



D2.2 Initial product and service portfolio



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CI	Classified, information as referred to in Commission Decision 2001/844/EC	

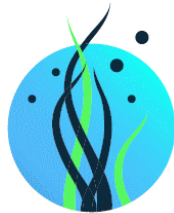
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CoastObs Project

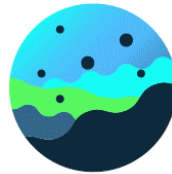
CoastObs is an EU H2020 funded project that aims at using satellite remote sensing to monitor coastal water environments and to develop a user-relevant platform that can offer validated products to users including monitoring of seagrass and macroalgae, phytoplankton size classes, primary production, and harmful algae as well as higher level products such as indicators and integration with predictive models.



phytoplankton



seagrass



harmful algal blooms



primary production

To fulfil this mission, we are in dialogue with users from various sectors including dredging companies, aquaculture businesses, national monitoring institutes, among others, in order to create tailored products at highly reduced costs per user that stick to their requirements.

With the synergistic use of Sentinel-3 and Sentinel-2, CoastObs aims at contributing to the sustainability of the Copernicus program and assisting in implementing and further fine-tuning of European Water Quality related directive.

Partnership



Water Insight BV. (WI)



UNIVERSITY OF
STIRLING

The University of Stirling (USTIR)



Consiglio Nazionale
delle Ricerche

Consiglio Nazionale Delle Ricerche (CNR)



UNIVERSITÉ DE NANTES

Universite de Nantes (UN)



UNIVERSITY
OF APPLIED SCIENCES

HZ University of Applied Sciences (HZ)



UNIVERSIDADE
DE VIGO

Universidad de Vigo (UVIGO)



BioLittoral

Bio-Littoral (BL)



GEONARDO
STATE-OF-THE-ART AND BEYOND

Geonardo Environmental Technologies Ltd. (GEO)

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Summary

Task objective (from Description of Action):

To create an initial service portfolio and service level models based on specific user requirements (Task 2.1).

Scope of this Document:

The scope of this document is to establish the initial service and product portfolio based on the meetings and discussions held with the users (deliverable 2.1ⁱ) and on the basic data products that can be obtained from optical remote sensing. This initial inventory of potentially relevant products will be a 'living-portfolio' that will keep being modified and tuned along the project.

Structure:

The product and service portfolio has five main sections:

1. **Standard products:** the common products used in water monitoring through remote sensing.
2. **Innovative products:** the creation of new products highly relevant to coastal zone management. These products will be tested and validated with the aim of progressing from a research topic to an operationally available product.
3. **Higher level products:** products taking up of Earth observation into operational water management. A combination of spatial and temporal aggregation, classification and integration with additional data and tools will bridge the gap between the products generated and the information needs of the users.
4. **Additional products:** other products not originally foreseen, but that have been identified as potentially useful.
5. **Service types:** A number of different service types that fulfil different user needs for water quality data. All products will be delivered in such formats that they fit seamlessly into the users' own data management and information systems.

Abbreviations

List of abbreviations	
Abbreviation	Explanation
CDOM	Coloured Dissolved Organic Matter
Chl-a	Chlorophyll-a
EO	Earth Observation
HAB	Harmful Algal Blooms
MA	Macroalgae
PC	Phycocyanin
PSC	Phytoplankton size classes
SG	Seagrass
SST	Sea Surface temperature
TSM	Total Suspended Matter
Tur	Turbidity

Introduction

This deliverable is built on the meetings held with the users for defining the content and quality requirements, as well as their technical and service requirements. In deliverable 2.1 “Initial User Requirements Document”, a questionnaire was set up and sent to the users to assess their needs and requirements regarding the services that CoastObs can offer. On the basis of the responses and the active collaboration with the users, the products and services proposed by CoastObs now have a wide diversity of demonstration cases at most of the representative locations in Europe for testing their products.

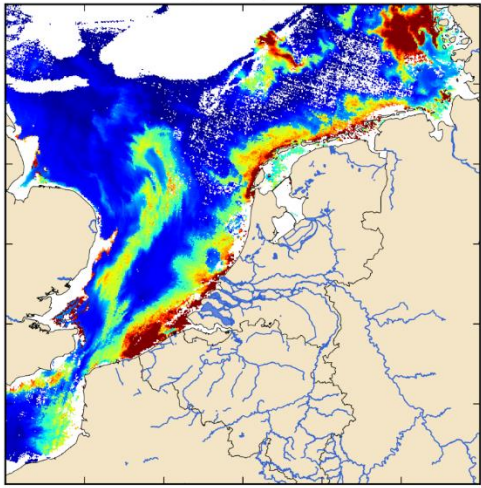
This document, with the potentially relevant products that CoastObs can offer, will be a ‘living-portfolio’ that will keep being modified and tuned along the project according to the users’ needs.

