Monitor ocean quality and productivity

Applications

Coastal Water Quality Monitoring

Two classes of information are available:

• Routine monitoring of water quality parameters to detect anomalies (e.g. algal blooms, temperature anomalies etc.) for coastal management and management of coastal facilities (e.g. aquaculture sites, desalination plants, water treatment facilities etc.

• Analysis of longer term trends and indicators (e.g. for assessment of climate resilience, environmental impact assessment etc.)

Any selection of the following parameters can be provided, depending on user priorities:

• Chlorophyll-A concentration in g/l

• Transparency (or turbidity if required) in m-1

• Sediment concentration in g/l

• Algal bloom detection and delineation

• Sea surface temperature in K

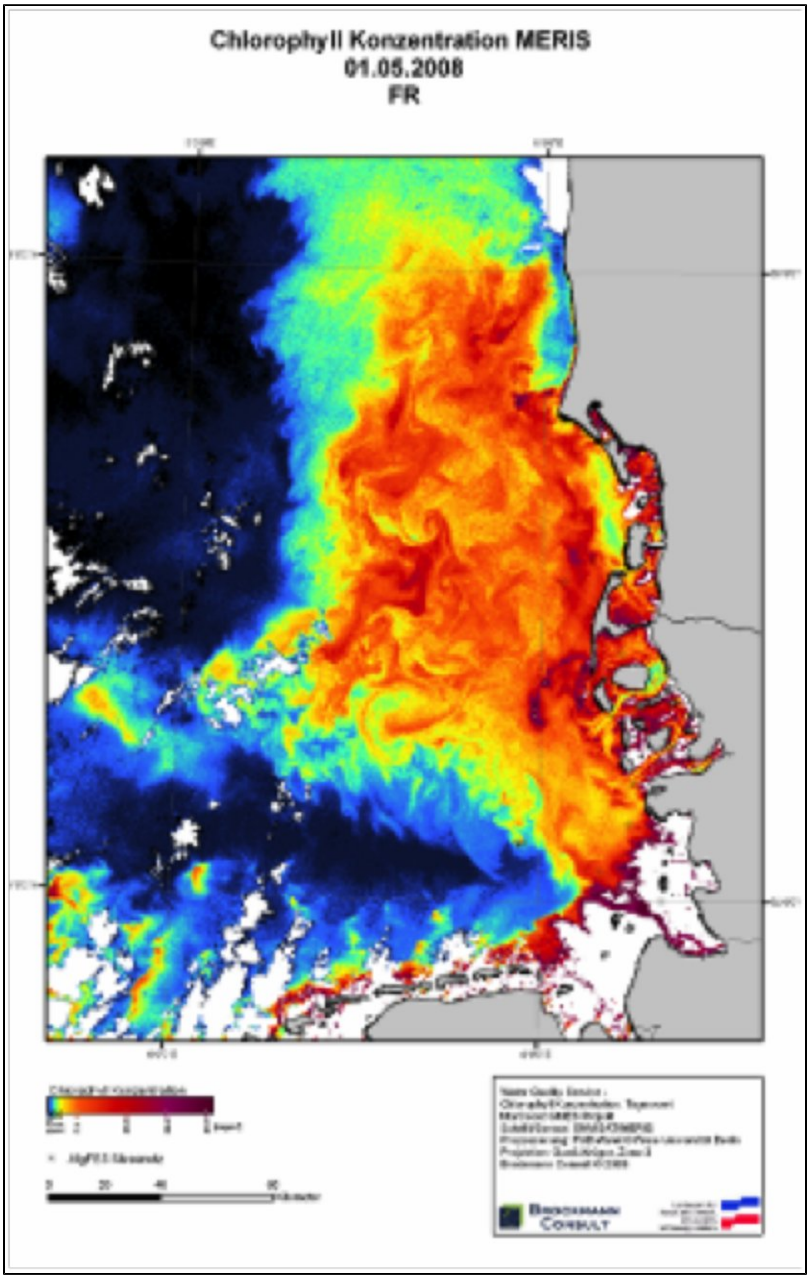
• Other customised parameters are available such as the delineation of the boundaries between different coastal water bodies including the boundary between turbid coastal waters and
the more transparent open sea as well as frontal structures linked to river outflow, upwelling/downwelling and coastal currents

