D1.2

Status of the use of Copernicus data in MSFD

December 2020

Disclaimer

MAREOS is funded by the National Center for Space Studies in the framework of the action FPA 2018-2-05 - COPERNICUS USER UPTAKE – Caroline HERSCHEL.

Table of contents

Table of figures

List of acronyms

CCIM - Coordinating Committee for International Environmental Policy

CIS - Common Implementation strategy

EC - European Commission

ESA – European Space Agency

EU - European Union

GES - Good Environmental Status

KTM - Key Type of Measure

MD – Marine Subdivisions

MSFD - Marine Strategy Framework Directive

OFB – Office Français de la Biodiversité

WFD – Water Framework Directive

1. Introduction

The MAREOS project (2020-2022), related to the Framework Partnership Agreement - FPA 2018-2-05, aims at a better integration of Copernicus data in the European regulatory framework, and particularly for the implementation of the Marine Strategy Framework Directive (MSFD).

In brief, MAREOS reviews the existing monitoring protocol and strategy currently in place for the MSFD (marine waste, contaminants and hydrographic conditions…) on the French territory, to ultimately define how Copernicus data could provide solutions to support and/or improve its implementation.

This current document is part of work package 1 "MSFD analysis and identification of Copernicus data opportunities" which aims at identifying conducive areas to the integration of Copernicus data and mapping French and European capabilities that can benefit from the implementation of MSFD.

Deliverable D1.2, entitled "Status of the use of Copernicus data in MSFD", describes the initial overview regarding the role of Copernicus in the MSFD and in particular how its data are (or could be) used and what are potential opportunities at European level.

Existing initiatives and projects at European level will be developed, along with a benchmark of five European countries to see how the MSFD is implemented in these countries.

Finally, an analysis of the use of Copernicus of French MSFD key stakeholders and the main drawbacks of this use will be done, through the answers given during our interview process.

2. Copernicus Review

2.1 Objectives

Copernicus is the European Union's Earth Observation Programme, looking at our planet and its environment for the ultimate benefit of all European citizens. It offers information services based on satellite Earth Observation and *in situ* (non-space) data.

In May 1998, a vision for a European environment monitoring programme was agreed upon in Baveno, Italy. Since that date, this vision has grown beyond expectations, giving rise to Copernicus, the most ambitious and successful Earth Observation programme in the world. The seven Copernicus Sentinel satellites in orbit, complemented by contributing missions, *in situ* sensors and numerical models, deliver terabytes of full, free and open data daily to hundreds of thousands of users.

Figure 1 : Copernicus organigram

The Programme is coordinated and managed by the European Commission. It is implemented in partnership with the Member States, the European Space Agency (ESA), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), the European Centre for Medium-Range Weather Forecasts (ECMWF), EU Agencies. Several agencies and institutions are trusted by the European Commission to implement the Copernicus programme, such as Mercator Océan, EU Satellite Center (EUSC), European Maritime Safety Agency (EMSA), Joint Research Centre (JRC), European Environment Agency (EEA) and FRONTEX.

Vast amounts of global data from satellites and from ground-based, airborne and seaborne measurement systems are being used to provide information to help service providers, public authorities and other international organisations improve the quality of life for the citizens of Europe.

The information services provided are freely and openly accessible to its users. There is no restriction on use or reproduction and redistribution, with or without adaptation, for commercial or non-commercial purposes. This data policy applies to the data and information generated within the Copernicus programme, *i.e.*, Sentinel mission data and Copernicus service information.

Copernicus also supports tens of thousands of jobs and generates billions of Euros in economic benefits, but the full potential of the programme is yet to be unleashed.

According to recent report[1], here is a list of outputs and benefits that Copernicus can unveil:

- Copernicus will generate €67 to €131 billion in benefits to the European society between 2017 and 2035 (10 to 20 times the cost of the programme);

[1] https://www.copernicus.eu/sites/default/files/2018-12/Coperniucs_Benefits%202018_navy_V3%20web.pdf

- Most ambitious and successful earth observation programme in the world and the third largest space data provider globally;
- With a full, free and open data policy, Copernicus is a global game-changer in Earth observation, a domain which was traditionally reserved for governments, large companies and scientists;
- Beyond 2020, Copernicus will generate about €1 billion of revenue for the space industry and create 4000 jobs every year;
- Since 2014, the ecosystem enabled by Copernicus data and information displays an annual growth of 17%. This is more than 8 times the EU economic growth rate, which is 2% on average;
- The number of Copernicus users has doubled every year since 2014.

2.2 Available products and services

2.2.1 Background

The Copernicus Space and Service Components have been specifically designed to meet user requirements. Through satellite and *in situ* observations, the services deliver near-real-time data on a global level which can also be used for local and regional needs, to help us better understand our planet and sustainably manage the environment we live in.

The Earth observation satellites which provide the data exploited by the Copernicus services are split into two groups:

1. The Sentinels, 6 families of satellites dedicated to Copernicus: the Sentinel satellites are specifically designed to meet the needs of the Copernicus services and their users;
2. Over 30 contributing missions from national, European or International organisations: existing commercial and public satellites designed for other purposes but still providing some of their observation capacity to Copernicus.

<u>The Sentinels</u>

Since the launch of Sentinel-1 in 2014, the European Union set in motion a process to place a constellation of almost 20 additional satellites in orbit before 2030:

- Sentinel-1 All-weather, day and night radar imagery for land and ocean services
- Sentinel-2 High-resolution optical imagery for land services
- Sentinel-3 High-accuracy optical, radar and altimetry data for marine and land services

- Sentinel-4 and Sentinel-5: Data for atmospheric composition monitoring from geostationary orbit and polar orbit (instruments carried on the next generation of meteorological satellites, *i.e.* Meteosat third Generation (MTG) and MetOp Second Generation)
- Sentinel-5 Precursor: Bridge the gap between Envisat (Sciamachy data in particular) and Sentinel-5
- Sentinel-6: Radar altimetry data to measure global sea-surface height, primarily for operational oceanography and for climate studies
- Sentinel-1, -2, -3 and -6 are dedicated satellites, while Sentinel-4 and -5 are instruments onboard EUMETSAT's weather satellites. Note that Sentinel-5P, which is a precursor to Sentinel-5, is also a dedicated satellite.

Figure 2 Representation of the Sentinel satellites (© Copernicus)

Contributing missions

The contributing missions are operated by national, European or international organisations and provide a wealth of data for Copernicus services.

The existing or planned contributing missions include missions from ESA, their Member States, and other European and international third-party mission operators that make some of their data available for Copernicus.

The following categories of Contributing Missions are considered:

- Synthetic Aperture Radar (SAR) sensors, for all weather day/night observations of land, ocean and ice surfaces;
- Medium-low resolution optical sensors for information on land cover, for example, agriculture indicators, ocean monitoring, coastal dynamics and ecosystems;
- High-resolution and medium-resolution optical sensors – panchromatic and multispectral – for regional and national land monitoring activities;
- Very High Resolution (VHR) optical sensors for targeting specific sites, especially in urban areas as for security applications;
- High accuracy radar altimeter systems for sea-level measurements and climate applications;
- Radiometers to monitor land and ocean temperature;
- Spectrometer measurements for air quality and atmospheric composition monitoring.

