



## **OBSERVER: The Copernicus Marine Service and Coastal Zones: Paving the Way Forward**



## **Copernicus Marine: a constantly evolving service**

The Copernicus Marine Service is one of the six pillar services of the Copernicus programme, dedicated to a sustainable use of the ocean. The Copernicus Marine Service monitors the marine environment globally with refinements on European seas, providing reference information on the physical (currents, waves, temperature, salinity, etc.), biogeochemical (carbon, plankton, oxygen, etc.) and sea-ice state in real-time, for the past decades and forecasts for the coming days.

The Copernicus Marine Service provides a core European response to user needs and policies related to all sectors of a sustainable blue economy. The service is user driven, validated by its users and responsive to their requests. The service also continuously evolves and is state-of-the-art scientifically and technically, with evolutions based on results of short- to long-term R&D activities driven by user demand. Two programmes have therefore been set up in the Copernicus Marine Service to complement operational activities and feed the development of the service from the upstream to downstream side, the Service Evolution and the User Uptake programmes respectively (see below for more details). The Copernicus Marine portfolio is thus regularly evolving, with upgrades of the systems and observations underpinning the production of ocean data, the addition and development of new products to better address key sectors. In line with European strategic considerations, the upcoming Copernicus Marine Service thematic enhancement priorities that will be considered for the next Multi Annual financial framework if budget allows, target the Arctic marine environment, marine biology, and coastal environments. In this article, the evolution of the Copernicus Marine Service to address coastal challenges is illustrated with the upstream, operational and downstream activities.

## **Coastal zones: a key sector for Copernicus users**



Coastal zones provide many services to society, including but not limited to: food, energy and other resources, shoreline protection, ocean recreation, tourism and coastal livelihoods, water quality maintenance, waste treatment, biogeochemical cycling, and regulating services, support of the green and blue economy and importantly, the maintenance of the basic global life support systems. Given the tremendous societal, biological and economic values of coastal zones (see box), the coastal environment is a key sector for Copernicus users, including to support EU policies and directives.



*Figure 1. Artificial satellite image of Europe by night, highlighting that coastal zones are more densely populated than the hinterland and can exhibit different behaviours, for instance for ocean colour.*

### **Did you know?**

#### **Why are coastal zones important?**

- In Europe alone, more than 50 million people live in low-elevation coastal zones (see figure 1) ([source](#)).
- Marine coastal ecosystems are amongst the most productive on Earth and provide a range of social and economic benefits to humans, including a regulating role for the climate, protection of shoreline (via dunes, mangroves, reefs) and yielding 90% of global fisheries output.
- The area of sea under the control (jurisdiction) of EU Member States is larger than the total land area of the EU. Including its outermost regions (territories and entities in the Atlantic, Pacific and Caribbean), the EU has the world's largest maritime territory ([source](#)).
- The EU coastline is 68,000 km long — more than three times longer than that of the United

States and almost twice that of Russia ([source](#)).

- In the 24 coastal countries covered by the European Environment Agency, there are 560,000 km<sup>2</sup> of coastal zones, corresponding to 13 % of the total land mass of these countries (based on Copernicus Corine Land Cover data from 2000) ([source](#)).

## What is the Economic Value of Coastal Zones in Europe?

- The global ocean economy represents USD 1.5 trillion in added value, with a strong contribution from coastal zones.
- Maritime transport is essential to the world economy. More than half of the volume of the EU's foreign trade is conducted by sea, with large portions of maritime routes in the coastal ocean ([source](#)).
- Economic assets within 500 metres of the sea have an estimated value of EUR 500 billion to 1000 billion ([source](#)).
- EU public expenditure on protecting coastlines from the risk of erosion and flooding is expected to reach EUR 5.4 billion a year for the period 1990-2020 ([source](#)).

