FORCOAST

Earth Observation Services For Wild Fisheries, Oystergrounds Restoration And Bivalve Mariculture Along European Coasts

PROJECT DELIVERABLE REPORT

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Description	This deliverable states whether ADDITIONAL datasets were used from the Copernicus Space Component Data Access (CSCDA) services Data Warehouse and how they were used. These ADDITIONAL Datasets provide for example higher resolution products which are necessary for aquaculture operation (task 3.1).
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Executive Summary

This document is an update of deliverable D3.4 *Data Warehouse (DWH) use for 2021*. Its purpose is to list the Earth Observation datasets used by the different partners within the FORCOAST project during 2022, together with their sources.

The introduction refers the reader back to deliverable D3.2 for more information on the DWH Core and Additional datasets available from the Copernicus Space Component Data Access (CSCDA) site, and for details behind the reasons for the lack of use of these datasets by the partners.

The main section describes the datasets used in each pilot area, indicating their source, a link to obtain further information about them or, where possible, to access the data directly.

The references section includes most of the links provided throughout the text.

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Acronyms and abbreviatures

CMEMS: Copernicus Marine Environment Monitoring Service

CSCDA: Copernicus Space Component Data Access

DWH: Data Warehouse

NWP: Numerical Weather Prediction

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1 Introduction

This deliverable presents an update of the datasets used by each FORCOAST partner during year 2022, compared to those expected to be used during the same period, which were presented in deliverable D3.4 in 2021. While that deliverable, together with the results of a survey on datasets usage by the different partners of the project, included information about the catalogue of products available from the Copernicus Space Component Data Access (CSCDA) Data Warehouse (DWH) –CORE and ADDITIONAL datasets–, this document focuses on the datasets finally used by each pilot. The reader should refer to deliverable D3.2 for further information on DWH datasets.

At this stage, the models created for each of the pilot areas and the service modules designed to answer user requirements from the different FORCOAST sectors have both reached their final development stage. Therefore, the list of previously considered datasets has been narrowed down to those found to be the most appropriate for the operational implementation of the models. With this idea in mind, and as mentioned above, this document presents the list of datasets finally selected to be used in each pilot area, as well as their purpose (model validation, model forcing, direct use or others). For a detailed explanation on the implemented models, the reader is referred to deliverable D3.8.

As was seen in deliverable D3.2, the high-resolution DWH datasets are, in general, not used in the pilot areas defined in the project. The reasons given in that deliverable based on feedback from the pilots, which are still valid today, include:

- The traditional datasets and their available variables provide enough information to develop the models.
- The large processing power required to process the DWH datasets makes their use unfeasible.
- Inability to set a daily-based processing operative chain.
- The available variables do not match some of the partners' needs.
- Some new high-resolution products offered by CMEMS since May 2021 have enough resolution (300m) for some of the partners' needs.
- CMEMS products are regularly validated and the quality is reported; this makes them more attractive to use than the DWH datasets, as validation, which is a very time and effort consuming procedure, has already been performed.
- The DWH datasets are not relevant for some of the service modules being developed.

In July 2022, CMEMS introduced a simplification of its catalogue. This new launch included an update to some of their models, which are used by some of this project's pilots and are listed throughout the text.

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2 Datasets used in each pilot area

The datasets used by each pilot are listed below, grouped by their use in the pilot/service. Within each group, their source and the selected variables in each of them are indicated.

2.1 Pilot 1 – Portugal

2.1.1 Direct use

This pilot reports that no datasets are directly used.

2.1.2 Model forcing

CMEMS

GLOBAL_ANALYSIS_FORECAST_PHY_001_024: Up to 6-hourly global ocean analysis and forecast system at 1/12° which contains physical variables such as sea water temperature, salinity, sea surface height and water velocity.

IBI_ANALYSISFORECAST_BGC_005_004: Daily L4 high resolution (0.028°) biogeochemical forecast, which provides dissolved molecular oxygen, phosphate, ammonium and chlorophyll.