Among these contributing missions and as an example, EUMETSAT delivers products to Copernicus from a number of contributing missions that include its Metop and Meteosat satellites, the Jason-3 satellite (NASA/NOAA/CNES/EUMETSAT/EU), and also from international partners, for example sea surface temperature and ocean colour data from the US Suomi-NPP satellite.

Data is collected by contributing missions and Copernicus Sentinel satellites that sometimes operate alone and sometimes combined with *in situ* sensors data (land, sea or air). Since 2012, these data are processed qualified and standardized to offer a set of core services that covers six main thematic domains. These Copernicus core services are formed by information which analyse, process and make available earth observation and in situ information to users. They are described below and are provided to users free of charge

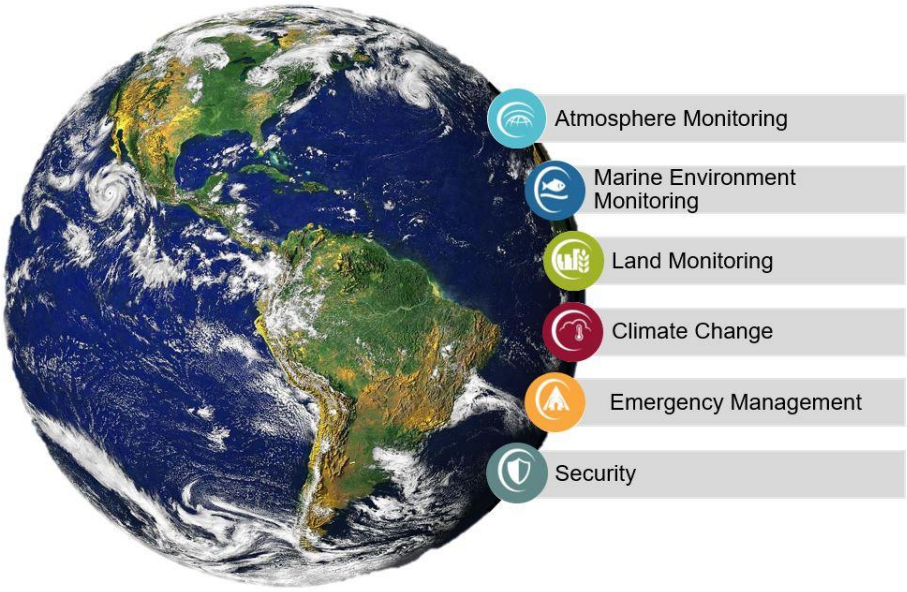


Figure 3 : Representation of Copernicus services

2.2.2 Atmosphere Monitoring

The Copernicus Atmosphere Monitoring Service (CAMS) provides continuous data and information on atmospheric composition.

The service describes the current situation, forecasts the situation a few days ahead, and analyses consistently retrospective data records for recent years.

The Copernicus Atmosphere Monitoring Service supports many applications in a variety of domains including health, environmental monitoring, renewable energies, meteorology and climatology.
The service focuses on five main areas:

- **Air quality and atmospheric composition;**
- **Ozone layer and ultra-violet radiation;**
- **Emissions and surface fluxes;**
- **Solar radiation;**
- **Climate forcing**.

It provides daily information on the **global atmospheric composition** by monitoring and forecasting constituents such as greenhouse gases (carbon dioxide and methane), reactive gases (e.g. carbon monoxide, oxidised nitrogen compounds, sulphur dioxide), ozone and aerosols.
It provides near-real-time analysis and 4-day forecasts, as well as reanalysis, of the **European air quality**, thus enabling a permanent assessment of the air we breathe.
It provides public and private organisations involved in solar energy usage with suitable and accurate information on the **solar radiation resources** at the Earth's surface, which is of major importance in domains like health, agriculture and renewable energies.

2.2.3 Marine Environment Monitoring

The Copernicus Marine Environment Monitoring Service (CMEMS) provides regular and systematic reference information on the physical and biogeochemical state, variability and dynamics of the ocean and marine ecosystems for the global ocean and the European regional seas.

The observations and forecasts produced by the service support all marine applications, including:

- **Marine safety;**
- **Marine resources;**
- **Coastal and marine environment;**
- **Weather, seasonal forecasting and climate**.

For instance, the provision of data on currents, winds and sea ice help to improve ship routing services, offshore operations or search and rescue operations, thus contributing to marine safety.

The service also contributes to the protection and the sustainable management of living marine resources in particular for aquaculture, sustainable fisheries management or regional fishery organisations decision-making process.

Physical and marine biogeochemical components are useful for water quality monitoring and pollution control. Sea level rise is a key indicator of climate change and helps to assess coastal erosion. Sea surface temperature elevation has direct consequences on marine ecosystems and appearance of tropical cyclones. As a result of this, the service supports a wide range of coastal and marine environment applications.

Many of the data delivered by the service (e.g. temperature, salinity, sea level, currents, wind and sea ice) also play a crucial role in the domain of weather, climate and seasonal forecasting.

2.2.4 Land monitoring

The Copernicus Land Monitoring Service (CLMS) provides geographical information on land cover and its changes, land use, vegetation state, water cycle and earth surface energy variables to a broad range of users in Europe and across the World in the field of environmental terrestrial applications.

It supports applications in a variety of domains such as spatial and urban planning, forest management, water management, agriculture and food security, nature conservation and restoration, rural development, ecosystem accounting and mitigation/adaptation to climate change.

CLMS is jointly implemented by the European Environment Agency and the European Commission DG Joint Research Centre (JRC) and has been operational since 2012.

CLMS main components:

- The **systematic monitoring of biophysical parameters** produces mainly a series of qualified bio-geophysical products on the status and evolution of the land surface. The products are used to monitor vegetation, crops, water cycle, energy budget and terrestrial cryosphere variables.

- **Land cover and land use mapping** produces land cover classifications at various level of detail, both within a pan-European and global context. At the pan-European level, these are complemented by detailed layers on land cover characteristics, such as imperviousness, forests, grassland, water and wetness and small woody features.
- **Thematic hot-spot mapping** aims to provide tailored and more detailed information on specific areas of interest, known as hot-spots. Hotspots in the context of CLMS are prone to specific environmental challenges.
- **Imagery and reference data** provide satellite image mosaic in high and very high resolutions and reference datasets. It consists of reference datasets providing homogeneous pan-European coverage of some key geospatial themes, such as hydrography and elevation.

In addition to the above-mentioned components, a new **European Ground Motion** activity is being set up. The activity will measure ground displacements, including landslides and subsidence, as well as deformation of infrastructure.