STANDARD PRODUCTS



Standard products

1. Chlorophyll -a (Chl-a)

Standard products		
Chlorophyll -a (Chl-a) ⁱⁱ		
Significance	<p>Essential pigment in phytoplankton;</p> <p>Used as a proxy for algal biomass;</p> <p>Monitoring of trophic status, eutrophication, food availability for shellfish.</p>	
<p>Chl-a derived from MERIS by HYDROPT 2007-05-01</p> 		
	<p>[µg/l]</p> <p>[mg/m³]</p>	Unit
	<p>300m (daily)</p> <p>10m (5 days)</p>	Spatial/temporal resolution
Limitations	<p>Quality of retrieval depends on sensor characteristics, can be impacted by high sediment or CDOM concentrations;</p> <p>In shallow waters, bottom visibility can interfere with the signal.</p>	

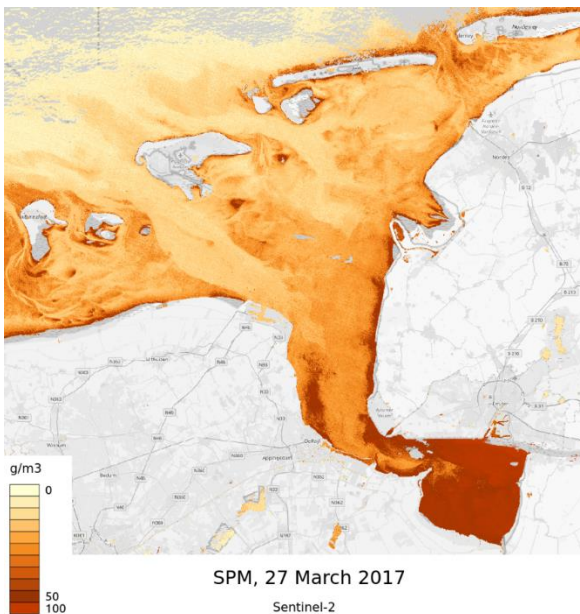
2. Total suspended matter (TSM)

Standard products

Total suspended matter (TSM)ⁱⁱⁱ

Significance

Determines the light climate in the water;
Insight into coastal dynamics (erosion, accretion) and anthropogenic impacts (e.g. dredging).



[mg/l]

[g/m³]

Unit

300m (daily)

10m (5 days)

high resolution (variable)

Spatial/temporal
resolution

Limitations

Regional variability of sediment characteristics may require algorithm calibration;
In shallow waters, bottom visibility can interfere with the signal.

3. Turbidity (Tur)^{iv}

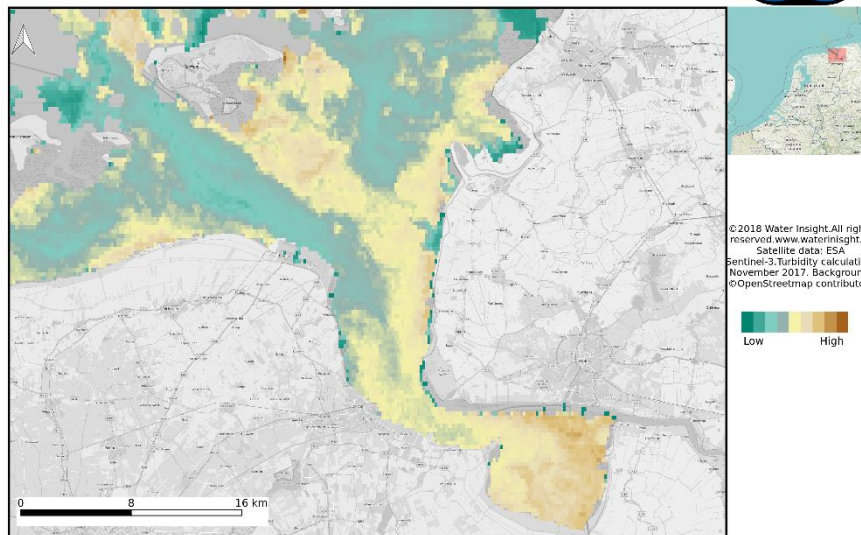
Standard products

Turbidity (Tur)^{iv}

Significance

Determines the light climate in the water;
 Insight into coastal dynamics (erosion, accretion) and anthropogenic impacts (e.g. dredging).