The sustainable management of coastal zones and their exploitation can be conflicting, as there is often friction between economic development and ensuring a sustainable environment. Coastal zones are prone to various marine hazards, both of natural origins or related to human activities, for which marine monitoring is essential (Fig 2). Numerous EU policies, directives and their implementation need to be supported by information and data on coastal zones, e.g. the Marine Strategy Framework Directive, Flood Directive, Water Framework Directive, Bathing Water, Habitats & Bird Directives, Maritime Spatial Planning, Common Fisheries Policy, Green Deal, etc.

The Copernicus Marine Service provides a 'core' service supporting expert value-adding services that can be developed by the private sector or national public administrations and complying with the Copernicus programme delineation process between core and downstream services.

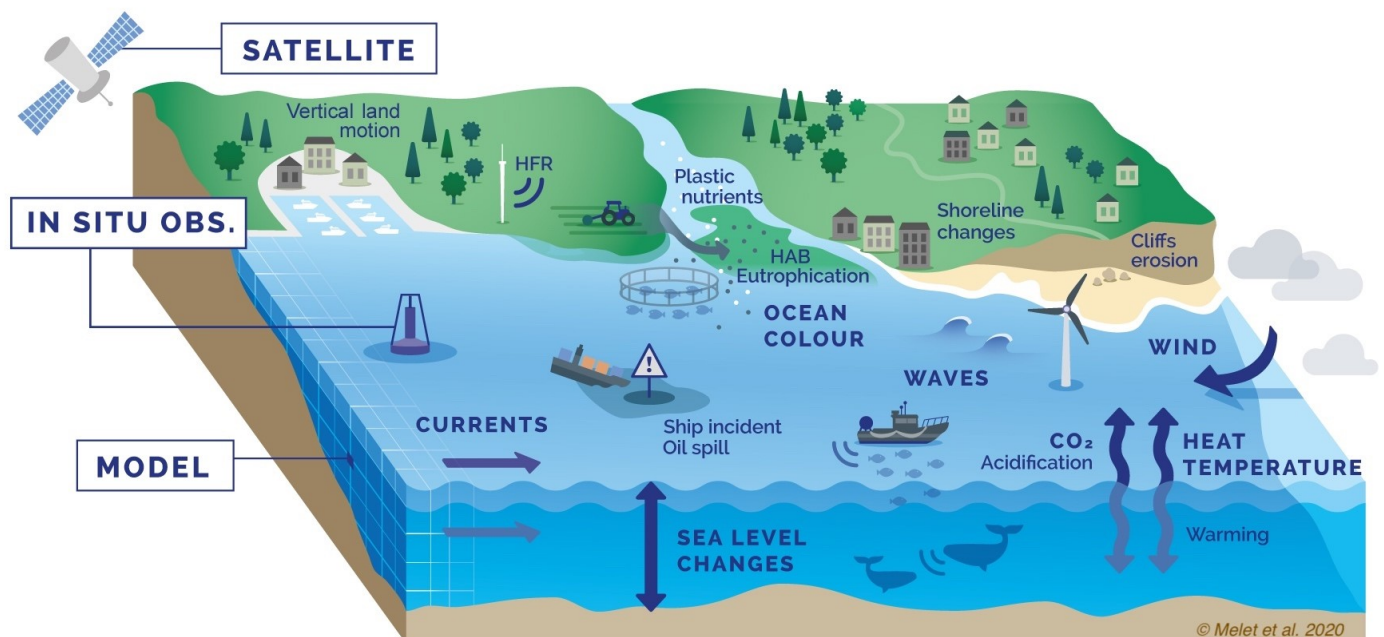


Figure 2. Schematic representation (non-exhaustive) of the coastal zone, hazards (in normal font), and ocean and atmospheric variables (in bold font) that are relevant for coastal marine hazards and their monitoring [HFR: high-frequency radar; HAB: harmful algae bloom]. The different information

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*sources used in the Copernicus Marine Service are also presented, with satellite observations (including Copernicus' Sentinels), numerical models and in-situ observations ([source](#)).*

## **An inspiring example: The addition of high-frequency radar data in the Copernicus Marine Service and its use for search and rescue**

As a European core service, the Copernicus Marine Service focuses on activities of pan-European interest that can be implemented centrally for best quality and cost-efficiency, to support the downstream development of products and services. Coastal monitoring services operated by Member States or private groups are important and strategic users of the Copernicus Marine Service. The overall value chain is designed to enhance the socio-economic value of the Copernicus Marine Service by contributing to the implementation of environmental policies and the sustainable use of marine resources in coastal areas.