2.2.5 Climate Change

The Copernicus Climate Change Service (C3S) supports society by providing authoritative information about the past, present and future climate in Europe and the rest of the World.

The C3S mission is to **support adaptation and mitigation policies** of the European Union by providing consistent and authoritative information about climate change. It offers free and open access to climate data and tools based on the best available science.

C3S provides **climate data and information** on impacts on a range of topics and sectoral areas through its Climate Data Store (CDS). The CDS is designed to enable users to tailor services to more specific public or commercial needs.

Its work complements the established range of meteorological and environmental services that each European country already has in place. C3S derives maximum benefit from the existing infrastructure and knowledge by involving national climate service providers as well as relevant academic communities in the implementation of C3S.

2.2.6 Security

The Copernicus service for Security applications aims to support European Union policies by providing information in response to Europe's security challenges.
It improves crisis prevention, preparedness and response in three key areas:

- **Border surveillance**: the main objectives are to reduce the death toll of illegal immigrants at sea, to increase the internal security of the European Union and to the fight against cross-border crime.
- **Maritime surveillance**: the overall objective of the European Union is to support Europe's maritime security objectives and related activities in the maritime domain. The corresponding challenges mainly relate to safety of navigation, support to fisheries control, combatting marine pollution, and law enforcement at sea.

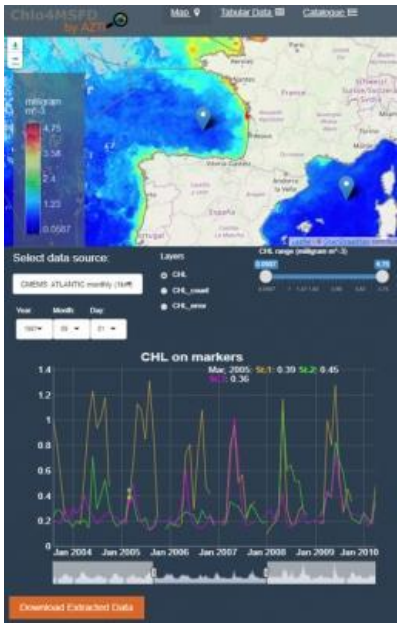
- **Support to EU External Action**: EU can provide assistance to third countries in a situation of crisis or emerging crisis and help preventing global and trans-regional threats having a destabilising effect.

3. MSFD vs Copernicus

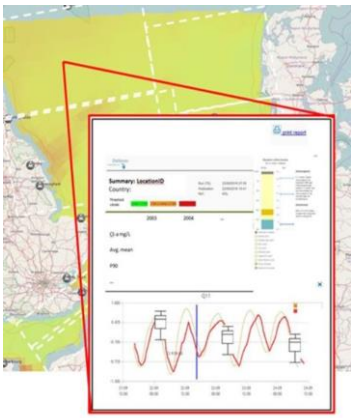
3.1 Existing demonstration initiatives

Several initiatives exist in this Copernicus-MSFD framework. In particular the European Commission funded some interesting projects through the 'CMEMS User Uptake programme'.

3.1.1 CHLO4MSFD

Description	**CHLO4MSFD is a web portal service focused on satellite data to answer the Marine Strategy Framework Directive (MSFD) over all European Marine Regions**	 **© AZTI**
Descriptor involved	Descriptor 5 - Eutrophication	
Data collected	CHLO4MSFD is meant to incentivate and support MSFD actors to use chlorophyll-a values from satellites, in their monitoring and assessment processes. Covered regions by this service are: Baltic Sea, European North-west Shelf Seas, Iberian-Biscay-Irish Regional Seas, Mediterranean Sea, Black Sea.	
Main objective	Led by AZTI, CHLO4MSFD Service will help users to: – Visualize satellite chlorophyll-a data maps for all EU Marine Regions from 1997 to today. – Extract and view time series data from user selected locations (markers). – Download time series data as csv files.	
For more information	http://chlo4msfd.azti.es/	

3.1.2 MSFD-EUTRO

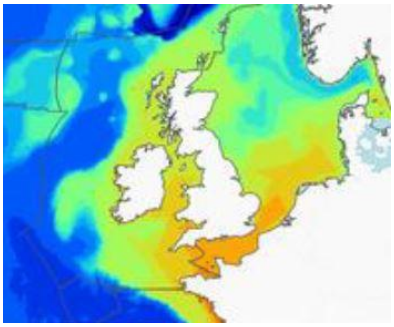
Description	**MSFD-Eutro is a free and open, active and interactive web-mapping service that shows chlorophyll indicator maps based on growing-season statistics (mean, and max as P90)**	 **© Copernicus**
Descriptor involved	Descriptor 5 - Eutrophication	
Data collected	The Copernicus Marine Service delivers satellite chlorophyll-a products which are combined with standard satellite Chlorophyll-a products for turbid waters. Statistics (such as multi-year mean and maximum) as well as trend analysis of CHL are performed to help with the MSFD reporting	
Main objective	Led by Deltares, MSFD-Eutro aims to facilitate the use and appreciation of ocean colour data by policy advisors and policy makers for the European Marine Strategy Framework Directive (MSFD)	

For more information	https://www.deltares.nl/en/projects/msfd-eutro/	

3.1.3 QUONOPS

Description	**QUONOPS is a webservice that provides noise monitoring and forecast**	 **© Quiet Oceans**
Descriptor involved	Descriptor 11 - Energy incl. Underwater Noise	
Data collected	An estimation of spatio-temporal distribution of noise levels generated by human activities at sea is provided. This is done by aggregating multiple sources, and assessing short-, mid- and long-term source contributions to the global noise field	
Main objective	Created by Quiet Oceans, this tool aims to support management decisions by assessing, quantifying and prioritizing direct and indirect anthropogenic pressures on marine life, according to regulations on underwater noise	
For more information	https://qos.quiet-oceans.com/qos/Copernicus_Marine_Service/index.html	

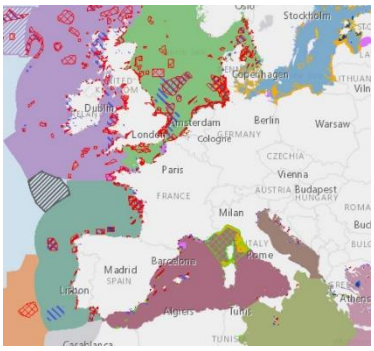
3.1.4 CEFMAT

Description	**Marine assessment webtool developed by Cefas to support MSFD (and OSPAR) indicators assessment**	 **© CEFMAT**
Descriptor involved	Descriptor 5 - Eutrophication	
Data collected	Satellite and modelling data from the Copernicus Marine Service are used to offer customised data products to support assessments in relation to hydrographical conditions, water quality and eutrophication, biodiversity and marine food webs	
Main objective	Environmental variables data are processed in CefMAT to generate products that are directly relevant to MSFD assessments are Temperature, salinity, suspended particulate matter, nitrates and chlorophyll-a	
For more information	https://www.cefmat.org/AtlanticAssessments	

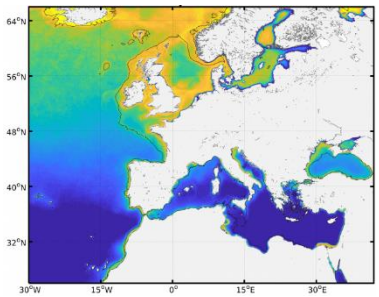
3.2 Projects and other initiatives supporting Copernicus and MSFD

Along with the supporting initiatives that have been listed previously, key projects and incentives have been launched to support Copernicus and MSFD. Some of the most relevant ones are listed below.