Instituto Português do Mar e da Atmosfera (IPMA)

IMPA provides outputs of the meteorological AROME model at a resolution of 2.5km, which are used as atmospheric forcing by the pilot.

Instituto Superior Técnico (IST)

The pilot also uses the WRF model at a resolution of 3km for atmospheric forcing provided by IST.

MOHID

The pilot uses the MOHID land model for land forcing.

2.1.3 Model validation

CMEMS

OCEANCOLOUR_GLO_BGC_L4_NRT_009_102: Daily L4 1/24° resolution chlorophyll dataset (cmems_obs-oc_glo_bgc-plankton_nrt_l4-gapfree-multi-4km_P1D).

SST_ATL_SST_L4_NRT_OBSERVATIONS_010_025: Daily L4 high resolution (0.02°) sea surface temperature dataset.

OCEANCOLOUR_ATL_BGC_L4_NRT_009_116: Daily L4 high resolution (1km: cmems_obs-oc_atl_bgc-plankton_nrt_l4-gapfree-multi-1km_P1D) chlorophyll dataset.

OCEANCOLOUR_ATL_BGC_L3_NRT_009_111:

- Daily L3 high resolution chlorophyll datasets (1km resolution: cmems_obs-oc_atl_bgc-plankton_nrt_l3-multi-1km_P1D; 300m resolution: cmems_obs-oc_atl_bgc-plankton_nrt_l3-olci-300m_P1D).
- Daily L3 high resolution transparency dataset (1km: cmems_obs-oc_atl_bgc-transp_nrt_l3-multi-1km_P1D), which provides the concentration of inorganic suspended particulate matter in sea water.

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2.1.4 DWH datasets

No DWH datasets are used in this pilot area.

2.1.5 Differences between 2022 prevision and final use

No differences were reported between the expected and final use of datasets for 2022.

2.2 Pilot 2 – Spain

2.2.1 Direct use

This pilot has no direct use datasets.

2.2.2 Model forcing

The following datasets are used to force this pilot's models:

CMEMS

IBI_ANALYSISFORECAST_PHY_005_001

- Hourly L4 3D fields of current speed components (*uo*, *vo*), temperature (*thetao*) and salinity (*so*) (cmems_mod_ibi_phy_anfc_0.027deg-3D_PT1H-m).
- Hourly L4 2D fields of sea surface height (*zos*) (cmems_mod_ibi_phy_anfc_0.027deg-2D_PT1H-m).

MeteoGalicia

12-hourly WRF 12km resolution 2D model output used for atmospheric forcing: Air temperature at 2m (*temp*), sea surface temperature (*sst*), relative humidity at 2m (*rh*), precipitation rate (*prec*), downward short-wave radiation (*swflx*), downward long-wave radiation (*lwflx*) and wind components at 10m (*u*, *v*).

Euskalmet

WRF 1km resolution 2D model output used for atmospheric forcing (AZTI FTP server): Air temperature at 2m (*t2m*), sea surface temperature (*tsk*), relative humidity at 2m (*rh2*), precipitation rate (*pre*), downward short-wave radiation (*swd*), downward long-wave radiation (*lwd*) and wind components at 10m (*u10*, *v10*).

2.2.3 Model validation

The following datasets are used to validate this pilot's models:

CMEMS

INSITU_GLO_UV_NRT_OBSERVATIONS_013_048: L2 *in situ* observations of sea currents, obtained from three different sources:

- DBCP's Global Drifter Program drifting buoys: Near-surface zonal and meridional velocities.
- European High Frequency Radar Network radars: Near-surface zonal and meridional total velocities and near-surface radial velocities.
- Argo floats: At parking depth and near-surface zonal and meridional velocities.

In the case of the SE of the Bay of Biscay, the data is provided by HF radars with a 5km spatial resolution.