To ensure that the Copernicus Marine Service's coastal products are fit for purpose, a "Roadmap for the evolution of Copernicus marine and land services to better serve coastal users" was elaborated between 2017 and 2019 after two workshop and in consultation with Member States. The roadmap, delivered to the European Commission, highlights the proposed evolution of coastal zone monitoring over the next 7 years. In the meantime, based on this roadmap, the Copernicus Marine Service has started to implement services and is developing new products relevant for coastal zone monitoring. For example, the [high-resolution ocean colour products using Sentinel-2](#), as well as several Service Evolution and User Uptake funded projects focused on coastal zone monitoring to support the short to mid-term continuous improvement of the service.

The introduction of high-frequency radar (HFR) data in the portfolio (Figure 3) which aims to improve the monitoring of surface currents at high resolution in the coastal environment, was the first project to address coastal needs and service better coastal users. Find out more about this project below through INCREASE and IBISAR



## Upstream: Service Evolution R&D



2016

**INCREASE project**  
Building a EU node  
for HFR data

2018

## Operations: CMEMS portfolio



**HFR data are  
integrated in  
CMEMS portfolio**

April 2019

HFR data are  
available in  
CMEMS portfolio

2020

Extension of  
HFR data in  
CMEMS portfolio

2021

## Downstream: User Uptake



Mid 2018

**IBISAR service**  
Integration of HFR data  
for search and rescue  
and oil spill responses

End 2019

Operational IBISAR  
downstream service

2021

Figure 3. Timeline of the development, ingestion and use of HFR data and information in the Copernicus Marine Service catalogue, notably through the Service Evolution and User Uptake programmes. Learn more [here](#).

## What are high-frequency radars?

High-frequency radars are cost-effective remote-sensing instruments installed along coasts (Figure 4). They offer unique insights into ocean surface currents and waves at high-frequency (from tens of minutes to an hour) and high-resolution (typically from 200-m to 5-10 km resolution, depending on the operating frequency of the radars) up to tens of kilometres offshore. HFR-derived information supports a number of applications such as maritime security hazards, maritime pollution, ecosystems monitoring and integrated management of coastal zones (Figure 2).

The number of HFR networks has substantially grown over the last decade; more than 50 HFR systems are operational in Europe, and several new networks are planned (Figure 4).