The information parameters are available in the following modes:

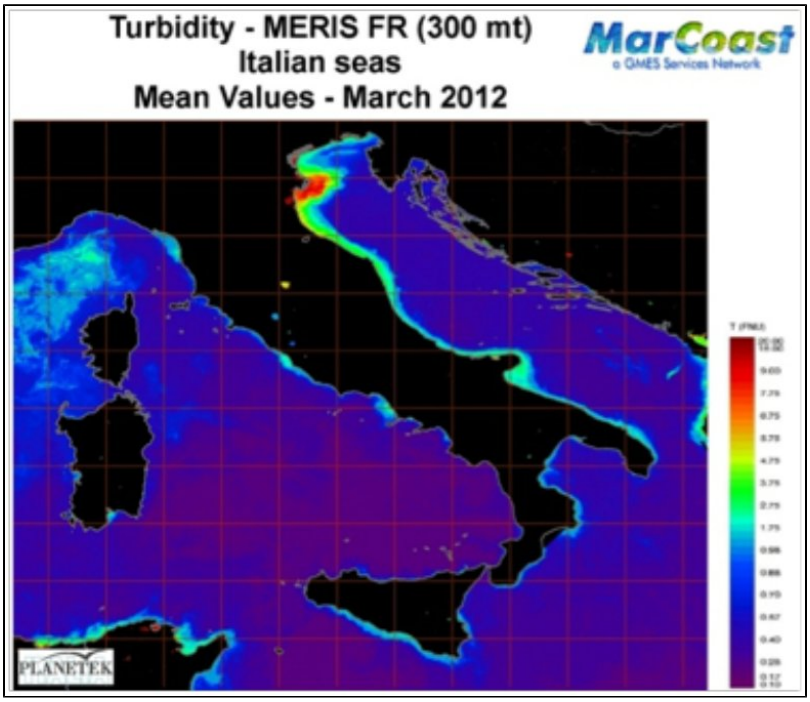
• For monitoring purposes, information can be daily samples or maps showing the values of the paramters averaged over a representative time period (typically weekly, monthly or seasonal). In addition to average values, p90 values (ie the measurement value below which 90% of the measured values fall) are also used in many monitoring or analysis activities

• For trend analysis and historic baseline assessments, information can be provided as maps of the average or p90 value where the statistics are compiled over appropriate time periods.

Information can be provided at a range of resolutions depending on the measurement objective and with some constraints for time periods after March 2012. For the time period 2003–2012, all information parameters except temperature can be provided at 300 m resolution. Outside of this period, information parameters are provided at 1 km resolution.



Example of a daily chlorophyll concentration product based on data from the ESA MERIS sensor. This example is from 1 May 2008 for the Wadden Sea. The capability to detect fine scale current and frontal structures within the higher resolution (300m) imagery is evident. Changes in frontal structures are of increasing interest to understand climate change induced evolution of coastal processes. Credits: Brockman Consult.



Monthly mean value for turbidity for Italian waters for March 2012 based on data from the ESA MERIS instrument. These measurements are obtained at a spatial resolution of 300 m and averaged on a pixel
by pixel basis over all images acquired during the month of interest. Credits: Planetek / MarCoast.

Sea Surface Temperature is provided at 1km resolution for all time periods.
In some cases, monitoring and reporting may be structured around a set of identified water bodies.
In such cases parameters can be provided as a spatial average over the water body. However, it is recommended that the highest spatial resolution available is also analysed to maximise the quality of the information.

