data network (EMODnet): visions and roles of the gateway to marine data in Europe. Frontiers in Marine Science, 6. 12 July 2019 https://doi.org/10.3389/fmars.2019.00313	EMODnet Secretariat and wider network
Argyropoulos, V., & Stratigea, A. (2019). Sustainable Management of Underwater Cultural Heritage: The Route from Discovery to Engagement - Open Issues in the Mediterranean. Heritage, 2(2), 1588-1613. https://doi.org/10.3390/heritage2020098	Bathymetry
Barreca, G., Scarfì, L., Gross, F., Monaco, C., & De Guidi, G. (2019). Fault pattern and seismotectonic potential at the south-western edge of the Ionian Subduction system (southern Italy): New field and geophysical constraints. Tectonophysics, 761, 31-45. https://doi.org/10.1016/j.tecto.2019.04.020	Bathymetry
Böttner, C., Berndt, C., Reinardy, B. T., Geersen, J., Karstens, J., Bull, J. M., ... & Schramm, B. (2019). Pockmarks in the Witch Ground Basin, Central North Sea. Geochemistry, Geophysics, Geosystems, 20(4), 1698-1719. https://doi.org/10.1029/2018gc008068	Bathymetry
Bradwell, T., Small, D., Fabel, D., Smedley, R. K., Clark, C. D., Saher, M. H., ... & Roberts, D. H. (2019). Ice-stream demise dynamically conditioned by trough shape and bed strength. Science advances, 5(4), eaau1380.	Bathymetry
Caterino, A. (2019). Le Carte Nautiche: dalla carta ai BIT. GEOmedia, 22(6).	Bathymetry
Correia, A., Pinto, L., & Mateus, M. (2019, June). Implementation of a 3-Dimensional Hydrodynamic Model to a Fish Aquaculture Area in Sines, Portugal-A Down-Scaling Approach. In International Conference on Computational Science (pp. 265-278). Springer, Cham. https://doi.org/10.1126/sciadv.aau1380	Bathymetry
Datema, M., Sangiorgi, F., De Vernal, A., Reichart, G. J., Lourens, L. J., & Sluijs, A. (2019). Millennial-scale climate variability and dinoflagellate-cyst-based seasonality changes over the last~ 150 kyrs at "Shackleton Site" U1385. Paleoceanography and paleoclimatology, 34(7), 1139-1156. https://doi.org/10.1029/2018pa003497	Bathymetry

	Portal
Di Bella, L., Sabbatini, A., Carugati, L., Martire, M. L., Luna, G. M., Pierdomenico, M., Danovaro, R., Negri, A. (2019). Living foraminiferal assemblages in two submarine canyons (Polcevera and Bisagno) of the Ligurian basin (Mediterranean Sea). Progress in Oceanography, 173, 114-133. https://doi.org/10.1016/j.pocean.2019.02.011	Bathymetry
Diociaiuti, T., Aubry, F. B., & Umani, S. F. (2019). Vertical distribution of microbial communities abundance and biomass in two NW Mediterranean Sea submarine canyons. Progress in oceanography, 175, 14-23. https://doi.org/10.1016/j.pocean.2019.03.005	Bathymetry