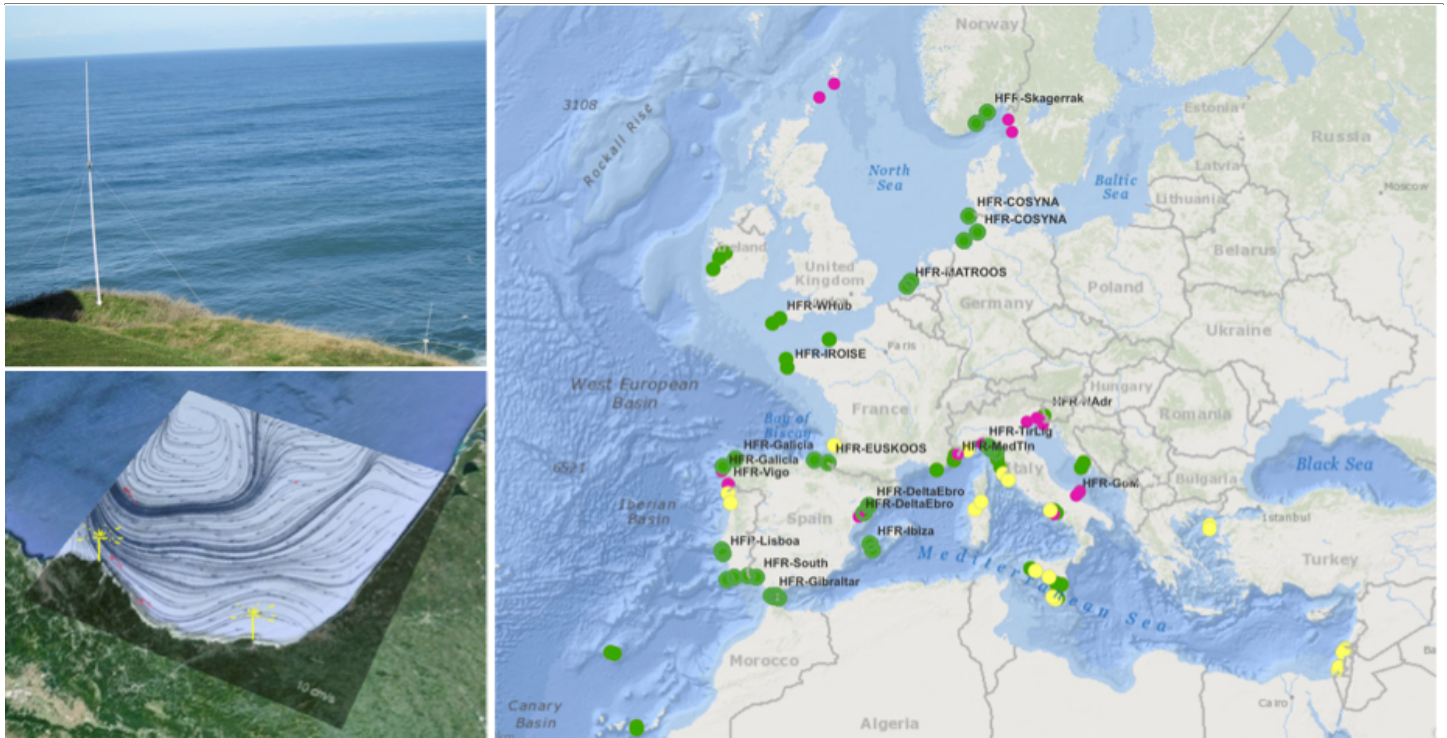


Figure 4. An example of HFR installed along the EU's coast (upper left, here close to the Spain/France Atlantic border) and corresponding illustrative view of HFR derived ocean surface circulation (lower left). Right: Map of the location of 105 EU HFRs (March 2020). The 59 operational systems are plotted in green, the 20 being installed are in yellow, and the 26 that are not functioning (either inactive stations or historical deployment) are in purple. 30 HFRs are connected to the HFR node sending data in near real time to CMEMS. Source: [EuroGOOS HFR task team](#).

### **INCREASE, the Service Evolution project to introduce HFR in the Copernicus Marine Service**

[INCREASE](#), a Copernicus Marine Service Evolution project led by [AZTI](#) between 2016-2018 (Figure 3), laid the necessary foundations to prepare the integration of the existing European HFR operational systems into the Copernicus Marine portfolio, following four main objectives:

- Provide HFR quality-controlled real-time surface currents and key derived products;
- Set the basis for the management of historical radar data and methodologies for advanced delayed mode quality-control techniques;
- Boost the use of HFR data for improving Copernicus Marine numerical modelling systems;
- Enable an HFR European operational node to acquire HFR data from partners, to quality control and validate the data, and to distribute them operationally to the Copernicus Marine Service.