Update frequency can be daily for low resolution information over a restricted area (typically 1000km by 1000km) but there is anassociated risk of cloud contamination within the data. In most situations today, operational users do not require daily data except where heightened monitoring is in place (eg during periods of algal bloom).Instead, they typically request update times as follows:

• For routine monitoring, information is updated every week/10 days as a running average over the previous 7/10 days. If particular processes are detected (e.g. algal bloom formation) then the update frequency can be shortened. Note that even where 7/10 day or monthly merged products are being generated, these still rely on data being collected as often as possible, preferably daily

• For statistical analysis and trend monitoring, updates are usually provided on a monthly, seasonal or annual basis comparing the most recent values of water quality indicators with the historic trend.

Satellite based water quality monitoring information is available in theory for any coastal region world wide. However in some areas (e.g. West Africa), cloud cover may hinder data collection for large portions of the periods of interest. In such situations, a reduced quality information service would be provided.
With respect to historic time series of data, satellite based water quality information products are available for most areas for the time period 1998 to the present.
Absolute accuracies are regularly demonstrated to be of the following orders of magnitude:

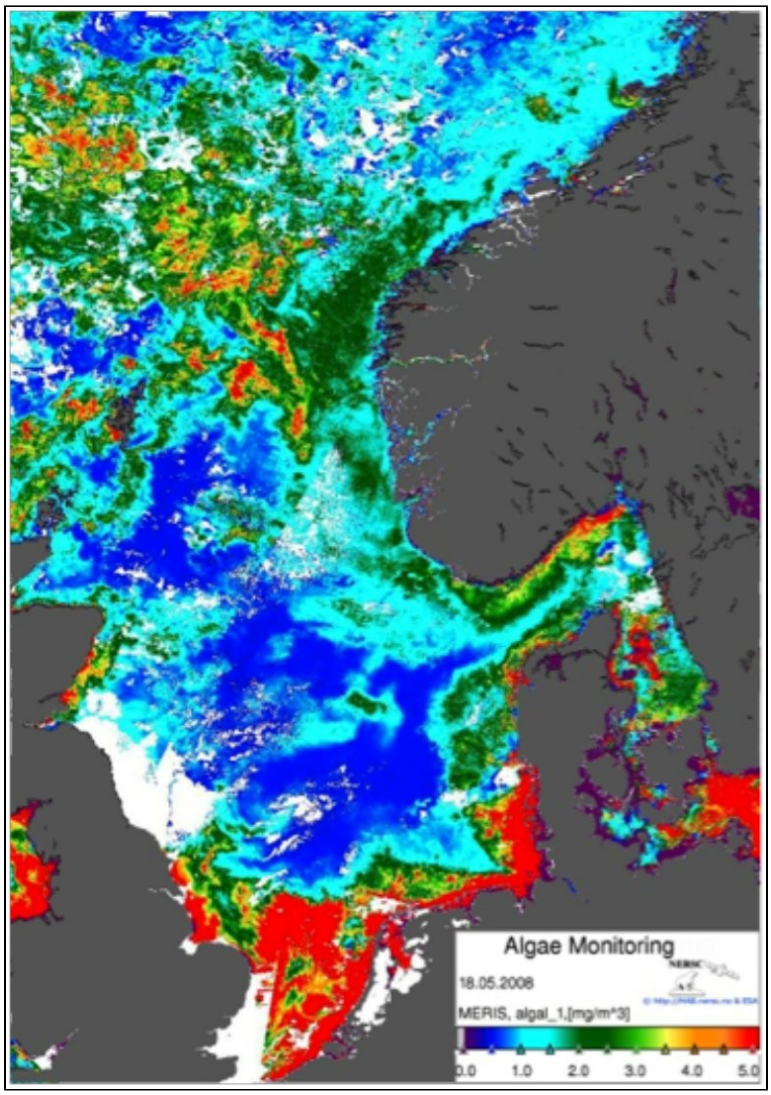
• Sea surface temperature – better than ±0.5K