Durán, R., Guillén, J., Ribó, M., Puig, P., & Muñoz, A. (2019). Evolution of offshore sand ridges in tideless continental shelves (Western Mediterranean). MARID VI, 83.	Bathymetry
Enrichetti, F., Bo, M., Morri, C., Montefalcone, M., Toma, M., Bavestrello, G., & Bertolotto, R. M. (2019). Assessing the environmental status of temperate mesophotic reefs: A new, integrated methodological approach. Ecological indicators, 102, 218-229. https://doi.org/10.1016/j.ecolind.2019.02.028	Bathymetry
Fabbri, T., & Vicen-Bueno, R. (2019). Weather-routing system based on METOC navigation risk assessment. Journal of Marine Science and Engineering, 7(5), 127. https://doi.org/10.3390/jmse7050127	Bathymetry
Ferranti, L., Pepe, F., Barreca, G., Meccariello, M., & Monaco, C. (2019). Multi-temporal tectonic evolution of capo Granitola and Sciacca foreland transcurrent faults (Sicily channel). Tectonophysics, 765, 187-204. https://doi.org/10.1016/j.tecto.2019.05.002	Bathymetry
Güneroğlu, A., Samsun, O., Feyzioğlu, M., & Dihkan, M. (2019). The Black Sea—The Past, Present, and Future Status. In Coasts and Estuaries (pp. 363-375). Elsevier. https://doi.org/10.1016/B978-0-12-814003-1.00021-6	Bathymetry
Hazim, S., El Ouatouati, A., Janan, M. T., & Ghennioui, A. (2019). Marine currents energy resource characterization for morocco. Energy Procedia, 157, 1037-1049. https://doi.org/10.1016/j.egypro.2018.11.271	Bathymetry
Hoffman, L., & Freiwald, A. (2017). A unique and diverse amalgamated mollusk assemblage from the Coral Patch Seamount, eastern Atlantic. Miscellanea Malacologica, 7(4), 61-79. http://www.marinespecies.org/aphia.php?p=sourcedetails&id=287859	Bathymetry

	Portal
Innangi, S., Di Martino, G., Romagnoli, C., & Tonielli, R. (2019). Seabed classification around Lampione islet, Pelagie Islands Marine Protected area, Sicily Channel, Mediterranean Sea. Journal of Maps, 15(2), 153-164. https://doi.org/10.1080/17445647.2019.1567401	Bathymetry
Kint, L. (2019). Multi-scale analysis of sandbank features optimising geomorpho-logical mapping of sandy shelf environments: Belgian part of the North Sea. MARID VI, 127.	Bathymetry
Kurjanski, B., Rea, B. R., Spagnolo, M., Winsborrow, M., Cornwell, D. G., Andreassen, K., & Howell, J. (2019). Morphological evidence for marine ice stream shutdown, central Barents Sea. Marine Geology, 414, 64-76. https://doi.org/10.1016/j.margeo.2019.05.001	Bathymetry
Micallef, A., Spatola, D., Caracausi, A., Italiano, F., Barreca, G., D'Amico, S., & Pavan, A. (2019). Active degassing across the Maltese Islands (Mediterranean Sea) and implications for its neotectonics. Marine and Petroleum Geology, 104, 361-374. https://doi.org/10.1016/j.marpetgeo.2019.03.033	Bathymetry