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NASA – Jet Propulsion Laboratory (JPL)

GHRSST Level 4 MUR Global Foundation Sea Surface Temperature Analysis (v4.1): Daily L4 sea surface temperature (*sst*) at 0.01° resolution obtained from various satellite missions, microwave radiometers and *in situ* observations.

EuskOOS

Salinity and temperature profile data at fixed stations with a variable time frequency, from hourly to monthly, provided by EuskOOS.

2.2.4 DWH datasets

No DWH datasets are used in this pilot area.

2.2.5 Differences between 2022 prevision and final use

This pilot has used the same datasets during 2022 they had initially planned to use.

2.3 Pilot 3 – Bulgaria

2.3.1 Direct use

The following datasets are used with the purpose of direct use:

CMEMS

SST_BS_SST_L4_NRT_OBSERVATIONS_010_006: Daily L4 sea surface temperature ultra-high resolution (0.01°) dataset (SST_BS_SST_L4_NRT_OBSERVATIONS_010_006_c_V2).

BLKSEA_ANALYSISFORECAST_PHY_007_001: Daily L4 high resolution (0.025°) physical analysis dataset with variables such as temperature at different depths, salinity, sea surface height and water velocity.

BLKSEA_MULTIYEAR_PHY_007_004: Daily L4 high resolution (0.037° x 0.028°) physical reanalysis dataset similar to the previous one.

European Space Agency (ESA)

Non-time critical (NTC) Sentinel products:

- Sentinel 3 OLCI Ocean Colour Full Resolution: Chlorophyll concentration, diffuse attenuation coefficient and turbidity.
- Sentinel 3 SLSTR Sea Surface Temperatures.

Both products can be downloaded from this link.

2.3.2 Model forcing

CMEMS

BLKSEA_MULTIYEAR_WAV_007_006: Hourly L4 high resolution (0.037° x 0.028°) waves reanalysis dataset with all the associated variables, such as significant height, mean period, direction, swell and Stokes drift.

2.3.3 Model validation

This pilot is not using any dataset for model validation during this period.

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2.3.4 DWH datasets

No DWH datasets are used in this pilot area.

2.3.5 Differences between 2022 prevision and final use

This pilot has used the same datasets during 2022 they had initially planned to use.

2.4 Pilot 4 – Belgium

2.4.1 Direct use

Royal Belgian Institute of Natural Sciences (RBINS)

The Marine Forecasting Centre of the RBINS issues 5-day forecasts of the marine conditions in the North Sea twice a day. The related datasets are available at this link.

Physical State of the Sea - Belgian Coastal Zone - COHERENS UKMO: This hourly dataset contains the operational 3D baroclinic hydrodynamical COHERENS forecasts for the Belgian part of the North Sea. The domain covers the latitudes 51° to 51.9° and the longitudes 2.1° to 4.2° with a 0.0069° x 0.012° resolution grid. The sea surface is forced by the 6-hourly meteorological forecasts provided by the UK MetOffice. The used variables are sea velocity, salinity, temperature and sea surface elevation.

Physical State of the Sea - North Sea - COHERENS UKMO: This dataset is similar to the previous one, but with forecasts for the North Sea. The domain covers the latitudes 48.5° to 57° and longitudes -4° to 9° with a 1/12° x 1/24° resolution grid. The used variables are the same as in the previous dataset.

Tide - Continental Shelf - COHERENS UKMO: This hourly dataset contains the operational 2D barotropic hydrodynamical COHERENS tide forecasts for the Belgian part of the North Sea, providing sea surface elevation data, with latitudes from 48° to 62° and longitudes from -12° to 13°, and a resolution of 1/24° x 1/12°. The sea surface is forced by the 6-hourly meteorological forecasts provided by the UK MetOffice.