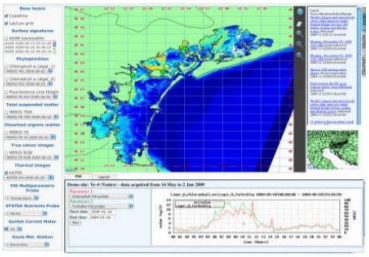
3.2.1 WISE-MARINE

 © DG-ENV	**Description**	**Portal and infrastructure for sharing information with the marine community on the marine environment at the European level**
	Descriptor involved	Descriptor 5 - Eutrophication
	Data collected	It presents available data related to the implementation of the MSFD in European Seas. WISE-Marine has developed a GIS map viewer https://maps.eea.europa.eu/wab/wise-marine-map/ displaying different layers originating from various sources, among which salinity and Chlorophyll-A from the Copernicus Marine Service.
	Main objective	It is developed in a partnership among Commission services (DG-ENV, DG-JRC), the European Environment Agency (EEA) and Eurostat. It shows the information and knowledge gathered or derived through the Marine Strategy Framework Directive (MSFD) process and other key marine policy drivers
	For more information	https://maps.eea.europa.eu/wab/wise-marine-map/

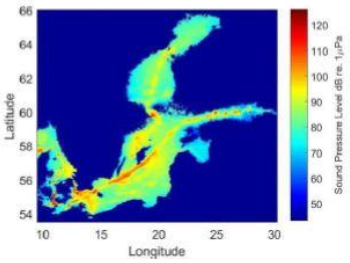
3.2.2 SIMSEA

 © JRC	**Description**	**Tool to generate future scenario simulations considering different policy options and climate change scenarios**
	Descriptor involved	Descriptor – 5 Eutrophication
	Data collected	Monthly mean temperature and salinity, chlorophyll_a, nitrate and phosphate fields are extracted from the Copernicus Marine Service Black Sea reanalysis model. Satellite sea surface temperature and ocean colour data in the Black Sea are also used
	Main objective	SIMSEA is a former European project (SIMSEA) that designed a tool based on marine modelling from the Joint Research Centre (JRC) to examine the present and future state of the marine ecosystem
	For more information	https://cordis.europa.eu/project/id/660841/fr

3.2.3 AQUAMAR

 © Thales Aliena Space	**Description**	**Delivering several services including indicators for the reporting requirement of the Water Framework Directive and MSFD**
	Descriptor involved	Descriptor 5 - Eutrophication
	Data collected	The Copernicus Marine Service Ocean Colour satellite data were therefore used to provide value-added services to the public sector organisations responsible for implementing policies at European, national and regional levels
	Main objective	AquaMar was an FP7 research project (2009-2013) developing water quality downstream services supporting the EU Directive
	For more information	https://cordis.europa.eu/project/id/241759/reporting

3.2.4 Listening to ocean's noise

 © TNO	**Description**	**Understanding the impact of underwater anthropogenic noise on aquatic life, develop solutions for ocean noise monitoring and reduce the impact of anthropogenic noise through regulation**
	Descriptor involved	Descriptor 11 - Energy incl. Underwater Noise
	Data collected	TNO uses the Copernicus Marine Service Global model as an input source for ocean density. Mark Prior from TNO says that the Copernicus Marine Service global model is an accurate tool for providing seawater density, which affects our underwater sound propagation model
	Main objective	TNO has developed an underwater sound modelling system that performs mathematical calculations of underwater sound pressure as a function of time, space and the frequency of sound sources
	For more information	https://marine.copernicus.eu/usecases/listening-oceans-noise/

3.2.5 iFADO

© IST	**Description**	**Assisting the MSFD competent authorities by notably providing tools for the optimisation of observing strategies for better forecasting**
	Descriptor involved	All
	Data collected	Remote sensing and modelling have been recognised by the CMEMS as suitable methodologies to characterise the global

		ocean both for nowcast and forecast. iFADO aims to demonstrate that similar strategies are valid at the regional scale and that downscaling is the most suitable mechanism to generate the required solutions and that new technologies are able to provide data in higher quantity, with wider spatial coverage and for remote marine areas
	Main objective	iFADO is an INTERREG atlantic project aiming at downscaling CMEMS products and combining the conventional monitoring programmes with emerging technologies such as gliders, ocean buoys and satellite data, to develop tailor-made and innovative products
	For more information	http://www.ifado.eu/

3.3 EU benchmark

After reviewing the main initiatives and projects linking Copernicus and the MSFD, an analysis of processes and methods at European level is a crucial point to see the impact of Copernicus and its potential/existing involvement in the MSFD implementation at European level.

Five countries of Western Europe have been selected and benchmarked, taking into account that these countries are very diverse, in terms of size, location and national strategy regarding EU directives. The results of this analysis are synthesized in the sections below.

3.3.1 Spain

The MSFD was incorporated into Spanish legislation by means of Law 41/2010, of 29 December 2010, on the protection of the marine environment. That law establishes the general legal framework for the protection of the Spanish marine environment.

The Spanish marine environment has been divided into 5 marine subdivisions (MD), taking into account the hydrological, oceanographic and bio-geographical characteristics of each area: north Atlantic MD, south Atlantic MD, Estrecho and Alborán MD, levantine-balearic MD and canary MD.

For each Spanish marine subdivision, a marine strategy has been developed and its implementation follows an iterative process which is carried out in six-year cycles.

The design of the programmes of measures was undertaken in such a way that there is a close link with the previous phases of the strategies.