• Chlorophyll concentration - ±20-30% for coastal waters

However in most cases, the absolute accuracy is not a priority as users are interested in relative measurements (e.g. spatial variation in sea surface temperature or transparency or time series trends in indicators). This means that long term consistency in instrument properties is highly desirable. Most organisations providing satellite derived information maintain dedicated teams tasked with monitoring and reporting on the performance and status of the satellite instruments. This ensures that the quality of satellite derived information (eg chlorphyll concentration, transparency) can be continuously assessed. There is also a continuous activity by many satellite operators, in particular ESA, to ensure that data are processed using state of the art algorithms. Once an improved algorithm becomes accepted by the scientific community then these are incorporated into the satellite operators data processing infrastructure both for new measurements and also (after a delay due to the processing effort required) for archived historic data also.

Traditional methods for water quality monitoring involve taking in-situ samples and conducting laboratory tests such as laser fluorescence to measure parameters such as chlorophyll concentration. This is time consuming and requires considerable effort and cost. The sampling itself requires a dedicated cruise or collection of water samples at specific coastal locations and the laboratory analysis requires certified equipment. Satellite derived information are available over a wide area, relatively quickly and the data processing ensures consistency in estimated parameter values over the entire image area.

Satellite derived information is used primarily to complement limited in situ measurements by enabling an extrapolation of the in-situ measurements to entire areas or to provide data outside the in-situ data collection time periods. :



Algal Bloom detected in the North Atlantic and forecast to cause potential problems for aquaculture operators in southern Norway, North West

Scotland and Northern Ireland. Environmental Protection Agencies in each country as well as aquaculture associations and regional organisations were alerted. Credits: NERSC

Examples include

• Monitoring activities required by local environmental agreements or legislation

• Assessing changes in particular areas as a result of engineering activities, infrastructure development etc, eg changes in sediment load, increase in temperature etc• Monitoring areas with aquaculture operations, tourist activity or desalination activities for the presence and evolution of algal blooms

• Compilation of baseline historic reference conditions for coastal water bodies in support of environmental legislation

• Elaboration of indicators to support the identification of potential new sites for activities such as aquaculture operations

• Assessing long term stress on sensitive coastal ecosystems (eg coral reefs, mangroves, sea grass beds , coastal wetlands etc)

The primary benefits reported are lower cost and increased spatial coverage for collecting water quality information. In cases where organisations also conduct dedicated in-situ measurement campaigns, the small additional cost of the satellite derived information results in several benefits:

• increased confidence in the data collected by the in-situ measurements

• an understanding of the context of the conventional measurements (e.g. the degree to which the sampled point is representative of the area of interest)

• the capability to extrapolate the limited duration in-situ measurement to monthly, seasonal or annual intervals.

In addition the satellite derived information provide a homogeneous baseline against which different measurements in different locations can be related to each other

The Contribution of the Sentinel Missions Sentinel-3 data will ensure long term continuity of the high quality data originally provided by the MERIS and AATSR instruments on board ENVISAT. Other lower quality systems have been available to cover the gap in data from 2012 to 2014 between the ENVISAT and Sentinel 3 missions and these, if properly combined with historic ENVISAT data can ensure consistent (but slightly lower resolution) time series of coastal water quality parameters.

References:

ESA 2013, Earth Observation for Green Growth: An overview of European and Canadian Industrial Capability

Products

Products	Ext. Source	Descriptions	Product Standards	Ref. Project
harmful algal bloom (HAB)	Asimuth	• forecasting capabilities to warn of impending harmful algal blooms in western Europe through the development and implementation of physical – biological mathematical models • the present (H) AB detection services that exist in Europe are based on daily satellite-derived chlorophyll-a imagery, possibly supplemented with information from in situ measurements.		ASIMUTH
high biomass blooms		coastal Biomass (monitoring and prediction of high biomass blooms in coastal waters along Europe´s Northern and Baltic shores)		CoBIOS

Success Stories

References

Topic	Description	Keywords	Reference

References