**Eems estuary November 17th 2017,
 Turbidity, Sentinel 3**



Unit

[FNU]
 [NTU]
 [FTU]

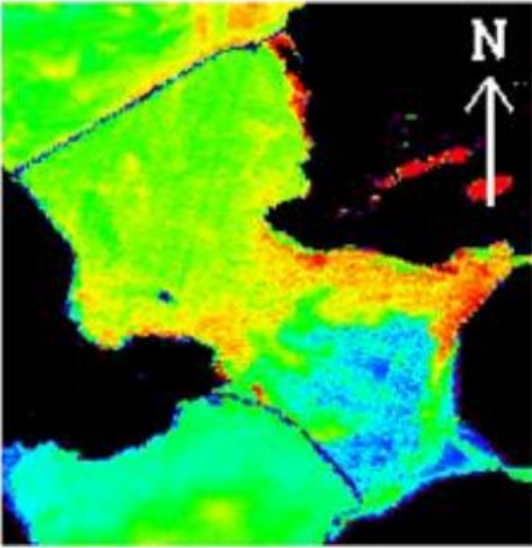
300m (daily)
 10m (5 days)
 high resolution (variable)

**Spatial/temporal
 resolution**

Limitations

Regional variability of sediment characteristics may require algorithm calibration;
 In shallow waters, bottom visibility can interfere with the signal.

4. Phycocyanin (PC)

Standard products		
Phycocyanin (PC) ^y		
Significance	<p>Essential pigment in cyanobacteria;</p> <p>Cyanobacteria can be harmful/nuisance species and indicators of eutrophication.</p>	
PC_concentration 22/3/2011		Unit
	<p>[µg/l]</p> <p>[mg/m³]</p>	
	300m (daily)	Spatial/temporal resolution
Limitations	In shallow waters, bottom visibility can interfere with the signal.	

5. Coloured dissolved organic matter (CDOM)

Standard products

Coloured dissolved organic matter (CDOM)^{vi}

Significance

CDOM has a limiting effect on photosynthesis and can inhibit the growth of phytoplankton populations, which form the basis of oceanic food chains and are a primary source of atmospheric oxygen.

	<p>[1/m]</p>	<p>Unit</p>
<h5>Limitations</h5> <p>In shallow waters, bottom visibility can interfere with the signal.</p>	<p>300m (daily)</p>	<p>Spatial/temporal resolution</p>

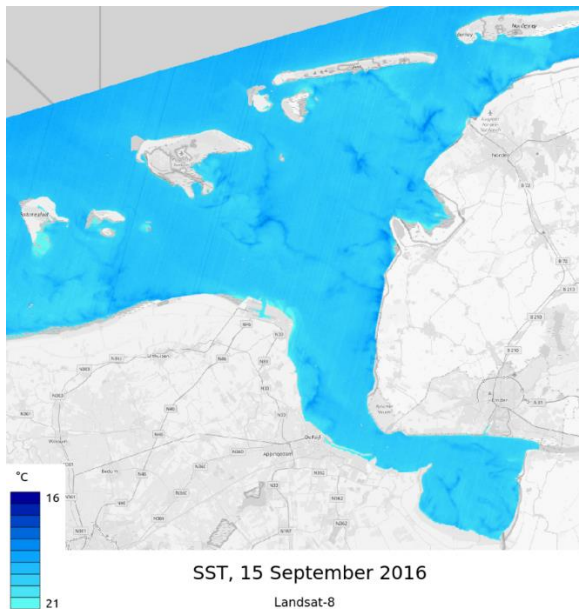
6. Sea surface temperature (SST)

Standard products

Sea surface temperature (SST)^{vii}

Significance

Important factor for all aquatic life, for weather and climate studies.



[K]

[°C]

Unit

1km (daily)
100m (16 days)

Spatial/temporal
resolution

Limitations

EO can only retrieve skin temperature.

INNOVATIVE PRODUCTS



Innovative products

In recent years, research has been under way to exploit the possibilities offered by the Copernicus satellites for the creation of new products, some of which are highly relevant to coastal zone management. Building on the specific expertise of the scientific partners in CoastObs, several of these products will be tested and validated with the aim of progressing from a research topic to an operationally available product. The products phytoplankton size classes, primary production and harmful/indicator algae species make use of the narrow dedicated spectral bands of Sentinel-3 OLCI that resolve the spectral characteristics of water constituents well enough to derive these parameters. The seagrass and sublittoral habitats products will be based mainly on Sentinel-2 MSI, in combination with optical in situ measurements. Also, for sublittoral habitats, tests will be performed with very high resolution multi-spectral images to test the capabilities of these sensors for the detection of the respective parameters. For services that are based on longer time series (spatial suitability analysis, historic analysis), MERIS data will be used in combination with OLCI.