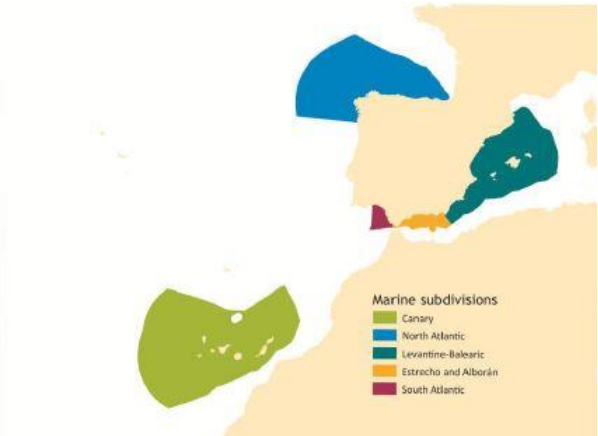


Figure 4 : Spain marine subdivisions (© CIEM)

The programmes of measures are the most executive part of the marine strategies and they maintain a conceptual link with the first three phases of the marine strategies:

- Regulations applicable to activities which have an impact on the marine environment, guidelines on the uses of the marine environment, action projects, geographical or temporal restrictions of uses, and measures to control and reduce pollution, among others
- Spatial protection measures, to contribute to the creation of coherent and representative marine network of protected areas network
- Specific measures for the protection of species and habitat types

Each one of the measures which are included in the programme of measures of the marine strategies was assigned to a KTM (Key Type of Measure). KTMs are a predefined set of types of key measures and are the unit into which the measures must be bundled to be reported to the European Commission. There are 25 KTMs deriving from the WFD (intended mainly for pressures having their origin on land), 20 of which have been identified as relevant for marine strategies. In addition to these, in the working groups of the Common Implementation Strategy of the MSFD, 14 additional, clearly marine KTMs were defined to address other types of pressures related to the activities which take place in the sea and other types of actions which could affect marine waters.

Once the inventory of existing measures had been completed, they were analysed and discussed with the stakeholders through numerous meetings:

- On the one hand, four workshops were held with experts from scientific background and environmental NGOs, on the following themes: biodiversity (Descriptors D1, D4, D6 and marine protected areas), marine turtles, marine litter and elasmobranches;
- On the other hand, the inventory was discussed in the framework of the Inter-Ministerial Marine Strategies Commission (CIEM) and the five Marine Strategy Committees of the five marine subdivisions;
- Through bilateral meetings held with all the competent authorities, such as Ministry of Agriculture, Food & the Environment, Biodiversity Foundation, Ministry of Public Works, Ministry of the Interior, Ministry of Industry, Energy and Tourism and Ministry of the Economy and Competitiveness.

By means of the analysis of effectiveness of the existing measures, a gap analysis was carried out for each of the themes to be addressed in the programmes of measures. The proposal of new measures therefore stemmed from different sources, and the methodology for its preparation.

In terms of Copernicus data and the involvement of the programme in the Spanish MSFD implementation, it was difficult for us to get pertinent information and feedback as key stakeholders were hardly identifiable and therefore to contact. Further enquiries will be carried out.

Apart from examples that can be found online, such as the CHLO4MSFD initiative which is described in Section 3.1.1, it was not obvious that Copernicus is widely used in the MSFD's Spanish implementation.

3.3.2 Ireland

Ireland has been working on the development of a strategy for Ireland's marine waters since the directive was transposed into Irish Law in 2011. The following work has been completed so far:

- An Initial Assessment of Ireland's Marine Waters to establish the current status of Ireland's marine waters;

- A series of environmental targets and indicators were established to guide progress towards achieving or maintaining GES;
- A coordinated monitoring programme for the on-going assessment of GES has been established.

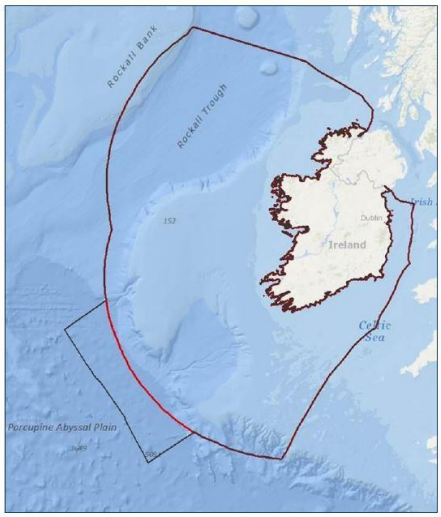


Figure 5 : Ireland marine waters (© DECLG)

Ireland has developed a draft Programme of Measures for Ireland's marine waters designed to meet targets set to achieve or maintain GES by 2020.

Ireland exercises a more limited form of jurisdiction in the area of continental shelf that extends beyond 200 nautical miles into a region abutting the Porcupine Abyssal Plain. In this area of more limited jurisdiction the requirements of the Directive apply only to the seabed and subsoil but not to the water column.

The Department of Environment, Community and Local Government (DECLG) is the Competent Authority. This authority is provided for under Article 7 of the Directive and by the European Communities (Marine Strategy Framework) Regulations S.I. No. 249 of 2011. Other government departments and agencies[2] assist the DECLG with the implementation of the MSFD.

All of Ireland's Marine Waters are located within the North East Atlantic Sub-region of the Celtic Seas. Ireland shares the Celtic Seas Sub-region with the UK and France. Ireland, along with all of the EU countries of the North East Atlantic, Iceland and Norway are members of the OSPAR Regional Sea Convention for the Protection of the Environment of the North East Atlantic. OSPAR is the key regional coordination forum and works to improve the adequacy and coherence of MSFD implementation.

Ireland plays a significant role in the development of OSPAR plan for further coordination and coherence in the development of regionally coordinated measures. This work ensures that, where it is practical to do so, the Member States of the EU that are also Contracting Parties to OSPAR cooperate on the development of their MSFD Programmes of Measures. Ireland has made considerable efforts to coordinate its approach to the development of the draft Programme of Measures with their neighbouring countries. Ireland also plays an active role in the development of the OSPAR Regional Action Plan on Marine Litter and continues to contribute to and participate in all OSPAR work areas.

In terms of Copernicus data and the involvement of the programme in the Irish MSFD implementation, it was difficult for us to get pertinent information and feedback as key stakeholders were hard to identify and therefore to contact. Further enquiries will be carried out. Once again there was no obvious use of Copernicus to the MSFD implementation.

[2] Department of Agriculture, Food and the Marine; Department of Arts, Heritage and the Gaeltacht; Department of Transport, Tourism and Sport; Department of Communications, Energy and Natural Resources, Marine Institute, Environmental Protection Agency, Bord Iascaigh Mhara, Seafood Fisheries Protection Authority, Petroleum Affairs Division, Radiological Protection Institute of Ireland, Food Safety Authority of Ireland, Health and Safety Authority, Department of Jobs Enterprise and Innovation, Inland Fisheries Ireland, and the Marine Survey Office.

3.3.3 Portugal

The MSFD requires EU Member States to take the necessary measures to achieve a good coastal and oceanic environmental status by 2020. In Portugal, the DGRM (General-Directorate for Natural Resources, Security and Maritime Services) is one of the national agencies in charge of implementing such measures.

In the first cycle, a set of environmental targets and associated indicators was also established, with a view to guiding progress towards achieving the good environmental status of the marine environment by 2020.

The 2nd cycle of implementation of the Directive has started (2018-2024), the Initial Report of the Marine Strategies (MSFD articles 8, 9 and 10) was updated for the four national subdivisions - Madeira, Azores, Continent and Extended Continental Shelf (ECS).