### **Addition of HFR data in the Copernicus Marine Service portfolio**

Following this Service Evolution project, and in collaboration with other initiatives such as [EMODnet](#) (DG MARE) and [EuroGOOS](#) specialised in in-situ sensors deployment and data collection, the data of the existing European HF Radar network was progressively integrated in the Copernicus Marine in-situ observation Thematic Assembly Centre. It marked the first time that a Service Evolution project led to the injection of a [new product](#) in the operational Copernicus Marine portfolio. The ingestion started in [April 2019](#) and is still ongoing with reprocessed total currents from HFR released in July 2020, allowing users to access high-resolution surface currents in the first tens of kilometres up to 200 kilometres offshore (depending on the radar system). As of today, data from 35 radar sites are

distributed by the Copernicus Marine service catalogue. By the end of 2020, this will be expanded to 50 EU radar sites (Figure 3).

### ***IBISAR, an example of downstream User Uptake of the newly integrated Copernicus Marine HFR data***

Once in the portfolio, demonstration of the HFR data benefits on the field was made by IBISAR.

In the framework of the Copernicus Marine User Uptake programme, [SOCIB](#), a Spanish entity, developed [IBISAR](#), a new operational and coastal service, that uses the newly available Copernicus Marine High Frequency Radar product.



See the video [here](#).

IBISAR provides a user-friendly ocean data quality assessment with easy to interpret metrics that help Spanish Search and Rescue (SAR) operators and emergency responders select the most accurate near-real time ocean current velocity products (i.e. observations and forecasting) in the Bay of Biscay.

Using in-situ high spatiotemporal resolution surface current observations derived from emerging technologies such as the [High-Frequency Radars \(HFR\)](#) that is available in the recently upgraded Copernicus Marine catalogue, facilitates decision making in support of emergency response at sea, particularly for drifter trajectories calculations (e.g. man overboard, floating objects or oil spills).

## **More on the Copernicus Marine Service Evolution programme**

The Service Evolution programme aims to ensure that the Copernicus Marine Service remains state-of-the-art and a world leading service for Copernicus. Two reference documents provide the [high-level strategy](#) of the service evolution as a whole, and [R&D priorities for CMEMS](#). To improve CMEMS' scientific information content, calls for tenders are opened and specific short term [R&D projects](#) dedicated to CMEMS system improvements are funded. Longer term evolutions heavily rely



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on Horizon 2020 and Horizon Europe programmes.

Although the project illustrated here, INCREASE, was technical by nature, most Service Evolution projects are tackling scientific developments. A total of 30 two-year R&D Service Evolution projects were funded by CMEMS, with a large uptake in the operational service. Service Evolution projects are also paving the way toward major evolutions of CMEMS. With regard to coastal zone monitoring and forecasting, Service Evolution projects have addressed key issues such as:

- Satellite derived coastal zone turbidity, nearshore bathymetry, shoreline position based on Sentinel-2 and other missions over specific areas as an investigative step for a potential future core pan-EU coverage;
- The development of generic and coherent approach to downscale Copernicus Marine products for high resolution operational modelling of coastal areas, taking into account the active nature of the coastal boundary (more [here](#));
- A better representation of the land-estuary-ocean continuum with improved river discharges into the ocean (more [here](#) and [here](#)).

## More on the Copernicus Marine User Uptake programme

The 2016-2021 User Uptake programme [strategy](#) is primarily intended to stimulate innovative ideas from all categories of intermediate Copernicus Marine users and to develop and demonstrate downstream applications based on Copernicus Marine Service information. An “intermediate user” is a user that implements a downstream service using Copernicus Marine information; the “end-user” is the one who uses this service. It is essential for the Copernicus Marine user community to learn about the successes of new services related to the coastal and offshore marine application markets that use Copernicus products. For Copernicus Marine it is important to develop through this programme, the growth of sustainable businesses across various societal and industrial sectors, such as national institutions, private companies, and especially SMEs.

Currently, 40 contracts signed with 46 different entities from all coastal European Member States, have developed or upgraded services integrating Copernicus products or are still on progress to achieve them by the end of November 2020. To learn more about the User Uptake programme and all the services relying on this programme, you can visit our [Use Case Demo page](#). In the coming months, this page will be enriched by 12 other new services.