Wave field - North Sea - WAM ECMWF: This hourly dataset contains the operational WAM wave forecasts for the sea state of the North Sea, covering latitudes from 48.5° to 57° and longitudes from -4° to 9° with a 1/15° x 1/10° resolution grid. The sea surface is forced by the hourly meteorological forecasts provided by the ECMWF (European Centre for Medium-Range Weather Forecasts). The used variables provided by the spectral analysis are significant wave height, wave direction and mean zero upcrossing period.

Wave field - North Sea - WAM UKMO: Similar to the previous dataset, in this case the sea surface is forced by the 6-hourly meteorological forecasts provided by the UK MetOffice.

2.4.2 Model forcing

RBINS

Harmonic Astronomical Tide - Continental Shelf - COHERENS: This hourly dataset, which provides the surface elevation above mean sea level (MSL), contains the operational 2D barotropic hydrodynamical COHERENS astronomical tide forecasts for the Belgian part of the North Sea, covering the area given by the following coordinates: latitudes from 48° to 62° with a 1/24° resolution; longitudes from -12° to 13° with a 1/12° resolution.

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ECMWF

The seasonal forecasts provided by the ECMWF are also used in this pilot area to initialize their models. These forecasts provide wind at 10m, air temperature at 2m, atmospheric pressure at MSL, relative humidity or dew point at 2m, cloud coverage and total precipitation.

2.4.3 Model validation

Two CMEMS datasets are used for model validation in this pilot area.

INSITU_NWS_NRT_OBSERVATIONS_013_036: Sea wave height and sea surface elevation data are used from these *in situ* observations.

NORTHWESTSHELF_ANALYSIS_FORECAST_PHY_004_013: L4 high resolution (0.014° x 0.03°) physical analysis dataset which provides temperature and salinity with an hourly temporal resolution, and water velocity and sea surface height with a temporal resolution of 15 minutes.

2.4.4 DWH datasets

No DWH datasets are used in this pilot area.

2.4.5 Differences between 2022 prevision and final use

There were no differences between the expected and final use of datasets by this pilot in 2022.

2.5 Pilot 5 – Ireland

2.5.1 Direct use

The model developed by the pilot is directly used in this area:

Marine Institute

Inner Galway Bay model: Currents, sea temperature, salinity and coliform bacteria and/or tracers.

2.5.2 Model forcing

This pilot area uses the following data for both atmospheric and land forcing.

- Atmospheric forcing: Hourly 0.1° ECMWF atmospheric fields.
- Land forcing: NRT discharge data of the Corrib, Clarin and Dunkellin rivers, together with daily climatology based on a 2007-2019 time series.

2.5.3 Model validation

Marine Institute and Cuan Beo

Five non-public datasets are produced locally by the Marine Institute and Cuan Beo and used to validate the model developed by the pilot:

- Temperature series from loggers located at Kinvara and Killeenaran farms.
- Weekly temperature and salinity measurements at Killeenaran farm from a CO 310 hand-held sensor
- Surveys in Galway Bay to get temperature and salinity profiles.
- ADCP data from three moorings in Galway Bay during summer 2018.

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2.5.4 DWH datasets

No DWH datasets are used in this pilot area.

2.5.5 Differences between 2022 prevision and final use

There were no differences between the expected and final use of datasets by this pilot in 2022.

2.6 Pilot 6 – Denmark

2.6.1 Direct use

No datasets are reported to be directly used by this pilot.

2.6.2 Model forcing

CMEMS

NWSHELF_ANALYSISFORECAST_PHY_LR_004_001: Daily L4 high resolution (0.111° x 0.067°) physical model dataset which provides sea temperature, salinity and sea level used by the pilot.

BALTICSEA_ANALYSISFORECAST_PHY_003_006: Up to 15-minute temporal resolution L4 physical dataset with a spatial resolution of 2km. This dataset provides the same variables as the previous one.