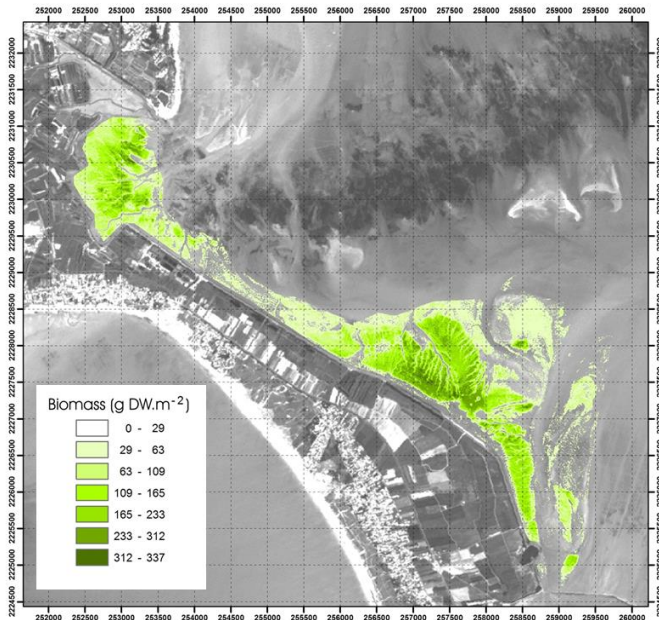
1. Seagrass/macroalgae (SG / MA)

Innovative products

Seagrass/macroalgae (SG / MA) ^{viii}

Significance

Protected habitat (EU directive);
 Bioindicator of water quality (WFD), eutrophication, coastal erosion.



[% cover]

[g/m²]

10m (5 days)

Unit

Spatial/
temporal
resolution

Limitations

Sensor spectral resolution has an impact on the discrimination between different types of vegetation;
 The presence of epiphytes can interfere with the signal.

2. Phytoplankton size classes (PSC)

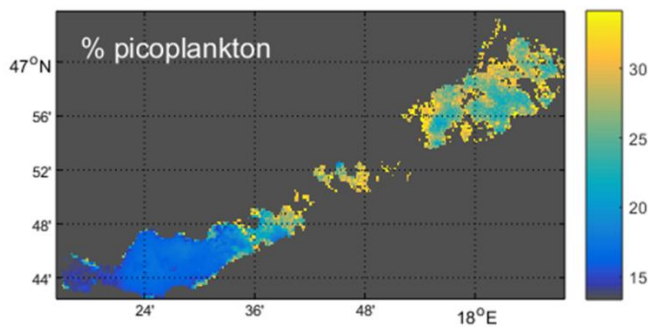
Innovative products

Phytoplankton size classes (PSC)^{ix}

Significance

It represents thresholds in the continuum range of phytoplankton size fractions from 0.2 μm to 200 μm (normally pico- nano- and micro plankton);

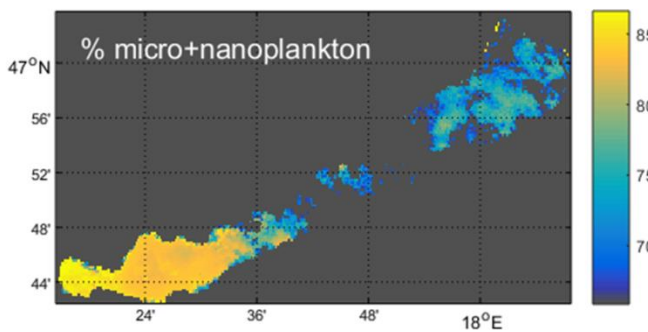
Carbon cycling, fisheries & aquaculture management.



[cells/m³]

[%]

Unit



300m (daily)

Spatial/temporal resolution

Limitations

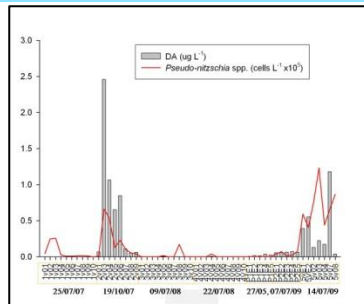
Limitations specific to different retrieval approaches and availability of representative datasets.