Mitchell, P. J., Aldridge, J., & Diesing, M. (2019). Legacy data: how decades of seabed sampling can produce robust predictions and versatile products. Geosciences, 9(4), 182. https://doi.org/10.3390/geosciences9040182	Bathymetry
Caterino, A. (2019). Le Carte Nautiche: dalla carta ai BIT. GEOmedia, 22(6).	Bathymetry
Monteleone, V., Minshull, T. A., & Marin-Moreno, H. (2019). Spatial and temporal evolution of rifting and continental breakup in the Eastern Black Sea Basin revealed by long-offset seismic reflection data. Tectonics, 38(8), 2646-2667. https://doi.org/10.1029/2019TC005523	Bathymetry
Janin, A., Rodriguez, M., Sakellariou, D., Lykousis, V., & Gorini, C. (2019). Tsunamigenic potential of a Holocene submarine landslide along the North Anatolian Fault (northern Aegean Sea, off Thasos island): insights from numerical modelling. Natural Hazards & Earth System Sciences, 19(1). https://doi.org/10.5194/nhess-19-121-2019	Bathymetry

	Portal
Karkani, A., Evelpidou, N., Giaime, M., Marriner, N., Morhange, C., & Spada, G. (2019). Late Holocene sea-level evolution of Paros Island (Cyclades, Greece). Quaternary International, 500, 139-146. https://doi.org/10.1016/j.quaint.2019.02.027	Bathymetry
Larsén, X. G., Du, J., Bolaños, R., Imberger, M., Kelly, M. C., Badger, M., & Larsen, S. (2019). Estimation of offshore extreme wind from wind - wave coupled modeling. Wind Energy, 22(8), 1043-1057. https://doi.org/10.1002/we.2339	Bathymetry
Loureiro, C., & Cooper, A. (2019). Temporal variability in winter wave conditions and storminess in the northwest of Ireland. Irish Geography, 51(2), 155-170. https://doi.org/10.2014/igj.v51i2.1369	Bathymetry
Mortelmans, J., Deneudt, K., Cattrijsse, A., Beauchard, O., Daveloose, I., Vyverman, W., ... & Knockaert, M. (2019). Nutrient, pigment, suspended matter and turbidity measurements in the Belgian part of the North Sea. Scientific data, 6(1), 1-8. https://doi.org/10.1038/s41597-019-0032-7	Bathymetry
Nilsson, E., Rutgersson, A., Dingwell, A., Björkqvist, J. V., Pettersson, H., Axell, L., & Strömstedt, E. (2019). Characterization of wave energy potential for the Baltic Sea with focus on the Swedish Exclusive Economic Zone. Energies, 12(5), 793. https://doi.org/10.3390/en12050793	Bathymetry
Ohlsen, G. L., Clausen, N. E., & Abrahamsen, A. B. Positioning of Danish offshore wind farms until 2030-using Levelized Cost of Energy. https://doi.org/10.1017/CBO9781107415324.004	Bathymetry
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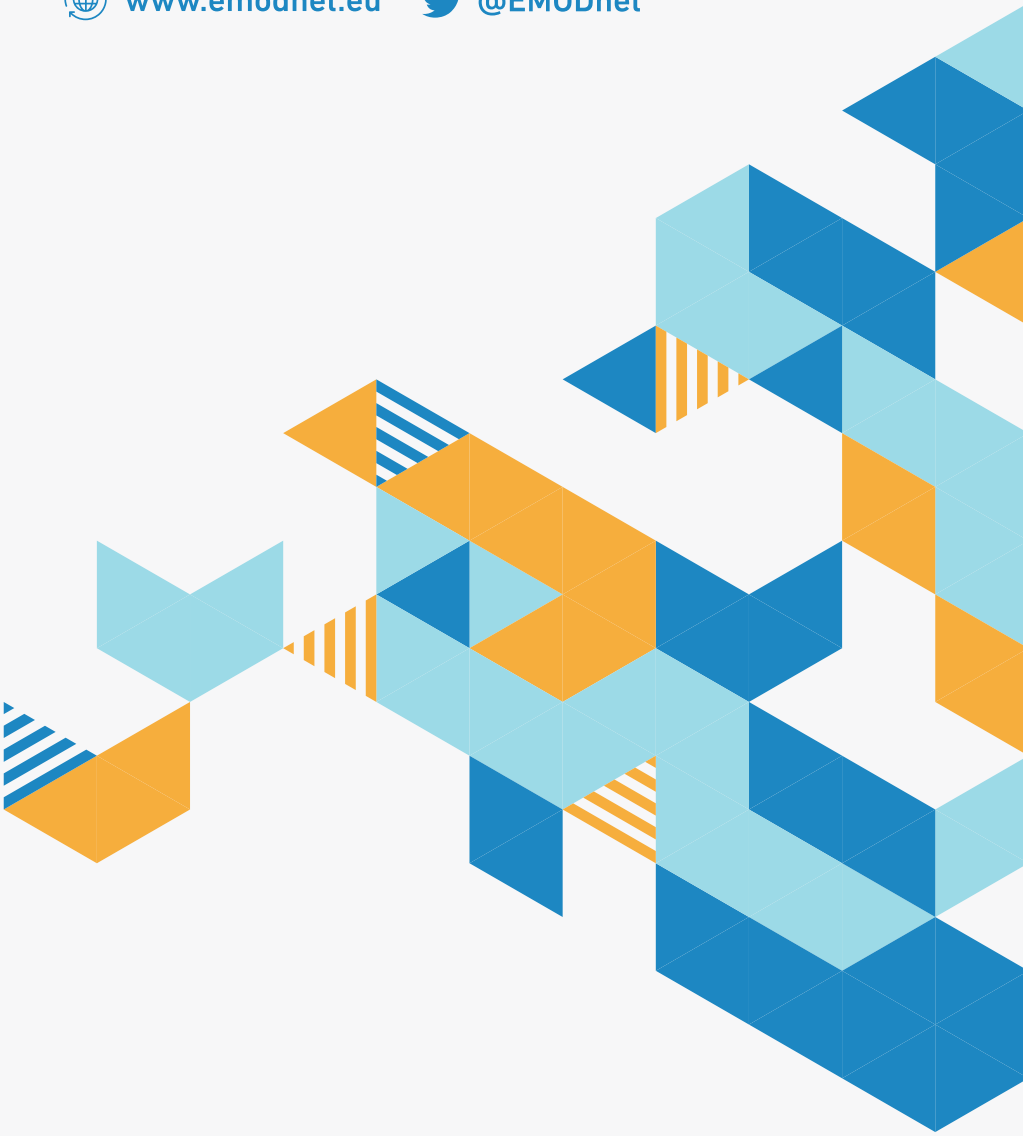

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