Figure 6 : Portugal marine waters (© DGRM)

In view of the management model that was established at national level for the implementation of the MSFD, the management is, with regard to the Continent and ECS subdivisions, coordinated by the Directorate-General for Natural Resources, Safety and Maritime Services (DGRM), with Portuguese Institute of Sea and Atmosphere, IP (IPMA) responsible for the scientific component in the evaluation of the GES of marine waters, and the Directorate General for Sea Policy (DGPM) responsible for the economic and social analysis of the use of marine waters. In the Azores subdivision, the work was coordinated by the Regional Directorate for Marine Affairs (DRAM) and in the Madeira subdivision by the Regional Directorate for Spatial Planning and the Environment (DROTA).

Regarding the use of Copernicus data in Portugal, Copernicus Marine Service Ocean Colour Satellite data are key inputs for monitoring some of the 11 Descriptors, especially Descriptor number 5 dealing with eutrophication. Elisabete Dias from the DGRM has stated that “the Copernicus Marine Service Ocean Colour data are central for the MSFD, as they enable us to improve consistency in eutrophication assessments based on chlorophyll, using satellite-derived chlorophyll provided by CMEMS”.

3.3.4 Germany

In their 2012 assessment of the German parts of the North and Baltic Seas, the Federal Government and the Länder concluded that marine waters were not at a good status, in particular concerning benthic habitats and species, fish, seabirds, phytoplankton and, especially in the Baltic Sea, marine mammals.

The present programme of measures for the German parts of the North and Baltic Seas constitutes the final step in the first implementation cycle of the MSFD. It is also to contribute to implementation of the objectives of the "Entwicklungsplan Meer – Strategie für eine integrierte Meerespolitik" (Marine development plan – Strategy for integrated marine policy) adopted by the Federal Government.

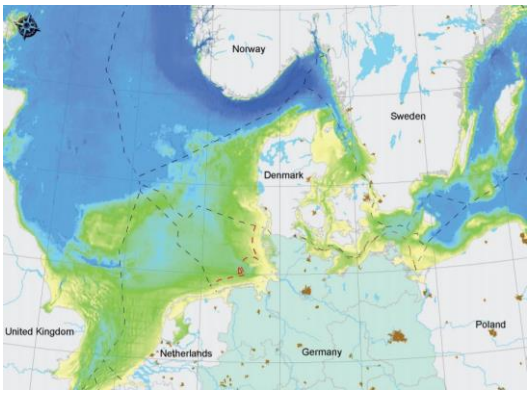


Figure 7 : Germany marine waters (© Länder Hamburg)

The programme considers the contribution to the achievement of the MSFD objectives made by existing national measures under European environmental directives and as part of regional and international agreements.

It is expected that the measures proposed in the MSFD programme of measures will have exclusively positive effects on the assets protected and environmental objectives set by statute, in particular with regard to water, wildlife/plants/biodiversity, terrestrial soils, landscape, air, cultural goods and material assets as well as human health. Moreover, it is expected that there will be positive transboundary effects. The magnitude of these impacts will depend on the detailed specification of the measures in the course of their implementation.

The national sovereign responsibility for MSFD implementation and the execution of measures in the North
and Baltic Seas principally rests with:

- the coastal Länder Hamburg, Lower Saxony, Mecklenburg-Vorpommern and Schleswig-Holstein for coastal waters;
- the Federal Government for the Exclusive Economic Zone and the continental shelf including the seafloor and its subsoil.

The coastal Länder named above, Bremen and the Federal Government have agreed to jointly implement
the MSFD in the entire German section of the North and Baltic Seas. To this end, the Federal/Länder Committee on the North Sea and Baltic Sea (BLANO) was established which, as the national competent authority, has taken on responsibility for coordination and liaison with regard to MSFD implementation. BLANO, as delivery authority for the programme of measures, is also in charge of conducting the SEA process.
Consultations between government departments within the Federal Government and among the Länder governments represented in BLANO are used to formally coordinate the programme of measures.

Apart from examples that can be found online, such as the CURAE use case, it is difficult to find concrete example of Copernicus use in MSFD in Germany.

3.3.5 Belgium

Just like all the members of the European Union bordering the sea, Belgium had to develop a marine strategy to achieve the "good environmental status" by 2020.

The Marine Strategy Framework Directive was transposed by Belgium into a Royal Decree of June 23, 2010. To meet the 2020 target, the time frame imposed by Europe had to be closely monitored:

- 2012:
  - an initial assessment of the Belgian part of the North Sea;
  - a description of our good environmental status and the environmental objectives associated with it that must be achieved by 2020;
  - and finally, a socio-economic analysis of the activities at sea;
- 2014: preparation of a monitoring program;
- 2016: implementation of the program of measures;
- 2018: the first six-yearly review of the previous evaluation in terms of the results achieved.

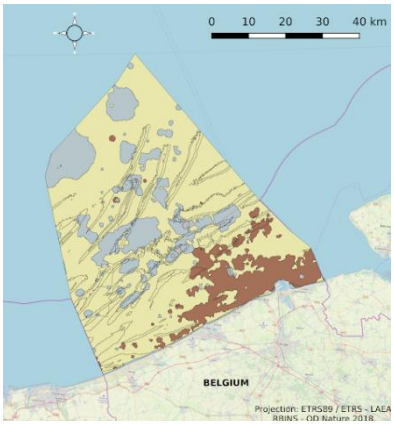


Figure 8 : Belgium marine waters (© RBINS)

The Marine Environment Service (FPS Health, Food Chain Safety and Environment) is the competent authority for coordination and implementation of the MSFD. This is organized primarily in the context of the 'North Sea and Oceans' steering group of the Coordinating Committee for International Environmental Policy (CCIM) of DG Environment. This committee hosts competent federal departments and as well as representation of the Regions and is chaired by the Marine Service. The North Seas and Ocean Steering Group prepares, agrees and finalizes the official Belgian position and MSFD documents.

At an operational level, several instruments were used by the Marine Service for effectively translating relevant MSFD scientific findings into concrete policy guideline. These included multi-actor consultations, working meetings, targeted consultations, bilateral meetings and public consultations. All are coordinated by the Marine Environment Service who act as a channel for presenting scientific advice and the expert recommendations to the North Sea Oceans Steering Group.

To achieve a successful implementation, the Marine Environmental Service coordinated the different steps in the implementation of this framework directive. The cooperation between the federal authorities and the regions takes place in the CCIM Steering Committee of North Sea and Oceans and the cooperation with neighbouring countries is coordinated in the OSPAR Convention.

There must be expressly pointed out that the Belgian part of the North Sea is only a very small part (0.5%) of the North Sea, bordering the waters of three neighbouring countries. Consequently, some environmental goals can only be achieved on condition that there is a strong cooperation with these neighbouring countries. Several problems in the marine environment cannot be addressed thoroughly on a unilateral manner.

Apart from examples that can be found online, it is difficult to find concrete example of Copernicus use in MSFD in Belgium.