3. Harmful / indicator species (HAB)

Innovative products

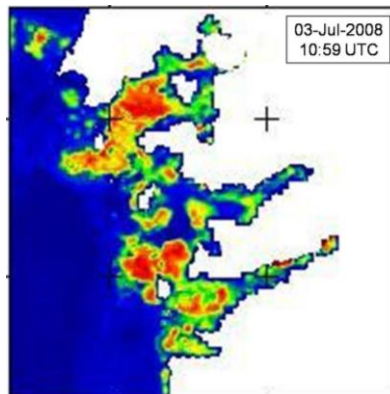
Phytoplankton size classes (PSC) ^x

Example 1



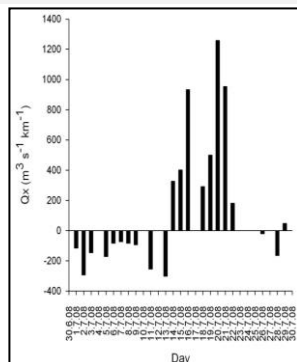
Pseudo-nitzschia blooms

EO data in order to provide information about the relationship between environmental conditions in *Pseudo-nitzschia* blooms



Example 2

Example 3



Geostrophic Wind

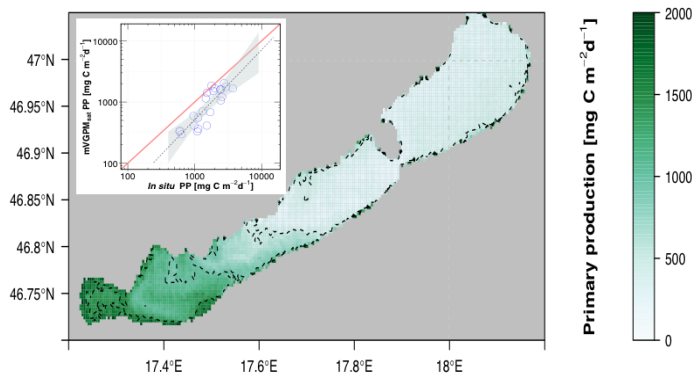
4. Phytoplankton primary production

Innovative products

Phytoplankton primary production ^{xi}

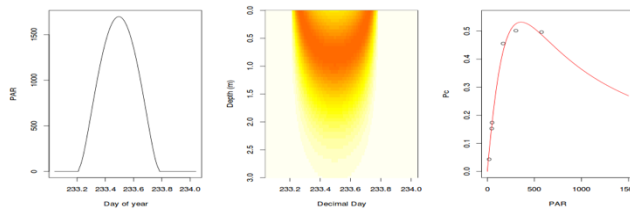
Significance

Primary production is an indicator of ecosystem metabolism and the transfer of carbon between the atmosphere and ocean and its uptake by phytoplankton.



[mg C m⁻² d⁻¹]

Unit



300m (daily)

Spatial/temporal resolution

Limitations

The models require accurate retrieval of Chl, Kd and SST are sensitive to variability in the photosynthetic rates of the phytoplankton community.

HIGHER LEVEL PRODUCTS



Higher level products

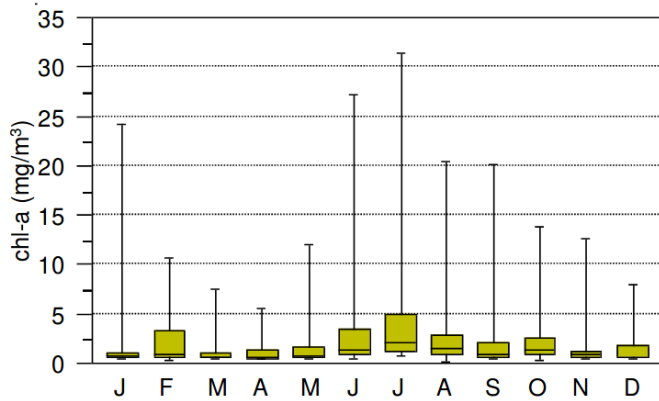
In earlier projects, a common mismatch between the products generated and the information needs of the users has been identified as a major factor impeding the take up of Earth observation into operational water management. Bridging this gap is an important activity of the CoastObs project and will require a highly inter-disciplinary approach. Based on the analysis of the users' spatial, temporal and content-level information needs, the basic products will be aggregated into innovative higher-level products. These products can consist of (or a combination of) spatial and temporal aggregation, classification and integration with additional data and tools.