Danish Meteorological Institute (DMI)

The DMI runs different NWP models, among which are two used by this pilot:

- The Harmonie NWP model at a 2.5km resolution, used as atmospheric forcing.
- The HBM 3D ocean model.

Soil & Water Assessment Tool (SWAT)

As stated in the website where this land model can be downloaded from, “SWAT is a small watershed to river basin-scale model used to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change”. This model is used as land forcing input by the pilot.

Hydrological Predictions for the Environment (HYPE)

The Hydrological Predictions for the Environment (HYPE) model is a semi-distributed, physically based catchment model, which simulates water flow and substances on their way from precipitation through different storage compartments and fluxes to the sea (Lindström et al., 2010) (source). It is also used by the pilot as land forcing input.

2.6.3 Model validation

- In situ sea level observations carried out by the DMI are used as model validation.
- Overfladevandsdatabasen ODA (Aarhus university): Database which contains biogeochemical and sea level data, part of NOVANA, Denmark’s Nationwide Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments.

2.6.4 DWH datasets

No DWH datasets are used in this pilot area.

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2.6.5 Differences between 2022 prevision and final use

No differences were reported between the expected and final use of datasets for 2022.

2.7 Pilot 7 – Romania

2.7.1 Direct use

CMEMS

BLKSEA_ANALYSISFORECAST_WAV_007_003: Hourly L4 high resolution (0.037° x 0.028°) spectral wave model dataset that provides, among other variables, Stokes drift, significant wave height and mean wave period.

2.7.2 Model forcing

CMEMS

BLKSEA_ANALYSISFORECAST_PHY_007_001: The variables used from this dataset are temperature, salinity, sea surface height and sea velocity.

BLKSEA_ANALYSIS_FORECAST_BIO_007_010: Daily L4 high resolution (0.037° x 0.028°) dataset based on the Biogeochemical Model for Hypoxic and Benthic Influenced areas (BAMHBI) model. It provides analysis and forecast for 3D concentration of chlorophyll, nutrients (nitrate and phosphate), dissolved oxygen, phytoplankton carbon biomass, net primary production, pH, dissolved inorganic carbon, total alkalinity, surface partial pressure of CO2 and surface flux of CO2. All available variables are used by the pilot.

ECMWF

ERA5: This dataset is used for atmospheric forcing, and it contains hourly estimates of a large number of atmospheric, land and oceanic climate variables. The data cover the Earth on a 30km grid and resolve the atmosphere using 137 levels from the surface up to a height of 80km. The variables used by the pilot are temperature at 2m (*T2M*), dewpoint temperature at 2m (*D2M*), wind velocity at 10m (*U10*, *V10*), pressure at mean sea level (*PMSL*), total cloud cover (*TCC*) and total precipitation (*PRECIP*).

PERSEUS

Dataset produced by the EU FP7 PERSEUS project and used for land forcing.

2.7.3 Model validation

CMEMS

OCEANCOLOUR_BLK_BGC_L4_NRT_009_152: Daily L4 1km resolution chlorophyll dataset (cmems_obs-oc_blk_bgc-plankton_nrt_l4-gapfree-multi-1km_P1D).

OCEANCOLOUR_BLK_BGC_L3_NRT_009_151: Daily L3 300m resolution chlorophyll dataset (cmems_obs-oc_blk_bgc-plankton_nrt_l3-olci-300m_P1D).

SST_BS_SST_L4_NRT_OBSERVATIONS_010_006: Daily L4 sea surface temperature high resolution (0.01°) dataset (SST_BS_SST_L4_NRT_OBSERVATIONS_010_006_c_V2).

2.7.4 DWH datasets

No DWH datasets are used in this pilot area.

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2.7.5 Differences between 2022 prevision and final use

This pilot has used the same datasets during 2022 they had initially planned to use.