4. French use of Copernicus data and main drawbacks

To further investigate and try to identify how to align/use the substantial capabilities of Copernicus for the MSFD, a set of interviews were planned to:

- Better understand the complexity of the MSFD implementation at the French level (inputs to be found in MAREOS D1.1);
- Inventory in which agencies in charge Copernicus is used and if not, what are the reasons why.

Below is the list of agencies that were interviewed, along with the interview date and internal referent:

Organisation	Contact	Date	PMBA's referent
IFREMER	Lucile Delmas	01/10	Phil Monbet
OFB	Dorothée Vincent	16/11	Nolwenn Beaume
CEDRE	Camille Lacroix	19/11	Anais Turpault
CEDRE	Loic Kerambrun	19/11	Anais Turpault
CREOCEAN	Denis Valance	20/11	Phil Monbet
CREOCEAN	Sébastien Thorin	20/11	Phil Monbet
IFREMER	Francois Galgani	20/11	Anais Turpault
BRGM	Olivier Brivois	23/11	Anais Turpault
SHOM	Emilie Tew-Kai	25/11	Nolwenn Beaume
SHOM	Valerie Cariou	25/11	Nolwenn Beaume
MNHN	Francoise Claro	25/11	Juliana Carvajal
MNHN	Fanny Girard	25/11	Juliana Carvajal
OFB	Benjamin Guichard	25/11	Juliana Carvajal
La Rochelle Université / CNRS	Matthieu Authier	26/11	Juliana Carvajal
La Rochelle Université / CNRS	Auriane Virgili	26/11	Juliana Carvajal
OFB	Muriele Chevrier	27/11	Nolwenn Beaume
OFB	Julie Charmasson	27/11	Nolwenn Beaume
OFB	Sophie Beauvais	27/11	Nolwenn Beaume
IFREMER	Alain Lefebvre	02/12	Nolwenn Beaume
IFREMER	David Devreker	02/12	Nolwenn Beaume
IFREMER	Antoine Huguet	02/12	Nolwenn Beaume
MNHN	Laurent Guerin	04/12	Juliana Carvajal
MNHN	Marine Delesalle	04/12	Juliana Carvajal
MNHN	Pierre Thiriet	04/12	Juliana Carvajal
MNHN	Anthony Acou	04/12	Juliana Carvajal

Figure 9 : List of interviews conducted in the framework of MAREOS

4.1 Use of Copernicus data in the French MSFD-linked entities

Based on the interviews done with relevant French stakeholders, it seems that Copernicus is a key tool for the French MSFD implementation and for ensuring a Good Environmental Status.

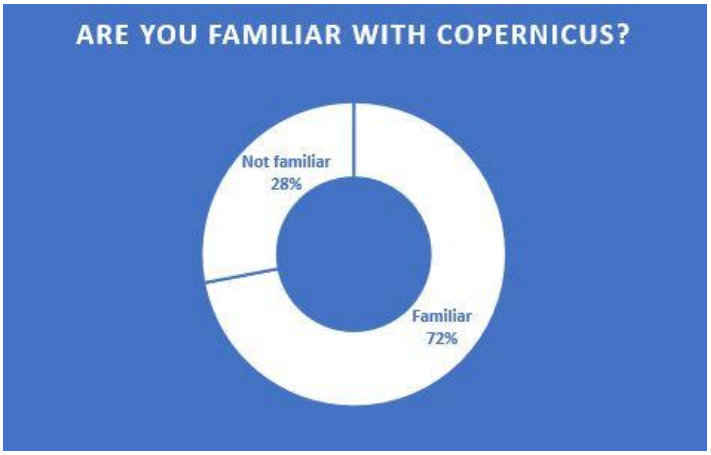


Figure 10 : Interviewees' familiarity with Copernicus

Among the interviewees, **more than 70% of them** are quite familiar with Copernicus and its services and use them frequently to work on their dedicated descriptors. It could be of interest to note that some of them didn't know what Copernicus was offering and the diversity of its data before participating to a training session about Copernicus data and services.

Modelling and simulation

Modelling and simulations are the most cited aspects from Copernicus, being a focus point on the researchers' daily work.

Copernicus is commonly used coupled with *in-situ* data to develop models and gather information that is missing. When available, interviewees use *in situ* data for the monitoring reporting and uses Copernicus data if a campaign at sea cannot be done, if the data are not treatable or if they need more heterogeneity.

"The priority for the D6 is to have data on the activities. Then, in a second stage, we need environmental data that will allow us to evaluate the impacts of these activities. To be fully in place for the acquisition of activity data, it will take at least another 10 years."

Olivier BRIVOIS, BRGM

Reporting and validation processes

Most of our interviewees who use Copernicus services used it for the MSFD latest reporting cycle, for post-production of the monitoring programme. Some of them have their own internal models but they use Copernicus large scale data for forcing purposes and to introduce limit conditions for downscaling purposes.

"CMEMS is listed in the latest documentation of D7, as a data provider for the monitoring programme. For validation processes, we work with the Copernicus In Situ pack along with the CORA data (Coriolis Ocean Dataset for Reanalysis) in order to efficiently validate our models."

Emilie TEW-KAI, SHOM

The main idea for them is to use satellite data and models to cover all seasons and get more frequent data (monthly basis) and therefore get better insights.

One example was given regarding the Mediterranean area and work within Descriptor 5: the current model used for this area is not fully operational, so Copernicus services are really important to gather the right information/data.

Durability of access and data

Most of our interviewees see a great asset in the Copernicus services, which is the access to data from various sources and the durability of this access. These tools were not self-sufficient in terms of financing and are depending on financing that can be stopped the next day.

"One of the greatest asset of the Copernicus services is that these data come from various sources and is "durable". I experienced some difficulties with national incentives, since they are subject to financing that can be stopped the next day. If there is no financing, there is no data."

Emilie TEW-KAI, SHOM

Even if Copernicus services can apply to all Descriptors, the ones that can benefit from its services are using the portal and its data and are quite satisfied with the offered services. The wide quantity and the good date quality that can be downloaded from the portal is appreciated.

4.2 Drawbacks and reasons for not using Copernicus data

Even if Copernicus is sometimes key for the French MSFD implementation and for assessing the Good Environmental Status of waters, some drawbacks and limitations of the Copernicus services have been highlighted by end-users. Below is displayed the main reasons why end-users do not use this source of data within the framework of the MSFD.