1. Statistics/aggregation

Higher level products

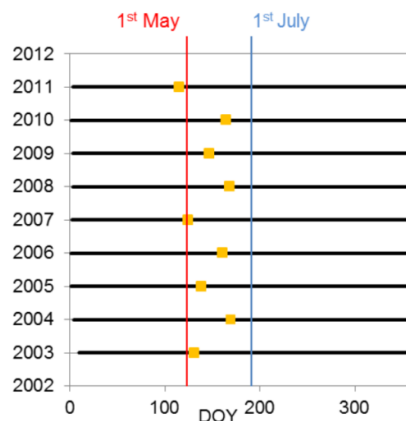
Statistics/aggregation ^{xii,xiii}

Example 1



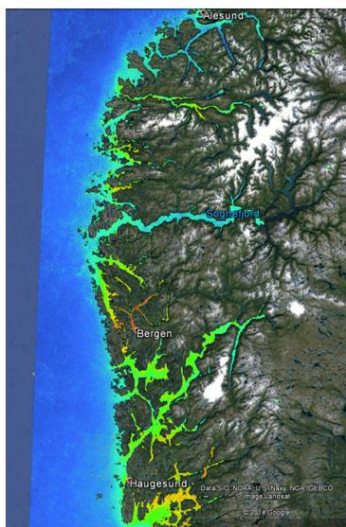
Long-term statistics of Chl-a concentrations per month in a region

Start day of phytoplankton bloom over time



Example 2

Example 3



Long-term average Chl-a concentration

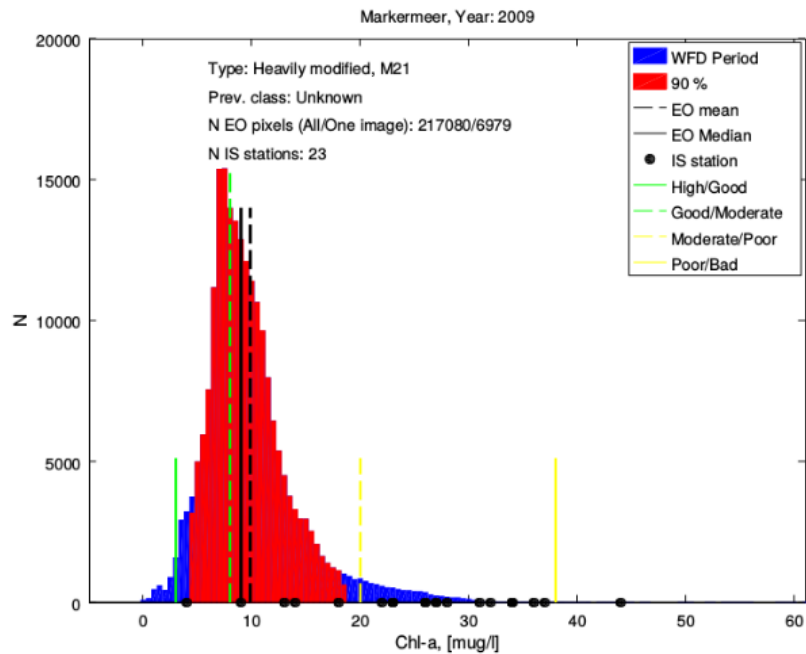
2. Indicators for water framework directive reporting

Higher level products

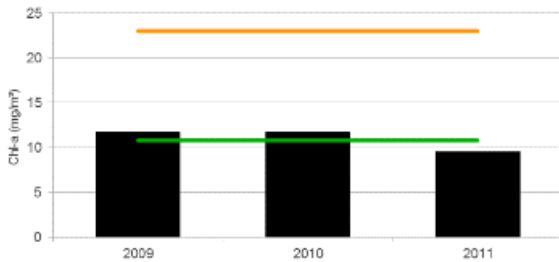
Indicators for Water Framework Directive reporting ^{xiv}

Example

Classification of water bodies according to criteria of the Water Framework Directive (WFD)



IJsselmeer (M21)



- Chl-a
- Transparency (Kd)
- Macrophytes

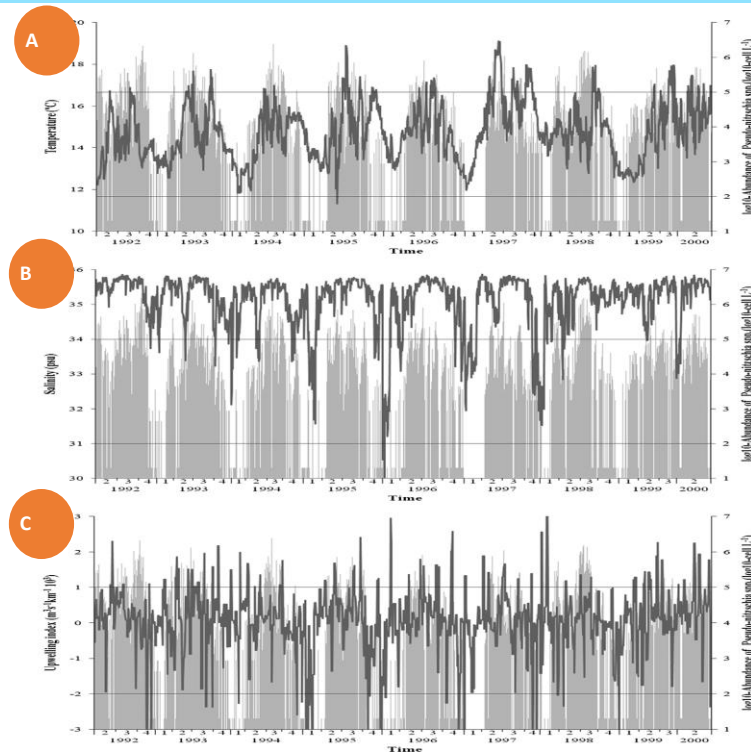
	2015	2016	2017
Water body 1	Moderate	Good	Good
Water body 2	Bad	Poor	Moderate
Water body 3	Good	Moderate	Moderate