2.8 Pilot 8 – Italy

2.8.1 Direct use

The following datasets are directly used in this area:

CMEMS

OCEANCOLOUR_MED_BGC_L3_NRT_009_141: Daily L3 chlorophyll (*chlor_a*) at 300m resolution (cmems_obs-oc_med_bgc-plankton_nrt_l3-olci-300m_P1D).

SST_MED_SST_L3S_NRT_OBSERVATIONS_010_012: Daily L3 sea surface temperature (*sst*) at 0.01° resolution (SST_MED_SST_L3S_NRT_OBSERVATIONS_010_012_b).

2.8.2 Model forcing

The following datasets are used to initialize the models created by the pilot:

CMEMS

MEDSEA_ANALYSISFORECAST_PHY_006_013: L4 coupled hydrodynamic-wave model at 1/24° resolution. The following variables are used:

- Sea water velocity (*u*, *v*), with a temporal resolution of up to 15 minutes.
- Hourly sea water potential temperature (*T*)
- Hourly salinity (*S*)

MEDSEA_ANALYSISFORECAST_BGC_006_014: Daily L4 dataset that contains several biogeochemical variables at 1/24° resolution.

ARSO Meteo

The Slovenian Environment Agency publish operational products based on the ALADIN model that are used by this pilot as atmospheric forcing.

Arpae data

Two different models from The Regional Agency for Prevention, Environment and Energy of Emilia-Romagna (Arpae Emilia-Romagna) are used for model forcing.

- COSMO 2I atmospheric model.
- Real time Po River data: This dataset is used for land forcing as the Po river is the major freshwater contribution for the Adriatic Sea.

2.8.3 Model validation

CMEMS

OCEANCOLOUR_MED_BGC_L3_NRT_009_141: Daily L3 chlorophyll (*chlor_a*) at 300m resolution (cmems_obs-oc_med_bgc-plankton_nrt_l3-olci-300m_P1D).

SST_MED_SST_L3S_NRT_OBSERVATIONS_010_012: Daily L3 sea surface temperature (*sst*) at 0.01° resolution (SST_MED_SST_L3S_NRT_OBSERVATIONS_010_012_b).

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2.8.4 DWH datasets

At the early stages of the project, this pilot had reported that they expected to use DWH Additional datasets to help them investigate biogeochemical small-scale patterns over the study area. However, after carrying out preliminary tests it was found that DWH Additional datasets were not suitable for a daily-based operational chain for the needed spatial resolution. Moreover, satellite products from DWH Additional datasets did not include regional, calibrated validated algorithms, which are necessary for an *ad hoc* estimation of water quality in the area of interest. Apart from all these reasons not to use them, the May 2021 CMEMS products catalogue update included new chlorophyll products with a 300 metres resolution which met this pilot's needs.

2.8.5 Differences between 2022 prevision and final use

- Only L3 products (OCEANCOLOUR_MED_BGC_L3_NRT_009_141 and SST_MED_SST_L3S_NRT_OBSERVATIONS_010_012) are expected to be used for the visualization on the platform.
- The use of L4 SST products for model assimilation is delayed and, most likely, will not be ready by the end of the project (October).
- CoastColour products (2002-2012) were at the beginning of the project the only calibrated and validated coastal product at 300 m of resolution publicly available. However, from May 2021, the Ocean Colour Instrument (OLCI) on-board the Sentinel-3A and 3B satellites started operating at a 300 m spatial resolution. For this reason, CoastColour products were replaced by Sentinel-3 OLCI products, which provide near-real time information compared to CoastColour.

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3 References

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- Meteogalicia WRF 2D 12km model outputs: http://mandeo.meteogalicia.gal/thredds/catalog/wrf_2d_12km/fmrc/files/catalog.html
- NASA JPL MUR model: https://podaac.jpl.nasa.gov/dataset/MUR-JPL-L4-GLOB-v4.1
- EuskOOS: https://www.euskoos.eus/en/
- Sentinel data access: https://sentinels.copernicus.eu/web/sentinel/sentinel-data-access
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