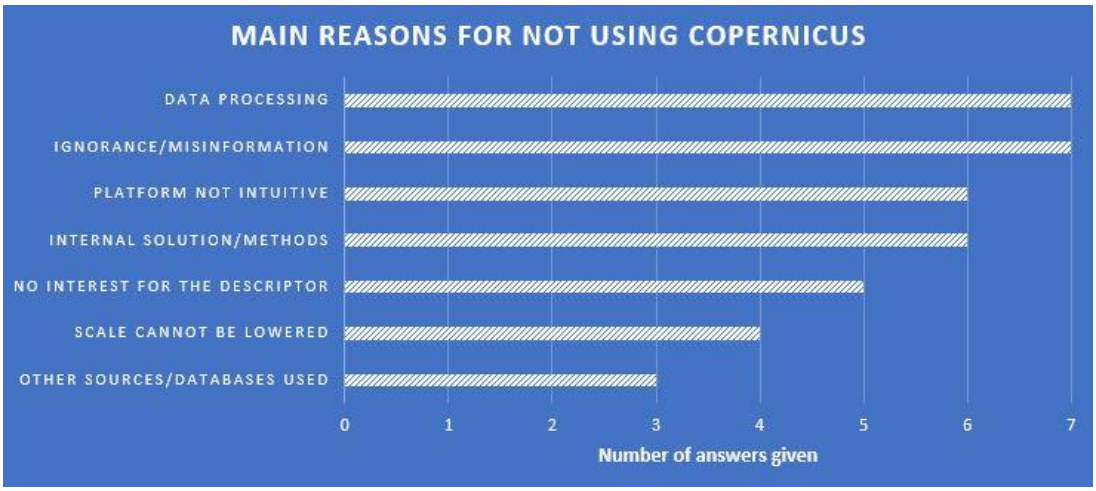


Figure 11 : Interviewees' reasons for not using Copernicus

Data processing

Data processing is a key issue for them as the data that can be extracted from the platform is not well filtered, there is work to be done afterwards to use the data. People who are not used to coding or to deal with large data can feel lost. Copernicus should provide the data along with a pre-coding, so that people can easily read the data and analyze them, especially if they are not used to code.

"Another aspect would be to harmonize the data format or at least use a format with which everyone feels comfortable (csv for instance), so that people who are not experts and/or who don't have the proper software can still use the data."

Alain LEFEBVRE, Ifremer

Ignorance/misinformation

Ignorance/misinformation is also a key issue for them as there seems to have an ignorance about the subject that should be interesting to further investigate. They are not aware of what the Copernicus program has to offer in terms of data and services.

"An effort has to be made by Copernicus supervisors to better advertise their data and tools, to reach more audience."

Dorothée VINCENT, OFB

Platform not intuitive

Another aspect that was often cited during the interviews is the fact that the **platform is not intuitive.** Work should certainly be done on the treatment of occurrences and analysis capacities. Some people see Copernicus portal as something which is time consuming and seem to be very technical. It seems time consuming because the user has to register, search for the data, download it and analyze the data. This was not what they were initially looking for, they were looking for derived products and intuitive ones, to be able to easily use them and not waste too much time on the data search and treatment.

"the access was quite difficult, the navigation was long and the user only had access to raw data. This was not what they were looking for, they wanted for derived products to be able to use them by integrating them directly into their analyses"

Matthieu Authier, Université La Rochelle

Internal solution/methods

One of the reasons for not using Copernicus data is also that users already have **internal solution/methods.** They have internally designed solution, so there's no need for them to use/integrate extra data and in particular Copernicus data.

"Among MSFD descriptor actors, everyone has its own data base, its own method and evaluation. This results in difference in terms of conclusions and divergence"

Alain LEFEBVRE, Ifremer

Not of interest for the descriptor

Some interviewees declared that there is **no interest for the descriptor.**

For Descriptor 8, when there is a marine pollution, particularly related to an oil spill, a satellite image is obtained in order to have an aerial view of the area. However, the image is not processed or analyzed at this stage. It is only used to feed the report into the POLREP database.

For Descriptor 10, there is not much of interest since the descriptor is based on samples collection. But perhaps there could be some inputs.

"The use of these data is not "direct" or automatic (for benthic habitat or marine birds for instance), as they will not address the problematics and will not characterize the status of these habitats"

Muriel CHEVRIER, OFB

Scale cannot be lowered

The scaling of data was also mentioned, as currently, the **scale cannot be lowered.** Better resolution would be needed to fulfil scientific needs.

"One of the main drawbacks of Copernicus data is that the scale cannot be lowered as much as the team would need it."

Dorothée VINCENT, OFB

Data from other sources/databases

Last point to be addressed it the fact that scientific teams are collecting their **data from other sources/databases.**

For instance, among the OSPAR community, it has been decided that the common data base to be used for the evaluation process would be the hOMe data base, operated by the International Council for the Exploration of the Sea (ICES). The ICES is an intergovernmental marine science organization, meeting societal needs for impartial evidence on the state and sustainable use of our seas and oceans.

"We take advantage of the institutionalized campaigns, particularly for the monitoring of the fisheries which are financed by the DCF (data collection framework) to collect waste at sea. This allows the Commission to capitalize on existing initiatives. Within the framework of Horizon Europe, the Digital Ocean Twin call aims to make the link between EMODNET and Copernicus articulation of the two databases"

François GALGANI, Ifremer

5. Conclusion

Copernicus remain one of the greatest assets for Europe and ultimately to the wellbeing of its citizens. This programme shifted from a scientific initiative to an operational infrastructure able to provide a wide range of observation and environmental data on earth. The recent Copernicus market report highlights the programme's growing and enduring benefits. The value of the programme continues to significantly exceed its cost (€8.2 billion) with estimated economic benefits forecasted to reach a figure between over €16 billion. Besides direct economic benefits, there are also indirect benefits with better natural disaster management reducing casualties or even better prevention regarding our everyday life regarding food security or improved air quality in cities.

As Copernicus is fast growing, it also increased its footprint and now supplies 20% of the world's Earth Observation data, meaning that it can provide more and more data and services that could help managing the regulation in place. This is particularly true for the marine areas where *in situ* infrastructures and networks are costly and sometimes hard to maintain and operate.

Within the framework of the Marine Strategy Framework Directive, the COPERNICUS programme has a lot to offer in term of earth observation capabilities and to monitor the Good Environmental Status (GES) of the EU's marine waters. This report presented the wide capabilities of Copernicus and reviewed the existing initiative related to MSFD. The first findings of this report show that Copernicus data and services appears to be used for supporting two main MSFD descriptors Eutrophication (#5) and underwater noise (#11).

However, there are 11 GES descriptors and all need information describing their surrounding environment to be determined. Therefore, there are certainly opportunities to involve Copernicus data considering their capabilities. This is particularly true for the following GES descriptor:

- Sea floor integrity (at least in shallow waters),
- Alterations to hydrography,
- Contaminants,
- Marine litter.

Within the above context, this report initiated a review at the French level by setting up interviews of the agencies in charge of the implementation of the MSFD. Copernicus is well known by most of key stakeholders but even if some agencies may use it, it is definitely not well spread. Those who use it, take great advantage of CMEMS.

The interviews indicate that not all the GES descriptors require modelling, so in this case it remains very hard to find and extract isolated specific data. In that case, very high and specific expertise is required, and this extra work is not expected for monitoring purpose, but rather scientific research.

Ignorance about the services offered by Copernicus have a clear impact on this involvement, as some scientists and key players don't know the diversity of the data to be provided and how to collect and manage it.