3. Harmful algal blooms forecast

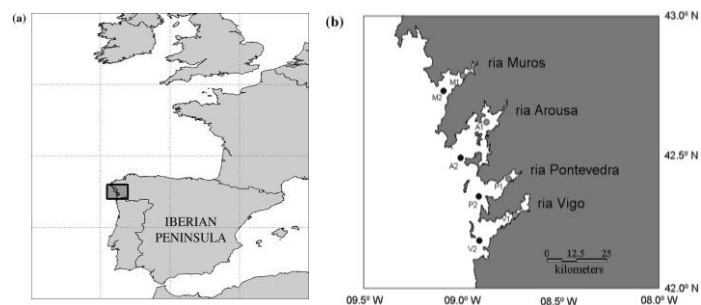
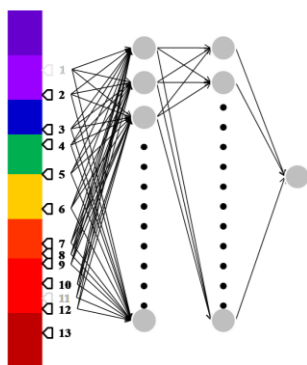
Higher level products

Harmful algal blooms forecast ^{xv}

Example



(a) Temporal evolution of the temperature (dark grey line) and the abundance of *Pseudo-nitzschia spp.* (light grey columns). (b) Temporal evolution of the salinity (dark grey line) and the abundance of *Pseudo-nitzschia spp.* (light grey columns). (c) Temporal evolution of the upwelling index (dark grey line) and the abundance of *Pseudo-nitzschia spp.* (light grey columns).



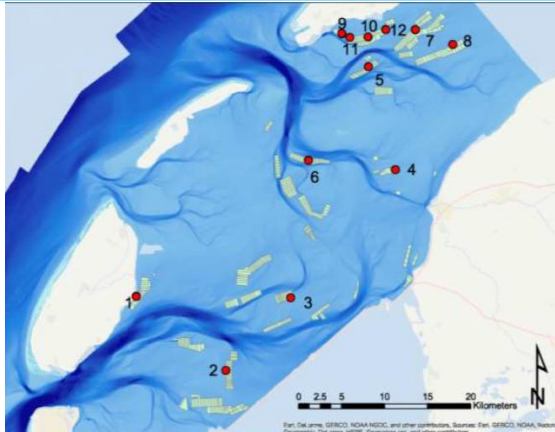
Basic architecture of the MLP networks used in this product. The inputs are the satellite remote sensing reflectance values for bands centred on different wavelengths (nm) and the geometry of the images.

4. Shellfish culture potential

Higher level products

Shellfish culture potential ^{xvi, xvii, xviii}

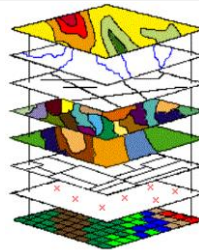
Example



A combination of:

1. Maps of modelled food availability for mussels, derived from mussel growth data at 24 measurement stations on mussel culture plots

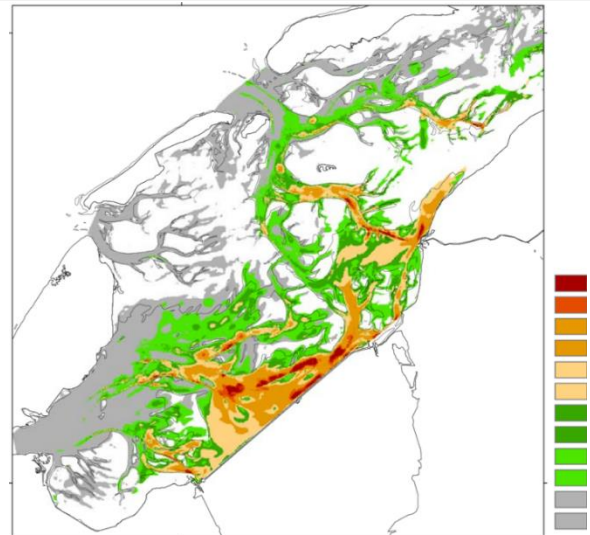
2. Overlay maps of interpolated food availability using EO data calibrated with data from measurement stations



3. Overlay maps (EO) with other relevant parameters for mussel culture, such as: temperature, turbidity, phytoplankton size classes, HAB's.

Shellfish culture potential map:

Management tool to optimize shellfish culture practises and to identify suitable shellfish culture locations.



Developing a relation between EO and shellfish growth provides a product that can be applied to culture sites around the world.

ADDITIONAL PRODUCTS



Additional Products

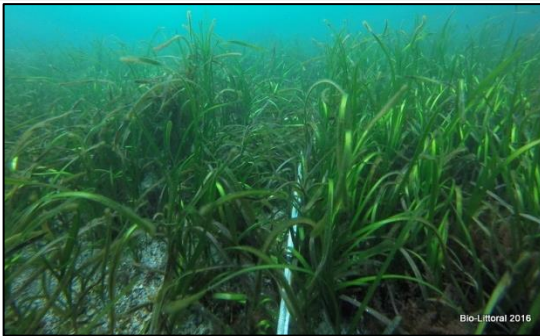
1. In situ data for EO validation

Additional products

In situ data for EO validation ^{xix,xx}

In situ data for EO validation can be provided using standardized protocols in intertidal and subtidal areas (multiparametric probes, scuba-diving measurements....)

Example



SERVICE TYPES



Service types

A number of different service types are envisioned to fulfil different user needs for water quality data. All products will be delivered in such formats that they fit seamlessly into the users' own data management and information systems.

Near real time service

Harmful algae bloom warning for aquaculture industry.
Turbidity threshold monitoring for dredging.



One off analysis

Spatial suitability analysis
Source identification

Periodic reporting service

Water Framework Directive reporting
Monitoring of trends (e.g. eutrophication, carrying capacity)

REFERENCES

- ⁱ Braga, F., Brando, V., Barbanti, A., Ferrarin C., Poser K., Peters S., Gernez P., Barille L., van der Hiele T., Capelle J., Torres J. and Barille A.L. (2018). "D2.1 - Initial user requirements document". CoastObs Project.
- ⁱⁱ FP7 CoBIOS project (GA 263295)
- ⁱⁱⁱ RVO/NSO HBOTE project
- ^{iv} RVO/NSO HBOTE project
- ^v Chawira, M. (2012): Monitoring blue-green algae in the IJsselmeer using remote sensing and in-situ measurements. Unpublished MSc Thesis at the Faculty of Geo-Information Science and Earth Observation of the University of Twente.
- ^{vi} ESA/Worldbank EOWorld Zambezi River Basin project
- ^{vii} RVO/NSO HBOTE project
- ^{viii} Barillé L., ROBIN M., HARIN N., BARGAIN A., Launeau P., 2010. Increase in seagrass distribution at Bourgneuf bay (France) detected by spatial remote sensing. **/Aquatic Botany*/92, 185-194.///*
- ^{ix} EU FP7-SPACE INFORM project
- ^x EU FP7-SPACE INFORM project
- ^{xi} EU FP7-SPACE INFORM project
- ^{xii} FP7 GLaSS project (GA 313256) (images one and two)
- ^{xiii} FP7 AQUA-USERS project (GA 607325) (last image)
- ^{xiv} FP7 GLaSS project (GA 313256)
- ^{xv} ECOSSUMER (Marie Curie Project) with data from INTECMAR
- ^{xvi} Innovatie en rendementsverbetering mosselproductie: project INNOPRO 2017-2019 EFMZV Europese Unie, Europees Fonds voor Maritieme Zaken en Visserij. WMR & HZ University of Applied Sciences. <https://www.geologyin.com/2014/05/a-geographic-information-system-gis.html>
- ^{xvii} <https://www.geologyin.com/2014/05/a-geographic-information-system-gis.html>
- ^{xviii} A.C. Smaal, A.G. Brinkman, T. Schellekens, J. Jansen, A. Agüera & M.R. van Stralen (2014) Ontwikkeling en stabiliteit van sublitorale mosselbanken, samenvattend eindrapport. Wageningen IMARES Rapport C066.14.
- ^{xix} Bio-Littoral (Anne-Laure Barillé).
- ^{xx} WISP-3 photos: Wikipedia article 'Water insight spectrometer with three radiometers'.